# TIERRA Y AGUA (SOIL AND WATER)

A Study of the Ecological Factors
in the
Development of Meso-American Civilizations

By

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The civilization of a race is simply the sum-total of its achievement in adjusting itself to its environment.

- Hu Shih.

TABLE OF CONTENTS


LIST OF MAPS AND PLANS vii-viii

INTRODUCTION ix-xvii

BASIC GEOGRAPHY OF MESO-AMERICA 1- 37
1. Geology and Topography . . . . . 1
2. Climate . . . . . 4
3. River Systems . . . . . 17
4. Soils . . . . . 19
5. Summary . . . . . 36

EL LAGO Y EL VOLCAN - THE CHINAMPAN 38-100
1. Natural Setting . . . . . 38
2. San Gregorio Atlapulco
a. Introduction . . . . . 43
b. Agriculture in the Chinampa Area . . . . . 48
c. Temporal Cultivation at San Gregorio
1. Canada Cultivation . . . . . 51
2. Loma Cultivation . . . . . 55
3. Maguey Cultivation . . . . . 60
4. Ejido Cultivation . . . . . 63
5. Solar Cultivation . . . . . 66
d. Chinampa Cultivation
1. General Description . . . . . 70
2. Chinampa Distribution and Manufacture . . . 72
3. Chinampa Crops . . . . . 77
4. Irrigation at San Gregorio . . . . . 78
5. Maize Cultivation . . . . . 80
6. Soil Fertility . . . . . 85
7. Plant Care . . . . . 92
3. Demography and Settlement Patterns . . . . . 93

BARRANCAS AND MANANTIALES - THE VALLEY OF TEOTIHUACAN 101-160
1. The Natural Setting . . . . . 101
2. Agriculture
a. Introduction . . . . . 109
b. Irrigation Technology . . . . . 112
c. Agricultural Technology . . . . . 122
1. Maize Cultivation . . . . . 123
2. Cultivation of Other Crops . . . . . 127
3. Soil Fertility . . . . . 128
d. Village and Family Economy
1. Middle Valley - Humedad Area . . . . . 130
2. Middle Valley - Temporal Area . . . . . 137
3. Lower Valley - Permanent Irrigation Area . . 141
3. Demographic History of the Teotihuacan Valley . . 148
4. Community Settlement Patterns . . . . . 151
5. Zonal Settlement Patterns . . . . . 155

Pages

EL RIO - THE CHONTALPA 161-213
1. Ecological Background . . . . . 161
2. Agriculture in the Chontalpa
a. Introduction . . . . . 169
b. Maize Cultivation . . . . . 172
c. Other Annual Crops . . . . . 187
d. Perennial Crops . . . . . 191
3. Demography . . . . . 200
4. Zonal Settlement Patterns . . . . . 204
5. Community Settlement Patterns . . . . . 210

CENOTES AND PEDREGALES - NORTHERN YUCATAN 214-274
1. General Description . . . . . 214
2. Yucatecan Agriculture . . . . . 217
a. Seasonal Round . . . . . 218
b. Economic Aspects of Maize Cultivation . . . . 221
3. Agriculture in Kantunil Kin
a. Introduction . . . . . 229
b. Milpa Agriculture . . . . . 231
4. Demography and Settlement Patterns
a. Introduction . . . . . 242
b. Izamal-Acanceh . . . . . 247
c. Valladolid . . . . . 251
d. Ticul . . . . . 257
e. Northern Quintana Roo . . . . . 261
f. Community Settlement Patterns . . . . . 266
g. A Trip Through Northern Yucatan . . . . . 269

MODERN ECOLOGY AND ECONOMY OF MESO-AMERICA 275-337
1. Ecological Types . . . . . 275
2. Agriculture in Meso-America Today
a. Technology . . . . . 285
b. Techniques
1. Soil Conservation . . . . . 287
2. Humidity Conservation . . . . . 296
3. Miscellaneous Techniques . . . . . 302
c. Economy of Maize Cultivation in Modern Meso-America . . . . . 303
1. Highland Economy - The Teotihuacan Valley and the Chinampa Area . . . . . 304
2. Lowland Economy
a. Huimanguillo . . . . . 310
b. Northern Yucatan . . . . . 316
3. Comparative Data from Other Areas . . . . . 317
4. Double Cropping . . . . . 332
5. Crop Variety . . . . . 334
6. Percentage of Land Use . . . . . 335

ANCIENT AGRICULTURE IN MESO-AMERICA 338-356

Pages

MODERN AND ANCIENT SETTLEMENT PATTERNS AND DEMOGRAPHY IN MESO-AMERICA 357-408

1. Settlement Patterns in Modern Meso-America . . . 357
   a. The Valley of Mexico . . . . . 357
   b. The Chontalpa . . . . . 360
   c. Yucatan . . . . . 361
   d. The Papantla Area . . . . . 362
   e. Highland Michoacan . . . . . 364
   f. Highland Guatemala . . . . . 366
2. Ancient Lowland Settlement Patterns . . . . . 370
3. Ancient Settlement Patterns in the Mesa Central . 384
4. Demography and Zonal Settlement Patterns in Modern Meso-America . . . . 395
5. The Demographic History of the Meseta Central in the Sixteenth Century . . 399
6. The Sixteenth Century Demographic History of the East Coast . . . . 405

MARKETS AND SPECIALIZATION IN MODERN MESO-AMERICA 409-414

CONCLUSIONS 415-575

1. Introduction . . . . . 415
2. Origins . . . . . 417
3. The Highland Pattern . . . . . 423
   a. The Mesa Central . . . . . 425
   b. Oaxacan-Guatemala Highlands . . . . . 450
   c. The Barbarian Frontier . . . . . 453
4. The Lowland Ecological Pattern . . . . . 456
5. The Origin of Urban Society - A Comparative Study
   a. Introduction . . . . . 498
   b. The Americas . . . . . 501
   c. The Nuclear Region of the Old World . . . . . 521
   d. India and Further India . . . . . 534
   e. Negro Africa . . . . . 545
   f. China . . . . . 564
   g. Summary . . . . . 574

APPENDIX - ECOLOGICAL AREAS OF MESO-AMERICA 576-670

BIBLIOGRAPHY 671-683

# INTRODUCTION

Approximately 2000 B.C., plus or minus some five hundred years, somebody, somewhere in the area we call Meso-America, stumbled upon one of the greatest discoveries in the history of Man - that of the domestication of maize. From this date agricultural society began in Meso-America and from this root developed the elaborate Hieratic Civilization which gives Meso-America its peculiar flavor. For some fifty years we have tried to unravel the threads of historical development of this great civilization. To do this we have traced the origin of its more elaborate aspects and have failed to place emphasis on the character of the agricultural base which produced and supported it. Some of the answers to the origin and development of the more glamorous aspects of this civilization lie in this peasant base, and my paper is an attempt to point out these solutions.

Meso-America is one of the most extraordinary areas of the world from the purely geographical standpoint. No area of comparable size has such a complex internal micro-geography. In forty-eight hours the author, travelling in Meso-America, has gone from the arctic to the tropical; has travelled through deserts, lush rain forests, savannahs, high steppes, boreal forests, mountains and valleys and sea shore plains.

This extraordinary complexity, in itself, provided one of the bases for the wealth and richness of the Meso-American tradition, and the Meso-American cultivator set out, armed with a digging stick, to conquer this amazing area. This paper is an essay on how he did this, and what happened to him and the culture he erected.

It has become axiomatic in anthropology that the more primitive a given technology the more powerful an influence environment exerts over not only the economy but social organization and religion of a culture. This is especially true of Hunting and Gathering cultures, less so for agriculturally based ones. However in the case of Meso-America we are dealing with a curious combination of an enormously complex urban society based upon as primitive an agricultural technology as can be found anywhere in the world. Furthermore, transport, with the exception of local use of simple boats, was entirely dependent upon human backs. This situation I think results in bringing into sharper focus the role of ecology in conditioning a culture.

The first obvious steps in a formulation of this kind is the definition of those environmental factors which might have conditioned the way in which the Meso-American farmer adjusted himself to the landscape, and second to define what I am calling in this study Ecological Areas which are areas of a uniformly similar combination of significant geographical traits. Significant environmental factors selected are topography, altitude, soils, hydrography, and climate, and in the following geographical introduction each is assessed for Meso-America as a whole. The Appendix contains my division of Meso-America into its component Ecological Areas. The sources for these data are of several types. A number of good geographies of Mexico have been published, of which Tamayo's is by far the best, although Vivo has made valuable contributions. Neither, however, gives the detailed climatological and topographical data needed in a study of this type, and for this I relied heavily on Secretaria de Agricultura files and published contour maps. A third source was personal

observations made over a period of four years wandering around Central and Southern Mexico.

The major defect in this geographic groundwork is in my summary treatment of Guatemala. I have never visited Guatemala and therefore have not had access to government files nor have recorded personal observations. Published studies such as that by McBryde are of great value but only deal with a fraction of the total area.[1]

After defining the Ecological Areas and broader Ecological Patterns I have attacked the problem using a basic anthropological approach: the ethno-historic, working backward from the present. Obviously Meso-America could not be studied personally as a whole; this is a future job of gigantic proportions. The only way of working out the basic relationships of geography and culture was to utilize data already published and to make test studies of my own. I selected four test areas which I think filled the most urgent gaps in our regional studies of modern peasant societies. The Valley of Teotihuacan and the Chinampan provide good test studies of the Meseta Central in both its unfavorable and favorable aspects as ecological types.

In the case of the Valley of Teotihuacan my work was greatly facilitated by the fact that Manuel Gamio and co-workers had already done a magnificent three-volume study of the same area in the early decades of the present century. In this study he reached a level of method and synthesis which, in my opinion, has never been approached in later anthropological studies in Meso-America. All the anthropo-

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1. McBryde, 1943.

logical tools known for his time were utilized; geographical research, documentary studies, archaeological field work, ethnographic studies, and physical anthropological research were all carried out in a truly "conjunctive approach".[2] My own study has as its main value the fact that it brings Gamio's work up to date, and I was able to collect more data on crop production (mainly because of the favorable impression that the Instituto de Antropologia has had on the present rural population.

Armillas and West had already published a study of the history and technology of chinampa agriculture[3] so my main emphasis was on production and other economic aspects of the system.

The Chontalpa study is a good type study for the flood water alluvial plain type of the tropical lowlands. In the study of Yucatan I utilized heavily Steggarda's data plus some of my own work from the frontier region of Quintana Roo.[4] Of published sources heavily used, Kelly and Palerm offer a first-class study of rolling lateritic Gulf Coast Plain regions with slash and burn agriculture;[5] Sol Tax a superb study of a Guatemala Highland community, Panajachel;[6] and Lewis another first-class study of rugged sub-humid escarpment country.[7]

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2. Gamio, 1922.
3. Armillas and West, 1950.
4. Steggarda, 1941.
5. Kelly and Palerm, 1950.
6. Sol Tax, 1953.
7. Lewis, 1951.

A number of minor sources have been used and are listed in the bibliography.

Each of my individual studies, of which there are four, follow a standard format, which includes a detailed study of local geography, agricultural techniques and economy, and what to me is simply the statistical method of assessing human ecology - demography and settlement patterns. To a real extent demography is a measure of the success to which a people have manipulated and adjusted themselves to their landscape; settlement patterns are, in effect, human ecology and in a very definite way determine the character of, intensity of and direction of human relations. In other words without overworking the point, I am convinced of the strong functionalistic relation between geography-agricultural system-settlement pattern-human relations.

How much of our data from modern village and regional studies is pertinent to Conquest and Pre-Conquest periods is of course one of the major problems treated here in this study, and the reader will have to judge the applicability himself. In the case of the tropical lowland communities the data are undoubtedly pertinent although certainly the introduction of the steel machete has revolutionized certain aspects of slash and burn cultivation. In the case of Highland hoe cultivators I think the data are almost certainly good for the Conquest period and this would of course include Chinampa cultivation. The introduction of the plow in some areas may be a significant change. In the sphere of settlement patterns there is a definite functional relationship between settlement types today and ecological systems, and I think the data in a broad sense can be utilized for interpretation of Pre-Hispanic settlement patterns.

Following the four type studies I have attempted to summarize and present comparative data on the major themes discussed for Meso-America as a whole today. Aside from anthropological sources I have used a series of official Mexican agronomic reports and regional studies to fill out the picture.

The following studies deal mainly with a projection of data backward, and here again my sources are varied. They can broadly be divided up into two types: ethno-historic and archaeological.

The bulk of my data on Aztec and Maya society - its economic structure and urban character - is derived from an earlier Honors Thesis written in 1949 entitled "The Urban Revolution in Ancient Mexico", plus considerable new data and revision. The sources are standard published sixteenth century Spanish, Indian and Mestizo writers such as Sahagun, Motolinia, Zurita, Pomar, Cortez, Bernal Diaz, Anonymous Conqueror, Lopez de Gomara, Peter Martyr, Cogulludo, Landa, Chi, Clavijero, Torquemada, Salazar, Hernandez, Ixtlilxochitl, Duran, and Tezozomoc (see Bibliography).

During the sixteenth century the Spanish government undertook an economic and demographic survey of the American colonies and we have a tremendous mass of data parallel with our official government reports of modern times. Foremost in the published material are the Papeles de Nueva Espana, Epistolario de la Nueva Espana, Codice Franciscano, Arzobispado de Mexico, and Suma de Visitas (see Bibliography). They offer crucial data on population, local specialization, agricultural crop zoning, distribution of irrigation (from which Palerm wrote an excellent summary) and settlement patterns. Most of these reports were written between 1540 and 1580 and are closely

applicable to the immediate Conquest period. Of great importance in my assessment of the significance of intensive agriculture in the Valley of Mexico was the archival discovery (combined with ground archaeological reconnaissance and aerophotostudy) of two maps of the Chinampa area, dating from the sixteenth and seventeenth centuries.

The demographic data from this period are of special importance in terms of their indirect bearing on the intensity of cultivation techniques and on settlement patterns.

Many of the problems and points stressed in this paper have never been tested archaeologically; some would be very difficult to do so. In recent years a number of settlement pattern studies have been made in Meso-America and we have an excellent beginning although that is all it is. Among them are Willey's studies in British Honduras, the Mayapan project carried out by Carnegie and my study of Tancah and other Quintana Roo sites along with Armillas and my studies in the Chontalpa - all studies from the Maya Lowlands. Armillas has collected considerable data on Teotihuacan, mostly unpublished, and I did a surface study of Xochicalco. This, along with Armillas, Palerm and Wolfe's studies of archaeological irrigation systems, just about summarizes our ground work in this highly important sphere of archaeological fieldwork.

The short section on modern trade and village specialization is based mainly on McBryde and Tax's studies in Highland Guatemala with minor data from other sources. I have summarized in full here because the data are extremely important for my final conceptualization of the problems.

The preparation for this thesis has been spread over some seven

years of research, of which four years were spent in Mexico and three in library research at home. The below listing summarizes the amount and type of preparation over this seven-year period.

1948-1949 - At Harvard University approximately nine months were spent in intensive study of published documentary sources on Aztec ethnography, the results of which are summarized in an Honors Thesis carrying the title of "The Urban Revolution in Central Mexico".

1951 - The entire year was spent in Mexico in which I concentrated on general geographical, ecological and documentary studies of both published and unpublished material. A considerable part of this time was spent in travelling to familiarize myself with the central part of the republic (Meseta Central, Vera Cruz, Oaxaca and Guerrero). Also six weeks were spent with the Instituto de Antropologia doing settlement pattern work at Xochicalco.

1953 - During the first four months of the year I acted as field assistant to Pedro Armillas for the New World Archaeological Foundation. We did a survey of the middle Grijalva River Basin and settlement patterns and chronological testing at a number of sites and collected data on modern agriculture, settlement patterns and demography.

The rest of the year was spent in the Valley of Mexico working on the Chinampa area. This included research in the modern communities of San Pedro Tlahuac and San Gregorio Atlapulco, and documentary research in the Archivo General de la Nacion.

1954-1955 - These two years were spent as Research Fellow for Carnegie Institution carrying on archaeological work in Quintana Roo. One month in 1954 was spent in the Chontalpa in Tabasco completing my

study of that area (modern ecology) and one month in 1955 in the Teotihuacan Valley studying modern ecology. The archaeological field work in Yucatan was mainly directed toward chronological problems but settlement pattern surveying and excavation was carried out at both Tulum and Tancah.

The final year, 1956, was devoted to the actual writing of the thesis plus library research, mainly to assemble comparative data.

Basic Geography of Meso-America

Geology and Topography

Although Meso-Amorica is climatically complex the basic physiographic land forms are relatively simple, and in the Mexican portion at least are simply extensions of physiographic provinces of the United States. Starting from the west we have first the Pacific Coast, a narrow, often hilly coastal plain, in places interrupted by mountains which reach the sea in steep cliffs and which is a projection southward of the Californian Pacific Coast. East of this in California is the Sierra Costa or coastal range which extends southward through the Peninsula of Baja California, then submerges to reappear in Guerrero as the Sierra Madre del Sur which runs through Guerrero and Oaxaca and finally breaks down at the Isthmus of Tehuantepec. Just north and east of this belt and paralleling it is a deep depression which includes the Gulf of California and the Balsas Basin, the latter a deep trough-like river valley separating the Sierra Madre del Sur from Sierra Volcanica Transversal. Following this depression and again paralleling it to the north and east is a projection southward of the Rocky Mountains called in Mexico the Sierra Madre Occidental which, before the volcanic upheavals which produced the Sierra Volcanica, evidently ended in Jalisco. Today it is connected by the latter in the south to the Sierra Madre Oriental, a parallel range to the east which originates in the hills and plateaus of the Ozarks, gradually increasing in grandeur until it is climaxed in the peak of Orizaba, the highest peak in Meso-America. Delimited to the east by the Sierra Madre Oriental, to the west by the Sierra Madre Occidental and to the south by the string of volcanoes known as the Sierra Volcanica Transversal

is a vast flat elevated plateau known as the Altiplanicie Mexicana or more commonly the Meseta Central. It has the form of a great triangle with its apex to the south and gradually increasing in altitude from north to south until it reaches its maximum in the Valleys of Mexico, Puebla and Toluca.

All three of the major mountain ranges, the Sierra Madre del Sur, the Sierra Madre Occidental and Oriental, join down in eastern Oaxaca to form a tangled mass of mountains which finally ends at the Isthmus of Tehuantepec in low foothills.

The mountain system of Guatemala is evidently of independent origin and is part of the West Indian system.

North and East of these mountain masses is our final physiographic province, that of the Gulf Coast Plain and the Peninsula of Yucatan.

Topography and altitude have had extremely important effects in the ecology of Man in Meso-America. The Meseta Central with its great open plains, in the southern portion at least, has provided modern Mexico with its greatest expanse of grain raising lands and might well be labelled the Mexican Maize Belt. The broken, tangled ranges of Oaxaca and Guatemala are areas of small, very fertile valleys dominated by great mountain masses. The valleys themselves are often extremely densely populated. The Coastal Plains except for the problem of dense tropical vegetation and excessive rainfall offer great possibilities once the problem of agriculture in the tropics is resolved.

Altitude more than topography is one of the key factors which have produced the extraordinary geographical complexity of Meso-America. Altitudes range from sea level to over 5000 meters above

sea level in the peaks of the volcanoes of Orizaba, Popocatepetl and Iztaccihuatl. On the tops of these peaks are permanent snow fields; just below them climates of the boreal type; below 2800 meters we have mixed forests and high steppes; below 1600 meters climates where the temperature never drops below freezing, and below 800 meters we are in a belt of tropical climates and tropical agriculture.

The thermal cycle in Meso-America depends almost entirely upon altitude, latitude playing in general a minor role. With the enormous range in altitude we have important differences in annual temperatures in sub-areas and hence zoning of natural and artificial vegetation.

## Climate

It is customary in speaking of climatic zones in Meso-America to refer to three basic divisions which are called "Tierra Caliente" or Hot Country, "Tierra Templada" or Temperate Country and "Tierra Fria" or Cold Country. There is some disagreement as to where the borders lie between the three divisions and in this thesis I adopt the following commonly used system in Mexico. The Tierra Caliente is here defined as all land lying below 800 meters above sea level. The mean annual temperature varies of course within the altitudinal range but variation from station to station at the same elevation is slight. For example the annual means of the following stations, all less than 100 meters above sea level, are as follows: Campeche 25.7°, Tonala 27.7°, Acapulco 27.1°, Salina Cruz 26.6°, Vera Cruz 24.8°, Minatitlan 26.2°, Tenosique 27.1°. All figures are in Centigrade. The stations are from both the Pacific and Gulf coasts. The hottest part of Meso-America is the canyon-like Balsas Valley where annual temperatures often are above 28° Centigrade. In general the annual

average is slightly higher on the Pacific Coast than on the Gulf Coast. Up around 600-800 meters the annual temperature drops off to 23.2° at Cintalapa, 24.4° at Tuxtla Gutierrez, 24.5° at Cuicatlan; Chicontepec records 21.5°.

The Tierra Caliente is the center of such agricultural produce as cacao, bananas, sugar cane, tobacco, cotton and is especially important in cattle raising.

The Tierra Templada lies between 800-1600 meters above sea level. The climate is noticeably cooler, but is still below the level of annual frosts and many of the tropical lowland crops yield well in this temperature zone. It is a zone of specialized coffee and citrus fruit production. Sample stations situated about the middle level of Tierra Templada (1000-1400 meters) record the following annual temperatures: Coatepec 19.0°, Orizaba 18.4°, Cuautla 22.2°, Ejutla 21.7°.

The Tierra Fria we may consider as occupying the 1600-2800-meter zone. It is mainly a grain producing area, wheat, barley, and especially maize. Above 2800 meters we find little settlement in Meso-America, especially agricultural settlement. Evidently this is the upper limit for maize. There is also an important difference between those municipios lying in the 1600-2000-meter belt and those lying above 2000 meters. Above 2000 meters the winters are characterized by severe frosts, and this is the major problem confronting the farmer. In the 1600-2000-meter zone frosts rarely damage the summer crops, but winter cropping is difficult to carry out successfully. The following stations running between 2000-2400 meters give an idea of annual temperature means: Actopan 16.3°, Las Casas 14.5°,

Tacubaya (Mexico City) 14.7°, Texcoco 16.1°, Patzcuaro 16.0°, Tlaxiaco 16.7°. The highest station for which I have data is Apipasco in Morelos, 2700 meters, where the annual temperature drops to 9.6°.

The second factor in determining the complex micro-geography is precipitation. The variation in annual rainfall is enormous and we have all types of world climates ranging from deserts to dense tropical forests and with all intermediate stages. The amount of precipitation which falls at any one point depends on a number of factors: the altitude, the direction of the prevailing winds, and finally the degree to which the topography shelters or exposes it.

Vivo summarizes the basic character and pattern of Meso-American rainfall in the following paragraph:

"During the month of January, the air masses from the Atlantic Ocean and, as a result, the winds from the east, which are trade winds only penetrate in the eastern region as far as 100 degrees of west longitude, while the masses of air from the high atmosphere, and in some cases from the Pacific Ocean, and as a consequence, the west winds, which are anti-trades, invade the rest of the national territory.

"And during the month of July on the contrary, the masses of air from the Atlantic Ocean and, in consequence, the east winds, which are trade winds transformed to monsoon, penetrate all of the national territory as far as the Sierra Madre Oriental, while the masses of the high atmosphere and of the Pacific Ocean, and consequently the west winds only occupy the northwestern regions of Mexico situated west of the Sierra Madre Occidental and the southernmost regions of

the country.

"This contrast between the invasion of masses of dry air in winter and humid air in summer influences decisively the humidity, rainfall and cloudiness."[1]

As a consequence of this situation we find universally in Meso-America a division of the precipitation cycle into a "Rainy Season" and a "Dry Season". On the east coast the dry season is often characterized by fairly regular and abundant showers allowing winter crops, but even here I know of no station in which the rainy season or summer season does not receive at least 3 times as much rain as the dry season and it is usually as high as 5-6 times. Outside of the east coast plain the dry season is characteristically a true drought period and agriculture without irrigation is impossible. One exception is the Pacific Coast of Guatemala and part of neighboring Chiapas where double cropping is also possible.

In the Meseta Central the first showers begin in May, in normal years June is a rainy month and the maximum occurs in July and August. September and October witness a tapering off and from November to March little rain falls. In some years rains may delay until the end of June and disaster may follow for the cultivator, as areas above 2000 meters suffer at times from early fall frosts. A late sowing may then be killed off by these premature frosts. Rainfall over the southern part of the Meseta Central (that part which lies within Meso-America) varies from 300 mms in the north to 1200 mms in the southern Valley of Mexico but in general runs between 500-900 mms.

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1. Vivo, 1949, p. 65.

If the rains begin on time this is adequate for good crops; the central problem is timing, not quantity except in those areas which receive below 500 mms as in most of the state of Hidalgo and eastern Puebla.

Over most of the lower mountain region of Guerrero, Oaxaca or the Sierra Madre del Sur physiographic province the rainfall closely parallels the pattern in the Meseta Central in quantity and cycle. There are, however, three modifying factors: (a) Most population units are at a lower altitude than in the Meseta and therefore the annual temperatures are higher and rainfall effectivity less - the same amount of rainfall in Oaxaca will result in a drier climate; (b) Frosts are a less frequent menace except in the Mixteca Alta and therefore crops may be sown later when the rainy season is under way in cases of retarded seasons; and (3) Rainfall is more irregular and annual rainfall variation greater.

In the Balsas Depression rainfall drops below that needed for effective agriculture and this is one of the driest areas in Meso-America.

The Pacific Coast, although as a whole it receives more rainfall than the Sierra Madre del Sur and Meseta Central, is characteristically much hotter and evaporation much more intense. Furthermore rainfall although on the average fairly high is exceedingly erratic and varies enormously from year to year. We can get a good idea of the overall pattern of rainfall along this stretch of coast if we give rainfall data by individual station proceeding from north to south.

Colima receives 877 mms of rain; Coalcoman in Michoacan 939 mms; La Union in Guerrero 1122; Atoyac and Acapulco 1250 and 1504, both

also in Guerrero. San Marcos further south in Guerrero 1078 mms; Pinotepa Nacional in Oaxaca records 1300 mms; at Juquila the figure jumps up to 2000 mms but drops to 1016 mms at Puerto Angel just southeast and finally drops to but 848 mms at Pochutla. At Salina Cruz in eastern Oaxaca it increases to 1040, Tonala in Chiapas records 1628 and at Tapachula near the Chiapas-Guatemala border we find the highest figure for the entire Pacific Coast, 2490 mms. Further east in Guatemala it drops off again to 1885 mms at Caballo Blanco and further reduces to 1685 mms in Rio Seco. Further east I have no data.

Except for the stretch from Tonala east most of the Pacific coast receives less rain than it needs for efficient agriculture, especially when we consider that the stations are also erratic.

The neighboring escarpment just behind the Pacific coast invariably receives more rain than the coast just adjacent to it; this is especially true in Guatemala, Chiapas and Oaxaca, and these escarpments are important coffee producing zones today.

The Highland Valleys of Guatemala in general receive more rain than the Highlands of Mexico; Guatemala City for example receives double the amount of rainfall which falls in Mexico City. Some of the higher valleys in Guatemala such as the Valleys of Huehuetenango and Quetzaltenango have precipitation cycles similar to those of the Meseta Central.

The East Coast and neighboring escarpment receives more rain than any other area in Meso-America. Within the generally humid coast plain we find three areas where rainfall falls below 1000 mms and conditions similar to those of the Pacific coast are met. One of these is the entire Lowland Huasteca from Tuxpan to Tampico although

a few stations within this huge area may record as high as 1200 mms. A second drier area is the coastal plain of Central Vera Cruz. Finally the northern part of the Peninsula of Yucatan represents a third sub-humid region. At Progreso and for a short distance inland we find a real coastal hot steppe climate.

To illustrate this overall pattern I will present a list of stations from the east coast running from north to south. Panuco on the Tamaulipas-Vera Cruz border receives 900 mms of rain, Ozuluama in Vera Cruz 1260 mms, and Tuxpan on the border between the Huasteca and Totonacapan receives 1380 mms. In the northern Totonacapan, Papantla receives 1400 mms of rain and Misantla on the rainy side of the Sierra de Chiconquiaco receives 2263 mms.

The Sierra de Chiconquiaco is a lateral spur of the Sierra Madre Oriental and acts as a rain shadow agent for the Central Vera Cruz Coast Plain just south of it. Stations from this sub-humid area range in rainfall from 674-1200 mms. Further south in the Papaloapan basin Alvarado receives 2315 mms and in the Tuxtla area rainfall increases to about 2 meters. To the south of Los Tuxtlas at Coatzacoalcos we get a maximum reading for strictly coastal stations with nearly three meters of annual rainfall. Most of the Tabasco plain receives about two meters of rain and this whole region from Santiago Tuxtla to Ciudad del Carmen in Campeche is the wettest large area of coastal plain in Meso-America. At the base, the Yucatan Peninsula evidently receives between 1400-1800 mms of rain a year. As you go north rainfall decreases and most of the Peninsula receives between 1000-1200 mms of rain. In the far north this drops off to below 1000 mms around Merida and finally decreases to 472 mms at Progreso.

As in the Pacific Coast the neighboring escarpment receives even more rain. The altitude of maximal rainfall varies from section to section of the coast - in Central Vera Cruz it occurs in the coffee belt between 1200-1600 meters above sea level, in Tabasco and Chiapas it falls at a lower altitude between 50-400 meters.

Along with the heavier rainfall the cycle on the east coast varies from the pattern in the Highlands. Rains often in coast stations do not begin until June and really don't get under way until July. Maximal rainfall occurs in August and September and in many stations October also is a month of heavy rain. In the three mentioned sub-humid regions rainfall tapers off sharply after September and little rain falls between November and May. In the wetter areas we have continuing, light, spaced showers through as late as March. April and May even in the wettest regions are drought months. On the coast when the rains get under way from July to September instead of the thundershower we often get a steady drizzle which may last for several days.

At present climatologists use two systems for world climatic classification. One is called the Koppen system, the other the Thornthwaite. Blair describes the two systems as follows:

"Koppen's five major climatic groups are:

"(A) Tropical rainy climates. No cool season; mean temperature of coldest month above 64.4° F. (18° C.).

"(B) Dry climates. Arid or semiarid; evaporation exceeds precipitation. The limits of the dry climates are determined not by the total annual precipitation, but by the amount of rainfall in relation to the temperature and to the season in which the rain

falls, since both temperature and the seasonal distribution of rain influence the soil moisture available to plants.

"(C) Humid mesothermal, or rainy climates with mild winters; coldest month less than 64.4° F. but warmer than 26.6° F. (-3° C.); warmest month above 50° F. (10° C.); short winters, but the ground may be frozen or snow-covered for a month or more.

"(D) Humid microthermal, or rainy climates with severe winters. Warmest month above 50° F.; coldest month below 26.6° F.; long winter; ground frozen for several months; much of winter precipitation in form of snow.

"(E) Polar climates. No warm season; mean temperature of warmest month less than 50° F.

"These five large divisions are subdivided into a large number of climatic types in accordance with temperature differences and variations in the amount and distribution of precipitation.

"The A climates

"Koppen divides A climates into the following types:

"Af - Tropical rainforest climate with all months wet, having at least 2.4 inches of rain each month.

"Am - Tropical rainforest climate with a short dry season under monsoon influence, but soil moisture remains adequate to maintain a dense forest.

"Aw - Tropical savanna climate with a distinct dry season.

"These types are further subdivided by adding a third or fourth letter to indicate differences in seasonal distribution of precipitation, range of temperature, and time of occurrence of maximum temperature.

"The B climates

"Two main subdivisions of the dry climates are made:

"BW - Arid climate; desert.

"BS - Semiarid climate; steppe.

"A small letter is added to these types to indicate differences in mean annual temperature, in the temperature of the coldest month, and in the time of least rainfall. The dividing line between BW and BS climates is determined by formulae which take account not only of the average annual rainfall, but also of its distribution through the year and of the average annual temperature.

"The C climates

"The warm rainy climates have these principal subdivisions:

"Cf - No distinct dry season.

"Cs - Summer is a dry season, and the driest month receives less than 1.2 inches (3 cm.) of rain. Winter is the wet season, and the wettest month has at least three times as much rain as the driest month. This is often called the Mediterranean climate.

"Cw - Winter is the dry season. The wettest summer month has at least ten times as much rain as the driest winter month.

"Differences of temperature and of time of occurrence of rain are indicated by adding a third letter.

"The D climates

"The cold humid climates are divided into Df, Ds, and Dw types, the added letters having the same significance as in the C climates; further subdivisions are made on the same basis as in the C climates.

"The E climates

"The polar climates have only two subdivisions:

"ET - Tundra; warmest month below 50° F. but above 32° F. (0° C.); a brief growing season for hardy, lowly plants.

"EF - Ice cap; perpetual frost; warmest month averages colder than 32° F.

"Thirteen major types of climate are thus obtained, each designated by two letters, and four or five times as many minor types are obtained by adding a third and sometimes a fourth letter.

"Thornthwaite's Classification

"A classification of the world's climates has been made by C. W. Thornthwaite based upon the following climatic elements:

"1. The effectiveness of the precipitation as determined by the ratio of the rainfall to the evaporation.

"2. The temperature efficiency obtained by dividing the mean monthly temperatures by the evaporation.

"3. The seasonal distribution of precipitation.

"Thornthwaite recognizes five rainfall types as follows: A - wet, rainforest; B - humid, forest; C - subhumid, grassland; D - semiarid, steppe; E - arid, desert. There are six temperature efficiency types: A' - tropical; B' - mesothermal; C' - microthermal; D' - taiga; E' - tundra; F' - perpetual frost. Four types of seasonal distribution of rainfall are used: r, rainfall abundant at all seasons; s, rainfall scanty in summer; w, rainfall scanty in winter; d, rainfall scanty at all seasons. Thornthwaite recognizes thirty-two types of climate, most of which are designated by a combination of three letters, one from each of the three elements just named. Actual evaporation observations that are comparable with one another are not widely available, and the values used in determining rainfall

effectiveness and temperature efficiency must therefore be estimated from tables of temperature, humidity, and wind movement."[2]

The Koppen system when applied to Meso-America offers some interesting general patterns and captures some but not all of the essential ecological differences between Meso-American sub-areas.

Koppen's climatic class A corresponds exactly with our Tierra Caliente with very few exceptions. Only the northwest of Yucatan, the center of the drought area of Central Vera Cruz, and parts of the Balsas-Tepalcatepec basin are too dry to fit in this category.

Within this A area it is of great interest and significance that the bulk of the Tierra Caliente fits into the Aw climatic classification or the drier of the three types and with the marked dry season. All of the Tierra Caliente of the Pacific side, and most of the Gulf Coast Plain along with nearly all of the Yucatan Peninsula falls within the Aw climatic type. Am climates are found along the lower escarpment of the Sierra Madre Oriental, occupying a narrow band running just about the whole length of the states of Vera Cruz and Tabasco and undoubtedly running on east to include the Peten. This climatic type is also characteristic of the lower escarpment of the Guatemala Pacific Coast and the lower Motagua, and of the San Martin range.

Af climates are very rare in Meso-America. Some areas such as the Peten have been labelled Af by some sources (Vivo[3]) but Lundell's climatic data do not bear this out.[4]

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2. Blair, 1942, pp. 123-5.

3. Vivo, 1949.

4. Lundell, 1937.

True B climates are rare in Meso-America. Their definition is of significance as these are areas where maize cultivation cannot be carried out without irrigation. The main area of B climate is a continuous zone which includes most of the state of Hidalgo, runs on to form a narrow rain shadow corridor in eastern Puebla, continues on into Oaxaca to include the Upper Papaloapan basin, some of the higher mesetas in Oaxaca such as Nochistlan and finally includes the central Valley of Oaxaca.

Smaller secondary areas include the lower Balsas depression, and the Middle Motagua Valley in Guatemala. A final small area is around Progreso in northern Yucatan and part of Central Vera Cruz Tierra Caliente. B climates range through all altitudes in Meso-America and cover a small total area.

Most of the Tierra Templada-Tierra Fria of Meso-America, in other words the Highlands, fall in a single one of Koppen's climatic types, the Cw. There are a few areas of Cf but these are mainly above the limit of agricultural occupation on the upper ranges.

D and E climates occur only as ecological curiosities and are above the level of human habitation, being found on the peaks of the higher mountains.

The Koppen system when applied to a complex region like Meso-America fails to catch some of the often crucial ecological differences between sub-areas but does point out one basic separation, that of the Tropical Lowlands, mainly Aw with some Am climates, from the Highlands with their Cw climate. Furthermore there is an interesting variation in Meso-America in the relationship between vegetation and climatic types, which as we shall see later may have had an

extremely important relationship to the history of ancient utilization of the Tierra Caliente.

If we apply the Thornthwaite system to Meso-America the following pattern may be summarized. Of the 32 types of climate, we find represented in Meso-America ten: DAd, DBw, CAw, CBw, CAr, BAw, BAr, BBw, BBr and AAr. Most of the Tierra Caliente is of the CAw type, with CAr in the Northern Totonacapan. We find a more humid type, BAw and BAr, covering a continuous belt in southern Vera Cruz and the Tabasco Plain. True AA climates are rare, being found only in the foothills of the Sierra Madre Septentrional in Chiapas and in the Maya mountains of British Honduras. Unlike the Koppen system this system enables us to sort out the Northern Totonacapan from the rest of the CA climates.

The bulk of the Highland area of Meso-America, especially the Plateau and Oaxaca Highlands, conform to a single climatic type, CBw. Thornthwaite's system neatly separates out the belt of arid Highlands of Hidalgo, East Puebla and northeastern Oaxaca as this falls into his DBw climatic type. It also clearly defines such humid escarpment areas as the Vera Cruz Tierra Templada-Fria which fall into his BBr type, and the Highlands of Guatemala which are generally BBw.

## River Systems

With the exception of the East Coast Plain true rivers of any size are rare in Meso-America. Even in the case of the East Coast Plain rivers with respectable drainage basins are limited to the southeast. The most important rivers of Meso-America in terms of volume of water are situated there, the Papaloapan and Coatzacoalcos in Vera Cruz (heading in Oaxaca), the Tonala, Grijalva and Usumacinta in Tabasco and Guatemala and the Candelaria in Campeche are

characterized by large drainage basins, abundant but seasonally varying flow of water, swampy deltas and annual flooding with the increase of summer rains. Further northeast the Yucatan Peninsula almost lacks surface drainage, further east than the peninsula on the border of Honduras with Guatemala we encounter a final major system, the Motagua, which is similar to those great rivers of the Gulf Coast. Further north and west from the Papaloapan the Vera Cruz coast is characterized by abundant surface drainage but streams are much smaller in volume, flooding less extensive, and drainage basins more reduced. The Panuco on the northern edge of our studied region is a more extensive system and today drains a huge area of the neighboring highlands including the Valley of Mexico.

Aside from these large East Coast rivers major permanent rivers are rare in Meso-America. One of these, the Balsas, drains an enormous area of interior Mexico and played an extraordinarily important role in Meso-American culture history. The upper tributaries were centers of the development of the most extensive single irrigation systems in Meso-America, especially the Amacusac, the Nejapa and the Atoyac. Armillas has clearly defined the role of this great river system in the economy of ancient Meso-America and it still plays a crucial role in modern Mexican economy. The Balsas receives all-year flow of water but the rainy season volume is many times greater than in the dry season. Today the Balsas is not a permanent stream as most of the dry season flow of water is captured by the irrigation system well up in the tributaries and little water reaches the main stream. During the rainy season, especially in early autumn, the Balsas becomes a raging torrent.

The permanent water flow in the Balsas is in part from the melt water of the snow fields of Popocatepetl and Iztaccihuatl and in part from springs from the Volcanic Ajusco range.

A second major interior drainage system is the Lerma-Santiago, which waters the Toluca Valley, the fertile Bajio and finally enters the Pacific in Nayarit. This is a major system and during the Colonial and Modern periods has been the irrigation source for Mexico's Breadbasket.

On the Pacific Coast there are numerous permanent streams but they are small and of reduced length.

Most of the drainage of Meso-America outside of the East Coast is of the seasonal, arroyo or barranca type. Characteristically these streams are dry most of the year and become torrential, often destructive during the rainy season.

## Soils

One of the least known aspects of Meso-American ecology is that of soils. Very few real soil studies have been made. Mexican geographers in general have established general soil distributions on the basis of climate. As climate seems to be the most important determinant in soil formation the broad outline is undoubtedly correct, yet Meso-America is so complex geographically that we really need a thorough soil survey by small regions to obtain an accurate picture. Before discussing Vivo's analysis of Mexican soil types I will first discuss basic soil types as the data applies to Mexico. I have no data for Guatemala.

Soil formation and origin is due to a number of geographical factors: (a) character of parent rock from which it is weathered; (b) the type of vegetation; (c) the topography; and finally and most

important (d) the climate. In Meso-America two other factors may be of great local significance: (e) volcanism and (f) alluviation.

In humid tropical lowland areas most soils fall into a great class usually termed "Lateritic Soils" or "Tropical Red Earths". These soils are of extreme interest to us as most of the Gulf Coast plain is evidently covered by lateritic soils. Robinson gives a good general statement about the character of these soils:

"Tropical soils often consist almost entirely of the products of chemical weathering, together with a greater or less admixture of unweatherable minerals such as quartz, magnetite, etc. Weatherable minerals such as felspars and ferromagnesian minerals, are, in some cases, almost entirely absent. Such soils, if derived from basic rocks that do not contain quartz, may contain very high proportions of clay, as much as 80% being by no means uncommon.

"Coming now to the actual processes of profile development we have, as in the case of weathering, the effect of the high temperatures, which not only favour plant growth but also those chemical and biological processes whereby plant residues undergo oxidative decomposition. We shall return to this later.

"Of equal importance with temperature in determining the type of profile development in the humid tropics is the character of the rainfall. Equatorial regions have generally high rainfalls, but two peculiarities must be noticed.

"Firstly, the rainfall tends to fall in heavy downpours, exceeding in intensity the heaviest rain encountered in higher latitudes. There are instances of as much as 6 inches of rain falling in an hour. Such intensity of rainfall can cause a strong erosion,

particularly where the natural vegetative cover has been removed as a preliminary to cultivation. This leads to the development of extensive alluvial and colluvial fans in valleys. A further consequence of the prevalence of erosion is the production of truncated or immature profiles. Many of the difficulties which present themselves in the study of tropical soils might be obviated if the part played by erosion were more clearly appreciated.

"Secondly, except in the regions of tropical rain forest, where rainfall prevails throughout the year, there is a general tendency for tropical humid climates to be divided into well marked wet and dry seasons. During the wet season, leaching by percolating waters may occur, resulting in a general impoverishment in bases and the production of acid profiles with consequent instability of the clay complex. The conditions during the dry seasons are totally different. By reason of the high temperature, evaporation is very intense and the soil becomes rapidly dried out to a considerable depth. Such climates are sometimes termed "monsoon" climates.

"The prevailing colour of freely drained tropical soils is red, the actual tinge varying somewhat according to the amount of organic matter present and the mutual effect of the parent material and the pedogenic processes. In basin-shaped areas with impeded drainage, and also where the parent material has a high lime status, dark-coloured or grey soils may result. It may be assumed that both the processes affecting the inorganic weathering complex and the decomposition of plant residues proceed differently according as the soil profile is developed with free or restricted drainage.

"Red soils appear, then, to result under conditions of free

drainage and low lime status. Contrary to the impression produced by their bright red colour, such soils, until they are cultivated, may contain appreciable proportions of organic matter, particularly where the natural vegetation forms a close association such as forest, forest steppe, or savannah.

"Topography has a marked effect on profile development. Whilst upland areas of convex topography are strongly leached and more or less eroded, lowland areas with concave topography are permanently or seasonally wet and carry soils having affinities with the gley soils of temperate climates. This often results in a characteristic pattern in which the elevated areas are occupied by freely drained red soils and the depressions by grey or black soils with impeded drainage.

"Soils subjected to submergence undergo characteristic changes, provided sufficient organic matter be present. Under these conditions, anaerobic decomposition occurs and rapid losses may ensue. There is also an increase in the solubility of the iron, manganese, calcium and magnesium, which are changed to hydrogen carbonates, the iron being in the ferrous state. The reductive processes result in a change from the red colour of well aerated soils to the grey colour associated with bottom soils. Where water movements can occur, the dissolved bases may be lost from the soil with consequent impoverishment."[5]

In James we find an even stronger statement with respect to the quality of lateritic soils which I quote below.

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5. Robinson, 1951, 394-6

"The tropical forest lands are regions of abundant runoff and many rivers. Contrary to popular belief, however, these parts of the world are not covered by extensive swamps. The evaporation is too rapid to permit the presence of standing water at the surface for any long period of time except during heavy rains or in such low-lying places as the river floodplains or the coastal lagoons. The river channels in rainy climates are generally kept open by the constant passage of water. The seasonal variation in the flow of the streams follows the seasonal distribution of rainfall. There is considerably greater seasonal variation in the areas of Aw climate than in those sections which receive heavy rains at all seasons. But even in the Afi climate there is in most cases a marked season of heavier rain and another season of less rain, so that in few instances do streams in this group have what would be classified as a uniform regimen. The floods in the larger drainage basins, such as the Amazon or the Congo, are very complex. The northern tributaries of the former river, for instance, flood in June, July, and August, whereas the southern ones flood at the opposite time of the year. Then, again, at times the irregularity of the rains may produce in the main stream exceptionally high water or unusually protracted periods of low water. However, as long as the forest cover is preserved, even during long-continued droughts there is enough ground water in the soil to keep the rivers flowing. Dry river courses are decidedly not characteristic of these lands.

"The abundant rains mean that a great deal of water soaks into the ground, percolating through the upper layers of the regolith and maintaining a high ground-water table. Furthermore, this percolating

water is able to accomplish much in changing the character of the regolith, especially as chemical action is speeded up by the prevailing high temperatures. The descending vadose water dissolves the soluble minerals in the regolith and carries these in solution down into the zone of saturation and thence out through the rivers to the sea. This process, known as leaching, results eventually in a soil composed chiefly of the insoluble residue - in this part of the world the iron and aluminum compounds. It is the iron which imparts to tropical soils their characteristically brilliant red or yellow color.

"In addition to leaching these soils, the percolating waters carry the finer soil particles down from the upper layers and concentrate them in the lower layers - twenty-five to fifty feet below the ground in parts of the Amazon Basin. This removal of the finer particles and concentration of the coarser material at the surface is known as eluviation. The result is a sandy surface horizon, with a clay hardpan at some distance below the surface. Thus, soils on plains which have been exposed to leaching and eluviation for long periods of time are extremely infertile, another fact which is in contrast to the prevailing popular belief. From the point of view of fertility the soils on hill slopes, where creep brings fresh unleached and uneluviated material to the surface, are much to be preferred to those on plains, which are composed of the coarse, insoluble residue of the former regolith. The alluvium deposited by rivers on their floodplains is composed of fresh material and possesses the highest degree of fertility.

"There is a third soil-forming process which contributes to the

characteristic infertility of tropical soils. The abundant moisture and the high temperature of these regions favor a remarkably active bacterial life on the forest floor. Organic matter falling on the ground is therefore quickly destroyed. The litter of leaves and twigs cannot accumulate as it does under the mid-latitude forests. Immediately below a thin covering of brown leaves, recently fallen from the trees, there is the yellow or reddish upper layer of the soil; there is no black humus layer of partly decayed organic matter, as in the mid-latitude forests. This absence of humus, which is revealed by the light colors of the tropical soils, is another element of infertility."[6]

In the U. S. Department of Agriculture study "Soils and Men" we find the following statement referent to lateritic soils:

"The soil-forming process called laterization is essentially the progressive hydrolysis of rock minerals, and its full development results in their conversion to silicic acid, aluminum hydroxide, and iron hydroxide or their more or less complete dehydration products - the Laterites. Since in general silica is more rapidly removed by solution than are iron oxide and alumina, a fully developed Laterite may consist of only aluminum and iron hydroxides, although the process is normally not complete in any soil. The ultimate decomposition products contain very little acidic material and, consequently, have little base-holding capacity. The Laterites are normally very deficient in plant nutrients and can only be used for the production of agricultural products by frequently repeated applications of

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6. James, 1935, pp. 70-71.

fertilizers, the phosphate portion of which is rapidly rendered unavailable. On the other hand, since high temperature and high humidity favor plant production and also hasten laterization, Laterites and lateritic soils are often productive when fertilized or when conditions favor the accumulation of much organic matter on the surface. The fertility resulting from the latter condition rapidly disappears under cultivation."[7]

The second major class of soils found in the Lowlands of Mexico is called Rendzinas. This soil type especially is characteristic of the Yucatan Peninsula. Robinson describes rendzina as follows:

"Soils derived from or associated with calcareous parent materials, such as limestone, chalk, or coral, appear to fall into two main groups. On the one hand, is a group of soils in which the mineral colour is grey or greyish-brown, and the colour of the soil as a whole tends towards brownish or greyish-black shades. With them may be grouped white or grey chalk soils in which the organic matter colour is masked by the excess of chalk. On the other hand is a group of soils in which the colour is predominantly red or reddish-brown, sometimes modified by the presence of organic matter, which would appear to be of a different character from the organic matter of the soils of the first group. The clay complex of the black and grey soils is more siliceous than that of the red and brown soils, which appears to contain free sesquioxides. Soils of the first group contain free calcium carbonate and are completely saturated with exchangeable bases, whilst soils of the second group generally show

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7. U. S. D. A. Yearbook of Agriculture, 1938, pp. 973-4.

a distinctly lower base-status and may be actually acid in reaction. To the first group belong the rendzinas, with which may be included the grey and white limestone soils of the temperate regions, and the black limestone and marl soils of the tropics. To the second group belong the so-called terra rossa soils, with which may be included the brown and red limestone soils of temperate regions and the red limestone soils of the tropics....

"We have seen that limestones can give rise to two distinct groups of soils. The one group is characterized by a high base-status, excess of calcium carbonate, a dark coloured type of organic matter, and a grey or greyish-brown mineral colour associated with a siliceous type of clay, probably devoid of free sesquioxides.

"The other group is characterized by a generally low base-status, sometimes even in the presence of fragmentary limestone, a type of organic matter of a lighter colour than that of the first group, and a red or reddish-brown mineral colour, associated with a type of clay having a $SiO_2/R_2O_3$ ratio of about 2.0 or less, in which there is a certain proportion of free sesquioxides.

"The formation of the second group appears to follow the de-saturation of the soil, and we may therefore regard the red limestone soils as more mature than the grey or rendzina soils. In a limestone country, it should be possible to discern different stages of maturity due to variations in topography. If mature leached soils are to be found, they may be expected in upland situations with relatively high rainfall and intense leaching, provided erosion is not severe enough to keep pace with profile development."[8]

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8. Robinson, 1951.

The U. S. D. A. study indicates that rendzina soils are generally of low to medium productivity for agriculture.

Most of the Highland soils fall into the general class of Pedocal soils, of which there are a number of sub-types. Most of these sub-types are represented in Meso-America. The U. S. D. A. report gives an excellent summary of these soils, which is quoted in full below.

"The calcification process results in the redistribution of calcium carbonate or carbonate of lime in the soil profile without complete removal of it. Magnesium carbonate accumulates along with the carbonate of lime. The areas so affected are normally those of restricted rainfall - varying from approximately 25 inches or less in the Temperate Zone to approximately 45 inches or less in the Tropics - and the dominant vegetation is grass or brush. Since the rainfall is low, the percolation of water through the profile is not sufficient to remove wholly the calcium carbonate that existed in the parent material or was produced by reaction between carbonic acid and the calcium hydrolyzed from silicate minerals. The usual result is the development of an accumulation of calcium and magnesium carbonates at some point in the profile below the surface, approximating the depths to which surface waters most frequently percolate. Marbut called these soils Pedocals (soils with lime accumulation). While this is the normal formation, a calcium-carbonate deposit does not necessarily always occur. A secondary result of calcification is that the calcium tends to keep the colloid (fine clay) in a somewhat granular condition, and there is therefore relatively little downward movement of the colloid in the profile.

"It has been possible to arrange a multitude of Pedocal soil

series into a few great groups, using their color, organic-matter content, depth, and amount of lime accumulation as criteria for making combinations. The group names are largely of Russian origin, and their application to soils of the United States was first made by C. F. Marbut, who modified some of them. In the present classification further modification seems advisable. They are: (1) Chernozem (black earth); (2) Chestnut soils (dark-brown soils); (3) Reddish Chestnut soils; (4) Brown soils; (5) Reddish Brown soils; (6) Sierozem soils; (7) Desert soils; (8) Red Desert soils.

"Chernozems are very dark brown or black in the upper 2 to 4 feet and have slightly acid or slightly alkaline reaction and a nutlike structure. Organic matter is high, and the soils are naturally very fertile. A yellowish-brown or grayish-brown transitional horizon of a few inches separates the dark surface soil from the very calcareous horizon of lime accumulation. The lime is silty in character, includes more or less magnesium carbonate, and occurs as irregular soft masses and vertical streamers, extending to a depth of several feet in many places. Parent material below is less calcareous and in places contains no free lime. Accumulated lime comes partly from lime originally present in the materials and partly from the carbonation of calcium and magnesium silicates.

"Chestnut, Brown, and Sierozem soils have prismatic, dark-brown, brown, and light brownish-gray upper horizons, respectively, and progressively less organic matter in the order listed. The thickness of the surface soils also becomes less in the order listed, and the lime accumulation usually reaches its maximum development in the first two, except in cases of extremely old Sierozems and Red Desert

soils. All typical members of these groups except the Sierozem and Red Desert soils have little or no free lime at the surface, but the brown horizons in places are calcareous in their lower portions. Calcareous dusts sometimes accumulate sufficiently to render calcareous the surface inch or two. Reddish Chestnut and Reddish Brown soils have a dull reddish tinge in surface horizons and reddish-brown or red heavier subsoils above the horizon of lime accumulation.

"Chernozems occupy grasslands with subhumid climate, and Chestnut, Brown, and Sierozem soils occupy regions with progressively drier climate and scantier grass cover. Sierozems have little grass and some small shrubs and are in semi-desert regions. Reddish Chestnut, Reddish Brown, and Red Desert soils support a greater percentage of shrubs and less grass than the corresponding groups farther north. True Desert soils have but a scanty growth of perennial shrubs and certain scattered drought-resistant grasses.

"Desert and Red Desert soils are in the true deserts - the first in temperate regions and the latter in subtropical and tropical regions. They are usually calcareous to the surface but more so in substrata. Winds remove finer particles from surface horizons and leave a protective desert-pavement cover of small and large rock fragments. In many of the Desert soils the lime accumulation takes the form of hard concretions or stony formations (caliche) and attains a thickness of many feet in places. Physiographic evidence indicates that some of these lime hardpans or crusts were formed in poorly drained depressions tens of thousands of years ago and have become well-drained during a geologically recent cycle of erosion.

"According to Nikiforoff's hypothesis, the reddish heavy subsoil

of Red Desert soils is due to weathering of minerals in deeper horizons under the influence of moisture which percolates downward during brief rainy periods. This assumption might also be made in regard to the heavy subsoil horizons of the Reddish Chestnut and Reddish Brown soils.

"Black crusts of iron oxide form protective coatings on rocks and pebbles of the hotter deserts and are known as desert varnish.

"The calcification process not only connotes the accumulation of lime in the soil but also the adsorption of calcium ions by the colloids. Grasses and other plants requiring relatively large amounts of bases, particularly of calcium, bring these bases to the surface and, through decay, replenish the losses of leaching. For this reason the surface soils are seldom strongly acid - usually approximately neutral - and may be even faintly alkaline. When colloids are high in calcium (and to a less extent in magnesium) the reaction will usually range from slightly acid to slightly alkaline, and there will be an abundance of calcium available for crops. Brown Forest soils presumably owe their lack of eluviation and illuviation to this kind of calcification and are limited to areas with a forest vegetation having a particularly high content of bases in its leaves. Rendzinas are also calcified but, in spite of calcareous parent material, do not always contain free carbonate of lime.

"Under a somewhat higher rate of rainfall than is characteristic of lime-accumulation soils (Pedocals) the mean flow of water through the profile may be sufficient to produce, under abundant grass cover, a soil profile containing no calcium carbonate accumulation and yet

with a high degree of base saturation. Such soils may have some free lime in the parent material. They are the most fertile and productive of the Corn Belt. They exist over large areas, particularly in central United States, and are known as Prairie soils. They have profiles similar to Chernozem and Chestnut soils but do not have any lime accumulation. There is no sharp division in areas or profile characteristics between the soils having a zone of calcium carbonate accumulation and the Prairie soils, which have none. The colloids of Prairie soils are usually high in calcium even though no free lime is present. Furthermore, as rainfall increases and grassland gives way to forests, the calcified soils merge into the Gray-Brown Podzolic, the Red and Yellow Podzolic, and other soils characteristic of forested regions. The northern Prairie and Chernozem soils merge with the Podzols in cooler regions. Reddish Prairie soils contain less organic material than Prairie soils and occur in warmer climates. They grade into Reddish Chestnut soils on the one hand and into Red and Yellow Podzolic soils on the other.

"When forests invade the Chernozem grasslands under the influence of changing climate, podzolization becomes active, and the dark color of the Chernozem begins to become lighter, especially in the lower part. Upper horizons begin to take on the character of Podzols and Gray-Brown Podzolic soils before the lime horizon is entirely leached away. These are known as Degraded Chernozems.

"The general effect of moderate rainfall, particularly when accompanied by grass cover, is to produce very fertile soils. Calcified soils are usually extremely productive if they receive sufficient water for crops. Even Desert soils of low organic content produce

bountiful crops if irrigated and drained."[9]

In general this class of soils are the best agricultural soils for grain production. The following chart from the U. S. D. A. Yearbook summarizes the productivity of the various sub-types. The main problem in cultivating these soils is humidity preservation, as they are normally associated with sub-humid climates.

| Soil Type | Agricultural Productivity |
|---|---|
| Chernozem | Medium to high<br>High to very high when irrigated |
| Prairie | High |
| Chestnut | Medium<br>High where irrigated |
| Reddish Chestnut | Medium<br>High where irrigated |
| Brown | High if irrigated |
| Reddish Brown | Moderate to high if irrigated<br>Not suitable for dry farming |
| Sierozem | Medium to high if irrigated |
| Desert | Medium to high if irrigated |
| Red Desert | Medium to high if irrigated |

The final class of soils for discussion are those called Podzols which have a very limited distribution in Meso-America. The following quotation from U. S. D. A. Yearbook summarizes as follows:

"Podzol soils are developed in cool-temperate - occasionally in temperate - humid climates under the influence of coniferous, deciduous, or mixed forest vegetation. Highly siliceous materials are most susceptible to podzolization. Podzol soils are characterized, in

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9. U. S. D. A. Yearbook of Agriculture, 1938, pp. 970-1.

undisturbed forest areas, by a surface mat of partly decayed leaves and wood fragments, over a very light gray leached layer averaging a few inches thick, with or without a very thin dark-gray mineral-humus horizon between. The upper subsoil ($B_1$ horizon or orterde) is brown or dark brown, somewhat heavier textured than the surface soil, and grades through the yellowish-brown, moderately heavy, lower B horizon to the parent material. The solum is usually less than 3 feet thick. Most of the Podzols are strongly acid and have a low natural productivity for cultivated crops, but those having a texture as heavy as sandy loam or heavier may be limed, fertilized, and used for general farming and for grass and other crops in support of dairying. Where these soils are used for potatoes, the amount of lime added should not be sufficient to raise the soil reaction to neutral and so encourage scab development. Much of the land within the Podzol area is either too stony or too sandy for profitable agriculture and is therefore used for forests. In transition zones, the Podzols are in close association with Brown Podzolic, Gray-Brown Podzolic, Prairie, and Chernozem soils."[10]

Distribution of these soil types in Meso-America is as follows:

Tierra Caliente, below 800 meters. In this area we find three basic soil types. Most of the Gulf Coast, especially that within Vera Cruz, is covered by Yellow Laterites. The Pacific Coast except Chiapas, where we have less rainfall and a tendency toward savannah rather than forest vegetation, most of the soils fall into the Prairie type of the Podzolic group. In Mexico these soils are referred to as "Prodera" and are a special tropical variant. The Yucatan Peninsula

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10. U. S. D. A. Yearbook of Agriculture, 1938, pp. 1020-1.

is covered by mainly rendzina soils of the "Terra Rosa" type, as is also a part of the Huasteca. Tabasco and the adjoining area of Campeche is classified as gley but most of it conforms more closely to the lateritic group and gley soils are limited to the swamps further down streams. Of local significance in soil formation in the Gulf Coast is the factor of alluviation, and in Tabasco at any rate river flood plains may be quite extensive. This more than any other factor is responsible for the importance of the Gulf Coast in modern Mexican economy.

Tierra Templada. These lands today remain largely unknown. General soil maps often do not even catch Tierra Templada zones as separate areas and they are often grouped with the adjoining Tierra Caliente area. In some cases this seems to be correct. The humid Tierra Templada escarpment of Vera Cruz in general has a soil similar to that of the Tierra Caliente. The Tierra Templada of the Balsas Basin on the other hand seems to fit in with the Pacific Coast in general with a prairie soil type. In general the Tierra Templada in interior Mexico is covered by Pradera soils; on the Gulf Coast escarpment we find lateritic soils.

Tierra Fria. Most of the Tierra Fria of Mexico is covered by a single soil type, chernozem, with chestnut and sierozem soils in the drier portions. Especially this soil type is characteristic of the Meseta Central and the Oaxaca Highlands.

True Podzols do occur in Meso-America but generally on the conifer forested upper slopes of mountain ranges above the limit of permanent agriculture.

These general soil classifications break down in effectivity

when we reach areas of complex mountain topography such as Guatemala, and in that area furthermore volcanicism has played an even greater role in soil formation than in the Mexican Highlands.

## Summary

This brief survey gives us a general picture of the complexity of geographical zones in Meso-America. For the purposes of the Human Ecologist a more microscopic examination of Meso-American geography is necessary to understand more fully how the ecological variation conditioned the origin and character of the various regional sub-cultures of ancient Meso-America. The most important factors in the geography of Meso-America in these terms are those which affect the technology and economy of agriculture. The following are considered to be of prime importance in this respect: (a) The Topography - of special importance is the limiting influence of topography in land utilization, its effect on the intensity of cultivation and type of demographic expansion, and finally its relation to transport and trade; (b) The Altitude and its related factor the thermal cycle - the most important effects here are in connection with technical problems of agriculture, e.g., the problem of frosts and rapidity of natural vegetation growth. Furthermore altitude more than any other factor causes zoning of agricultural production; (c) Rainfall or precipitation - probably one of the most crucial factors of all, the principal adverse effects lying in the problems of drought and the intensity of competition between natural and artificial plant life; (d) Soils - the central problem here is the determination of which soil types will support intensive agriculture with techniques available in pre-Spanish agricultural technology; (e) Vegetation - in general Highland vegetation types were easy problems for the

Indian farmer to control even with his primitive technology; in the Lowlands the natural vegetation severely limited zonal production; (f) Hydrography - of great importance is the availability of water sources for irrigation, especially in the Meseta Central and the Oaxaca Highlands. Aside from this the destructive aspects of hydrography, i.e., floods, were a severe limiting factor in occupation of riverside lands in Tabasco and Vera Cruz.

By a combination of all of these factors I have defined some 51 Ecological Areas for Meso-America. It is not a complete list as it includes only a fraction of the Huasteca and no area northwest of Michoacan. My data is only full for that part of Meso-America within Mexico; Guatemala and adjacent parts of Honduras and Salvador are either not treated or very summarily done so. Guatemala especially needs breaking down into at least six Ecological Areas.[11]

The data on rainfall and altitude is from the files of the Secretaria de Agricultura in Tacubaya, Mexico. The rest of the geographic data is from Vivo and Tamayo plus personal observation.[12, 13]

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11. See the appendix for a description of these Ecological Areas.

12. Vivo, 1946, 1948.

13. Tamayo, 1949.

# EL LAGO Y EL VOLCAN - THE CHINAMPAN

## Natural Setting

The Southern Valley of Mexico or the Lakes Xochimilco-Chalco drainage basin is probably the most favorable area in Highland Mexico for a subsistence agricultural population. We have here an ideal combination of ample rainfall and fertile soil rarely met with anywhere in Meso-America.

Two key ecological factors dominate the agricultural economy of the area - the lakes and the Ajusco volcanic range.

In general topography the southern valley divides sharply into two sub-regions which correspond roughly between the ancient provinces of Xochimilco and Chalco. The western half - or Xochimilco - is an area of very limited lake-shore plain in which steep volcanic hills and cliffs border the lake shore. The eastern, or Chalco, half is characterized by the presence of one of the most extensive lake plains in the entire Valley of Mexico along with an even larger area of gradually sloping terrain - mainly the flanks of Popocatepetl and Iztaccihuatl.

Most of the level flat land of the southern valley, aside from the Chalco plain, is or rather was occupied by a sheet of fresh water often called Lake Chalco-Xochimilco. The 2250-meter contour closely describes its shoreline. From the shoreline the land slopes up to the Ajusco and Nevada ranges with numerous peaks over 3000 meters above sea level. Very few settlements and no true villages occur above 2700 meters so our band of human occupation lies between 2250 and 2700 meters.

The lack of level lake shore plain in the Xochimilco area presented a difficult challenge to an expanding agricultural population and it was solved in two ways. One was the Peruvian technique of completely terracing the steep slopes by stone walled terraces converting agriculturally useless volcanic slopes into exceedingly productive farm land. The second, unique to Meso-America, consisted of an impressive invasion of the lakes themselves in which huge stretches of them were converted into a network of artificial islands or chinampas and canals. The total result was the development of the most intensive and productive agriculture anywhere in Meso-America. In Chalco on the other hand the lake plain along with gentle slopes and with abundant rainfall formed the basis of the development of a temporal agriculture; as far as I know irrigation has never played an important role in that area.

Two factors in the ecology of the southern valley dominated and still dominate the agricultural technology and economy: the volcanoes which are the chief source of the fertile soil and determine its peculiar drainage, and the lakes which were the scene of an intensive agriculture combined with rapid heavy transport based on primitive boats. The latter combination especially converted the southern valley into a key area in the development and maintenance of an urban society in pre-Spanish and Colonial Mexico. The lakes are or rather were fed by several sources. True rivers are rare and are mainly concentrated in Chalco. These include the Rios Amecameca and Tlalmanalco which conduct run-off from the permanent snow fields of Popocatepetl and Iztaccihuatl. With the abundant seasonal rain and steep slopes arroyos are common all along the rim of the southern valley and provide both abundant

drainage and fresh soil to the valley floor. The third and possibly most important source are the springs of the province of Xochimilco which up until 1940 provided most of Mexico City with water. A high percentage of the rainfall which falls in the nearby Ajusco range sinks into the porous volcanic rock and later a substantial percentage bursts out from the foothills rimming the lake in the form of springs. Today most of this spring run-off has been collected in tubes and is carried off to Mexico City, leaving the lake bed dry.

Unlike Lake Texcoco the double lake (in reality a single lake as the division is based on an ancient artificial causeway running from Tlaltenco to Tlahuac to Tulyahualco) of Chalco-Xochimilco did not shrink during the colonial period, so that Orozco y Berra's study of the hydrography of the valley in the late nineteenth century in the case of the southern valley applies for the entire Aztec and Colonial Periods on up until the capturing of the springs and construction of the central drain in the late nineteenth and early twentieth centuries.

In 1869 or the date of Orozco's observations the lake level of Chalco-Xochimilco varied from 1.175 (Chalco) to 1.202 meters (Xochimilco) above that of the Zocalo in Mexico City, and 3.082 and 3.139 meters above Lake Texcoco. The total surface area in his time of the double lake was 8.66 square leagues or approximately 150 $km^2$ or 15,000 hectareas, of which two-thirds lay east of the Tlahuac causeway and one-third west of it. From Xochimilco to Chalco, which is approximately the east-west extension of the lake, is about 30 kilometers. The width varies greatly from four at Tlahuac to ten at its widest point. The depth of the two lakes varies considerably but in general they are very shallow. Just off the shore at Chalco Orozco's soundings

indicated a depth of .8 meters to 1.2; at Tlahuac on the Chalco side of the causeway he recorded 2.4, and at Xico he reached the greatest depth in Lake Chalco, 2.85 meters. In Lake Xochimilco he recorded a maximum depth of 3.0 meters. At this time the surface of the two lakes was almost completely covered by a thick mantle of surface vegetation in places so matted that a man could walk on it. Often plants would take root on the raft of floating vegetation rather than the bottom itself. Canals had to be cut through it and periodically cleaned out to permit efficient boat transport, and in the nineteenth century this was an important federal responsibility. The lakes were also exceedingly rich in lacustrine life and a number of villages were specialized in fishing.

Due to the thick cover of vegetation evaporation was slight and lake levels varied little, unlike Texcoco. During the dry season the normal flow was from Xochimilco to Chalco but once the rains got under way the situation was reversed.

As has been stated this part of the Valley of Mexico enjoys a higher precipitation than the rest of the valley. The only statistical data I have pertains to the Province of Chalco and is from Sanchez Colin, but it probably applies to Xochimilco as well. In total precipitation we find the following figures: San Rafael (Municipio of Tlalmanalco 2530 meters) 1142 mms; San Juan de Guadelupe (Municipio of Chalco 2294 meters) 1015 mms. The average annual rainfall is almost twice that of the Teotihuacan Valley and what is even more important the average rainfall and number of days of rain in May is significantly greater - and May is the critical month for sowing. We have the same sharp seasonal differentiation of rainfall, however, with most of it

falling between June and September, beginning in May and tapering off in October and with a maximum in July. Over five-sixths of the annual rainfall comes during the six months of May to October. On the flat Lake bottom rainfall is significantly less and the drying out of the chinampas has created a serious economic problem. On the upper slopes, above 2800 meters - or in other words above the village zone - it is probably around a meter and a half. We may consider that the precipitation in the life zone of 2250-2800 meters varies between 1000-1200 mms. a year. The most important agricultural problem in our area are the frosts. At altitudes around 2500 meters they begin normally in October and in exceptional years September, and end in March or occasionally last until May. Further down at Chalco itself they run from November to March and rarely occur before October. Mean annual temperature varies from 12.7°to 13.6° Centigrade according to the altitude and may vary from a mean monthly temperature of 10.6° in January up to 15.8° in May. Temperatures may drop as low as -8.2° and reach as high as 31.0° but such extremes are very rare. The average maximum temperature over a 22-year period was 20.3° and 5.1° minimum at San Rafael, and 20.4° and 6.8° at San Juan.

Soil classification in the southern Valley gives the general soil type as Chernozen but the situation is undoubtedly much more complex than that. Its basic origin is volcanic, later transported and deposited by water as in the Teotihuacan Valley. Upon this base the general effect of climate is to produce prairie soils in the zone of human occupation and boreal-coniferous-bearing soils above that level. Theoretically from 2800 meters up we would expect podzols - the delimitation of human agricultural occupation is undoubtedly in

part based on this basic soil shift - podzols are notoriously poor and chernozens generally exceedingly fertile soils. Many villages above 2500 meters are dependent partly on agriculture and partly on lumbering and the manufacture of wood objects.

From Sanchez Colin the following data on soil is given for the Chalco lake plain: pH or acidity value 9.7, humus or organic content very rich, nitrogen and ammonia rich, phosphorus very rich, both calcium and nitric acid in moderate quantities.

Farmers from the Chinampa area utilize a soil classification system perfectly adapted to their needs and based on permeability, drainage, texture, color, origin, topography and productivity. We will discuss this system shortly.

## San Gregorio Atlapulco

### Introduction

San Gregorio Atlapulco is one of the largest agricultural communities or villages in modern Mexico. In 1950 it recorded nearly six thousand inhabitants and the population is still increasing. Politically it is situated within the delegacion of Xochimilco and is classed as a sub-delegacion within that unit. The people consider themselves as Xochimilca and the community has always been dependent on that center from Aztec times to the present. Geographically it is situated on the south shore of the old lake Xochimilco and approximately 7 kilometers east of the town of the same name. The village is connected to the town of Xochimilco by a paved highway which runs on to Mexico City to the northwest and on to Chalco and the Tierra Caliente of Morelos to the southeast. There exists a regular bus service from

Mexico City with buses leaving every twenty minutes and arriving in San Gregorio within forty minutes. The village is therefore within easy communication with the capital and passenger traffic incredibly congested. It is rare that buses passing through San Gregorio to Xochimilco are not jammed to the roof with seated and standing passengers, at times as many as seventy or eighty in a single bus. Most of the passengers are farmers going to or coming from the big Xochimilco market. There is probably no other area in Meso-America with as dense a rural population, as large a number of rural villages per linear mile or as heavy a rural traffic as the stretch of highway between Xochimilco and Chalco.

From the air or the nearby volcanic slopes the village and its agricultural lands present an unforgettable sight to a student of human ecology. First one sees the congested compact village community of nearly six thousand inhabitants compressed into an area not exceeding 50 hectareas. The average house lot is not over 20 meters square. To an American the congestion of this rural community seems almost unbelievable but as we shall see one of the fundamental facts about San Gregorian living is congestion.

The street pattern is typically colonial Mexican with streets laid off in checkerboard pattern enclosing blocks of roughly 100 meters square. At least that seems to have been the intention of the Spanish padres when they planned the community. Actually hundreds of secondary alleys wind through the square blocks cutting them up into irregular-sized and shaped house plots. Houses are shoved into the middle of the blocks one behind the other with narrow entrance alleys, and house lots are often fractioned by low loose stone walls into sub-lots based

upon a family inheritance division. The only paved street is the Chalco-Xochimilco highway which runs through the center of the village. The other streets are of earth and become almost impassable when the heavy rains come. In the center of the village is the usual plaza with a few open air shops, a large church, a school and various administration buildings. Commerce is of little importance in San Gregorio and shops are rare. In the entire village there are fewer than a dozen small Mesalaneas (small general stores). The bulk of the farmer's buying is done at the big regional market of Xochimilco about fifteen minutes away by bus.

Just south of the village, and upon which it stands, is a small flat lake shore depositional plain almost entirely devoted to maize cultivation. This is called El Llano in local terminology and comprises some 80 hectareas aside from that occupied by the village.

Behind or south of the plain the San Gregorian landscape divides sharply into two ecological zones: El Cerro to the southwest and La Loma to the southeast.

El Cerro or the Hill as it is called would better be called a meseta. It is a long narrow tongue of volcanic rock built up in several flat-topped terrace-like levels and with very steep slopes. The slopes are completely reworked into stone-lined terraces - today only in partial use. The flat top is pitted by hundreds of soil-filled depressions rimmed by rock outcrops. The depressions are called Canadas and are extraordinarily productive due in part to the soil fertility and in part to their natural humidity. The rocky outcrops surrounding the depressions are usually covered by artificial terraces. The canadas are centers of maize and tomato production,

especially the former.

The "loma" refers to the long gentle slope of the northwest flank of the volcano of Teuctli. The volcano stands just southeast of the village and dominates the villages of the central part of the lake, the peak towering approximately 500 meters above the lake bottom. Most of the volcanoes slopes are cultivable up to the 2600 meter contour. At that point the steep soilless slopes prohibit agricultural utilization. The total amount of agricultural land probably approximates 3000 hectareas, which is divided up among San Gregorio, San Luis, Tulyahualco, Ixtayopan, Tecomitl, Milpa Alta and Atocpan. Erosion on these slopes is controlled by simply planting maguey along the slope contours or entirely around each holding. The most important cultivates on the loma are maize, amaranth, chile and tomate along with maguey. Maguey is of greater importance at Milpa Alta than at San Gregorio. A barranca separates the loma from the Cerro, heading in the Sierra Ajusco and running down to the lake shore just west of San Gregorio. Most of the soil in the small lake plain of the village represents deposition from this barranca. In the past during excessively rainy years the added flow from the barranca and backing up of the lake have caused total inundation of the lake plain and the villages.

The northern edge of the village is the old lake shore line. Today a wide main canal runs the length of the village delimiting it. This is part of the old Xochimilco to Chalco transport canal but today has water only in the section fronting on San Gregorio and San Luis. San Gregorio more than any other chinampa village has an abundance of water due to the existence of local springs. These latter are ample enough to water the 400 hectareas of chinampas held by the village

but not enough to interest the federal government. All along the southern shore of the main canal scores of springs continually feed the hundreds of secondary canals that provide the water for chinampa irrigation and provide the San Gregorian with his greatest economic asset.

To the north of the village stretches 400 hectareas of the most valuable agricultural land in modern Meso-America - the chinampas. With their huejote trees sown along the edges as soil retainers and the exuberant vegetation the chinampa area appears as a vast swampy jungle chopped up by canals into rectangular plots. On these tiny gardens we find the most extraordinary variety of crops and most intensive utilization of land anywhere in Highland Mexico. The chinampas are mainly used by the San Gregorian for cash crop production, especially vegetables.

One of the most picturesque sights in San Gregorio are the scores of small boat basins, the larger main boat basin with literally hundreds of flat-bottomed boats anchored along the shores.

To the north of the Chinampa area lies the dessicated lake bottom of Lake Xochimilco. Today it is broken up into ejidos of which San Gregorio possesses 400 hectareas divided up among some 700 ejiditarios. This area is considered by many San Gregorianos as the granary of the village and is given over entirely to maize cultivation. The soil is rich black chernozen and some of the finest maize crops in Mexico come out of these lake bottom ejidos.

This then is the economic and ecologic world of the San Gregorian farmer. It is an extremely small world - most of his activities take place in an area which at no point is over two kilometers from his

house. The entire landscape is broken up into tiny holdings and there is no piece of it without an owner. The average unit of property certainly is below an acre in size and the average farmer does not hold over two hectareas of land.

Approximately two months were spent studying the technology and economy of San Gregorio and considerable data was also collected from the neighboring village of Tlahuac. In both cases difficulties were encountered due to the suspicion of the villagers but in general our data is fairly complete. Tlahuac is situated in the center of the old lake bed and was therefore hard hit by the dessication of the lake. Only a fraction of the chinampas are in full production. The situation has been partially ameliorated by the granting of a substantial lake bottom ejido to the village along with the increase of the industrial labor market in Mexico City. Aside from this ejido the village holds no temporal land - in the colonial period its economy was based entirely on the lake-chinampa agriculture and fishing.

## Agriculture in the Chinampa Area

One of the outstanding characteristics of agriculture in San Gregorio Atlapulco is the complexity of techniques, directly related to the complexity of the natural environment. Six different technological systems are in vogue today and over fifty crops are raised.

Another outstanding trait is the combination of commercial and subsistence economies. The average San Gregorian produces a cash surplus of even a staple like maize. This is due to the excellent quality of the land and to his own expert knowledge of it. There are few communities in Mexico with such a neatly balanced commercial-subsistence economy. There are, however, two fundamental lacks:

frijol and pulquo, both staples in highland Mexican diet. Tlahuac in the middle of the lake and lacking temporal lands is more unfavorably situated as its economy in recent years has been over-commercialized and therefore more dependent on outside markets.

We stated that six types of agricultural technology may be defined for the village. These are closely tied in with the described ecological zones and there is considerable crop differentiation by zone as in the Mediterranean region. The canadas are humid fertile lands exactly suited for maize and are cultivated with the plow without irrigation. The steep terraces on the Cerro are to a great degree uncultivated today but were once centers of frijol and tomate cultivation based on the hoe and temporal techniques. In both cases the land is cultivated intensively and fertilized with only vegetal fertilizers.

The slopes on the "Loma" are terraced with lines of maguey, are dry farmed with horse and plow, and are fertilized with animal fertilizers or simply rested on a fallowing cycle or crops are rotated and maize, amaranth, tomate and chile peppers are cultivated.

The Llano is almost entirely devoted to maize cultivation - dry farmed with horse and plow and animal fertilizers are extensively used.

The chinampa area is the scene of the most distinctive and intensive cultivation of all. We shall not describe the system here as I shall discuss it in much greater detail at a later point.

The ejido or lake bottom is a maize-producing area, dry farmed with horse and plow and in general not fertilized.

San Gregorians are well aware of these ecological zones and their relationship to their technological systems. They also use a complex

soil classification system which is closely related to both general ecological zones and technological systems.

Tierra Negra refers to the rich black humus laden soil of the ejido lake bottom and Pantano (swamp) soil is the almost vegetal soil of the chinampas. Tierra Arenosa refers to the soft loose permeable soil of the lake shore plain and the lower slopes of Teuctli. It is mainly an arroyo-deposited soil. On the middle and upper slopes of Teuctli the term Tierra Cascajosa is used simply meaning Tierra Arenosa but with more loose stones - the further up the slope the higher the percentage of cascajo. The canadas on the Cerro are filled with a very fertile yellow clayey-textured soil called Tierra Amarilla with extreme humidity retention ability. Tierra Chiclosa or sticky soil, of the same color as Tierra Amarilla, is characteristic of the delta deposits of the arroyo on the lake shore. The term Tierra Salitrosa is also used for those lake bottom lands with a high salt content. In terms of productivity the San Gregorian ranks the chinampas as number one followed by the canada, ejido, llano and loma in that order.

We might group San Gregorian agriculture in three broad categories for our analysis. First we have field agriculture, whether done with hoe or plow and without irrigation. Of the 2000 hectareas or so I calculate as held by the village approximately 1500 fall into this class. Second in our grouping is chinampa cultivation embracing some 500 hectareas and finally house lot fruit cultivation limited to the 50 hectareas or so of the village area. Before the agrarian revolution the entire llano was sown in olive orchards but they were cut down and have not been replaced.

## Temporal Cultivation in San Gregorio

### Canada Cultivation

As we have noted southwest of the village is a volcanic formation locally known as El Cerro. The top is flat and pitted by small depressions separated by soilless ridges and filled with tierra amarilla. The average size is from one to three acres. These canadas as they are called are considered among the best lands in the village and are given over mostly to maize cultivation although the green tomato is important also. The typical canada appears as a flat level plain of a hectarea or so divided up into two or three holdings by low loose stone walls. It is surrounded by a rocky ridge which is usually terraced although today abandoned for agriculture. The terraces may or may not be owned by the owner of the canada parcel. They are in general, however, kept in repair and bear an important symbiotic relation to canada cultivation. They are probably pre-conquest in date as almost all have heavy Aztec sherd deposits. They are called "Cercas" on enclosures in San Gregorio.

The canadas are extremely humid lands and really should be classed as Tierra de Humedad rather than Temporal. One canada studied covered approximately 1.5 hectareas and was divided up among three owners. The surrounding terraces are uncultivated and are covered by a mat of natural vegetation. This canada is entirely given over to maize cultivation.

Although uncultivated the surrounding terraces play a key role in canada cultivation. A number of plants, locally called palo loco, yecaxtlolotl and chantlacatl - the last a herb and the first two small woody bushes - abound on the terraces, especially toward the middle and end of the rainy season. Starting in August many farmers

uproot or cut down these plants and start throwing them into the canada milpa. This is the only fertilizer used on the canada and conscientious farmers apply it every year during the August-to-October season. It was more generally practiced during the nineteenth century; with the rise in the vegetable market in Mexico City in recent years the San Gregorian often neglects to apply this technique as he devotes most of his labor to his chinampas. One of the important causes of ill feeling between villagers is over the use of this vegetal fertilizer from terraces belonging to someone else.

One test canada was measured and studied. The areal dimension was calculated as approximately .7 hectareas of which .4 hectareas had been held by the owner for the past ten years, the remainder was purchased the year of the study.

In December or January this land was given a thorough plowing with a light wood plow and a team of horses, the farmer taking special pains in turning all rastrojo and weeds into the soil as fertilizer. Maize then was sown in April, the canadas because of the exceptional humidity of their soil enabling pre-rainy season sowing. For the past ten years he has sown maize every year on the original holding and yields have been maintained without any observed decline. Yield has varied, of course, but irrespective of the soil factor, being strictly related to climatic fluctuations. He fertilizes his holding every year by the technique described of green fertilizer but no animal manures are used at all. He received the plot from his father-in-law who cultivated it continuously all his life without resting almost entirely in maize - and with only occasional use of green fertilizers. The field therefore is a good test of the success of the San Gregorian

farmer in maintaining good crop yields with continuous cultivation. The informant estimated his yield on .4 hectareas as 10 cargas with a range of 7-12 cargas. The carga at San Gregorio is the same measure as that used in the Teotihuacan Valley being 100 curtillos, the latter usually being estimated as from 1.2 to 1.5 kilos. Most informants estimate the latter. I estimated a cuartillo of seed corn as 1.4 kilos, seed corn being of larger grain than the harvest as a whole and probably being a little denser and heavier than the general harvest.

His production calculates out at approximately 3000-3700 kgs per hectarea or 50-55 bushels of shelled corn per acre. The range would be from 2000-4500 kgs depending on the year and which of our cuartillo conversion figures we use. The probable general average is about 3.0 tons per hectarea. The informant stated that he sows 3 cuartillos of maize on the .4 hectareas or 7.5 per hectarea. His proportion yield is then 333:1.

The owner also stated that his father-in-law obtained an average maize yield of 4 cargas without using any or rarely using green manure and continuously sowing maize without rest. This would calculate about 1200-1500 kgs per hectarea depending on the weight of the cuartillo. The production drops to half that of the fertilized field. Aboriginal yields would be somewhat lower than those of the fertilized canada; considering more intensive utilization and relative scarcity of vegetable manure, possibly running between the two sets of figures.

These yields are very high for highland Mexico but seem to be confirmed by our other data. Another canada measured 1.6 hectareas

and was cultivated by the same technique - year after year sowing of maize, without rest, plus abundant use of green fertilizer. Average yield on this field was 30 cargas or 19 cargas per hectarea calculated in kilos as 2280-2850.

We can safely say that the average yield on fertilized canada is at least 2300-3000 kgs and possibly somewhat higher, with unfertilized lands yielding about half as much or slightly less than half. Aside from these generally high yields production is very dependable with partial or complete crop failure being exceedingly rare. Maize is the chief crop grown on the canadas - it is the San Gregorian's life insurance due to high and dependable yields. A man is considered very fortunate to possess canada lands and a man with a hectarea or two is considered as a "rico". Men with canada land who do not cultivate it are often under severe criticism by fellow villagers.

Today terraces on the Cerro are rarely cultivated but in general are carefully maintained - especially those on the ridges bordering the canadas. Those on the slope of the mesa are less carefully maintained, however, and erosion has taken its toll. The entire slope at one time was carefully reworked into hundreds of tiny stone-faced terraces, often but a few yards wide, and were carefully cultivated by hoes and coas. No data on production was obtained but those few seen, sown in maize, indicate a production at least as high as the unfertilized canadas.

The only other crop grown in quantity on the cerro is the tomate which yields very well and is chiefly a cash crop.

## Loma Cultivation

The Loma in local use refers to the long gradually sloping flanks of Teuctli, a huge volcano, the surface of which is divided up among at least seven villages, all with one exception being of considerable size. The maximum size of the volcano held by inhabitants of San Gregorio cannot be over 500-600 hectareas. A more precise estimate is almost impossible to achieve as the lands of the members of one village are not always mutually exclusive or continuous. My estimate may be as much as 20 percent off but the margin of error is certainly not greater than that.

The slopes of Teuctli are quite gentle and the bancal technique of erosion control (in general use all over the plateau) is extensively used. This means that the plots are levelled off to flat earth terraces and bordered by rows of maguey at least on the side paralleling the slope. The entire surface of Teuctli up to 2600 meters is completely covered by these bancales and under intensive cultivation.

The soils of the Loma are of sandy texture, porous and easily worked. Their natural fertility and humidity is considerably below that of the canadas, however, and to cultivate intensively both crop rotation and animal fertilizers are necessary. Many farmers neglect to practice either of these techniques and rest their lands alternating with the sowing years, ordinarily sowing maize one year, then resting the field a year and continuing the third year with maize again and so on. Animal fertilizers are scarce at San Gregorio and much of the Loma is cultivated by either continuous cultivation but rotating crops without fertilization or by the resting system described above.

Those fields on the lower slopes, aside from their basic sandy texture, are often heavily mixed with broken rock and the San

Gregorio uses the term "Arenoso Cascajoso" to classify this soil type; the further up the slope the field the more loose rock and less soil and the upper slope soils are called "Cascajoso". Maize production declines sharply as you go upward.

Although maize does not yield as well on the loma it does grow fairly well under careful management. Aside from their role as secondary maize lands the Loma fields are important in the cultivation of huauhtli, or amaranth or alegria - the latter term being in use in San Gregorio - chile peppers and tomato. Huauhtli yields very well and may have been the principle crop grown on these lands in pre-Spanish days. It is of special importance to our study of San Gregorio economy since it evidently can be used to rotate with maize to maintain soil fertility.

One of the holdings studied is situated almost on the base of the slope and therefore is more productive than the majority of Loma lands. Yields approach those of the Llano or flat coastal plain. Yields are higher also than the Cerro terraces.

The owner of the plot is one of the best farmers in San Gregorio and the test field is under intensive cultivation.

His system involves careful crop rotation and use of animal fertilizers. His present procedure is to sow huauhtli mixed with jitomate one year, followed by maize, then in the third year tomate and chile mixed completing the cycle. The following year the cycle is repeated. His land is never rested and is fertilized approximately once every two years, mainly cattle manure of which he puts 20 costals on the field studied. This field covers an approximate area of .2 hectareas or 1/4 of a yunta. The year of my study it was in alegria

and jitomate.

The alegria or huauhtli is a low herb-like bush growing approximately a meter high and producing a fiery red seed-bearing crown, the seeds being considerably smaller than barley seed and used for making candy for fiestas. In pre-conquest times it was an important staple food like maize. Alegria is sown in seed beds in the chinampas and sown in the field in April. It resists drought better than maize and the plants are given a good start and carefully selected from the chinampa seed bed, thus enabling an early sowing in the field. The field is prepared by plowing with a team of horses. The rows of alegria on fertilized fields are generally sown a meter apart and the individual plants are spaced 50 cms or so within the rows. Following the sowing of the alegria a row of chile or tomate plants (again transplanted from chinampa seed beds) are sown in between the lines of the alegria. Alegria is harvested by lopping off the crowns with a small sickle and gathering them into sacks. The seed is then beaten off with poles onto mats and sold by the cuartillo. On the .2 hectareas of the test field the average production is about 300 cuartillos or 1500 cuartillos per hectarea. Unfortunately I was not able to check the weight of a cuartillo.

Following the year of huautli-tomate production or huautli-chile, the next year maize is sown alone. Maize here as in the canada is closely sown, only a half meter or so separating the plants. Sowing of maize is usually delayed until May in an attempt to hit the beginning of the rainy season as closely as possible. Sowings are rarely delayed until June because of the danger of early fall frosts. Approximately 2 cuartillos of seed are used on this plot. The average

yield on this field was 300 cuartillos or 360-450 kilos depending on whether a 1.2 or a 1.5 conversion is used and the yield per hectarea calculates at 1800-2250 kilos or about 30-40 bushels per acre. In percentage the yield is 150:1. These figures probably apply generally to maximum production on carefully cultivated fields in the Llano and low-lying Loma lands.

By alternating one year of maize, one year of rest, or by rotating crops and without animal fertilizers, in either case the yield on these same lands drops to about one-half. Individual plants are sown further-spaced to give them more room in the unfertilized soil. Yields then are at a minimum 900-1125 kilos per hectarea for this zone (e.g., lower Loma and Llano).

Chile pepper and tomate yields are next to impossible to calculate into modern measures on the basis of an informant's data. His knowledge of the kilo as a weight is rather vague and judgments on production in kilos are not to be overly trusted. Also it is rare that an entire field is sown with one of these crops. One informant stated that if an entire "quarteron" or 1/4 yunta (about .2 hectareas) were sown in tomate he would harvest approximately 36 "bultos". These bultos are the same burlap sacks used in harvesting corn. In the latter case they hold half a carga. The tomate seed is sown first in seed beds in the chinampa and transplanted in May and harvested through September and October. In the Llano on fields near the village many farmers irrigate tomate sowings throughout the growing season with buckets slung from Chinese-style shoulder yokes, the water being taken from public fountains in the village and carried to the plot. The field is the same one described in huauhtli and maize cultivation.

On the same land chile yields approximately 3 maize bultos each harvest (sown mixed with tomate so only half the field is actually under cultivation), a bultos weighing 60-70 kilos (approximately the weight of maize). The yield per hectarea of chile sown mixed with tomate is then approximately 900-1050 kilos per hectarea, which figure checks well against government chile production data for fertile soils and humid climates. Chile is sown in a special way distinct from the other plants named for the Loma area but similar to the way many of the vegetables are sown in the chinampas. Double rows of young plants (transplanted from chinampa seed beds) are sown 20 cms apart with each pair of rows being spaced 1 meter. The intervening space between the double rows is usually sown with tomate. One intervening space between the double rows is usually sown with tomate. One interesting and probably ancient custom with respect to chile cultivation is the use of bat dung fertilizer. This material throughout the colonial period was brought from the other side of the serrania Ajusco in Morelos from caves.

This .2 hectarea parcel then over a three-year period will yield approximately 300 cuartillos (360-450 kilos) of maize, 300 cuartillos of huauhtli, 180-210 kilos of chile plus 18 cargas of tomate - the latter being sown mixed with huauhtli one year and with chile the other year. We may use these figures to represent maximum yields on the better sandy soils with most intensive application of local agricultural know-how. For unfertilized lands the overall production with continuous but rotated cropping would be about half. If the third procedure was followed - only maize cultivated and alternate year resting - our average production over a three-year period drops

to an average of 225 cuartillos of maize. These figures dramatically illustrate the role played by land management in crop production.

At the time of the Agrarian Revolution during the early decades of the present century the Llano was covered by olive groves. They were cut down by the Carranzistas and never replaced. Today it is mainly sown in maize. Minor crops also sown in the Llano include frijol, often in between the rows of maize and tomate, and in recent years many farmers are trying out truck vegetables in this area. They are irrigated by the yoke-bucket technique. Techniques of cultivation in the Llano are similar to those described in the Loma cultivation.

In general weed growth on the described temporal lands is of slight importance and weeds are easily kept under control. Actually natural plant growth is an aid rather than a hindrance as it provides valuable green fertilizer. However there is one low spreading herb called chicolate, a tough resistant plant which grows rapidly and on abandoned fields quickly forms a tangled mat-like cover which successfully smothers out all other plants, weeds and sown crops alike. Once it takes over it possesses an extraordinary tenacity and is with great difficulty eradicated. Farmers are extremely critical of fellow villagers who let this plant invade their fields as it spreads rapidly to infect nearby plots as well.

## Maguey Cultivation

In the economy of the farmers of the Valley of Mexico there are three major food staples. One is of course maize, which is universally sown by all villages and provides their main starchy food. The second is the bean or frijol, their main protein source which is in general cultivation, but many villages do not supply themselves with this

staple and often have to import substantial quantities while others sow very little. The third staple is pulque, the fermented juice of the maguey plant. The latter is mainly cultivated in the drier, more arid northern valley as it is very tolerant of dry soil and poor regions. In the south, as around San Gregorio, it is much rarer as it is uneconomical to waste good maize lands in maguey cultivation. The only important center of maguey cultivation in the lower or southern valley is around Milpa Alta where most of the land is hillside land.

At San Gregorio we find that maize is sown in quantity not only meeting local needs but is an important export. Frijol on the other hand is almost absent and almost the entire village supply comes from outside. Villagers say that there is a local disease which reduces frijol yield so much that the sowing of frijol would be uneconomical. Maguey also is of slight importance and most of the pulque consumed locally comes from Milpa Alta. It is found scattered on almost soilless slopes or abandoned stone terraces on the Cerro and especially on the Loma where it is sown along the edges of most of the lands to prevent erosion.

In the case of our Loma test field, for example, the owner had sown 25 maguey plants entirely around the field, of which one plant was producing at the time of study. The maguey here has two functions: as erosion control and to make pulque. Only those farmers who have holdings on the Loma possess maguey and the average farmer plants from 15 to 50 in all. The pulque produced by these small holdings is mainly for family consumption, especially used for guests as most publicly-sold pulque is of rather poor quality due to mixing with

other ingredients.

The maguey is a cactus-like plant with long spreading roots as have most arid country plants. The large parent plant sprouts scores of tiny seedlings called hijos which are selected, uprooted, the roots shaved and then left to dry in the sun. They are ordinarily uprooted in February, March or April and sown around the bancal in September. No fertilizer is used, but careful weeding of the area around the plant is a prerequisite for best results. At San Gregorio carefully weeded maguey plants will reach about a meter in neight and start producing in about seven years. Wild maguey takes much longer, 20 to 25 years. The young plant is sown in deep (50 cms) pits excavated with hoes to give it a humid footing for the first months of growth. Maguey plants, once they start producing the agua miel, are milked twice a day. A single plant at San Gregorio gives on the average four to six liters of agua miel a day for a period of four months and then must be replaced. Six liters of agua miel yields about four of pulque. This beverage is of great importance in the life of the San Gregoriano and the average farmer drinks personally two to four liters a day. Each laborer, aside from salary, must be paid three liters a day of pulque which for the San Gregoriano means a cash outlay of an extra peso as he rarely produces enough for laborers. Aside from its definite food value the average farmer considers pulque a good combination stimulant and sedative and helps relieve the monotony of his arduous daily labor in the field.

A single yielding plant then will just about provide a man with his daily supply. As a plant needs seven years to mature and yield for only four months a simple calculation may be made that a man

must have at all times at least 21 plants in various stages of growth to insure a permanent supply. For the average family this would be increased at least two- and probably three-fold as even women drink it. A holding of at least a half hectarea of bancal on the Loma is then necessary for a family to have a permanent supply. The average farmer, however, holds much less than a half hectarea of Loma, and many none at all, so pulque is an important import.

## Ejido Cultivation

In 1924, as a result of the great land reforms following the Agrarian Revolution the economy of the village received a tremendous boost due to the addition of approximately 400 hectareas of rich dessicated lake bottom lying to the north of the chinampas. These lands are the only ejido lands of the village, the other lands being entirely private property. This land is considered by the San Gregorianos as the maize granary of the village and most of the local maize consumption comes from the ejido area. With the exception of the chinampas I have never seen a more productive maize crop anywhere in Mexico to equal that of these lake bed ejidos. These lands should be classified rather as Tierra de Humedad than Tierra de Temporal. They are rich black deep soils, almost entirely of organic origin and with a natural humidity. These lands are sown in March as in the case of the Canada maize and Chinampa proper. In recent years, however, with the general progressive dessication of the Mexican valley as a whole this natural humidity is rapidly disappearing and the year of my visit was a poor year from the point of view of rainfall. The result was that the chahuiztli invaded the dessicated milpas and in some areas as at Tlahuac almost the entire maize crop on the ejido was lost.

Informants from both Tlahuac and San Gregorio insist that the chahuiztli was unknown in the southern valley until about 1950 and that from 1924 to 1950 they never lost a crop on these ejido lands. The chahuiztli is a fungus pest which comes in force during drought periods and spreads like a plague from milpa to milpa. The maize plant starts to dry, turns brown and dies. It evidently, to date, has not affected the abrileno or April-sown corn on temporal lands. This latter corn is drought-resistant, unlike that sown on the ejido which is of the chinampa type. Once under way its spread is incredibly fast. When I studied at Tlahuac in June and July approximately 20 percent of the ejido was infected. Within two months following - August and September - at least 70 percent of the ejido was infected and the plague was making rapid inroads into the chinampa zone. (In Tlahuac most of the chinampas today lack water due to the draining of water sources to provide the City of Mexico.) In November I was informed by the Secretario Ejidal that the ejido crop was a total loss and that the chinampa maize suffered very heavy damage.

The ejido of San Gregorio is divided up into parcels and each parcel doled out to a family. The parcels are labelled "de primera", "de segunda" and "de tercera" according to the distance it lies from the humid chinampa zone, the more favorable parcels being just off the chinampas and termed "de primera". The parcels of primera and segunda measure 380x16 meters, thus similar in shape to oversized chinampas. Those of the classification tercera are 480x14. The areal measurements are therefore .6, .6, and .67 hectareas.

One test milpa was "de primera". In recent years the owner has been harvesting on this land an average of 15-17 cargas or 25-30 cargas

per hectarea, a very good yield for highland Mexico. This is about the same yield as the highest canada yield. He stated that for several years after he received the parcel he was harvesting up to 40 cargas per hectarea, which surpasses even our chinampa yields and equals the best yields of the American corn belt. These were then of course yields for virgin soil. The maize on the ejido today looks about as productive as that of the chinampas. The plant itself appears as vigorous, the hills are spaced the same, the same number of stalks per hill and ears per stalk, often totalling eight to ten ears per hill.

However these were exceptional yields even for the ejido and all parts of the ejido do not yield equally well. Those parcels near the north shore of the lakes, for example, often have a high salt content in the soil and some will not even support a maize crop. My data from Tlahuac shows a great range of productivity. One holding of 2.4 hectareas yields an average of but 5-8 cargas per hectarea or 600 (or 750) to 960 (or 1200) kgs per hectarea. Another field yields an average of 16 cargas per hectarea or about that of the fertilized loma parcel at San Gregorio. Nearer Mixquic the parcels yield as well as "Tierra de Primera" at San Gregorio.

The report of the Mexican government on ejido production for the Xochimilco delegation ejidos as a whole indicate a general average of 1885 kilos per hectarea, and for Tlahuac 1973 kgs. These figures seem reliable,-most official data is much too low - and check well against our general range of production.

The ejido parcels at San Gregorio are not fertilized and in general not rested, and maize is normally the only crop sown. Many farmers cultivate their ejido parcels with the same tools they use

in chinampa cultivation - coa, hoe and shovel - rather than the plow.

## Solar Cultivation

Another theatre of agricultural activities at San Gregorio is the solar or village house lot. These are extremely small parcels as our village population density data indicates. I completely mapped and measured one test house lot with a total surface area of 400 square meters. This lot was longer in one dimension than the other and split into two almost equal parts by an intervening house lot. The larger segment is occupied by the house, kitchen, granaries, and work spaces of the owner, with but a few cultivates, mainly young fruit trees and flowers. The smaller segment is entirely covered by cultivated plants with the exception of a small space devoted to pigpens, manure pit and storage of fire wood.

In this second segment, slightly less than 200 square meters, I noted the following cultivated plants: nopal, nine all in their final years of production; two peach seedlings, neither in production; apricot, one tree still not producing; two pomegranates, one in production; two fig trees, one starting to produce; one orange seedling; one chayote in its final year of production. Other trees often found in the chinampa area are the apple and pear. With the exception of the chayote and nopal all of them are of old-world origin and there must have been a definite scarcity of fruit in the area in pre-Spanish times.

Sown in front of the house in the larger division of the solar are six seedlings, none in production: one orange, three fig, one pomegranate and a chirimoya.

All of the seedlings except the nopal were first sown in chinampa seed beds and later transplanted in the house lot. To protect the

seedling from fowl a broken pot neck and upper body sherd is usually half buried in the ground and the seedling sown inside it. Some may be sown in baskets. The young trees are carefully watched, and frequently irrigated by hand, a ring of stones often being placed a round the base to help retain water.

The other house lot which enters and splits Number 1 into separate halves possessed the following cultivates: two chayotes, three fig trees, three granada trees and approximately thirty nopal, all except the chayotes being seedlings not yet in production.

From my general observation of house lots at San Gregorio, Tlahuac, Mixquic, and other villages I would say that both of these house lots are exceptional in the number of cultivates. Most lots have very few or no cultivated plants.

Below we present a brief description of techniques of cultivation of the two solar cultivates which are of native Mexican origin - the nopal and the chayote.

Nopal Cultivation: The nopal is undoubtedly the most important fruit plant grown in the Valley of Mexico and is probably a native of that area - wild nopal or as it is called nopalillo (little nopal because of the smallness of the fruit of the wild varieties) is quite common on the terraces of the Cerro behind the village. It is quite generally found in wild and cultivated state throughout the Valley, especially in the arid northern zone. It, like the maguey, is adapted to semi-arid climates and will yield even on the driest stoniest soils. I have seen it in the east coast in Tabasco but it does not yield fruit in wet climates. It is economically of great importance - in pre-conquest times undoubtedly of even greater value to the Valley farmers - the

fruit being consumed for its high sugar content and the leaves as a green vegetable. Besides being important in his diet, it is useful (because of its spiny leaves) as a corral for livestock or to protect milpas from livestock. Finally, both the fruit and leaves are an important cash crop.

In the test solar I stated there were nine matas, all in production. All of them - and the majority of the nopal in San Gregorio - belong to a single variety called locally "Nopal Casero". Two field or wild types are known in the village, called locally tepozpapalotl and pipitza. They differ chiefly from the cultivated variety in the smaller size of plant and fruit and in their more spiny leaves. The nopal is a cactus-like plant with hollow woody stems and branches and flat, rounded, fleshy leaves covered with spines. These leaves or pencas fall from the mother plant in the summer. A small root sprouts out of the base and inters itself in the soil; as the plant grows the penca gradually lifts itself upright. At this stage the farmer selects the healthier-looking pencas and sows them in seed beds half a meter apart. They are continuously irrigated during the early stages of growth which is much faster than the wild nopal. This is done by buckets, usually by the women if the nopal is in the solar. As the plants grow, the smaller, weaker seedlings are weeded out to select the better ones and give them more room to grow. The large producing plants of the test solar are spaced about a meter and a half to two meters. As the selected plants grow they spread out and start throwing out hijos underneath, forming a veritable jungle of nopal so that it is often difficult to count individual plants. No one as far as I know feeds nopal plants in San Gregorio. One of my informants' are

approximately 25 years old and the mass of interlaced nopal has an average height of about 2-4 meters and covers an area of approximately 20 $m^2$. Cultivated nopal start producing in the third year of growth and reach their best production in the two or three years following. The production beyond twenty years is considerably lower; my informant plans to clear out his 25-year plants next year and sow new ones. He stated that a single mata when in the best years of its production will give in a year an entire huacal of nopal-tunas or fruit. A huacal is a wooden crate of regular size used to sell several classes of agricultural products, and he stated it would hold about 300 tunas. The tunas are either sold by huacals or units of 100 fruits. His nine 25-year-old nopals together last year gave him but two huacals in all. The nopal has the distinct advantage of yielding fruit over an exceedingly extended part of the year, from April until the end of autumn, so that the farmer is insured an excellent source of sugar food through most of the year. The wild nopal gives during the winter months and is drawn upon to ease the shortage during those months. These wild tunas are much liked in San Gregorio because of their sweeter, stronger flavor, especially the pipitza. Aside from the Casero a second cultivated variety is sporadically found in the village but is not very well liked. It is called "Nopal Colorado" because of the reddish color of the fruit; they say, however, that it does not give much fruit and the leaves are not edible. It probably is a nopal from outside the immediate area of Southern Valley.

Chayote Cultivation: In modern San Gregorio the chayote is sown in two situations, in the house solar or in the chinampas. The chayote is a grape-like vine (in its general appearance, size and

growth characteristics) which in the chinampas is sown at the base of the sauce or huejote trees sown along the edge of the chinampa to retain its soil The trunk provides the chayote with its climbing support. In the solar poles are sown to give it climbing support. The chayote is not found wild in this area. It, like the nopal, is a very important plant in that it provides for a much-needed lack in the diet of the San Gregoriano - fresh greens. It produces a large avocado-like fruit in shape and size, is either dark green in color with small dull spines, or a light green and lacking them, is cooked - usually boiled in stews - and has a delicious flavor similar to cabbage or cauliflower. The plant is sown from a sprout which emerges from the fruit. The vine starts to produce fruit the first year although in small quantity. The highest production is reached in the third and fourth years and drops sharply in the fifth year. The plant is usually replaced in the sixth year of its growth. The root of the chayote is also eaten and has a potato-like flavor. The season of fruit production is from August to October at San Gregorio.

Three types of chayotes are known at San Gregorio, of which only two are grown in quantity - a dark green spiny variety and a pale green spineless type. The third is a spiny type but rarely found in the village.

## Chinampa Cultivation

### General Description

Agriculture at San Gregorio, even of the rainy season type, indicates clearly the campesino's ingenuity and ability to manage his lands to achieve maximum possible productions, but his true ability as a cultivator may only be appraised by an analysis of chinampa cultivation.

A number of excellent technological studies have been carried out by other enthusiasts but no one to date has examined in detail the economic aspects of this fascinating agricultural system. The best studies of the latter type have been those of Santa Maria and more recently Armillas and West. In this analysis I will draw heavily on both of these sources for data on technology and present new data gathered by myself. I will then attempt to appraise the economic aspects of chinampa cultivation as seen by the present author.

Chinampa cultivation is a highly specialized system of cultivation, limited in its exact form, as far as we know, to the Valley of Mexico.

The fundamental characteristic and which gives it its specific character is the chinampa itself. A chinampa is an artificial island, constructed by hand by piling up lake mud or earth and lake vegetation in alternate strata to raise its level above that of the lake. Important geographical prerequisites are fresh water lakes fed by springs, with an outlet to facilitate drainage and prevent salts from concentrating, and with shallow depths permitting chinampa construction and supporting a dense aquatic vegetation.

The soil is entirely organic in origin and extraordinarily fertile. The spongy porous quality facilitates natural drainage and irrigation, presenting ideal conditions of humidity for crop growth.

The main characteristic of cultivation of these artificial islands is its intensity with purely hand techniques. Tools consist of hoe or shovel-like implements. Irrigation, especially during the dry season, is a further characteristic, again done by hand-pole and bucket in this case. The chinampa is of course surrounded by water

and irrigation is carried out by simply dipping containers in the water and tossing it on the field.

A further characteristic is continuous cropping, year after year bv a great variety of crops. This is made possible by the extensive use of seed beds, and mixed cropping along with crop rotation is characteristic. Several crops, up to four, may be sown a year, and the longest period a land is rested is not over three months and even here this long a rest period occurs but once every three or four years.

One of the fundamental features of chinampa cultivation is the use of seed beds. This is the key to the economy of chinampa cultivation and enables him to sow from two to four crops a year and earn as high as 1000 pesos on a tenth of a hectarea of land. One can appreciate more the significance of this cash return when one realizes that the average farm laborer in the Valley receives five pesos a day and the city worker from eight to ten.

Finally we have the abundant use of fertilizers which enables him to carry on continuous cropping of a permanent type. By almost annual additions of fresh soil from the bottom of the lake plus abundant use of aquatic vegetation as green fertilizer, chinampa fertility is carefully maintained. Animal fertilizers are rarely used, bat dung for chile and tomato cultivation being the only important exception.

Geographers define intensive agriculture as a system in which an enormous amount of time and labor is expended per unit of land. In this sense chinampa cultivation can only be equalled by the wet rice cultivation of Japan or the Yangtze Valley in China.

## Chinampa Distribution and Manufacture

At the time of the conquest the chinampa area was quite extensive.

We shall not discuss this in detail here as it falls more properly in the section of pre-Spanish agriculture. I will simply state here that most of the surfaces of Lake Chalco-Xochimilco along with large areas around Tenochtitlan in Lake Texcoco were converted to chinampas. The area declined considerably during the colonial period due to the total population decline of the Valley following the conquest, but still was large enough to supply the urban market of Mexico City with most of its fresh vegetables and continued to do so up until the early twentieth century. Even today the chinampas are one of the key food sources for vegetables at Mexico City, especially during the winter and spring.

The functioning chinampa area today, however, has shrunken considerably. Much of the old lake bottom still preserves the form of the chinampa area but many canals are dry and vegetal fertilizer is scarce so that two fundamental traits of chinampa cultivation, continuous cropping and irrigation, are no longer possible.

This decline is in direct ratio to the growth of the huge urban colossus of Mexico City, now over 2,000,000 inhabitants. As the city has grown the Valley has become dessicated. Most of the springs which formerly fed Lake Chalco-Xochimilco have now been collected into one huge tube and the water conducted to the city, leaving most of the chinampas high and dry. The only community today with abundant water is San Gregorio Atlapulco and this only because there are scores of small local springs just off the old lake shore, the volume of which is too small to interest the federal government but enough to feed the 400 hectareas of chinampas owned by the villagers.

The great northern Chinampa zone of Ixtacalco, Ixtapalapa,

Mexicalcingo and Culhuacan, studied by Santamaria, is no more, now being covered by urban constructions or is dessicated lake bed. The Tlahuac chinampas are almost without water today, Mixquic is in almost as critical a state and Xochimilco, the queen of the chinampa communities, is almost entirely dessicated. The chinampa zone of Xico-Chalco is no longer in existence.

Today limited chinampa cultivation is practiced at the following communities: Xochimilco, Acalpixca, Atlapulco, Tlaxialtemaco, Tulyahualco, Ixtayopan, Tlahuac, Tetelco, Atzompa and Mixquic. Atlapulco has most of its chinampas in full production.

At the time of my study and also of that of Armillas chinampas were no longer being made. We have, however, an excellent account in Santamaria which we translate below:

"To start the manufacture of a chinampa, the first step is to look for a 'cimiento' (literally a basement), this operation is very easy, and consists of sounding the bottom of the canal with an oar (paddle) until a point on the bottom is located of lesser depth, then with the same paddle they find the limits of this cimiento marking its perimeter with long stakes or 'carrizos'.

"Above this cimiento they go extending strata of earth and 'cesped' (aquatic vegetation) until they raise it above the water level.

"The cesped grows in the so-called 'cienagas' which occupy large areas, and consists of a mass of aquatic plants, especially the lirio (lily - Hitckoria coerulea), which grows in such compact masses that one can easily walk on them without sinking. To use this cesped they cut it with shovels or coas (the cienagas are shallow swampy sections

of the lake).

"The earth used in making the chinampa is taken from ancient chinampas which as a result of the cultivation they receive, as later we shall see, have grown so high above the water that they are difficult to cultivate (that is to irrigate - the growth of the chinampa is due to the practice of adding mud and aquatic vegetation periodically to fertilize it).

"Once the chinampa being made has reached a height of 20-25 centimeters above the water level, they plant cuttings of sauce or huejote (Salix - a tree which grows to considerable height but in which the branches grow up almost vertically, thus do not cast much shade) on the edges with the motive of consolidating the soil (prevents erosion). The cuttings are planted at intervals of 4-5 meters.

"Once the sauces are planted the chinampa is ready for cultivation.

"Four years after its manufacture, the decomposition of the organic matter is almost complete, 'ya se hizo tierra' (now land is made) according to the expression of the natives.

"The dimensions of the chinampas depend in great part on the extension of the cimientos. The width is small with the objective that the water, by infiltration, can penetrate to the center of the chinampa.

"Generally they are small, fluctuating in size from 5x3 meters up to 900x6; these latter are rare and found in Ixtalapa. The average surface area can be estimated at 90 square meters.

"All the labor necessary for chinampa manufacture requires great patience and industry, qualities which abound among the cultivators."

The chinampas may be quite irregular in shape but in general they form very long, narrow rectangles. At San Gregorio the average chinampa is from 6 to 10 meters wide and 100-200 meters long with a general probable surface area averaging 1000 $m^2$. At Mixquic Armillas notes frequent cases of additions to this basic rectangular pattern, some chinampas being L- or U-shaped, but the general rule of narrow width is universal. At Mixquic, where Armillas did most of his research, the size of the average chinampa is much less than at San Gregorio; here we have extreme irregularity of pattern, numerous tiny chinampas, extreme fractioning and dispersion of holdings, the total effect being that of an incredibly complex maze of tiny chinampas and winding canals. At San Gregorio the chinampa area looks more like a planned colonization with canals and fields forming a vast checkerboard (with long narrow rectangles instead of squares of course).

As both Santamaria and Armillas point out, the narrowness of the chinampa is to facilitate natural humidity absorption. The soil being rather porous and spongy, due to its origin, the narrow width enables the water from the canals on all sides to soak into the center. The narrow width also facilitates hand irrigation from boats.

Most of the chinampa areas are just off the ancient lake shore as in the case of Xochimilco and San Gregorio. At Mixquic the chinampas completely cover an ancient bay. The only modern exception is Tlahuac situated on an isla nd in the center of the lake, which is surrounded on all sides by chinampas. In pre-Spanish times there were several island centers of chinampa cultivation such as Xaltocan in the northern Valley, Tenochtitlan itself and Mexicalzingo.

In the early stages of chinampa colonization there are numerous

patches of open water and cienagas and some outlying chinampas may actually appear as separate little islands. As the colonization progresses, however, large segments of the lakes become converted into a network of canals and fields, the canals usually only about two meters wide or even less. Larger wider transport canals 4-5 meters wide cross and interconnect chinampa zones providing an intricate highway system. One of the most important tasks is keeping these canals free of vegetation.

Informants at Tlahuac stated that chinampas in the old days were made by mutual aid groups of four to six men. They estimated that a chinampa measuring 8x200 meters could be manufactured in about eight days with this size work team.

## Chinampa Crops

The variety of crops grown today on the Chinampas is extraordinary. This is especially true of San Gregorio as the chinampas there are in full-time production.

The following crops are under cultivation there: Aboriginal cultivates - maize, squash, tomato or jitomate, tomate, frijol calnario (a yellow-brown bean), stringbean, chile pepper, chilacayote, chayote, quilites (a green, now rarely sown, being replaced by European vegetables) and huazontli (a seed bearer which today is an escape from cultivation, growing wild on the slopes of the chinampas), and finally the frijol negro or black bean; European cultivates - cauliflower, cabbage, spinach, alfalfa, celery, lettuce, broad beans, carrots, turnip, radish, onion, cucumber, beet, peas, parsley, coriander, salt-wort, and mint.

Aside from food plants a large number of flowers are sown, being sold cut and potted. An even greater variety is under cultivation

at Xochimilco which has been a specialized flower-producing center since pre-Spanish times. The most important flowers cultivated at San Gregorio are violets and carnations.

In San Gregorio today the most important crops are maize, tomate, string bean, squash, cauliflower, cabbage, spinach, celery, lettuce and coriander. My informants at Tlahuac stated that most of the European cultivates were of minor importance until the present century, that the key cash crops before were chile and jitomate.

## Irrigation at San Gregorio

This is one of the basic characteristics of Chinampa agriculture. I have already stated that the natural porosity of the almost vegetal soil and the narrowness of the plot permit natural irrigation. This supplemented by hand techniques of artificial irrigation enable the San Gregoriano to keep his field in continuous cultivation in spite of the long dry season.

As we have noted in our introductory section the rainy season in the Southern Valley begins in May with a few sporadic showers, really gets under way in June and tapers off sharply in October. From November to April rainfall is insufficient to promote crop growth. It is during this season that artificial irrigation is mainly employed and this is also the most profitable season for the farmer as the chinampas are practically the only source of fresh vegetables during this part of the year. Irrigation is also employed with crops whose main growing period is during the rainy season when those crops are to be sown in March and April before the rains start. This is often the case with maize, the idea being to give the plant a head start to avoid damages from early frosts. In this case the crop is periodically irrigated until the rains get under way and is then maintained

by rainfall alone. Irrigation is also resorted to during the rainy season for all crops if there occurs a prolonged drought period. The techniques are entirely hand ones.

One system, most often used, is by the use of a heavy pole with a cloth bucket hung from the slender end of the pole. The chinampero stands on the edge of the chinampa, grasps the pole somewhat below the actual center, dips the bucket into the canal and waters each plant individually. By holding it off-center and using the heavy free end of the pole as a counter-weight he reduces somewhat the work involved in lifting the weight of the bucket, although irrigation by this means is always arduous. Generally he works from each side only to the center of the chinampa, moving over to the opposite canal to finish the job. I have seen some farmers use just a metal bucket, dipping it into the canal and watering plant by plant. A third more casual method is to paddle along by canoe in the bordering canal and splash water up on the chinampa with the canoe paddle, irrigating half way and then doing the same thing from the canal on the opposite side. This system is often a very casual, almost unconscious, one; the chinampero often in just passing by his chinampa may splash water up en route.

During the dry season the San Gregorian often constructs low walls of mud around the edge of the chinampa to retain water. He may even build partition walls within this to further equalize the distribution of the water. During the rainy season when drainage is more of a problem than drying out he usually constructs parallel flat-top ridges, "Camellones", running across the width of the chinampa, and sows the plants on top. This is especially done for

vegetable cultivation.

Irrigation is a laborious back-breaking job and most chinamperos who hold a sizeable amount of land look for hired help when it has to be done. I collected data on time involved in chinampa irrigation which is briefly summarized below.

During the dry season a chinampa is irrigated once or twice a week. With maize three to four plants are watered with one bucket of water. An informant from Tlahuac stated that he could irrigate his three small chinampas, if sown in maize, in one day. These chinampas measured 50x6 meters, 150x6 and 100x4, a total surface area of .16 hectareas. Altogether these chinampas yielded 500 cuartillos of maize. Another informant from San Gregorio stated that he considered one of his big chinampas a "tarea del dia" (work day) for a peon. This chinampa measures .2 hectareas, somewhat larger than the three together from Tlahuac. Vegetables at San Gregorio during the early stages of growth are irrigated every three days; later on this is decreased to once a week. The exact number of irrigations and thoroughness depends on a number of factors: the height of the chinampa above water (reducing natural absorption), its age or condition of soil, and most of all on the precise rainfall condition of the month in question. Under a theoretical situation of complete drought and no hired labor, a man could hardly keep much more than half a hectarea under commercial production due to the labor involved. Actually the situation is alleviated by a wet, rainy season in the summer and abundance of cheap part-time labor mainly from the Valley of Toluca.

## Maize Cultivation

One of the most important crops on the chinampas

is maize. The cash return from a maize crop is so low as compared to vegetables that it seems puzzling that the chinampero bothers to sow it at all. As Armillas has pointed out this is in part a basic feeling of insecurity in the farmer about market prices and commercial agriculture in general, so he sows at least one chinampa in maize, just as insurance. Thus if the vegetable market drops and his temporal crop fails he at least has some maize for his home needs. At San Gregorio this factor is not as important as at Tlahuac because many farmers have first-class temporal lands for maize cultivation and loss of their temporal crop is rare. Actually, in the case of San Gregorio there is an even stronger reason. After double and triple vegetable harvests over a three- or four-year stretch even the fertile, abundantly fertilized chinampas show signs of wear and the chinampero then "rests" the land for a year by sowing maize and then reverts back to a second period of heavy vegetable cropping.

Today maize is not usually transplanted, being seeded directly into the chinampa. In Armillas's time it was sown first in seed beds and later transplanted to the chinampa. Today this is very rarely done. Also irrigation, even of the young plant, is often not done, so that maize cultivation is not really chinampa cultivation in its strict sense in modern San Gregorio. We might rather class it as a "humedad" or "jugo" crop. In Santamaria's time it was both transplanted and given irrigations and his somewhat higher yields may in part be due to differences in cultivation care.

The usual situation in maize cultivation today at San Gregorio is as follows. After a chinampa has been sown in vegetables for a two- to four-year period, the final harvest being made in December,

the land is given a three-month rest from January to March. Toward the end of March the chinampa is given a thorough working with the hoe. It is then seeded by poking holes with the coa and dropping four to five seeds in each hole. The rows are spaced about .8 meters apart and the plants or holes in each row are spaced about .5 meters. Approximately a cuartillo of seed is used per .1 hectarea or ten cuartillos per hectarea. Seeds are selected from the largest ears of the previous harvest, only the large middle grains being used, and are not germinated before sowing.

Following sowing the only labor involved in maize cultivation consists of (1) hilling, done in June, and (2) one or two weedings and cultivations. Once the maize has a good start weeds rarely can get going as the foliage is very luxuriant and the ground very well shaded. Hilling according to the chinamperos is done to give the maize plant a better chance to resist the stormy downpours which often come in late summer. With chinampa maize this factor may be important as plants often reach heights of 4-5 meters. It may also be a feeding technique.

The harvest generally falls around November.

At Tlahuac the informants offered the following schedule for the old days. In February the maize seed was sown in seed beds. In March the chinampa was hoed and fertilizer, including cattle manure, agualodo and huachinango, was added. Toward the end of March the young plants were transplanted and placed in the chinampa. Squash and frijol were sown along the edge of the milpa. Neither in Tlahuac or San Gregorio are other crops sown mixed with maize. During April, May and June periodic irrigations were given, up to twice a week

during the early stages. A cultivation was given in April, and in May a weeding followed by hilling. Finally in October a final cultivation was given followed by the harvest in November.

Maize yields from the chinampas are extremely high. From each hill grow three to five vigorous stalks often reaching a height of 5 meters, and each stalk yields an average of one to three ears. From a single hill are harvested at least seven to ten ears and they are of good size. One chinampero told me he extracted a kilo of seed from seven of the larger ears.

I collected considerable data on yield from both Tlahuac and San Gregorio Atlapulco, all given in bultos per chinampa. Most informants stated that a bulto is 50 cuartillos of seed (one dissenter said 40) and that a cuartillo is 1.5 kilos of seed. A bulto was also stated to be half a carga - the common measure at the Teotihucan valley. My own feeling is that the weight of a cuartillo varies from 1.2 to 1.5 kilos with rainy-season maize due to the variability of seasons but irrigated crops or humedad crops should produce maximal quality maize all of the time. The figures in the chart below are based on the 1.5 conversion. They may need revision downward about 20 percent if my hunch is incorrect. The numbers to the left refer to specific informants of which data was obtained from five. To avoid naming them directly I use a number designation.

| Informant No. | Size of Chinampa (hect.) | Yield | | | |
|---|---|---|---|---|---|
| | | Bultos per Chinampa | Cuart. per Hect. | Kilos per Hect. | Bushels per Acre |
| TLAHUAC - PRE-DROUGHT PERIOD | | | | | |
| 1 | .32 | 25 | 3700 | 5550 | 76 |
| 2 | .10 | 5-6 | 2500-3000 | 3750-4500 | 50-60 |
| 2 | .16 | 10-12 | 3100-3700 | 4650-5500 | 62-75 |
| 1 | .10 | 5-6 | 2500-3000 | 3750-4500 | 50-60 |
| 2 | .16 | 10 | 3100 | 4650 | 62 |
| 3 | .16 | 15 | 4650 | 6300 | 92 |
| TLAHUAC - PRESENT YIELDS ON DESSICATED CHINAMPAS | | | | | |
| 1 | 2.0 | 90 | 2000 | 3000 | 45 |
| 2 | .36 | 21-28 | 3000-3300 | 4500-4950 | 60-70 |
| 4 | .40 | 25-30 | 3300-4000 | 4950-6000 | 60-75 |
| 2 | .26 | 8-9 | 1600-1700 | 2400-2550 | 30-35 |
| SAN GREGORIO - MEASURED CHINAMPAS IN FULL PRODUCTION | | | | | |
| 5 | .2 | 10-12 | 2500-3000 | 3750-4500 | 50-60 |
| 5 | .21 | 10-12 | 2400-2900 | 3600-4350 | 48-58 |
| 5 | .10 | 5-6 | 2500-3000 | 3750-4500 | 50-60 |
| 5 | .12 | 8 | 3300 | 4950 | 66 |

Santamaria's general estimate was 200 to 1 and 80 hectoliters per hectarea. This calculates at about 225 bushels per hectarea or 90 per acre. Only one informant, at Tlahuac, claimed that high a yield even for the old pre-drought chinampas.

My own feeling about the data offered by the chart may be summarized as follows. My data from San Gregorio was based on a first-class informant, whose chinampas are still functioning and under heavy vegetable cultivation. The data is from his estimates on chinampas measured by the author and check internally comparing chinampa with chinampa. The data from this source indicates an average production of about 4000 kilos per hectarea using the 1.5 conversion. The cuartillo of chinampa maize must average close to this upper figure as it is maize of the best quality found in the Valley, but even if we must reduce our conversion ratio to 1.2 his chinampas are

still yielding at least 3500 kilos per hectarea.

Data from the Tlahuac informants in general checks very well with our measured fields at San Gregorio. The estimate by informant 2 of 50-60 bushels per acre and informant 1 of the same estimate is not based on any particular chinampa but was based on their questioning the old people of the village as to the average production per "cuartillo" of land (.1 hectarea) in their time. The estimates are exactly the same as those of measured fields at San Gregorio. In all other cases the yields are based on individual chinampas, the size of which were estimated by the informants. Even so only one seems probably incorrect: that of informant 3 (although it checks with Santamaria).

I believe we can safely say that maize in the chinampas yields a minimum of 3.5 and more probably 4.0 tons per hectarea, with the possibility that under more intensive care, especially with irrigation, this estimate may need revision upward.

This average represents the highest average long-range maize yields in modern Mexico with the exception of government experimental hybrid maize sowings which often go over 5 tons per hectarea on highland soils.

## Soil Fertility

One of the major problems facing chinamperos is the maintenance of soil fertility under the extraordinary intensity of cultivation. As has been stated, at least two and at times up to four sowings and harvests may be made of vegetables in a single chinampa in one year, and also the seed is sown in extremely concentrated amounts per unit of area. The result is an enormous production per chinampa per year and the consequent drain on the soil is very heavy. The soil itself

due to its organic origin undoubtedly is one of the most productive soils in the world, and the humidity conditions are ideal. Maintenance of soil fertility is accomplished in two ways: by artificial fertilization and by crop rotation.

A number of fertilizers are used in chinampa cultivation but those of vegetable, especially aquatic, origin are the most important. As has been stated the ancient lakes, because of their shallowness, were covered by a thick mat of swamp vegetation which was utilized in the actual manufacture of the chinampa. "Tule cuadrado" was the most important single plant and aside from its use in chinampa manufacture was up until the twentieth century heavily used for fertilizer. In the old days there probably were abundant sources of aquatic vegetation, especially in those sections of the lakes unoccupied by chinampa cultivation. Tepalacate, a small, round-leafed, floating plant, is another ancient plant heavily used for fertilizer. The most important plant, however, in modern days is the introduced Huachinango, a water lily bulbous-like plant which furnishes the best fertilizer of all. Today with the increase in chinampas followed by the complete dessication of most of the ancient lakes there is a shortage of aquatic vegetation, and one of the important disputes is over its utilization. Today most chinamperos stake off the entrances and exits of those canals alongside of their chinampas to prevent floating away of the vegetation. A common sight is to see a canal with the mouth staked off and choked with a mat-like covering of huachinango except small patches of open water near the two mouths of the canal where it disembarks into wider transport canals. This is due to theft of the fertilizer by some other chinampero passing by

and disputes may be quite heated over this petty larceny.

One of my informants, from San Gregorio, gave his fertilization schedule as follows. In September of each year he, with one hired peon, working together fertilized one of his chinampas. This was done in sections, that is, the entire chinampa was not fertilized each year, only a fourth or fifth of its area. The entire chinampa received a complete cap of aquatic fertilizer once every four to five years. This is done using large pitchforks, the vegetation being scooped out and later distributed over the section. It is done in September to prevent the rapid drying-out of the fertilizer which would occur for example from late spring to early summer. A section of one of his big chinampas (.2 hect.) was fertilized in one day. I was told that formerly when aquatic vegetation was more abundant, much more fertilizer was added with resulting higher production.

Aside from aquatic vegetation animal fertilizers are used, although sparingly. In San Gregorio animal fertilizers are not used as the organic content would pass the tolerance point of the soils. In Tlahuac, however, cattle fertilizer is used on the drier chinampas where aquatic vegetation is exceedingly scarce and the soils are wearing out. In the old days an important type of fertilizer was bat dung which was brought from Morelos and Guerrero, especially for chile and tomato cultivation. This was especially used in pre-vegetable days not only on the chinampas but on Teuctli for chile cultivation as well.

One of my informants remembered that approximately twenty years ago mule trains still arrived at San Gregorio from Guerrero. Twice

a year a mule train of 50 to 60 burros, each loaded with two bultos of bat droppings, arrived in a three-day trip. These were joint projects, each muleteer owning three or four animals and travelling in large groups for protection against bandits. Today chicken droppings have to a great degree replaced bat guano for chile and tomato cultivation.

Aside from these sources the chinampero often adds what he calls agua-lodo (mud-water) to his chinampa soil. Using the described irrigation pole and bucket, he scoops up liquid mud from the canal bottom and throws it on the chinampa. A less formal technique is hoeing under the dying remains of crops, such as maize leaves and stalk (the latter, however, is also exploited for fodder to feed solar cattle or to sell to nearby ranchos).

There is some evidence for pre-Spanish days of the use of human fertilizer for agriculture. All informants questioned on this point denied its use in their village, but then immediately started telling tales about its use in other nearby communities. Tlahuac informants, for example, told me that in the old days they worked as oarsmen hauling human droppings from the city of Mexico to Tulyahualco two kilometers south of Tlahuac on the old lake shore, to be used in chile and jitomate cultivation on the Teuctli slopes. Others stated that it is today shipped to Puebla from Mexico for use in chile cultivation in nearby villages. In the solar of a San Gregorian informant he has a pig pen with a manure pit alongside which I was told was for the pigs and fowl of the solar. On another occasion, for curiosity's sake alone, I asked him where he and his family went to defecate, and he pointed out the manure pit! The same man vigorously

denied the use in his village of human offal for fertilizer. Evidently it is used, in an informal way, for fertilization but today plays a very minor role.

The other basic technique to maintain soil fertility is crop rotation. We have already seen that it was employed by the San Gregorian farmer in temporal cultivation on the Teuctli slopes. It can be stated that he understands the basic principle of it - at least he knows how to do it and what the results are if not the chemical process involved - and that he uses it whenever necessary to his family economy.

In chinampa cultivation this technique is more generally used and more thoroughly carried out for obvious reasons. In the old days before the wholesale acceptance and production of European vegetables it was an important and well-known technique. Maize was alternated with tomato and chile; one informant with two chinampas simply reversed the crops each year, one year maize, second year double crops of tomate and chile on each chinampa, while one was sown in maize the other in the two crops mentioned. In this way he was ensured of a subsistence and a cash crop each year. His father owned eight chinampas and sowed all in maize one year, then four in maize and four in tomate and chile the second year. This data is important because the crops are entirely aboriginal, the technique is before the introduction in quantity of European vegetables and seems to describe a semi-commercial agricultural economy which probably isn't far from the pre-Spanish commercial set-up.

Today the chinampero is a full-time commercial farmer and his rotation cycle more complex.

In San Gregorio I was able to secure the complete history of the four chinampas of Jose Galicia for the year 1953 with a brief statement of what was sown in 1952 and what was to be done in 1954. It is an exceedingly complicated process as we shall see. It took me approximately an hour to get the year's activity of a single chinampa.

The following chart gives the picture for 1953 pretty well. I visited and studied these four chinampas approximately the first week of September 1953 and saw what I have drawn as No. 4. Chinampa 2 was completely sown in celery and spinach intermixed. Chinampa 2 was divided up into five cultivation sections including two sections of celery and spinach intermized, with another patch holding the final remains of a squash harvest and two separated almacigas or seed beds, one in head lettuce and the other a combination spinach and coriander seed bed.

The cycle of cultivation may be easily worked out following the first three crops. Chinampas 2, 3 and 4 were occupied the previous year by a series of sowings and harvests of vegetables similar to that of the year 1953 on chinampas 1 and 2. Chinampa 1 the previous year was in maize. The previous year's final vegetable harvests were taken out of chinampas 3 and 4 around February of 1953. Chinampa 3 was then sown in maize which will be harvested in November. This is to be resown in the roman lettuce I saw in the seed bed in September. It will probably be then followed by another vegetable to be harvested in February. Chinampa 1 was sown in beets in December of 1953 following the previous year of vegetable crops. These were harvested in May and followed by celery and spinach. The celery is a long-growing crop and will not be harvested until January of 1954.

The spinach, however, will be harvested in September and another crop planted in the same chinampa to grow and mature with the final phases of celery maturation. Chinampa 2 had maize last year which was harvested in November. The chinampa was then left to rest until March of 1954 (the only case of rest over the period considered). It was then sown in celery and spinach intermixed. This celery will be ready around November. When I visited the chinampa the celery was well developed and the spinach in its second crop. He will probably squeeze a third crop of spinach or coriander this year on this chinampa.

I was told that next year he intends to sow all four in maize to give them a rest. His general practice is to sow a chinampa two years in heavy truck production and then sow in maize the third year and return to two years of vegetables followed again by maize. Actually the cycle never is exact; he goes really by his production figures rather than a set schedule. As you can see, general rotation of maize with vegetables is not the whole story; within years of intensive vegetable production the vegetables themselves are rotated, e.g., squash to lettuce on chinampa 4, beets to celery-spinach on chinampa 2. Very often while the celery goes through its long growth period instead of a double spinach crop the chinampero will sow spinach and then cylantro.

A third very minor technique of fertility restoration is resting. As you can see, however, resting of the land is never done for more than three months and usually only one. There are chinamperos with abundant land who occasionally let a chinampa rest a year or more, but this is exceedingly rare and uneconomical. His fellow chinamperos

don't approve of it and usually feel that he is just lazy (even though the heavy labor on a large landholder's land may be done by laborers it still involves considerable work for the owner). In general there is strong disapproval of letting land of whatever class lie idle, or of sale of lands - a man who does either is a "flojo" or a "tonto" (lazy or foolish).

## Plant Care

The cultivation of the tomato gives a good average idea of the intensity of care given to crops and of the amount of work going into their production. My data is from Tlahuac but cultivation is the same in San Gregorio. We must remember also that the tomato is an aboriginal crop. The seed was sown by my informant in the almaciga or seed bed in December. He always made his seed beds in his house solar to protect them against theft. This meant transporting mud and fertilizer from the canals near the outskirts of his village to his house solar. In those days the canals arrived almost to his doorstep so that the bulk of the transporting was via canoe over a comparatively short distance. After going through the highly specialized seed bed cultivation described by Armillas, the plants were transplanted in his chinampas in March. The land was first fertilized and hoed in the technique described. Then shallow pits were made at regular intervals. These were then filled with aquatic plants, then a cap of agualodo and the plant inserted. During the first month the chinampa was irrigated using the pole and bucket technique with agualodo every three or four days; later when the plant was well developed they were watered once a week. Several weedings and cultivations were carried out over the growing season. In May the plants were pruned of their lower leaves to increase their

spread - job for two to three days for one man on his three chinampas totalling .16 hectareas. The first fruit started to yield in June but the major harvests were made in July to August. When the tomato started to yield the plants were covered with dead vegetation to protect the fruit from the sun. During the harvest season a chalipa or cut was made once every eight days filling his 1x6 meter canoe. He carried this to Mexico by canoe the following day. One can see that from the moment the seed is inserted into the seed bed until the carrying of the tomato to market the plant is being almost constantly tended and cared for - nothing is left to chance. My informant added that once the tomato started to produce he lived almost continuously on the chinampa during the harvest season, stationed in a small lean-to with a shotgun to prevent theft.

## Demography and Settlement Patterns

We have just painted a picture of an ecological pattern based on an extraordinarily intensive form of agriculture with very high crop production per sown unit of land and extreme fractioning of holdings. We shall now see what the effects of such a pattern are on population settlement.

The southern Valley of Mexico as defined in the introduction is today one of the most densely populated parts of the Mexican republic and is the most densely populated of any rural area. Politically the southern Valley includes the delegaciones of Xochimilco, Tlahuac and Milpa Alta and the ex-distrito of Chalco. Geographically it would also include Tlalpan but the latter delegacion today is in a process of urbanization and so we do not include it in our population study. The censuses of 1900, 1910, 1930, 1940 and 1950 are summarized

below.

| | Area 1950 ($km^2$) | Population 1900 | 1910 | 1930 | 1940 | 1950 | Density 1950 |
|---|---|---|---|---|---|---|---|
| Chinampa Area | | | | | | | |
| Xochimilco | 131 | 42610 | 30093 | 27712 | 33313 | 47082 | 360 |
| Tlahuac | 82 | incl.in Xochim. | | 11780 | 13843 | 19511 | 238 |
| | 213 | 42610 | 30093 | 39492 | 47156 | 66593 | 313 |
| Temporal Area | | | | | | | |
| Milpa Alta | 269 | 9415 | 16268 | 12608 | 14786 | 18212 | 68 |
| Chalco | 1606 | 69478 | 71930 | 64566 | 79656 | 96767 | 60 |
| | 1875 | 78893 | 88198 | 77174 | 94442 | 114979 | 61 |
| Grand Total | 2088 | 120503 | 118291 | 116666 | 141598 | 181572 | 89 |

Two salient facts stand out in the chart. First of all, from 1900 to 1930 there seems to have been a steady population decline in the area, probably an aftermath of the agrarian revolution as the southern valley was one of the battlegrounds. From 1930 on, however, the population has climbed up extraordinarily fast, increasing fifty percent in but twenty years.

Second, there is a very sharp contrast in the population densities of those delegaciones classed as chinampa compared to units with a rainy season economy. The population density of the chinampa area is approximately double that of the Teotihuacan Valley floor, the latter area being based on an irrigation agricultural economy. Even allowing for some urbanization at Xochimilco the rural density is still over fifty percent greater in the chinampa area. The temporal area, however, in spite of the exceedingly favorable environment for the practice of rainy season agriculture still cannot compare in demographic potentiality with the irrigated Teotihuacan Valley. The population density of the temporal area is, however, considerably above that of most rural areas in Mexico and

is one of the heavier populated areas in the Meseta Central. The history of population indicates that the demographic limits under present subsistence patterns have not yet been reached. The average family in the temporal area has theoretically 8 hectareas of land (including agricultural lands, pastures and uncultivable lands) at its disposal. In the chinampa area this reduces to 1.6 hectareas.

Throughout the southern valley the bulk of the population live in nucleated settlements of either the town or village type. Although isolated livestock ranchos do exist the total number of people living in such units is very small, probably less than 2 or 3 percent.

Xochimilco may be classed as a true town and the following are either towns or town-villages: Chalco, Amecameca, Tlahuac and Milpa Alta. The rest of the communities are villages.

The congestion in these nucleated centers is about as heavy as one finds in an urban center. One has the general impression of a veneer of the Spanish type street pattern (the checkerboard grid) covering a basically aboriginal settlement type. The regular square blocks are divided and subdivided by scores of winding alleys. In some cases the Spanish organization is almost lost as in the case of Mixquic. In the case of the latter we find a very compact, densely settled village in which over 3000 people are compressed into an area of 30 hectareas. The average individual has a living space of but 10 meters square. In the center of the village is the plaza, and streets and canals spread out in thin wavy or winding lines in all directions, often becoming lost in the maze of massed dwellings. The Spanish grid is almost absent here. Mixquic is entirely a chinampa village in economy and is situated in the center of a little

bay completely covered by 400-500 hectareas of chinampas. The furthest field is only a kilometer from the village. Some villages have preserved the Spanish street pattern to a much greater degree than Mixquic as in the case of Tecomitl. San Gregorio Atlapulco represents a half-way case between the two extremes. Mixquic certainly preserves the aboriginal pattern of settlement, at least for villages based on a chinampa economy.

As has been stated the population density within these nucleated centers is very high. Utilizing aerophotos of villages in the delegaciones of Tlahuac and Xochimilco along with the 1940 census figures (date of photos) we get the following village population densities.

| Community | Area (hect.) | Density per $km^2$ |
|---|---|---|
| Mixquic | 30 | 8500 |
| Tecomitl | 25 | 7500 |
| Ixtayopan | 25 | 7700 |
| Tulyahualco | 40 | 7000 |
| Tlahuac | 50 | 6600 |
| Tlaltenco | 40 | 6700 |
| Zapotitlan | 25 | 8900 |
| Tlaxialtemaco | 10 | 7800 |
| Atlapulco | 40 | 10200 |
| Acalpixca | 25 | 7900 |

Our community densities run from 6600 to 10200 per square kilometer and all but Tlahuac are true villages.

The southern Valley of Mexico is an area of big villages, with numerous communities exceeding one thousand inhabitants. Below we summarize the distribution of population by community size.

The list includes the delegacion of Tlalpan along with the other units of our population analysis.

| Category | Number of Communities In Each Category | Percentage of Total Population In Each Category |
|---|---|---|
| Over 5000 inhabitants | 3 | 25 |
| 3000-5000 | 7 | 20 |
| 2000-3000 | 9 | 13 |
| 1000-2000 | 28 | 25 |
| Below 1000 | 63 | 17 |

Of the ten communities with over 3000 inhabitants all but four are towns or town-villages; all communities with less than 2000 are villages.

Nearly half of the population of the southern Valley live in nucleated communities with over 3000 inhabitants and 83 percent live in villages exceeding a thousand inhabitants. Even including only the completely rural communities we find that well over two-thirds of the rural population live in villages exceeding 1000 inhabitants. The greater majority of the smaller villages are situated in the zone of populatioh above 2400 meters; most villages on the lake plain are of large size.

This pattern of big villages is clearly illustrated by a brief survey of those communities situated along the old lake shore. Today there is a paved highway connecting Xochimilco to Chalco which runs along the shore for a distance of 28 kilometers.

At the western terminus of the highway stands the queen of the Chinampa communities - Xochimilco. This was the center of one of the political states of the Valley at the period of contact, and throughout the colonial period remained as an important administrative center. Today it is the capital of the delegacion, has a huge daily

regional market which serves the other villages of the delegacion, and may be classed as a town. A high percentage of the 20,000 inhabitants are farmer-chinamperos, or at any rate were before the dessication of the chinampas, but the community is full of part-time and full-time specialists.

Leaving Xochimilco the highway skirts along the edge of the volcanic foothills of the southern valley, crossing the pockets of limited lake shore plain and always within view of the man-made jungle of the chinampa zone. Actually in many places the chinampas and old lake shore almost join, the rocky massif of the mountains just allowing room for the highway and no more. Level dry land is rare and very limited here. To the north of the highway one sees continuous rocky tongues of mountain reaching out to the lake shore alternated with small depositional fans. The hillsides are in general thoroughly worked into rock-walled terraces for cultivation and the lake plains below completely utilized either for habitation or crops. To the north lies the continuous belt of canals and chinampas.

Over this stretch the highway passes through the following communities: San Lorenzo Atemoaya, population 199, 2.2 kms from Xochimilco; Nativitas, population 1872, .8 kms from Temoaya; Santa Cruz Acalpixca, population 2696, 2.0 kms from Natavitas; San Gregorio Atlapulco, population 5555, 2.0 kms from Acalpixca; San Luis Tlaxialtemaco, population 1016, 2.3 kms from San Gregorio; and Tulyahualco, population 4089, 2.7 kms from San Luis. San Gregorio, San Luis, and Tulyahualco have as a scenic backdrop the huge isolated cone of the volcano Teuctli, worked into maguey-lined bancales

covered by maize, huauhtli, chile and tomate crops.

Beyond Tulyahualco the lake plain fans out into one of the most extensive stretches of level shore land to be seen in the southern Valley. In crossing the mentioned lake plain the highway passes through the villages of San Juan Ixtayopan, population 2595, 1.4 kms from Tulyahualco; Tecomitl, population 2452, 3.6 kms from Juan; and then enters the ancient bay of Mixquic now covered by chinampas.

At the entrance of the bay is situated Tetelco with 902 inhabitants and 2.5 kms from Tecomitl while in the center of it is Mixquic, one of the key chinampa communities with 3364 inhabitants and 1.0 kms from Tetelco. The bay at Mixquic indents the coast almost to the foothills sealing off the lowland plain of Tecomitl just noted.

Upon crossing the bay the highway then enters the huge Chalco plain, one of the greatest extensions of level land in the Mexican Valley. The chinampa zone also ends abruptly at this point and we are in an area of pure rainy season agriculture on level lake plain soils.

Beyond Mixquic we pass through Huicilcingo with 923 inhabitants 3.0 kms from Mixquic; Chimalpa, population 318, 2.0 kms from Huicilcingo; and finally end our trip at Chalco, population 5000, 3.5 kms from Chimalpa. The latter is a true town, being an administrative and market center.

Alohg this stretch of 28 kilometers we pass through no less than 14 communities, two of which may be classed as towns and 12 as villages. The population of these communities run from approximately 200 up to 20,000, with most of them falling between the 1000-6000 bracket (nine

of the 14). The average distance between these big communities is but 2.0 kilometers.

## BARRANCAS AND MANANTIALES - THE VALLEY OF TEOTIHUACAN

### The Natural Setting

In the preceding section we discussed the ecology of one of the prize natural regions of the Meseta Central, the southern Valley of Mexico. The Valley in human occupational terms may be divided into three parallel east-west running bands. The southern, hydrographically the Lake Xochimilco-Chalco drainage, includes the Chinampan and possesses an almost ideal combination of fertile soil, dependable rainfall and good drainage. The central band, the Lake Texcoco drainage system, includes the extensive lake plain around Texcoco to the east and the gentle slopes around Mexico City to the west. The rainfall is lighter than in the southern region but is still ample for rainy season crops and the soil is very fertile, at least around Texcoco. The northern valley or the Zumpango-Xaltocan drainage basin is the most inhospitable part of the Valley, with limited level spaces, being mainly low slope country with scanty soil and more arid climate.

The Teotihuacan Valley is a small sub-valley just on the border between the central and northern bands of the Valley of Mexico. In general, it runs northeast-southwest, sloping very gently down to the southwest. It is well defined to the north, east and south by low mountain ranges. This peculiar topographical situation offers both advantages and disadvantages. In the latter sense the surrounding ranges close in the valley floor and reduce sharply the rainfall below the level of most of the Valley of Mexico. On the other hand we find here, as in most arid regions, that arid climates usually go

with soils of very high natural fertility. This combined with the fact that the rainfall on the hills is considerably higher offers decided advantages to a numerous, industrious population capable of building irrigation systems. This combination of fertile soil and water for irrigation is the key factor in the important role played by the Teotihuacan Valley in Meso-American history.

The average elevation of the valley floor is approximately 2280 meters above sea level. The surrounding range to the north reaches its maximum elevation with the two peaks of Cerro Gordo, 2930 meters, and Cerro Malinalco, 2530 meters. To the south the maximum is found at the Cerro Patlachique, 2650 meters. The range bordering the valley to the south is merely an extension of the Sierra Nevada, while that to the north represents the remains of an isolated chain of volcanoes.

In this paper the Valley of Teotihuacan is considered as the area extending from the village of Atepoxco in the northeast to Tepexpan to the southwest, a total length of 25 kilometers. Its widest breadth is reached in the northeast - the Otumba plain from foothills to foothills measuring 8-10 kilometers. In the middle reaches, where the archaeological zone is located, it narrows to 6, which breadth is maintained as far down as Calvario Acolman. At the latter place it constricts to 4 and then it fans out to form part of the Texcoco plain.

Ecologically the valley floor may be divided up into four sections.

(1) Upper Valley. This includes the extensive plain and adjacent slopes around Otumba. The section is characterized by moderately deep soils around Otumba itself where they run to one or two meters but areas of deep soil are very limited. The bulk of the section

includes gentle slopes with scanty soil cover running from half a meter to almost no soil at all as one proceeds up the slopes. This is the most unfavorable part of the valley for human occupation for two reasons. The lack of deep soils prohibits extensive use of the "cajete system", and second the surrounding hills are all very low and catch very little more water than the valley floor itself so irrigation is very limited. In general it is a maguey rather than a grain producing area.

(2) Middle Valley. This is the section from a few kilometers west of Otumba to San Juan Teotihuacan. It is an area of rainy season and seasonal irrigation grain cultivation. This section of the valley is bordered to the north and south by high hills which catch a considerable volume of water and are sculptured by numerous barrancas which the ancient and modern population have tapped for seasonal irrigation. The Barranca de los Muertos, which originates in the southern range, especially delivers a considerable volume of water for irrigation. The part of the Middle Valley which lies between Otumba and San Martin de Las Pyramides is characterized by very fertile soils running between 1 to 3 meters in depth which are excellent for "cajete" techniques of cultivation. From San Martin to San Juan the situation is less favorable. The soils in general run between 30 and 100 cms in depth, averaging around 50. Cultivation is mainly simple rainy season in type with limited use of dam irrigation. The latter technique in this area is really a necessity for secure crops due to the rapid drying-out of the scanty soil cover. A huge chunk of this area is covered by the ruins of San Juan (700 hectareas) and the soil is full of building rubble - adobe and chunks

of volcanic rock. For simple rainy season cultivation this is actually a help as the humidity retention is greater than in pure soil. This stony area of "tlatel" today is occupied mainly by nopal orchards. In the Middle Valley maguey is an important secondary crop, being sown mainly on low slopes and hillsides.

(3) Lcwer Valley. This is the section lying between San Juan and Calvario Acolman. It is the prize agricultural area of the valley with deep fertile soils running from 3 to 7 meters in depth. The key factor, however, and which gives the section its importance, is the existence of hundreds of springs at San Juan which provide a constant, permanent source of water for irrigation. It is an area of grain production, especially maize and wheat, with dairying as an important secondary activity.

(4) Lake Plain. This is but a segment of the extensive plain which lies east of Lake Texcoco and runs on south to Chimalhuacan. It is sharply defined to the north by the Cerro de Chiconauhtla and to the south, of course, it runs on to form part of the mentioned plain. In ancient times it was partially detached from the rest of the Texcoco plain by the Cerro de Tizoyuca which approached to within a few kilometers of the lake shore. It may be defined as that segment of the Texcoco plain which is drained by the two mouths of the Teotihuacan River, the Rio Nexquipayac and Rio Ixtapan. In ancient times we would consider it as the delta of the river.

The subsoil of the Valley of Teotihuacan, as is most of the Valley of Mexico, is "tepetate". Its origin is volcanic although deposition has not, in general, been direct but fluvial in method. It is mainly white to yellow tobas exuded by the volcanoes surrounding

the valley and later carried down by the numerous barrancas and deposited on the valley floor. It is a hard, compact, crumbly, earth-like formation. The organic soils above it vary considerably in thickness but are fairly uniform in type, sandy and clay textures being rare with most falling in the loamy class. It is notable in permeability (combined with high humidity retention as the tepetate below acts as a drainage floor) and in the high incidence of lime, potash and phosphoric acid. Under irrigation the soil is very productive, a characteristic of most semi-arid and arid country soils. Both Vivo and Tamayo classify the soil of the Teotihuacan Valley as Siernozen. Local farmers point out three basic soil types: (a) loams (migajon) of the middle valley; (b) tlatel-stone and earth mixed as at the archaeological zone; and (c) black earth (tierra negra) in the flatlands of the lower valley. The presence of permanent water in the lower valley probably accounts for the higher humus content of the soil. Looking at the valley as a whole one of the main agronomic problems is the maintenance of the humus and nitrogen content. Soil minerals, useful for plant nutrition, are in general abundant and can support the present agricultural system for a long time.

The rainfall in the Teotihuacan Valley runs in general between 500 and 600 mms a year, most of it falling between the months of June and October. The most crucial climatic problem for the cultivator is not the quantity, as the soil has high humidity-retention ability and the rainfall is ample and well distributed, but the time table. As the valley lies over 2000 meters the months of November and December are characterized by frosts. Under normal years maize may be sown as late as June and the plant be well enough along in its

growth to withstand the November frosts. The difficulty lies in the fact that the first frosts may and often do begin in October and even September. Under these conditions a May sowing is imperative to insure harvests and actually if crops can be sown in April or even March it would be much better. A combination of late rains and early frosts may and has brought disaster for the rural population in the past. A careful check with informants indicates that heavy losses may be due to two factors: (a) on rainy season lands a farmer risked an early May sowing and the rains delayed until July; or (b) the farmer waited until the end of June to sow following the first rains and his milpa was hit by an early frost in September or October. On irrigated or "cajete" sown lands crop loss is very rare. It may happen in the latter case if the crop was sown in April and the rains delayed until July. As we can see, the timing of agricultural activities is of greatest importance and both the fluvial and thermal cycle play significant roles. The central problem of the cultivator of the valley is timing, and the key to his problem is early sowing using artificial irrigation. Below I present a rainfall chart from San Juan Teotihuacan taken from Sanchez Colin. It is based on observations made over 24 years (1921-1944).

| Month | Temperature (°C.) | | | | | Precipitation (mms) | Days of Rain |
|---|---|---|---|---|---|---|---|
| | Mean | Mean Max. Monthly | Absolute Max. | Mean Min. Monthly | Absolute Min. | | |
| January | 11.1 | 20.1 | 28.0 | 2.1 | -9.0 | 5 | 2 |
| February | 12.5 | 21.9 | 29.8 | 3.1 | -8.0 | 8 | 3 |
| March | 14.2 | 23.8 | 32.2 | 4.5 | -9.2 | 16 | 4 |
| April | 15.7 | 25.0 | 32.8 | 6.4 | -5.0 | 24 | 7 |
| May | 16.6 | 24.8 | 32.5 | 8.3 | 0.0 | 53 | 10 |
| June | 16.2 | 23.1 | 30.5 | 9.3 | 0.0 | 86 | 14 |
| July | 16.0 | 22.5 | 28.6 | 9.4 | 4.0 | 105 | 18 |
| August | 15.8 | 22.8 | 29.0 | 8.0 | 1.0 | 104 | 16 |
| September | 15.7 | 22.2 | 28.5 | 9.2 | 2.0 | 92 | 15 |
| October | 14.4 | 22.1 | 30.0 | 6.7 | 4.2 | 39 | 8 |
| November | 12.8 | 21.5 | 31.0 | 4.2 | 6.2 | 18 | 4 |
| December | 11.8 | 20.8 | 28.2 | 2.7 | 5.3 | 7 | 2 |
| Annual | 14.4 | 22.6 | 32.8 | 6.2 | 9.2 | 557 | 103 |

With the described climatic situation irrigation has always been an important factor in the economy of the Valley of Teotihuacan and a thorough understanding of the hydrography is of great importance. Due to the topography the valley is a hydrographic unit; all barrancas flow down the neighboring slopes, then enter the valley floor, and finally all join to form the so-called Rio de San Juan which is actually a true river only below San Juan Teotihuacan. All of the tributary barrancas are strictly rainy season streams.

In the Middle Valley one of the main streams is the Barranca de los Muertos, which for irrigation is the most important barranca in the valley. It collects the drainage from the mountain range which hems in the Middle and Upper Valley to the southeast. As this range forms part of the Sierra Nevada the rainfall is heavier and volume of water greater than in any other barranca. Finally in its middle and lower courses it flows through level deep soil valley floor so that utilization for primitive irrigation is facilitated and productive. On entering the Otumba plain it flows just south of Otumba itself and enters the deep soil plain of San Martin where it joins a companion stream, the Atlamajac or Ixtetes, a kilometer east of San Martin de los Pyramides. This latter stream originates in the hills and slopes north of Otumba and flows parallel to the Muertos after passing north of Otumba. Upon passing Otumba it receives several tributaries, the barrancas of Terrenate, Acholoco and Xalmeyo, which drain off Cerro Gordo and have facilities for irrigation.

Upon joining, the Atlamajac and Muertos form a single barranca, the Rio de San Juan or main drainage canal of the valley. Further

down the Rio de San Juan is joined by the Barranca de San Martin to the north (draining off the Cerro de Malinalco) and the Tlalchichinamitl (Ciego) to the south. Below La Purificacion the main stream is further joined by the Barranca de Oztotipac or Metepec which, together with the Tlalchichinamitl, drain off the Cerro de Patlachique.

Below San Juan the Rio de San Juan in truth becomes a river with a permanent flow from the springs of Maquixco and Puxtla. It is joined by its final tributary, the Maquixco, just below Santa Mario Acolman. It collects the drainage of the Cerros de Malinalco and Maravillas. Below Calvario Acolman the river splits into two mouths, the Ixtapa and Nezquipaya; in ancient times the former emptied directly into Lake Texcoco and the latter ended in swamps.

Gamio and his co-workers did a study of the hydrography of the Lower and Middle Valleys. The valley floor over this zone was estimated at 10,000 hectareas and the area of captation of the drainage system at 37,000 hectareas or 370 $kms^2$. They estimated a minimum precipitation of 220,000,000 cubic meters a year over this basin. Actually our rainfall chart shows this figure to be an average rather than a minimum. They estimated that 20 percent of this quantity runs through the barrancas as surface water, 30 percent is lost through evaporation, and the rest infiltrates into the soil. Of the latter a good percentage is not lost but breaks out in springs at San Juan and its barrios (over 100 of them). According to their estimates the total output of these springs was about 1000 liters a second and the annual volume 31,000,000 cubic meters. Approximately, then, one-third of the water captured by the Lower and Middle Valleys is available for primitive irrigation. They estimate that

this amount, completely harnessed, would irrigate the entire 10,000 hectareas of the valley floor.

For the entire Valley of Teotihuacan as we have defined it these figures would have to be revised upward. The area of the valley (as I have defined it) is approximately double that studied by them, and the area of captation as well. The total precipitation would likewise be considerably higher and theoretically the area of irrigation could be extended somewhat beyond the 10,000 hectareas estimated by them. Actually the increase in irrigable land would not be great including the rest of the valley, as those sections not included in the Gamio study are not favorable for primitive irrigation.

## Agriculture - Introduction

Ideally, a survey of the agricultural technology and economy of the Teotihuacan Valley should involve studies in all of the nearly 60 communities or selected studies of communities in each of the four sections. Unfortunately time did not permit even the latter degree of thoroughness. Approximately one month was spent in the survey and only the Middle and Lower Valleys were covered.

San Martin and San Pablo Isquitlan were selected to represent the deep soil "humedad" area of the Middle Valley, San Francisco Mazapan and Santa Maria Coatlan the Tlatel zone of the Middle Valley, and Santiago Atlatongo and Calvario Acolman the irrigated Lower Valley. Throughout the Teotihuacan Valley the technological knowledge and practice of the farmer is quite uniform but the application of it is not, mainly due to individual inclination. Crop production varies considerably according to soil quantity, sources of irrigation,

topography, and especially the degree to which the agricultural technology is applied.

Gamio and field workers conducted an excellent survey of roughly the same zone from which I collected data. They give considerable data on agricultural technology, especially irrigation. Their report is deficient in the economic aspects of cultivation, a defect based on the lack of cooperation of the big landholders. As most of the lands were held by them, especially the better lands, their data on crop production was rather meager.

The valley in general is a producer of grains. Maize is the chief crop, followed by barley, wheat, alfalfa and frijol, and in much less quantities peas and habas (Spanish beans). Alfalfa and wheat are limited principally to the Lower Valley and Lake Plain sections, alfalfa being a dairy complex crop and wheat a winter irrigated crop. Maize is cultivated all over the valley, especially in the vegas or lowlands. Barley and frijol are the most tolerant crops and are found both in low flats and slopes, especially the latter. Farmers without facilities for irrigations or with scanty soil lands lean heavily on barley as a cash crop.

Aside from grains one of the important products of the valley is pulque, the fermented juice of the maguey plant. This plant is of great importance for several reasons. First, it is an important basic food, thus replacing pozol and cutting down on maize consumption. Second, it is tolerant of extremely thin or even denuded soil areas, especially slopes and hillsides, and will tolerate extremely dry soils and climates thus enabling many marginal lands to be profitably utilized. This is especially true in the Upper Valley.

Third, it is an important source of cash income. The maguey is really the staff of life for the population of the Upper Valley and an important secondary crop in the Middle Valley.

Squash is a minor crop, usually sown mixed with maize and frijol in the same field.

In the tlatel zone of the Middle Valley, especially in the villages of San Martin de las Pyramides, San Francisco Mazapan and Santa Maria Coatlan, nopal orchard cultivation is an important item in the family economy, providing a cash income. These villages supply a high percentage of the nopal market of Mexico City.

Domestic animals play a very minor part in valley economy and their lack is one of the major defects in the rural economic system. Animal fertilizers are never abundant, creating a crucial problem in the maintenance of soil fertility. The neat balanced symbiosis of European agriculture is lacking in highland Mexico in general. Most families have fowl in small quantity and a high percentage have a pig or two plus a few draft animals for plowing (oxen or horses) or burden carrying (donkeys). Sheep and goats are found but few families own them. In the Lower Valley and Lake Plains sections the economy is in a transitional stage between subsistence grain agriculture and dairy farming. With the increase in the urban market at Mexico City it seems certain that within a few years these sections will be completely converted over to commercial dairy farming.

Around the barrios of Maquixco and Puxtla, chinampa cultivation specializing in vegetables, especially onions, beets, lettuce and carrots, is an important but restricted system, probably not exceeding 50 hectareas in all.

Such pre-Spanish crops which we noted in the southern Valley of Mexico as tomato, jitomate, huauhtli, chile and chayote are very little cultivated in the Teotihuacan Valley. Fruit cultivation other than nopal is of little importance. Most of the farmers possess no fruit trees at all; a few have a few trees of apple, peach, plum, apricot, pear, tejocote, zapote blanco, pomegranate, date and capulin. The largest orchard seen comprised but a few dozen trees and that was exceptional. The only one of some importance is the capulin, especially found along irrigation canals and barrancas. The others are almost entirely sown in house lots.

Agriculture - Irrigation Technology

The most important ecological factor in human occupation of the Teotihuacan Valley is the hydrography. As has been stated, the amount of rainfall is ample for rainy season crops but the irregularity of inception of rains and of the thermal cycle makes irrigation a must for dependable harvests. The key to the problem lies in sowing the crops in March or April following a heavy pre-sowing irrigation. This irrigation will usually hold the crop over for 60 days of drought. If the rains hold off until July then a second irrigation is necessary in May or June, depending on the month of sowing. In normal years with the rains starting in May this second irrigation is not necessary. Once the rainy season is under way further irrigations are not really crucial. Many farmers do, however, give the milpa another in August during the "canicula" or short cessation of the rains when the cessation is prolonged. Some like to give another just before the plant is about to produce grain. No hard and fast rules can be stated; much depends on the character of the soil and

of course availability of water. Some farmers may give their land seven or eight irrigations during the season. In general, for maize, always sown during the rainy season, three well-spaced irrigations are all that are necessary and many farmers get along on the single pre-sowing irrigation. For wheat, a dry season crop, a pre-sowing irrigation plus a mid-season one, or two in all, are sufficient. When irrigation is combined with careful humidity-preservation techniques a minimum amount of water goes a long way due to the quality of the top and subsoils.

In the Teotihuacan Valley we can divide irrigation technology into two systems: (a) "Systema de Presa y Caja" or dam and box system; and (b) "Systema de Drenaje" or drainage system. The former is in use in the Middle Valley and the latter in the Lower Valley and Lake Plain.

In the Middle Valley the Presa y Caja system is the only one practicable. The hydraulic engineers of the Gamio study, in a thorough reconnaisance of the hydrography of the valley, pointed out that storage dams are not possible because of the steep gradients and high permeability of the soil. Actually the latter point is not correct as it is quite easy to store water by simply excavating a few centimeters down into the tepetate as is done in jaguey construction.

Irrigation in the Middle Valley is very irregular as it depends on rainfall in the neighboring hills. It is based on three important points: (1) the rainfall in the surrounding hills often falls sooner than in the valley floor, permitting pre-season sowing; (2) the rainfall is usually heavier than in the valley proper and often when rains

cease for extended periods during the rainy season it may rain quite heavily in the hills; and (3) the gradients of the lower slope permit simple irrigation systems to conduct this excess run-off from the surrounding hills. Irrigation in this part of the valley may be considered as primarily a regulator rather than basic producer of humidity, and second, what is more important, helps the farmer combat early frosts by pre-season sowing.

The system of "Presa y Caja" consists of the construction of a series of dams across the barrancas in order to raise up the water level to a point where it can be conducted off by simple irrigation canals. One or two large lead canals are excavated just behind the dam conducting the water off to the fields along both sides of the barranca. From these main canals a whole system of secondary canals carry water to the individual fields. Small temporary earth dams are built when needed to dam up the main canals for leading off water to the fields. Each field is surrounded by a low earth wall ("caja") varying in height from 30 to 100 cms. Each holding is completely inundated up to the level of the enclosing earth walls and the water then led onto the next field. Fields, which were originally irregular in surface are often levelled off and trimmed down to prevent uneven drainage and larger holdings are often divided up into sections by low earth walls to further equalize the flow of water. The principle of gradient is thoroughly understood, from the construction of lead canals to the irrigation of the individual field.

After a day or two of good rains there is usually a heavy flow of water in the barrancas. As soon as the flow reaches the first dam the water gates are closed and the farmers start irrigating those

fields served by it. These fields being irrigated, the water gates are opened and the water released down to the second dam. Some of the barrancas may have a series of half a dozen dams and serve two or three haciendas and as many villages. There is no real regulation. Those landholding units further up take as much water as they need and then allow it to pass on down. Those communities further downstream are in general hardest hit by severe droughts and most haciendas are situated almost at the headwaters of the barrancas to insure first rights. Actually under the hydrographic situation there is usually an abundance of water for all or no water for anyone as the irrigation system is based on flash floods. The only units which have really dependable irrigation are the haciendas located well upstream as they capture even the results of very light rains. Arguments and fights, although infrequent, are often bitter and at times violent, especially between the haciendas and the villages further downstream. When irrigations are given they are very heavy as one might expect from their irregularity, and the land is well prepared for conserving the humidity.

Dam construction and lead canal excavation and maintenance is everywhere today a group project. In Gamio's time the bulk of this work was done by the haciendas. Dams are of masonry and represent either a hacienda or a village project or a combination of both. Lead canals are maintained by those farmers whose lands are served by them, repairing and cleaning being done by communal work gangs. Earth dams are used for deviating water from the lead canals and these are either a group or individual project depending on their precise function. These latter are rebuilt several times during a

single season and represent considerable labor. One of the most important sources of quarrels and bad feeling is water rights, although it is much less marked than in the Lower Valley for reasons stated above.

To date there is no formal organization of water control as in the Lower Valley. Work projects are limited to the village level although a few exceptions may be noted. One case is that of the construction of a dam on the Oztotipac Barranca by the Hacienda of Tlajinga and the village of San Sebastian. A second exception is a cooperative lead canal cleaning and dam repair project carried out by the two villages of Santiago Tolman and San Martin de las Pyramides. It is possible that the irregularity of the irrigation system of the Middle Valley along with the difficulty of real control of the flow make higher organization superfluous, but I personally doubt that. I think we have a people who are just beginning to relearn to manage an agricultural technology that their ancestors once understood thoroughly and in which further development was aborted by the Spanish Colonial hacienda system.

From Gamio I've appended below a list of the permanent masonry dams in the Middle Valley. No important new dams have been constructed since their study so that it represents the present situation as well.

Arroyo de Atlamajac-Terrenate.- This stream which collects the drainage of the Cerro Gordo and smaller adjacent hills to the northeast possesses one of the most complex series of dams in the valley. Between the hacienda of Hueyapan and the point where the Terrenate and Acholoico join to form the Atlamajac there are three dams, one

at the hacienda itself, another 400 meters below it, and a third 800 meters below the second. The first dam serves only the hacienda, the second the hacienda and village of Santiago Tolman, and the third the two villages of Santiago Tolman and San Pablo Isquitlan. Below San Pablo there are two more dams, both built by the Hacienda de Cerro Gordo. Following the agrarian reforms they were both abandoned until a few years ago when the ejido secretary of San Martin secured the cooperation of his own villagers and those of Santiago to repair one of them and clean out the lead canals. The hacienda of Cerro Gordo also constructed two dams on the Barranca de San Martin and the Xalmeyo, two barrancas which collect the run-off from the Cerro Gordo and join the Atlamajac. That on the San Martin was one of the most ambitious projects of all, serving some 340 hectareas of very fertile bottom land. Today it is in only partial use by the villagers of San Martin.

One of the most interesting streams in the valley is the Barranca de los Muertos. As this barranca heads in the foothills of the Sierra Nevada it carries a greater volume than any other in the valley. Through most of its course it flows through rich bottom land, the bulk of which is prepared for irrigation based on a series of six dams. The most interesting thing about the system is that most of it was built by villages. The dams were constructed and are maintained by the villages of San Martin de las Pyramides, San Pablo Isquitlan, Santiago Tolman, Cuauhtlanzingo and San Francisco Mazapan. Quarrels between the villagers over water rights are frequent and often violent. To date the problems have not been resolved by centralizing authority.

The first dam on the Muertos is at the point where the F. C. C. Mexicano crosses the barranca. Nearly a kilometer further downstream is a second dam and 200 meters below the second a third, 800 meters below the latter is a fourth and 200 meters further down a fifth. Finally there is a sixth dam approximately 800 meters below the fifth. The stream then joins the Atlamajac to form the Rio de San Juan.

Aside from the two mentioned systems only two other dams are found in the Middle Valley. One, built by the Hacienda of Metepec, is on the Tlachichinamitl and provides water for the hacienda and lands of the village of San Francisco Mazapan. A second, built as a joint project serves the Hacienda of Tlajinga and the village of San Sebastian is on the Barranca de Oztotipac.

The system of dams as a whole is far from complete and could be extended.

The situation in the Lower Valley is quite different. Here we have true permanent irrigation based on an all-year flow of water from the springs of San Juan. The Gamio group estimated that the hundred or so springs at Puxtla and Maquixco produced 31,000,000 cubic meters of water annually. They measured the output in December following the rainy season and calculated 1500 liters a second and estimated a mean of 1000 during the year as a whole. Today the output has dropped to 588.6 liters a second. The local farmers blame this decline on incomplete cleaning and maintenance and on artesian well perforation. It is probably related to the overall dessication of the Valley of Mexico during this century.

The system of irrigation of the Lower Valley is primarily one of

drainage and is technologically quite simple. It consists of conducting water off from the springs by small excavated canals which conduct the water into three main lead canals which then distribute the water by secondary canals to the lands of the dependent villages. All canals are simple excavated ones. The terrain of the Lower Valley is very flat, unlike that of the Middle Valley, and only slightly inclines from northeast to southwest so that careful grading is unnecessary. The construction of cajas around individual fields is either not done at all or made very low, averaging 10-20 cms in height. Irrigation, as it is regular and fairly frequent, is done but lightly and high-walled cajas are unnecessary. In colonial times the construction and maintenance of lead canals was a cooperative activity joined in by all villages and haciendas; at the time of the Gamio study all irrigation was monopolized by the four haciendas of San Jose, Santa Catarina, Cadena and San Antonio who maintained canals and springs by continuous work gangs.

When the agrarian reforms were carried out in the 'twenties in the Valley of Teotihuacan the bulk of the spring-irrigated lands, 3,652 hectareas, was turned over to the villages, each hacienda receiving a small fraction of "casco" of the original holding. With this division the problem of water distribution became acute. An organization called the "Junta de Aguas de los Manantiales de San Juan Teotihuacan" was formed and a group of hydraulic engineers sent to assess the water production of the springs and organize its distribution. A "reglamento" or series of regulations were formally established and are now in force. The Junta consists of one elected representative from each hacienda and two from each village (one to

represent the ejido and one the private holdings) who elect a president and hold regular meetings at Calvario Acolman. The water is very carefully distributed and administered by a time clock system in which each unit receives water according to the size of its holding. The Junta also directs the annual labor of cleaning out the springs and the four main lead canals. Secondary canals are maintained by work gangs made up of the farmers who use them.

The Junta includes six haciendas with a total holding of 280 hectareas (Cadena, Santa Catarina, San Antonio, San Jose, Ixtapan and Tepexpan). The rest of the irrigated area, 3373 hectareas, is held by the villages of San Juan Teotihuacan, San Bartolo Acolman, Santa Maria Acolman, Calvario Acolman, Santiago Atlatongo, Xometla, Tepetitlan, Cuanalan, Chipiltepec, San Marcos, Santa Catarina Acolman, Tenango, Tepexpan, Tequisistlan, Nexquipayac and Ixtapan.

The bulk of the water flows through the two canals of San Antonio and San Jose with a total production of nearly 500 liters a second. One of the curious concessions violating the general rule of water distribution was the granting of Santiago Atlatongo a continuous year-round flow of water. Today this is a source of bitter discontent between that village and its neighbors and a movement is on foot to take away this privilege. Each unit of water division receives water approximately once a month.

The distribution system is reviewed in the following chart:

| Landholding Unit | Liters A Second | Duration | | | Number of Hectareas Irrigated |
|---|---|---|---|---|---|
| | | Days | Hrs. | Mins. | |
| Canal of Cadena | 12.66 | 10 | 6 | | 30.1 |
| Hacienda Cadena | 12.66 | 19 | 18 | | 57.96 |
| Ejido San Juan | | | | | |

| Landholding Unit | Liters A Second | Duration Days | Hrs. | Mins. | Number of Hectareas Irrigated |
|---|---|---|---|---|---|
| Canal of Texcalac | | | | | |
| Ejido San Bartolo | 50.36 | 3 | 10 | | 40.0 |
| Private San Bartolo | 50.36 | 2 | 6 | 30 | 26.50 |
| Ejido Santa Maria | 50.36 | 6 | 20 | 15 | 80.0 |
| Ejido Calvario | 50.36 | 4 | 15 | | 54.0 |
| Private San Bartolo | 50.36 | 4 | 6 | 30 | 50.0 |
| Private Calvario | 50.36 | 8 | 13 | 30 | 100.0 |
| Canal San Antonio | | | | | |
| Ejido Atlatongo | 200.26 | 1 | 5 | 30 | 47.51 |
| Hacienda Santa Catarina | 200.26 | 3 | 19 | | 175.28 |
| Private San Bartolo | 200.26 | 1 | 7 | | 60.0 |
| Ejido San Bartolo | 200.26 | 2 | 5 | | 102.5 |
| Ejido Xometla | 200.26 | 4 | 20 | 45 | 205.72 |
| Private Xometla | 200.26 | 2 | 9 | 40 | 101.28 |
| Ejido Calvario | 200.26 | 2 | 3 | 15 | 90.0 |
| Private Calvario | 200.26 | 1 | 13 | | 65.0 |
| Ejido Tepetitlan | 200.26 | | 19 | 45 | 32.0 |
| Ejido Cuanalan | 200.26 | 7 | 19 | 45 | 303.0 |
| Ejido Tepetitlan | 200.26 | | 16 | 45 | 26.96 |
| Hacienda San Antonio | 200.26 | | 4 | 30 | 7.19 |
| Ejido Chipiltepec | 200.26 | 1 | 5 | 15 | 47.0 |
| Canal of San Jose | | | | | |
| Ejido San Bartolo | 287.32 | 1 | 18 | 15 | 117.0 |
| Ejido San Marcos | 287.32 | | 20 | | 52.8 |
| Hacienda San Jose | 287.32 | | 4 | 30 | 11.0 |
| Ejido Santa Catarina | 287.32 | 1 | 14 | 15 | 96.7 |
| Ejido Calvario | 287.32 | 1 | 8 | | 81.0 |
| Private Santa Catarina | 287.32 | 1 | 8 | 45 | 79.0 |
| Ejido Cuanalan | 287.32 | | 21 | 15 | 50.0 |
| Private Tepexpan | 287.32 | 3 | 19 | 15 | 211.28 |
| Ejido Tequisistlan | 287.32 | 2 | 12 | 30 | 140.0 |
| Ejido Tepexpan | 287.32 | 2 | 7 | 45 | 128.94 |
| Private Tequisistlan | 287.32 | 1 | 8 | 45 | 76.0 |
| Private Nexquipayac | 287.32 | 1 | 15 | 30 | 91.0 |
| Ejido Nexquipayac | 287.32 | 3 | 4 | | 176.0 |
| Hacienda Ixtapan | 287.32 | 1 | | | 55.0 |
| Hacienda Tepexpan | 287.32 | | 5 | | 1.0 |
| Private Ixtapan | 287.32 | 1 | 5 | 30 | 68.56 |
| Ejido Ixtapan | 287.32 | 4 | 18 | 45 | 265.94 |
| Ejido Atlatongo | 38.0 | (permanent flow) | | | 240.0 |

The sizes of the irrigated holdings are summarized below:

| Landholding Unit | Ejido | Private Holding | Total (hect.) |
|---|---|---|---|
| San Bartolo | 259.50 | 136.50 | 396.0 |
| Santa Maria | 80.0 | | 80.0 |
| Calvario | 235.0 | 165.0 | 400.0 |
| Atlatongo | 287.0 | | 287.0 |
| Xometla | 206.0 | 101.0 | 307.0 |
| Tepetitlan | 59.0 | | 59.0 |
| Cuanalan | 353.0 | | 353.0 |
| Chipiltepec | 47.0 | | 47.0 |
| Santa Catarina | 97.0 | 79.0 | 176.0 |
| Tepexpan | 129.0 | 211.0 | 340.0 |
| Tequisistlan | 140.0 | 76.0 | 216.0 |
| Nexquipaya | 176.0 | 91.0 | 267.0 |
| Ixtapan | 266.0 | 68.0 | 334.0 |
| San Marcos | 53.0 | | 53.0 |
| San Juan | 58.0 | | 58.0 |
| Total - village holdings | | | 3373.0 |
| Hacienda holdings | | | 279.0 |
| Grand total - irrigated land | | | 3652.0 |

## Agricultural Technology

In the cultivation of the land, techniques vary according to local three-fold division of land types. First we have "Tierra de Humedad" which are deep-soil, flat vega lands in which a combination of humidity conservation techniques and temporary irrigation is carried out. Second, we have "Tierra de Temporal" which includes hillside, low slopes or thin soil flatlands where humidity conservation methods are impracticable. Finally there is "Tierra de Riego" or deep soil flat lands under permanent all-year-round irrigation. The value of land and consequently the production depend on two factors: (a) the facility and dependability of water for irrigation; and (b) the quantity of the soil cover. Production also, of course,

depends upon the degree to which the technological knowledge of the farmer is actually applied to the field.

## Maize Cultivation

The preparation of the land varies according to the character of it and the grain to be sown. Maize is given the most careful cultivation of the common crops in the valley, whereas barley needs little land preparation. In Tierra de Humedad in the Middle Valley we find the most careful preparation of the land for sowing than in any other part of the valley. This is due of course to the irregularity of irrigation and high productivity and value of the land. The only way to insure maximum use of these first-class lands is by practicing careful humidity preservation techniques. After the final rains of the year which generally fall in October, a land may be given a thorough irrigation following the harvest. This practice was more common at the beginning of the century than today. Following this, in November the land is given a deep plowing or "barbecho". This is done with horses or oxen, the plow being run down each line of maize hills, lengthwise down the field, breaking up the hills and loosening the soil. Informants estimated from three to four days per hectarea with one team. Farmers who work more carefully also run the plow down the field in between the rows of maize hills and cut the soil as deeply as possible. The main function is to loosen the soil to permit capillarity action between the upper and lower soil levels and to allow the humidity to pass downward. The "rastrillo" is then passed over the field to smooth down the surface and seal off the soil to prevent evaporation.

The land is then left until January when the "Cruzada" is given.

This is a second plowing made across the field at right angles to the barbecho. The cruzada is usually a more shallow plowing but much more closely done than the barbecho. It is often done following one of the rare winter rains. It necessitates approximately the same amount of time as the barbecho and is followed by an immediate "rastreo" as is the barbecho. Some farmers may add a third plowing with the lines done diagonally across the field just for extra insurance.

Some farmers carry out the two procedures in December and February instead of November and January.

For Tierra de Temporal many farmers do no preparation before the sowing, while some do give the land the late fall barbecho. On Tierra de Riego conscientious farmers give land as thorough a preparation as those who cultivate Tierra de Humedad, while others, confiding entirely in the regularity of the irrigations, simply give the fall barbecho.

In good deep soils these humidity conservation techniques give excellent result. It enables the farmer to sow in April or even March and the plant will have enough moisture to weather 60 rainless days following germination. If the sowing is done in the middle or end of April crop loss almost never occurs.

The technique of sowing also varies according to the type of land. In the old days in deep soil areas a special technique called "a cajete" or "a todo costo" was used to insure humidity preservation. In March or May the field was given the "zurcada". This is done again with the plow and consists of breaking up the soil for planting. The lines are spaced between 1.5 and 2 meters apart according to the

quality of the soil. Then small pits were excavated by hand in the soft broken soil at .5-1.0-meter intervals down as far as the humid soil layer. This humid soil on well prepared lands lies normally at 20-30 cms below. In the Texcoco area a thin cap of the humid soil itself is removed, the seed imbedded in the humid soil, then covered up by the removed wet soil, and finally a 10-cm cap of dry soil replaced over that. A slight hollow is usually left to further help in gathering humidity when the rains occur. In the Teotihuacan Valley the seed is simply imbedded in the first humid soil encountered and then covered over by a cap of the upper dry soil. The cajete technique is exceedingly laborious but the results are worth the effort. A single man sowing one hectarea would have to work 10-15 days to complete the job. One informant estimated even more time, stating that he needed two men working a month to sow his three hectareas using this technique (spacing 50 cm, better soil).

On temporal lands a technique called "tapa pie" is used. One man runs the plow opening up the rows while a second walks behind with the seed, dropping it at one-meter intervals and covering it up with his feet as he goes.

Today on tierra de jugo and tierra de riego a new technique called "al tubo" is replacing the more arduous cajete. First the land is plowed and then a deeper, narrower excavating steel plow is run through the soft soil. Attached to it is a rolled maguey penca, and a single man manages the plow and drops the seed continually in the tube as he moves. The deeper cutting plow moves aside the loose soil and cuts down to the humid soil below as the tube continually drops the seed into the uncovered humid soil. Conservative farmers

dislike the technique as they say the seeding is too uneven and some plants grow rickety due to improper spacing. Proponents of the system say that correct use of it results in yields equal to if not slightly better than the cajete system. The main argument in its favor, however, is time and labor saving as it necessitates but one man working three or four days to sow a hectarea. In a single hectarea estimates vary from 10 to 14 cuartillos or 15-22 kilos of maize needed for sowing. The higher figures come from the Lower Valley irrigated lands, the lower from the Middle Valley. Usually the seeds are sown mixed with frijol and squash in the same hole. If the tapa pie or cajete techniques are used the holes are staggered from each row to another to give more growing space. On irrigated lands maize is sown from March to May, on humedad lands generally in April, while on temporal lands sowing is done after the first good rain, generally in May and never later than June.

Following the seeding, labor in the milpa includes two cultivations to cut down weed growth, one six weeks after sowing and a second ten weeks after sowing. This work involves one team of animals and the labor of three men, and two days of work are needed to cultivate a hectarea.

In the Teotihuacan Valley we find the custom of hilling or "echar monton". This is done during August when the maize plant is well grown but before it has developed ears, and represents a ten-day job for one man per hectarea. Some farmers also practice the "despunte" or pinching off of the tip of the young ear. They claim that the despunte results in larger ears.

The harvest falls of course according to the date of sowing.

March sown maize is ready for harvest in September, April in October, and May in November. It represents on the average six days' labor with one man per hectarea.

## Cultivation of Other Crops

Barley cultivation represents a simplified version of the above cycle for maize. The land is not prepared, simply plowed up for sowing. The seed is sown broadcast and followed by a second plowing to bury it. Often no irrigation is given but when there is water it is given. Barley resists drought better than the other grains and is often sown on temporal lands. Approximately 75 cuartillos or 75 kilos of barley are sown per hectarea. After sowing most farmers do no work until harvest.

Wheat in the valley is invariably an irrigated dry season crop and is sown only in the Lower Valley. Following the maize harvest in September or October the land is given the barbecho and 15 days later the cruzada. It is then irrigated and plowed up for broadcast sowing; 45 cuartillos or approximately 70 kilos are sown per hectarea. A second irrigation is given 45-60 days after the sowing and that is the final job before harvesting in either May or June.

Frijol is rarely sown alone and usually is sown mixed with maize along with squash. The exact amount of seed varies with the inclination of the farmer; there is no set rule and he often sows only part of his milpa with frijol.

In the Middle Valley slopes are common even in the vegas and most fields are surrounded by a single line of maguey. Its main function is to act as a soil retainer and prevent erosion. Many plots lying on the edge of the barrancas further are faced with stone for the same purpose. The complex and costly system of true stone terraces

such as we noted at San Gregorio Atlapulco in the southern Valley is, however, not found here. Most of the cultivated slopes are very gentle ones and simple maguey terraces or "bancales" are sufficient. The valley has in general been effectively cultivated and erosion has been very limited. The very steep slopes are mainly denuded of soil and vegetation and are not used for cultivation.

## Soil Fertility

For preservation of soil fertility several techniques are known. In general soil minerals are abundant and self-replacing; the main problem is humus maintenance. Animal fertilizers, especially from cattle and draft animals, are used although the supply is very limited due to the lack of domestic animals in general. Only a fraction of the lands can be fertilized and it is done but once every five or six years on the average. No case of the use of green fertilizer was noted, although weeds and cornstalks are plowed under. Most animal fertilizers are allowed to rot two or three years before applying them to the fields. A few test fields studied indicate that for best results fields should receive fertilizer at least every three years.

Crop rotation is well known and thoroughly understood in the valley but not thoroughly applied. The reasons are obvious. Most farmers hold small holdings and their staple food as in most of Mexico is the maize tortilla. The first concern of the farmer is providing his family with maize for the year, and lack of land means he cannot rotate. In the Upper and Middle Valley maize is often rotated with barley and in the Lower Valley we find a maize-wheat-barley or -alfalfa cycle.

Another technique probably beneficial to soil conservation is

the custom of mixed sowing of maize, beans and squash in the same field.

Nowhere in the valley did the author note a single case of deliberate land fallowing; I would say that at least 80 percent of the cultivable land is sown in some crop every year. I do not doubt that fallowing does occur but we can safely say that it is of slight importance.

The main technique of soil conservation lies in irrigation. This is especially true in the Middle Valley where it is based on damming up barrancas. As the flow of water in the barrancas is due to heavy flash floods the water moves with great force and carries a heavy load of sediments down from the nearby slopes, thus we have an effect similar to that of the ancient valleys of the Near East. The local farmers recognize this and have a special word for this sediment, "lama". As most fields receive at least one heavy irrigation a year, and often as many as six or seven, this is an annual event. In the case of extra heavy floods such as the case of San Pablo in 1955 we may have a complete inundation over the entire holding of the village.

In the Lower Valley the irrigation is based on springs and the water is normally clean and free of sediments although it does have a high mineral content. At the time of the Gamio study the haciendados used to build temporary earth dams across the arroyos and purposely inundated their lands annually to artificially produce the natural situation in the Middle Valley. This was called "elame" or silting of the fields.

In general the farmers of the valley rely more heavily on

natural processes inherent in their ecology than artificial ones to maintain soil fertility. Their greatest technological achievement lies in the development of techniques of humidity conservation in order to harvest the greatest possible production out of a naturally fertile soil.

## Village and Family Economy

### Middle Valley - Humedad Area

In the deep soil humedad area of the Middle Valley two villages were studied.

San Pablo Isquitlan is one of the smallest villages in the valley, possessing but 353 inhabitants in 1940 or approximately 70 families. Ecologically it is one of the most favorably located communities with two major arroyos passing within a few hundred meters of it, each of which has a network of dams and irrigation canals (Barrancas de Atlamajac and Muertos). All of the village's lands are tierra de humedad and lie between the two barrancas or just north and south of them. The soil is uniformly from 1.5 to 3.0 meters deep and the cajete or other soil conservation techniques may be utilized over most of the village lands. All farmers, however, do not apply them equally over their fields, mainly because of the landholding system. When the old hacienda of Hueyapan was broken up and the lands turned over to the villages San Pablo received 88 hectareas of ejido. The lands, however, were all given to the 11 families in the village who already held private holdings, and those villagers who held no land received no ejido parcel. Some of the holders have loaned or turned over part of their ejido holding to relatives but the land division in general remains an unjust one. The result is that each ejiditario has a large holding running

around ten hectareas including ejido and private land, and he cannot cultivate such a large holding to the degree of intensity that his technological knowledge permits. Most of them cultivate their private lands as carefully and intensively as possible and only use their ejido grants as tierra de temporal for barley cultivation. The Secretary Ejidal feels that the lands are fully as good in the ejido as in the private holdings and that production could be raised to the level of the latter by fully applying their technology.

The holdings of one of the eleven land owners were studied. He held as private land a parcel measuring 300x118 meters or slightly over 3 hectareas. This plot borders directly on the Barranca de los Muertos, its long dimension situated at a 30 degree angle to the barranca. It is rich flat vega and has a line of maguey sown along its barranca side to prevent erosion. The holding is about average in the village for private land and has been held by the family for generations. It is given the complete cultivation described for tierra de humedad and is considered by the owner as his household granary. The field has been continuously sown in maize since he inherited it from his father and has never been rested. As it fronts on the Muertos he has rarely lacked water for irrigation, and averages three or four heavy irrigations a year. Soil fertility is maintained in several ways. First, the consistent and frequent annual irrigations provide a constant source of fresh soil. Extra heavy rains such as those witnessed by the author for May 18, 1955, often inundate all of the village and lands and further restore fertility. He also gives the field a light animal fertilization every six years.

He prepares his land carefully giving it a late fall barbecho,

early winter cruzada, and sows maize using the tube technique. He used to sow it a cajete but considers the tube more economical and has noted equal production.

Normally he sows an average of 10 cuartillos of maize mixed with .7 cuartillos of frijol and 1 cuartillo of squash per hectarea.

Under the system of cultivation practiced the production is very dependable and fairly high, especially considering the lightness of fertilization and practice of mono-cultivation without rest. My data on yield is based on the last ten years, agreed by all informants in all villages studied, to have been the worst in the last fifty years. During this ten-year period his yield dropped below 6 cargas per hectarea three years and during the remaining seven the yield varied from 6 to 10 cargas per hectarea. He estimates his average yield over the ten-year period at 8 cargas per hectarea. Converting these figures to kilos we get yields of 900-1500 kgs over the seven best years and a general average of 1200 over the ten-year period. Aside from this the 3 kilos of frijol sown on his 3-hectarea plot yielded an average of 75 kilos.

His family of seven consumes approximately 3 cuartillos or 4.5 kilos of maize a day or 1642 kilos a year. He could maintain his family in maize on just 1.4 hectareas of land. His excess production on the three hectareas - slightly over 100 percent of his consumption - is used as a cash crop.

Aside from his three hectareas of private land he has rights to eight hectareas of ejido, of which he has loaned one to a poor relative. These lands are all cultivated as tierra de temporal although they are irrigated when water is available. During the four years 1951,

'52, '53, '54 all seven were sown in barley, and in 1955 he switched to maize. Next year, 1956, he plans on sowing four in maize and three in barley and then in 1957 reverting to pure barley for a second four-year period. These lands have never been rested or fertilized. For barley cultivation the land is plowed but once, for sowing the seed. He has never suffered a complete loss of the barley crop but it has varied considerably year by year. He estimates a range of 3-10 cargas per hectarea or 300-1000 kilos. He feels a good average yield in barley is 500-600 kilos. The last maize harvest (1950) yielded 6 cargas or 900 kilos per hectarea.

According to the Secretario Ejidal, practically all of the ejido under proper management should yield an average of 8-10 cargas per hectarea or 1200-1500 kilos. Most of the ejido today is sown in barley, as barley requires a minimum of investment in time and labor and crops are more dependable under temporal farming techniques than maize. The total village holding probably runs to about 120 hectareas of which two-thirds is ejido. Our data suggests that the 70 families in the village would need a minimum of 100 hectareas to feed themselves and 200 to maintain a balanced economy.

San Martin de las Pyramides is the largest village in the valley (1940 population 2243, 1950 2629) and almost all families are landholders (450-520 families).

San Martin held the largest private holding of any community during the Gamio period. The"pequena propiedad" or small private holdings total nearly 1000 hectareas of rich vega lying in between the two barrancas of Atlamajac and Muertos and south of the latter. This zone is the granary of the village and the most important

element in the economy. It is mainly given over to maize cultivation with most fields being bordered by maguey. Barley and frijol are important secondary crops. The general depth of soil over this zone is from 2 to 2.5 meters. Those strips of flat land within 100 meters of the two arroyos, especially the Muertos, are the most productive due to their natural humidity and facility for artificial irrigation. The best lands of all are south of the Muertos, especially those further upstream. All of the pequena propiedad has facilities for irrigation based on two sets of dams and the canals are carefully maintained.

Aside from the private holdings the village received 500 hectareas of ejido. Of this 260 hectareas were taken from the old hacienda of Cerro Gordo. These lands are partly vega and partly slop but the slopes in general are very gentle and have a good soil cover varying between 30 and 100 cms. In the days of the hacienda the area was covered by maguey-lined bancales and the intervening spaces sown in barley and frijol, with some maize grown aided by irrigation from the dams of San Martin and the Xalmeyo. Today the irrigation system has fallen into disuse and the maguey has not been replaced. It is used mainly for temporal farming of maize and barley and the production has declined sharply from the hacienda level. The present Secretario Ejidal recently succeeded in uniting the farmers of Tolman and San Martin in a cooperative project of repairing the dam and cleaning out the canal system of the Xalmeyo, so a renaissance is on its way. He feels that a carefully maintained irrigation system could convert most of this part of the ejido into tierra de humedad.

Eighty hectareas of the ejido were taken from the hacienda of Tlacateupa and 160 from Oztoyahualco. These lands are mainly slopes with a scanty soil cover, in some sections with surface tepetate, and are the poorest lands held by the village. They were originally devoted to stock raising and maguey cultivation but today are tierra de temporal and sown in grains to produce exceedingly precarious and low-yield crops. These lands really should be reconverted to maguey. Part of them lie in the tlatel area of the ruins.

Aside from the private holdings and the ejido a third element enters into the village economy - the nopal orchard. Most houses have fairly large house lots or solares which are sown in nopal. The village is sprawled over 100 hectareas and has approximately 500 families, leaving an average of .2 hectareas per solar. Actually the average nopal orchard is somewhat larger as those solares near the plaza are very small and some of the streets off the plaza are urbanized. Also there are numerous orchards separated from houses on the edge of town. The average, however, is probably lower than that at San Francisco Mazapan (.4 hectareas).

The economy of the village, then, is based on 1000 hectareas of rich vega in private holdings, 500 hectareas of ejido of which half could be converted to productive grain-producing land and the rest serviceable as maguey land, and 100 hectareas of nopal orchards. The holdings in general are very small. The average landholder has about 2 hectareas of private land. The actual range is not very great. No one has over 10 hectareas and most hold less than 5. When the ejidos were offered only 185 men petitioned for parcels due to the influence of the local priest. Of these 136 were

inhabitants of the village itself and the rest of a nearby rancheria. The 136 ejiditarios of the community received parcels of 1 hectarea in both the hacienda of Cerro Gordo and Oztoyahualco and .5 hectareas from Tlacateupa or 2.5 hectareas each. Just below the huge dam on the Barranca de San Martin are 20-30 hectareas of the best lands in the village, being almost permanently irrigated lands. The ejiditarios received 1/4 hectarea parcels which were counted as half hectareas. The remaining 49 ejiditarios of the rancheria received but 2.0 hectareas, one in Cerro Gordo and the other in Oztoyahualco. Since the original division a few others have requested land. Most of the ejiditarios were landless men or held very small holdings. In general at San Martin abuses of the ejido system are small and the total land division an equitable one. My best informant, the Secretario Ejidal, is one of the biggest landholders of the village and he possesses 8 hectareas of land.

On May 18-19 fell two heavy thundershowers on Cerro Gordo. With the water flowing through the Atlamajac the villagers were able to irrigate one/fourth of the ejido and one-sixth of the vega. Informants stated that up to 1915 these early flash floods enabled them to irrigate the entire vega in May almost every year. The bulk of the water came from the Muertos.

In the vega or private lands techniques of cultivation are similar to those on the private lands at San Pablo. A post-harvest irrigation is common in San Martin and the land is then prepared with the typical barbecho and cruzada. In March those lands further up are irrigated and sown while further down it is done in April, and temporal sowings are made in May. Most farmers today use the tube

technique of sowing but a few still use the cajete.

One milpa studied lies in the best agricultural zone, just south of the Muertos. This land has been prepared as stated above and sown with the tubo and given light fertilizations every five or six years. It has usually been given several irrigations during the growing season and has never been rested, being sown in maize every year without change. Frijol is usually sown mixed with maize. The owner stated a range of 6-20 cargas per hectarea or 900-3000 kilos. He has never harvested less than 6 cargas. He feels that his average long-range production has been between 1500 and 2250 kilos per hectarea but that in the last ten years his yields have run along the lower limits of the given range. He normally sows 5 cuartillos or 8 kilos of frijol with the maize per hectarea and harvests 3-5 cargas or 480-800 kilos.

These yields are probably somewhat higher than that of the vega as a whole. In the ejido where the lands are cultivated in general as tierra de temporal the yields are much lower. During bad years when the vega lands are yielding 6-8 cargas per hectarea these lands are a total loss. In good years they yield approximately two-thirds that of the tierra de humedad or approximately 6-9 cargas.

### Middle Valley - Temporal Area

In the temporal area of the Middle Valley data was collected from two villages: San Francisco Mazapan and Santa Maria Coatlan. These two villages plus San Sebastian are all situated on tlatel and are only partially dependent on agriculture. They hold the poorest lands of the valley and rely in part on specialized handicraft industries. Also many men work for the federal government as laborers and caretakers at the ruins, some sell to the tourists and many

commute daily to Mexico City as factory workers. Almost all villagers further own nopal orchards as a source of cash income. Aside from the poor quality of the land then, most men have secondary occupations, and agriculture is only half-heartedly carried out.

The best lands of this stretch of the valley are those lying just south of the ruins where the soil runs to 30-100 cm. in depth. Only a small fraction could be cultivated as tierra de humedad but a high percentage could be irrigated if the barrancas were more thoroughly controlled by dams. To the north of the ruins the soil cover is scantier, running in general less than 30 cms with large areas of surface tepetate.

Both San Francisco and Santa Maria along with San Martin were the three villages with most land at the time of the Gamio study. Unfortunately it was not possible to ascertain the size of these private holdings. In 1928-29 the ejidos were distributed. San Francisco received 270 hectareas from the haciendas of Metepec and Tlacateupa which was doled out in parcels varying from 1 to 2 hectareas (the village has approximately 132 families). Santa Maria received 161 hectareas of which 98 are tierra de labor divided up among 53 ejiditarios also given in 1-2-hectarea parcels. The rest of the ejido is communal hillside pasture. In general the land division in the villages is equitable and very few men have respectable holdings. The probable average holding per person is certainly not over 3-4 hectareas including ejido and private land.

The majority of the lands are cultivated as tierra de temporal. Irrigation is limited to those lands lying near the two only dams in the zone. The bulk of the land is sown in maize and barley with

frijol running a poor third. Maguey is present only as field borders except in the hacienda "cascos" where it is the chief crop. These cascos are all on the nearby slopes and barrancas. Most lands are never fertilized and even the better cared-for lands are given a light fertilization every six years. The farmers depend mainly on the enlame process following flash floods for soil conservation. Crop rotation, however, is fairly common; a common pattern is maize one year, barley the second and maize and frijol mixed the third year.

The Secretario Ejidal of Santa Maria gave the following picture of production in the area. The years 1937, '38 and '39 were all exceptional with a general average of 10-12 cargas per hectarea over the ejido (1500-1800 kilos); 1940-1953 inclusive, all bad years, with an average of 3-6 cargas or 450-900 kilos with some lands suffering complete losses. In 1954 the year was a good one with yields running 1200-1500 kgs over the ejido as a whole. The data indicate a productive soil but that complete dependence on the rainfall timetable often leads to heavy loss and even disaster.

One parcel was intensively studied in the ejido of San Francisco. The owner has a regular permanent job at the ruins and does not work the parcel. He rents it "a medias" to a fellow villager. The parcel measures one hectarea and is situated on flat level bajo within a few hundred meters of the dam built by the Hacienda of Tlacateupa, and has facilities for irrigation. It could be converted to tierra de humedad as it has at least one meter of soil. However as the land is worked by another as an extra to his main work on his own field it has always been cultivated as tierra de temporal. It has never been fertilized or rested and is rotated barley and maize in a two-year-

cycle rotation system.

The land is given a fall barbecho and then left until the May sowing. If it doesn't rain or receive irrigation within 20 days the moisture dries up and the sowing is lost. In general water has been available for irrigation in most of the years and a maximum of five irrigations are given.

According to the informant the years from 1945-53 have in general been bad years with frequent combinations of delayed rains and early frosts. Nineteen fifty-four was a good year. Over this ten-year period the field has been sown in barley five years and maize five. Barley rarely is a complete loss and the crop has varied from 3 to 12 cargas over that period, or 300-1200 kilos. An average yield was estimated at about 600. During the five years of barley growing he estimates three average years and two poor ones. The maize crop was a complete loss one of the five years and the maximum yield was in 1954 when he harvested 6 cargas or 900 kilos per hectarea. He estimates that in the 25 years he has held the land it has yielded an excess of 6 cargas of grain eight years. In 1954 he had both his two hectareas of ejido in maize and harvested 1200 kilos, of which he received 600 and his rentee the other half. His 600 kilos provided his family (nine people but six are small children) for six months with maize.

These figures give us possible pre-conquest production data as no animal fertilizers were used. If we change the rotation of maize-barley to maize-huauhtli as at San Gregorio we can then reproduce a pre-conquest situation. With efficient irrigation the yields could be increased around 50 percent.

Lower Valley - Permanent Irrigation Area

In the Lower Valley two communities were studied: Santiago Atlatongo and El Calvario Acolman. The latter probably more correctly represents the water situation in the area, as the former has an all-round permanent water supply and is the only village with that privilege.

Santiago Atlatongo possessed 888 inhabitants in 1940 and 1091 in 1950 or from 177 to 220 families. It is one of the largest and wealthiest villages in the valley due mainly to its rights on the use of water from the springs at San Juan. They receive as a special privilege a continuous flow of water all year round running at a velocity of 38 liters a second from the canal of San Jose. From the canal of San Antonio they also receive a monthly dole for 26 hours at a velocity of 200.26 liters a second. Aside from this there are local springs which yield a continuous flow of 2 liters a second. With the officially distributed water from the main streams the Junta estimates that Atlatongo irrigates 287 hectareas. These irrigated lands are the life blood of the village and aside from permanent irrigation they are fertile deep soil vega running from 3 to 7 meters of topsoil.

The data offered by the Secretario Ejidal and Juez of Atlatongo differs somewhat from that of the Junta and is summarized in the chart below.

| | | |
|---|---|---|
| Vega (tierra de humedad) | | |
| Ejido | 132 hect. | (100 completely irrigated; rest "medio riego") |
| Pequena Propiedad | 103 | ( 40 completely irrigated; rest "medio riego") |
| | 235 | 140 |
| Cerril (hillside lands) | | |
| Ejido | 130 | (95 is flat mesa tierra de humedad) |
| Pequena Propiedad | 200 | |
| | 330 | |

In summary, the data indicates 235 hectareas of fertile bottom land of which but 140 is under complete irrigation and the rest, 95 hectareas, are cultivated as tierra de humedad, with just a pre-sowing irrigation. Three hundred thirty hectareas are hilltop and hillside, of which 95 hectareas are cultivated as tierra de humedad and the rest as tierra de temporal.

Lands fed by the continuous flow of water are given several irrigations during the growing season and yields are invariably good. The lands supplied by the monthly dole, however, are given an average of but two irrigations during the growing season. Normally this is sufficient but losses do occur in years of which a sowing is made in March and the rains hold off until July. Abuses of water rights within the village are common and quarrels frequent.

The ejido was taken from the haciendas of Cadena and San Jose. At Atlatongo the private lands are held by 30 families while the ejido is fractioned up among 210 ejiditarios. Ejido parcels run from 1/4 to 1.0 hectarea each in both irrigated and temporal lands, the former generally running to smaller parcels than the latter. Due to the unequal distribution of land there is an acute land shortage in the village and many poorer farmers also work in Mexico City as factory workers. Some farmers hold sizeable property even in irrigated land. If every farmer held an equal quantity of land with equal water rights the land could support an even larger population than it provides for today, as a full hectarea of irrigated land plus 1.5 of temporal would be more than he needs to maintain a balanced economy.

With the more permanent water supply crops are more varied than

than in the Middle Valley. Maize, wheat and alfalfa are the most important crops in that order. Aside from these chief crops, frijol (negro, bayo and amarillo), habas (Spanish beans), peas, squash and barley are important secondary crops. Formerly the area around the village was occupied by chinampas and most villagers cultivated onions, beets, lettuce and carrots in their solar-chinampas. Today these house lot chinampas have been converted to fruit orchards including such trees as apple, peach, cherry, apricot, pear, pomegranate and fig.

One of the important advantages that the farmer in the Lower Valley holds over those in the Middle Valley is double cropping. In one test case the cycle of cultivation practiced is as follows: In December the land is given the barbecho and rastreo. In February the cruzada and rastreo are made and in March the land is given an irrigation and plowed for tube sowing of maize. In Atlatongo today no one uses the cajete technique any more. If the rains delay until June the land is again irrigated and a third irrigation is done if the August "canicula" is prolonged. The maize for a March sowing is harvested in September. Some farmers sow their lands in April, others in May, and the harvest is hence delayed correspondingly. At Atlatongo the harvests are rarely poor and the variation is not great. On the land mentioned above the yield of maize runs from 12 to 15 cargas per hectarea or 1800-2250 kilos, with exceptional years bringing it up to 18 cargas or 2700 kilos. Following the maize harvest the land is given a barbecho and rastreo followed 15 days later by the cruzada. It is then irrigated and wheat sown in November. In 45-60 days after sowing a second and final irrigation is

given and the wheat harvested in May. The yield on the sample land runs around 12 cargas per hectarea or 1920 kilos. Following the wheat a rainy season crop of frijol or barley is sown, usually without irrigation. The barley usually yields from 1200 to 1600 kilos per hectarea. Following the barley harvest the cycle is repeated. Frijol and squash are often sown mixed with maize.

This system enables a maximum production on the land and spreads a limited water supply over as much land as effectively possible. The test holding is given animal fertilizer once every 5-6 years. In recent years the owner experimented with chemical fertilizers without positive improvement in yield. Over the two-year cycle, then, a single land will yield an average of two tons of maize, two tons of wheat, and nearly a ton and a half of barley, plus small amounts of frijol and squash. The experimental plot was the property of the local juez or judge, a noted abuser of water rights, and may be taken as the maximum production with abundance of water.

Calvario Acolman is a small village (population 660 in 1940) of approximately 130 families. It is situated at the entrance of the Lower Valley into the Lake Plain, is one of the villages which receive water from the springs at San Juan, and is the headquarters of the Junta. The water situation is perhaps more typical of the area than that at Atlatongo. The village is almost entirely dependent on irrigated land possessing very little temporal land.

Water is obtained by monthly dole from three of the major canals. From the canal of Texcalac with a capacity of 50.6 liters per second the ejido receives water for a period of 4 days 15 hours to water

54 hectareas, and the private property receives water for 8 days 13 hours 30 minutes to water 100 hectareas. From the canal of San Antonio with a capacity of 200.26 liters per second the ejido receives water for 2 days 3 hours 15 minutes to water 90 hectareas, and the private property receives it 1 day 13 hours to water 65 hectareas. From the canal of San Jose with a capacity of 287.32 liters the ejido receives water for 1 day 8 hours to irrigate 81 hectareas.

Today, due to reasons explained in the section on irrigation, there is a severe water shortage, and a single land receives a limit of four irrigations a year. As a single irrigation insures humidity for plant growth for a maximum of but 60 days crops may suffer from drought, especially in those cases in which maize was sown in March and the rains were delayed until June. Most villages from El Calvario down have in recent years (especially affected by the last ten years of poor rains), due to the decrease of spring production, shifted from grain-subsistence economy to an alfalfa-barley-dairy economy. Both of these latter crops are less sensitive to drought than maize and therefore more economical. The four chief crops at Calvario in order are alfalfa, barley, wheat and maize. The village can be truly said to be based on a full commercial economy.

All of the private holdings at Calvario are irrigated and total 165 hectareas. In general holdings are very small and approximately one-half of the families have private land. The ejido was taken from the ancient haciendas of San Jose and San Antonio and total 218.8 hectareas of irrigated land divided up into 116 parcels of 1.8 hectareas. Aside from this it includes 34 parcels comprising .2 hectareas of tierra de humedad and 3.0 hectareas of tierra de temporal

in the nearby slope country. There are than 150 ejiditarios in the community. According to the records of the Junta the village possesses in ejido land 235 hectareas of tierra de riego, a slight disagreement from the records of the ejido.

Cultivation techniques at Calvario are much simpler than at Atlatongo because of the general tendency to sow drought-resistant crops. Most farmers feel that careful humidity conservation techniques such as those practiced at San Martin and San Pablo would permit efficient maize cultivation, but the economy of dairy products is both less strenuous and more rewarding financially; the village economy has thus shifted in this direction in common with that of many villages on the Texcoco plain.

Many lands at Calvario today, therefore, are given but two irrigations a year, one just before each of the sowings. If maize and wheat are to be planted a maximum of four irrigations are given. Actually with the acute water shortage only one of these heavier water consumers is generally sown in a year, so that three irrigations is the normal maximum. That is, if wheat is to be sown in the winter a farmer may be allowed two irrigations for his winter crop but with the understanding that he will then sow a crop like barley in the summer which can get along on just one or if he plans on a summer maize crop he will then sow alfalfa and not wheat in the winter. Even wheat at times may be attempted with a single pre-sowing irrigation. The exact cycle to follow is one of individual choice but the amount of water to be given out is rigidly controlled. Farmers with spare cash may rent the ejido pump-artesian well in the village by the hour and give the land four irrigations, but the spring

irrigation system permits a maximum of three.

Even with the lack of careful land preparation and scarce water supply the crops are very rarely a complete loss and yields in general run similar to those of San Pablo. In general fields are fertilized once every five years.

Maize yields on the average 8-10 cargas per hectarea at Calvario or 1200-1500 kgs per hectarea, or considerably below our ideal test field at Atlatongo. During bad years it may drop to 900-1050 kilos but except for very rare years this is a lower limit. During the past ten years yields have often approached this lower limit. Informants state that yields on the same fields during the hacienda period were much higher due to the more careful techniques of maintenance of the irrigation system and combined use of barrance and spring irrigation. Wheat yields are also much below our Atlatongo figures as a considerable amount of the wheat is given but one irrigation. The yield drops to 1000-1200 kilos with this reduction of humidity. The soil is evidently as fertile as at Atlatongo and with the same number of irrigations as that generally given at Atlatongo will yield equally well.

The acute water shortage is dramatically illustrated by the development in recent years of sub-parcel irrigation. A holding may be divided up into strips 7 meters wide separated by low earth walls or even further broken up into small squares or rectangles to distribute the water more evenly over the field. This prevents what little water that is received from being wasted by uneven drainage and is a sign of extreme water shortage in the valley technology. To alleviate the problem somewhat the ejido has recently installed

an artesian well and gasoline pump which sells water at a rate of 10 pesos an hour.

## Demographic History of the Teotihuacan Valley

Gamio in his study presented a history of the population of the Middle and Lower Valley which is summarized in the chart below.

| Unit | 1868 | 1869 | 1873 | 1879 | 1894 | 1900 | 1910 | 1917 |
|---|---|---|---|---|---|---|---|---|
| Atlatongo (village | | 913 | 972 | 905 | 782 | 787 | 706 | 653 |
| Cadena (hacienda) | | 13 | 40 | 43 | 117 | 191 | 207 | 169 |
| California (rancho) | | | | | 26 | 73 | 52 | 50 |
| Calvario (pueblo) | | 387 | 351 | 438 | 379 | 342 | 394 | 420 |
| Cerro Gordo (hacienda) | 78 | 118 | 124 | 180 | 82 | 99 | 157 | 118 |
| Cozotlan (rancho) | | | 30 | 48 | 49 | 56 | 62 | 51 |
| Maquixco (barrio) | 262 | 245 | 283 | 291 | 264 | 305 | 377 | 167 |
| Metepec (hacienda) | 49 | 44 | 68 | 40 | 110 | 125 | 170 | 129 |
| Nextlalpan (rancho) | | 10 | 9 | 24 | 37 | 43 | 48 | 24 |
| Oztoyahualco (rancho) | 67 | 69 | 45 | 9 | 105 | 87 | 96 | 79 |
| La Palma (rancho) | | | | | | 14 | 7 | 14 |
| La Purificacion (pueblo) | 281 | 259 | 307 | 320 | 376 | 452 | 628 | 538 |
| Puxtla (barrio) | | 93 | 113 | 109 | 125 | 147 | | 113 |
| San Bartolo (village) | | 218 | 325 | 211 | 209 | 298 | 322 | 332 |
| San Francisco (village) | 403 | 381 | 444 | 421 | 497 | 523 | 419 | 351 |
| San Jose (hacienda) | | 46 | 23 | 29 | 36 | 108 | 74 | 26 |
| San Juan Ev. (barrio) | 273 | 234 | 330 | 323 | 320 | 327 | | 308 |
| San Juan Teot. (villa) | 688 | 596 | 1071 | 616 | 414 | 739 | 3368 | 760 |
| San Juanico (village) | | 116 | 116 | 133 | 72 | 95 | | 73 |
| San Lorenzo (village) | 182 | 196 | 220 | 218 | 201 | 186 | | 176 |
| San Martin (village) | 1335 | 1265 | 1424 | 1608 | 1670 | 1767 | 1639 | 1847 |
| San Sebastian (village) | 251 | 246 | 263 | 252 | 320 | 308 | | 301 |
| Santa Catarina (hacienda) | | 59 | 132 | 112 | 83 | 133 | 241 | 173 |
| Santa Catarina (village) | | 406 | 494 | 237 | 346 | 396 | 328 | 354 |
| S. Maria Acolman (village) | | 110 | 140 | 81 | 122 | 85 | | 113 |
| S. Maria Coatlan (village) | 202 | 200 | 261 | 228 | 313 | 221 | | 223 |
| Tenango (village) | | 120 | 154 | 126 | 118 | 132 | | 135 |
| Tlajinga (hacienda) | | 31 | 56 | 77 | 62 | 80 | 58 | 61 |
| Ventilla (rancho) | | | | | | 50 | 39 | 28 |
| Xometla (village) | | 354 | 461 | 343 | 315 | 433 | 387 | 484 |
| Total | 4071 | 6724 | 8256 | 7526 | 7550 | 8602 | 10779 | 8330 |

The censuses were obviously incomplete but the data offers some important conclusions. We can safely say that during the 44 years

represented by the table the population was extremely stable. We probably have a case in which the bulk of the lands were in a few large holdings and in which the majority of the production was sold outside of the valley. The result was that the growth of the villages demographically was completely aborted, haciendas reaching a state of stability and total demographic growth stifled by the landholding system. This can especially be noted in the history of individual villages. Atlatongo for example actually declined in population from nearly 1000 to 653 inhabitants. The population figure for 1873 has not been re-achieved until the 1950 census. In the case of El Calvario the population skipped up and down around the 400 mark with no real progression or regression. The bulk of the villages show one of the two mentioned histories a real gradual increase is very rare, San Martin being a notable exception. It is interesting to note in connection with San Martin that it was the village holding the largest quantity of land during the census period. At the time of the Gamio study approximately one-ninth of the population lived in haciendas and ranchos and the rest in villages, yet the villages held but one-tenth of the land.

A few years after the Gamio census of 1917 the large haciendas were broken up and the ejidos parcelled out. The effect of the land redivision along with the growth of the tourist trade and the industrial labor market in Mexico City has resulted in a phenomenal demographic growth equalled by very few areas in Mexico. Between 1920 and 1930 the population of the Middle and Lower Valley jumped from 9000 to 11,000 and in the ten years following it climbed up to 13,000 and finally in 1950 we find nearly 17,000 inhabitants or nearly

double that of the Gamio census and this in but thirty years of population growth.

Within our larger unit of the Valley of Teotihuacan we find represented seven municipios. The demographic history of these municipios is summarized below.

| Municipio | 1900 | 1910 | 1930 | 1940 | 1950 |
|---|---|---|---|---|---|
| San Juan Teotihuacan | 5175 | 5570 | 5418 | 6667 | 8348 |
| Calvario Acolman | 5822 | 5522 | 5827 | 7234 | 9422 |
| San Martin Pyramides | | with Otumba | 3717 | 4171 | 4718 |
| Otumba | | 11264 | 7167 | 7584 | 7598 |
| Axapusco | | 7944 | 7049 | 7662 | 8407 |
| Tezoyuca | | 1837 | 1960 | 2161 | 2531 |
| Atenco | | 3848 | 4413 | 5023 | 5424 |
| Total | 10997 | 35985 | 35551 | 40502 | 46448 |

These figures serve very well as estimates of the population of our defined Valley of Teotihuacan. A few communities within some of the municipios lie outside of the valley proper but the total population of these communities does not exceed ten percent of the total. In the valley as a whole the population has increased approximately 33 percent from 1910 to 1950. The chart shows clearly that most of the increase took place in the Middle and Lower Valleys. The Upper Valley grew very little. This is undoubtedly due to its greater distance from the urban labor market, lack of participation in the tourist trade, and third and most important the fact that it is the poorest section of the valley and a high percentage of the lands were held by villagers even in Gamio's time. In the Lake Plain section the overall increase has been approximately 50 percent.

In the Middle and Lower Valleys the population density on the

valley floor in 1950 reached nearly 150 inhabitants per square kilometer. The municipio densities within this section of the valley are lower as they include much unoccupied slopes and hill tops. However by simply comparing these gross municipio densities we can get a good idea of the comparative productivity of the various sections of the valley. For the Lower and Middle Valleys we find Acolman 110, San Juan 110; for the Lake Plain we have densities of 75 at Atenco and 100 at Tizoyuca; and in the Upper Valley the figures reduce sharply to 50 for Otumba and 30 for Axapusco.

## Community Settlement Patterns

Today most of the population of the valley lives in nucleated settlements. The majority of the settlements falls in our category of "village", being inhabited entirely by farmers. Two of the communities, San Juan and Otumba, should rather be classed as true towns as both possess numerous stores and work shops and many non-agricultural specialists, and both are weekly market centers for the surrounding villages. Other municipio centers such as Calvario Acolman and San Martin de las Pyramides are transitional town-villages. For most of the population of the valley San Juan Teotihuacan is the main shopping center and has the largest market and greatest volume of trade. Agricultural activities are paramount in all communities although a few villages such as San Sebastian have secondary specializations (pottery and roof tile manufacture).

The general layout of the nucleated community is quite regular. In most cases we find in the geometric center of the community a central plaza with church, municipal buildings and a few shops and the houses scattered about in all directions from this center.

Except for a few principal streets the Spanish grid street pattern is not characteristic in the smaller communities. In the larger, more urban communities we often find a more consistent use of the grid, as at San Martin. A number of communities are compound, that is, they are a single physical entity but are made up socio-politically of two or more joined villages. Often the component members are called "barrios" instead of villages. San Juan Teotihuacan is a notable example. First we have the community of San Juan itself officially classed as a "villa" or town. Joined to it on the east is the barrio of La Purificacion and on the western edge the two barrios of Puxtla (south of the highway) and San Juan Evangelista (north of the highway). These four units form a single physical community. Aside from this we find another detached barrio, Maquixco, 2.5 kilometers to the west. In 1940 the Villa of San Juan alone possessed 1353 inhabitants but the physical community San Juan-Puxtla-Purificacion-San Juan Evangelista possessed 2600 and adding Maquixco we find a total of 3059 inhabitants. San Juan is not alone as a compound community. We find at least two others; San Juanico and San Bartolo Acolman form a compound community and Santa Catarina Acolman-Tenango another. The origin of these compound communities goes back before the conquest. In some cases the ancient community was divided up into anywhere from two to six or even more sub-divisions called "calpulli", translated by the Spaniards as barrios. In other cases a large central community would have a number of physically separate dependent communities made of just one calpulli each and thus translated by the Spaniards as barrios also, although in reality they would be better called "aldeas". Following the

conquest in many cases the Spanish priests moved the population of these little aldeas to the central town to facilitate conversion, thus creating artificial compound communities as each moved community tended to preserve its social separativeness.

In the case of some communities such as Tepexpan and the compound community of San Juan the basic radial settlement pattern has been altered by the building of the highway. The houses are today stretched out linearly along the highway instead of being distributed equally around the central plaza. In San Juan the effect of this change is quite dramatic, leaving the principal church of the community stranded solitarily in the midst of chinampas well south of the edge of town.

The bulk of the population live in villages with populations ranging between 400 and 700 inhabitants. Only one-third of the population of the valley lives in communities with over 1000 inhabitants (Otumba, Tolman, San Martin, San Juan, Tepexpan, Cuanalan, Atlatongo, Nexquipayac and Ixtapan). The communities are much smaller as a rule than in the Chinampa area.

The internal population densities of the nucleated communities divide sharply into two classes. All of the villages with economies based on irrigation (permanent) have similar densities.

| Community | Area (hect.) | Density (per km$^2$) |
|---|---|---|
| Calvario Acolman | 15 | 5000 |
| Cuanalan | 30 | 3600 |
| Chipiltepec | 25 | 3300 |
| Santa Catarina Acolman | 17 | 4000 |
| Xometla | 18 | 4000 |
| Santa Maria Acolman | 3 | 4000 |
| San Juanico-Bartolo | 11 | 5000 |

The densities run from 3300 to 5000 with five of the seven communities falling in the 4000-5000 bracket. The densities are significantly below those of the chinampa area.

One of the interesting aspects of community growth is the relationship between the growth of its population and its physical expansion. We find that Gamio's estimate of the area of Xometla and Calvario Acolman in 1917 is exactly the same as our estimates. In other words these communities have not expanded in area; what has happened is that the population density has increased. Evidently in an expanding community this is the first step. Later on when fractioning of house lots is no longer practicable new colonies tend to appear on the outskirts. Atlatongo is a good example of the latter stage.

The nucleated communities of the Middle Valley have much lower densities.

| Community | Area (hect.) | Density (per km$^2$) |
|---|---|---|
| San Francisco Mazapan | 60 | 1250 |
| San Sebastian | 40 | 1250 |
| Santa Maria Coatlan | 25 | 1150 |
| San Martin | 100 | 2500 |

The higher figure for San Martin is probably due to the urbanization taking place in the blocks just off the plaza. The reason these communities show lesser densities than those in the Lower Valley undoubtedly lies in nopal orchard cultivation. One of the important sources of rural income is the nopal, and each house is surrounded by a sizeable orchard. The average house lot - buildings and orchards - measures .4 hectareas. Further up the valley outside of our nopal cultivation zone in the deep soil plain we find San Pablo

Isquitlan with a density of 5000 per $km^2$, thus equalling our Lower Valley communities.

Aside from the nucleated villages we find three other settlement types in the valley: (a) the scattered village; (b) the rancheria; and (c) the hacienda or rancho. Type (a) we find at Cuauhtlancingo, Santiago Tolman and Oztotipac. The first and last lie sprawled over long low hills without order or planned streets. Tolman lies on the lower flanks of the Cerro Gordo. They do, however, possess central plazas. This type of village probably was quite common in pre-Spanish and very early colonial times. The densities are somewhat lower than in the nopal villages; Tolman for example with slightly over 1000 inhabitants is spread over 100 hectareas of slope and Cuauhtlanzingo with 718 inhabitants is scattered even more diffusely over 160 hectareas.

The rancheria type settlement is an even more diffuse "community". It lacks entirely the central plaza. We find three communities of this type on the slopes of the Cerros Gordo and Malinalco: Palapa, Ixtlahuaca and Tlachinolpa. Palapa is scattered over at least 200 hectareas of slope and possesses but 400 inhabitants, with a density of only 200 per $km^2$.

The hacienda is a settlement type which never involved more than a small fraction of the population of the valley and is today losing what slight demographic importance it once held.

## Zonal Settlement Patterns

From Tepexpan in the southwest to Otumba in the northeast is a distance of 28 kilometers or exactly the distance between Chalco and Xochimilco in the southern Valley of Mexico. This distance is traversed

by a federal highway which is paved from Tepexpan to San Francisco Mazapan and unpaved from the latter to Otumba. There is also a railroad running the length of the valley parallel to the highway which connects Mexico City to Vera Cruz. A trip along the highway gives an excellent idea of the zonal settlement pattern of the valley as it passes through all five of the ecological sections and numerous communities.

Tepexpan is one of the largest communities in the valley and lies in our Lake Plain section. In ancient times it was situated on the shore of Lake Texcoco. It is a typical nucleated community with a population in 1940 of 1179 inhabitants. The population consists mainly of dairy and grain farmers and commuter laborers for the factories of Mexico City. In the decade 1940-50 it has doubled its population to 2048 inhabitants.

Leaving Tepexpan we find the compound community of Santa Catarina Acolman-Tenango at a distance of 3.3 kilometers. This community had 643 inhabitants in 1940 and is situated at the base of the Cerro de Maravillas on the western edge of the valley floor.

The highway then runs directly through the irrigated valley floor to Calvario Acolman situated almost in the center of the valley and at the narrow entrance between the Lake Plain and Lower Valley. Both Santa Catarina-Tenango and El Calvario are true farming villages with the cultivation of grains and production of dairy products as the base of their economy. Slightly over one kilometer before Calvario the highway passes the famous Convento de San Agustin Acolman, one of the great colonial monuments of Mexico. It was once situated in the center of a large semi-urban community, the

ancient Acolman, but the community has now disappeared and the convent stands alone. Calvario Acolman is one of the municipio centers of the valley, the headquarters of the "Junta de Aguas de los Manantiales de San Juan" and is a transitional town-village in type. In 1940 it possessed 660 inhabitants and it is situated but 2 kilometers from Santa Catarina Acolman-Tenango.

Upon leaving Calvario the highway runs up the center of the Lower Valley through the rich spring-fed bottomlands with their brilliant contrasts of yellow and green checkerboard squares of ripening or growing wheat and maize. At a point 2.5 kilometers from Calvario the highway passes along the western edge of the compound community of San Bartolo-San Juanico Acolman with a total population of 514 inhabitants.

From San Bartolo-Juanico to the next village, Santiago Atlatongo (888 inhabitants), is but 1.5 kilometers.

Upon leaving the latter village the highway then skirts along the edge of the valley offering a startling contrast between the green irrigated valley floor to the south and dry brown slopes and hills to the north. The stretch from Atlatongo to San Juan is the area with most water for irrigation and the maize and wheat crops yield significantly higher than further below. Beyond Atlatongo the first community met with is Santa Maria Maquixco, a detached barrio of the huge compound village-town of San Juan. In 1940 Maquixco possessed 459 inhabitants. It is approximately 3.0 kilometers from Atlatongo.

From Maquixco to the Villa of San Juan Teotihuacan is but 2.5 kilometers. The Villa is a large sprawling compound community made

up of a central community or villa which is a true semi-urban town plus three contiguous villages or barrios, San Juan Evangelista, Puxtla and La Purificacion. The market of San Juan is a shopping center for the entire valley and meets regularly Sunday and Monday. The villa is full of specialists: carpenters, bakers, tailors, pulqueros, cantineros, shopkeepers, restaurant operators, barbers, masons, etc.; it is a municipio center and has a mail and telegraph office. The total population in 1940 was 2600, of which approximately one-half lived in the villa and the rest in the three joined barrios. In 1950 it rose to 3500.

One of the important local features of the stretch from Maquixco to San Juan are the manantiales or springs which are the life blood of the Lower Valley and Lake Plain. At the barrio of Puxtla especially they are abundant. The entire zone just south of the villa possesses a very high water table and chinampas are constructed by simply digging narrow canals around each holding down to the water level. The chinampas here are of the same form and dedicated to the same type of production as in the Xochimilco area.

Beyond San Juan the landscape changes sharply and we are in the Middle Valley. The lower segment of the Middle Valley is one of thin barranca-cut soil, rainy season agriculture with very sharp color shifts according to the season. During the dry season it appears almost desertlike with the fine dry brown soil and nopal plantations, but during the rainy season both wild and artificial vegetation ameliorate the apparent aridity somewhat. Approximately 1.5 kilometers east of the plaza of San Juan the highway enters the tlatel or urbanized zone of the classic city of Teotihuacan, a huge sprawling

city far above the dimensions of any modern community in the valley today. At least 700 hectareas are occupied by the ruins as noted by the quantity of loose rock (tezontle) in the soil, exposed floors, and dense concentration of pottery. Within the urban area of the ancient city are no less than four modern communities whose economy is based on a combination of rainy season grain agriculture, nopal orchard cultivation, specialized local industries and the tourist trade. The highway passes a kilometer north and west of two of them on the way to the ruins but does not enter them. These are San Sebastian, population 448, and Santa Maria, 269. Airline distances are: San Juan to San Sebastian 3.0 kms; San Sebastian to Santa Maria 1.1 kms.

The highway makes several long turns between San Juan and the Pyramid of the Sun; in a direct line it is but 3.0 kms but by the road nearly 5. From the Pyramid of the Sun to San Francisco Mazapan, a village of 658 inhabitants, is but 1.0 km to the northeast. From Santa Maria to San Francisco in a direct line is 1.1 kilometers.

The paved highway ends at the ruins. From this point an earth and gravel road continues on, skirting the western edge of San Francisco, and continues on to San Martin de las Pyramides approximately 1.5 kms away.

San Martin is a municipio center, a transitional town-village, and the largest simple community in the valley both physically and demographically. It is also the community with the most consistent street grid pattern. In 1940 it held 2243 inhabitants.

Beyond San Martin the aspect of the valley changes considerably. From here on to Otumba we are in an area of deep fertile soils running

from 1 to 3 meters in depth in the vegas or riverside flats, interspersed with dry, long, gentle slopes. Irrigation based on rainfall in the neighboring ranges have converted the vegas into rich grain-producing lands and there is a sharp contrast in the vigor and verdure of crops planted in the vegas as compared to those on the slopes. Most fields are bordered by lines of maguey.

Between San Martin and Otumba the highway passes along the edge of but a single community (San Pablo Isquitlan, population 353, approximately 6 kms northeast of San Martin). The reason for the lack of villages in this expanse of good agricultural land lies in the size of San Martin. Most of the vega is owned by that community and the greater majority of the nearly 500 families living there hold land. At the same point on the highway as San Pablo but lying north of the highway and about one kilometer from it lies the scattered village of Santiago Tolman with slightly over 1000 inhabitants who also share this fertile section of the valley.

From San Pablo to Otumba is 4.0 kms and at the latter place our tour of the valley ends. Otumba is a true town of the San Juan type with a Tuesday market. In 1940 it possessed 1560 inhabitants.

Along the 28 kilometers of highway from Tepexpan to Otumba are located no less than 14 physical communities (counting those just off the highway) or an average distance of just 2 kilometers between communities. The combined population or linear population is 13,478 inhabitants or an average of 962 per community. The population range of the communities following the 1940 census was from 269 up to 2600 inhabitants. All are nucleated communities except Santiago Tolman which we class as a scattered village and two of the nucleated communities are true towns.

EL RIO - THE CHONTALPA

Ecological Background

The state of Tabasco along with the adjacent portions of the state of Chiapas together form a well defined ecological unit characterized by very heavy rainfall (the heaviest in all of Meso-America) and tropical temperatures. It may be divided into two ecological subregions: (a) the lower slopes and foothills of the Chiapas ranges; and (b) the flat coastal plain of Tabasco. The border between the two is fairly well defined by the modern Tabasco-Chiapas state line. Our study deals with a portion of the Tabasco plain.

Tabasco covers approximately 24,000 $km^2$. The entire state lies below 100 meters and Tabasco along with the Yucatan Peninsula forms the largest continuous extension of lowland in all of Meso-America. Unlike the Yucatan Peninsula, however, which although it lacks relief has an extremely broken topography, the Tabasco Plain is as flat as any land form ever is. The origin of this coastal plain is fluvial and depositional, and has an approximate breadth of 70 kilometers. However even after reaching this point, although the topography becomes broken to hilly, the actual increase in elevation is slight. Even at a point 100 kilometers from the coast the land rises to but 200 meters. From the latter contour, however, the rise is very abrupt with extraordinarily narrow ecological zones on up to the mountains and valleys of highland Chiapas.

Three major rivers collect the drainage from the Chiapas mountains and foothills and cross the Tabasco plain on to the sea. The smallest

in volume is the Tonala which drains the western part of the municipio of Huimanguillo. The river of heaviest volume is the Rio de Grijalva or Rio Grande or Mezcalapa, as it is variously called, which drains the rich agricultural region known as the Chontalpa and runs through the center of the state. The Usumucinta through most of its course drains northern Guatemala and only enters Tabasco in its lower course, draining through the eastern part of the state. They are all three characterized by large extended basins with numerous tributaries and, for Meso-American rivers, enormous volumes. All three annually inundate the lands lying off their middle or lower courses following the heavy summer and early fall rains, causing heavy damages to crops and villages on their margins. This is especially true of the Grijalva. This river, when it enters the Tabasco Plain, flows almost due north. At the town of Cardenas it makes a right-angle turn to the east and flows in an easterly direction as far as Villa Hermosa, where it makes a second right angle to the north and then flows on into the gulf. The effect of these two turns on the neighboring shore lands can easily be imagined. Swollen by the late summer and early fall rains the river bursts out of its normal bed and spills over into the lands lying south of the first big bend and floods villages and lands, especially in the municipios of Cunduacan and Nacajuca. In the year 1955 most of these two municipios were completely covered by water following the extra heavy rains of that year. Even those communities further upstream such as Huimanguillo along with the neighboring strip along the river suffer annual inundation, although in normal years damage to crops and communities is slight.

The two streams, Grijalva and Usumucinta, merge during their lower courses and the entire coastal strip below this point of juncture is a vast network of swamps, lagoons and streams most of the year.

Due to this annual process of flooding, the river, where not bordered by extended swamps, is paralleled by strips of alluvial flood plain which are of crucial importance in the economy of the state. The most important alluvial plains are those of the middle Grijalva from Huimanguillo to Villa Hermosa and of the Rio Seco which is the abandoned bed of the ancient Grijalva and includes most of the municipio of Comalcalco.

As has been stated the ecological region in which the Tabasco Plain is located is the wettest in Meso-America. This is especially true of the hillier hinterland sub-region. All along the Gulf Coast of Mexico the rainfall is heavier than in the rest of the country and within the Gulf Coast drainage the heaviest readings are on the middle and lower slopes of the bordering ranges rather than the plain itself. Our ecological region is no exception. The heaviest figures come from those stations within the 50-200-meter bracket. The annual precipitation ranges from 2500-5000 mms with a general tendency to cluster around 3000 mms. These figures are based on the stations of Palenque, Teapa, Pichucalco and Tacotalpa. On the Tabascan Plain itself the figures run much lower but still are higher than any other part of the Gulf Coast below 50 meters in elevation. Figures run as follows: Huimanguillo 1879 mm; Villa Hermosa 1829; Nacajuca 1524; Tenosique 1961; and Comalcalco 1905. In other words the general average is about two meters. However in spite of the lower rainfall the coast plain lands are undoubtedly more humid than those of the

foothills due to the more rapid drainage in the latter.

One of the important characteristics of Tabascan rainfall from an agricultural viewpoint is the fact that although there is a monsoon season of increased rainfall (July to November) there is really no true dry season as in most of Mexico. From April to May the rainfall drops off sharply, often to zero in the former month, but aside from this short drought crops may be grown throughout the year. There is a saying in Mexico that "en Tabasco hay dos temporadas, una de lluvias y una de aguaceros" which is an excellent description of the climate. The variation in annual rainfall year by year is slight in the coast plain, considerably greater in the hinterland.

The annual mean temperature, as throughout the Gulf Coast from Tuxpan to Merida, runs from 25 to 26 degrees Centigrade. The maximum temperature occurs during the short dry season of April-May when the heat may be really oppressive in its effect, especially as the humidity is excessive in spite of the lack of precipitation. Once the rains begin again the temperature becomes more livable. From November to December there is a short "winter" when, for an American, the climate is quite pleasant, but to the natives it is an unhealthy period of grippe, colds and influenza. Actually the monthly variation is very small as one might expect at this latitude and altitude. This thermal cycle is characteristic of Mexico's Gulf Coast as a whole.

Tabasco, along with 90 percent of the Meso-American area, is very poorly known in a pedological sense. I have not encountered a single published study of the soils of the state. On general soil

maps of Mexico the entire state is given a single soil classification - gley or swamp soils, a type characterized by excessive water content, extreme leaching, and almost unmanageable for agricultural use. Actually the situation is much more complex. Although not a soil specialist I did note striking differences in soils in the course of my agricultural studies. There seem to be three important soil types: laterites, gleys and alluvion. Gley soils occur mainly in areas near the lower courses of the major rivers or other permanently inundated lands. Alluvion, mainly sandy in texture, occurs along the shores of the middle and upper segments of the major rivers and along the banks of the numerous tributaries. These alluvial strips run from a few hundred yards in width to 7-8 kilometers. The rest of the state is covered by soils in various stages of laterization running in color from yellows to reds and are of clay texture. Top soil layers are in general quite thin - in areas of heaviest laterization may be entirely absent.

The soils vary enormously in fertility. In some sections, such as the elevated flat plain of Metepec, the laterization and leaching processes are so advanced that the soil will not even support tropical forest in spite of the fact that the climate should produce it. These sections are covered by a savannah vegetation and are useless for agriculture. In the hilly hinterland where drainage is rapid and leaching at a minimum these soils support an exceedingly dense tropical rain forest cover, give excellent double crops of maize, and are the main cacao-producing lands of the republic. In much of the flat coastal plain the soils do support a tropical forest but they are not of good quality and fertility can be maintained only

by extensive rest periods. With excessive rainfall their clayey texture prohibits good drainage and crop loss through inundation may be heavy. During the dry season this soil bakes as hard as brick and cracks open, making cultivation difficult.

The one single factor which modifies this generally unfavorable situation in Tabasco and converts it into an important banana and cacao-producing area is the very same factor which causes periodic loss of life and property: the rivers. No other single geographical factor dominates Tabascan life so thoroughly as the major streams, especially the Grijalva. Its huge volume carrying enormous amounts of sediments and its subsequent flooding, accompanied by annual deposition, results in the formation of a fertile, continually fertilized flood plain ideal for tropical commercial agriculture. The soils are sandy to loam textured and characterized by ease of working and good drainage.

The flood plain of the Grijalva begins just north of its crossing with the F. C. C. Sureste, although it is restricted to small pockets until reaching a point about ten kms south of Huimanguillo. At this point it fans out along both sides of the river to form a belt ten kms wide and continues increasing in width until it reaches the first right-angle turn. At this point it reaches a width of 15 kms. This width is maintained as far down as Villa Hermosa. The present Grijalva flood plain is the key to the economy of the state of Tabasco, along with the ancient flood plain of the same river, which today is called the municipio of Comalcalco.

Aside from the extensive flood plains of the major rivers each tributary also inundates and forms smaller flood plains so that the

total amount of land of this type is quite large. The most productive area of all is the Municipio of Comalcalco which is mainly occupied by the flood plain of the ancient course of the Grijalva. Most of the municipio is covered by a thick mantle of river-deposited alluvion, now a huge, humid, flat plain which unlike the modern Grijalva flood plain rarely suffers inundation. It is covered by cacao plantations and is the most densely populated part of the state.

Within the time available it was obviously impossible to study thoroughly the entire state of Tabasco so a much smaller area was selected for intensive analysis. The author became acquainted with the selected area first as a participant in an archaeological field party which undertook a thorough survey followed by selected excavations. The area is fairly representative of the state as a whole as it includes alluvial riverside plains, elevated savannah and tropical forest and has densely populated as well as almost uncolonized zones within it, and economically and technologically offers an excellent profile of Tabascan economy with a combination of cattle raising, cacao and banana plantation agriculture, and primitive slash-and-burn maize cultivation as its base.

The accompanying map will help localize our test area. It consists of a rough rectangle delimited by the Huimanguillo-Cardenas municipio borders to the north, the Grijalva river to the east, the Ferrocarril Sureste to the south and the limits of the map to the west. The total area is 900 $km^2$.

Within the test zone we can indicate three sub-zones from the standpoint of intensity of human settlement. First we have what we can call the nuclear zone, a strip of intensely settled land 10 km

wide and 30 long bordering the west bank of the river. Population in the nuclear area is reaching saturation with the present economic system. The second zone is an enormous stretch of elevated savannah, unpopulated except along the edges and economically useless except for cattle grazing. The third sub-zone comprises a stretch of elevated-flat tropical forest which is partially colonized, the westernmost segment being still unpopulated. This is the only sub-zone where demographic expansion is still desirable.

Rough estimates of the sizes of these various sub-zones are summarized below.

| | |
|---|---|
| Zone 1 - Nuclear Zone | |
| Grijalva Flood Plain | 125 $km^2$ |
| Hilly - Tropical forest lateritic soil | 40 $km^2$ |
| Transitional tropical forest - savannah | 40 $km^2$ |
| Level tropical forest lateritic soils | 95 $km^2$ |
| | 300 $km^2$ |
| Zone 2 - Savannah Zone | |
| True savannah | 150 $km^2$ |
| Transitional savannah-tropical forest | 200 $km^2$ |
| | 350 $km^2$ |
| Zone 3 - Elevated Tropical Forest Zone | |
| Small tributary flood plains | 50 $km^2$ |
| Elevated level tropical forest covered lateritic soils | 200 $km^2$ |
| | 250 $km^2$ |

Breaking this chart down by ecological types we find that alluvial flood plains comprise 22 percent of our test area, useless or limited-use savannah and savannah-transitional forest lands cover 33 percent, and the remaining 45 percent is made up of elevated flat or hilly tropical forest-covered lands with lateritic soils which are satisfactory for such crops as maize, beans and rice. The cacao and banana plantations are of course in the alluvial flood plains.

Agriculture in the Chontalpa - Introduction

Hester has stated of Maya agriculture in Yucatan that "Modern Maya agriculture requires relatively few tools and simple techniques but considerable know-how". We might paraphrase him in introducing the subject of Tabascan agriculture by stating that modern Tabascan agriculture is characterized by relatively few tools, simple techniques, and the expenditure of the minimal amount of energy possible, along with an incomplete ecological know-how. The quality of Tabascan agriculture is due to two principal factors: the colonial character of the modern population and the abundance of land.

The most important crop in modern Tabasco, as it is throughout most of Mexico, is maize. Within our test area the standard and only technique of cultivation practiced is the same described by Palerm and Kelley for the Tajin Totonac and by the Carnegie group for the Yucatecan Maya. The Mayan scholars have used the term "milpa", Palerm uses the term "roza", British scholars either use the local word from the area which they are studying or employ the general term "slash and burn". Palerm recently has suggested the term "bush fallowing".

Briefly it is a technique of cultivation practiced in semi-humid to humid tropical areas where the forest cover is heavy and once cut regenerates rapidly. The technique consists of a preliminary clearing of the forest with axe and machete followed by burning. With stone tools the burning seems to be relied upon for most of the clearing but with steel tools its main purpose seems to be to facilitate sowing with the digging stick. In sowing a simple pointed stick or metal-tipped stick is used and the seed is sown by simply

punching holes in the soil or soft ash at intervals; the soil is not turned over as in hoe or plow cultivation. The plot may be resown for several years and then it is abandoned. The exact period of cultivation depends principally on the quality of the soil and rapidity to which the natural vegetation comes back. The yields during the period of cultivation decrease from one year to the next due either to soil exhaustion or weed competition or both. The point at which the land is abandoned is that point in which the land no longer gives what the farmer considers a good crop. The situation is very complex and depends on other factors than pure ecological ones, especially demographic and economic ones. Weeding is a tremendously laborious process in humid tropical areas and with steel tools at any rate it is much more economical to let a two or three year milpa go and cut down new forest. It is less labor to do the latter and the harvest is greater. In the beginning of the colonization of a new area it seems almost certain that one field is ordinarily sown but a single year and then abandoned. The increase in period of cultivation is undoubtedly a reflection of demographic pressure and intensity of colonization.

Once a field is abandoned the natural vegetation comes back in, the first stages consisting of low shrubs, grasses and young trees. Within a few years the trees start to dominate and as they increase in height the lower vegetation starts to die out through lack of sunlight. If left without further cultivation the climax forest will be re-established. The exact period of this regenerative cycle varies enormously from area to area; in Yucatan it may be as much as 30 years, in Tabasco not over 8-10 years. The important point, however, for the

slash and burn cultivator is not completion of the cycle but the point in the regenerative cycle when trees dominate over weeds and the forest floor becomes bare of the latter. In most of northern Yucatan this occurs 10-12 years after a field is abandoned; in Tabasco in general it occurs within 4-6 years. The forest is then ready to be recut and the cultivation period begun again.

In some parts of the world such as the Reddi country in India there is so much land and so few people that a field is cultivated a single year and may never be re-cultivated during the lifetime of the farmer; in some parts of Tabasco such as on the Grijalva flood plain land may be rested but a year or two before it is back into cultivation. The system has caused more controversy than perhaps any other aspect of primitive economy. The exact number of harvests a year, number of consecutive years a field is to be sown, and number of years to be rested depend on a complex interlocking series of factors, some geographical, some cultural, and no simplistic description or judgment of the system can be accurate. The most important factors seem to be soil type, rainfall cycle, vegetation type, ecological adjustment of the population, population density, intensity of colonization, and even social pressure in the case of class structured societies.

The study of the system in terms of its functional effects on the culture which includes it may be phrased in four problems: (a) the overall effects of the system on the biological balance of a region and the relation of man to that balance; (b) the limitation the system places on demographic growth; (c) the effect of the system on the mode of settlement; and (d) effects on the ethos of the culture.

These problems will be discussed at a later point in our study.

Approximately two months were spent in a survey of agricultural techniques and economy in the Chontalpa. The following rancherias were visited for data: Chocoacan, San Fernando, Tierra Nueva and El Puente.

## Maize Cultivation

Tools used in maize cultivation in the Chontalpa are simple. They consist of the machete - in Tabasco the full-sized straight-bladed type, the axe - both used for primary clearing, and the first for the "chapeo" or slash weeding; the "macana" or pointed stick and nequen bag for sowing; and the "garabato" or improvised forked stick for gathering together low bush for cutting with the machete and for heaping up the refuse for burning.

The "Desmonte" or Clearing. In the Huimanguillo area three classes of land must be defined in describing the clearing. The term "canada" is used for land holding maize stalk from a previous harvest of the same or previous year. The clearing of this land is entirely a garabato-machete operation and consists of chopping down the maize stalks and slicing down the grassy and woody weeds at the roots. Sometimes this vegetation is left to rot but some farmers burn it off when it dries. This is the only case of the use of a fertilizer noted in maize cultivation in the Chontalpa. The Tabascan farmer for land measurement uses the hectare. A single man can clear a hectarea of canada in about 8-10 days of work. Usually clearing is a group job; members of the same family clear in succession the milpas of each member. The basis of this seems to be purely social as there is no technological function in group desmonte.

The term "acahual" is in common use all along the Gulf Coast in Vera Cruz and Tabasco and refers to lands which were milpas and were then abandoned and are in low bush or young forest. In the Chontalpa these lands would represent 2-6 years of forest regeneration which is the amount of time lands are rested, the exact cycle depending on the mentioned factors.

The plant cover on these lands is an extremely dense thicket-like growth of low bushes and young trees; on humid riverside lands this young forest may reach a height of 5-6 meters in two years and in 5-6 years a well developed, almost climax forest appears. In Yucatan the forest would need 10-12 years to reach the stage achieved on these lands in 2 or 3. For maximal maize yields these acahual lands are rested 5-6 years but cultivation may begin in 2. If a land has been rested 2 or 3 years most of the clearing can be done with the machete alone, but when the forest is left 5-6 years the axe must be used for felling the larger trees. A single man can clear a hectare acahual in approximately 12-15 days.

A third class of land are those lands covered with "monte alto" or virgin forest. The term is applied to those lands that a farmer has never cultivated in his lifetime or any lands in which the climax forest has grown back. In the nuclear sub-zone such lands are rare but once one travels 15 kilometers or so inland from the river in the municipio of Huimanguillo there are large stretches of monte alto. The operation of clearing is similar to that of Acahual except that more axe work is necessary due to the larger trees. A single man needs approximately 18-20 days to clear a hectarea.

Theoretically the exact time of clearing and sowing in Tabasco

is not of great importance. In the wetter hilly hinterland of pichucalco-Teapa one may sow crops any month of the year. In the Chontalpa, however, two factors make for more restricted sowing dates. One is the short drought of April-May and the other is the annual autumn inundations. Crops planted for example in August or September would be flooded out and those planted in, say, February or March would be affected by the short but extreme drought period. Actually the farmer feels it imperative to sow before June 15 for the main milpa of the year so that when the fall floods arrive the maize is well enough along to resist its effects. He has the same problem of timing as the Teotihuacano or Chinampero but the basis lies in fall flooding instead of fall frosts. Because of the drought his winter crop must be well along by March. The result is that, in spite of popular fancy, the agricultural timetable in Tabasco is as regular as that of the Valley of Mexico. The long rainy season, however, does permit a double cycle of sowing and harvesting on the same plot of ground during one year, in common with much of lowland Vera Cruz. This is not true of all of the Chontalpa; in the low hilly country of Chicoacan and Ostitan, and the transitional savannah-forests of Ocuapan, Metepec and western Tierra Nueva and El Puente, double cropping is infrequent as the winter or tonamil crop is often lost by drought.

Clearing for the summer crop or "milpa" as it is called in Tabasco takes place usually in April and May. A favorite starting date is April 15. The exact date depends on the class of land to be sown. The clearing of canada must wait until the previous tonamil is harvested while acahual and monte alto may be cleared as early as

April. It cannot be done much before April as the winter rains would give the soil enough humidity to result in an immediate growth of weeds once the forest was felled, and the Tabascan farmer is not overly fond of the extra labor of a pre-sowing weeding. It may even result in acahualization of the milpa or choking out of the maize plants in the early state of growth. In northern Yucatan with the extended winter drought land clearing often is begun as early as December or January.

The tonamil or winter crop is almost always sown in canada of a previous milpa, acahual or monte alto being rarely cleared for this crop. This is probably due to the fact that the milpa yields are always better than the tonamil and fresh lands are saved for the main crop. The land is not burnt over in the tonamil before sowing. In such cases where acahual or monte alto is cleared for tonamil the clearing is done in November.

The "quema" or burning takes place just before the sowing and is strictly limited to the preparation of milpa and even in the case of milpa is applied normally to cleared acahual or monte alto. Under the normal Chontalpa cycle of two years of consecutive crops (a milpa followed by a tonamil followed by a second milpa, then the land rested) the land would be burned over for sowing but once. This technique consists of first clearing a "guardaraya" or cleared path around the field 1-2 meters wide to prevent the fire from spreading into the neighboring forest. The firing is very carefully done and rarely do they lose control of it. The main function of firing is to facilitate sowing, to leave a cap of soft ash for imbedding the seed and to allow more regular spacing. Some anthropologists state that

the ash is a good fertilizer. Actually the reverse seems to be true as the fire itself burns out the humus of the soil. In the Chontalpa a number of farmers who believe the general effect is harmful have sown experimental milpas without burning off the land first with spectacular results: one milpa yielding in the first year 3 tons of maize per hectarea on a holding which never yielded over 2 with the burning technique applied. With the use of steel tools burning actually seems to be more harmful than useful. In great part it may be a survival of a technique which with a stone-age technology once played a greater part in the actual clearing of the land.

The "siembra" or sowing is a very simple process and only a simple pointed stick or macana for punching the holes and a small nequen back for carrying the seed is needed. The macana is not shod with a metal point. The seed is selected from the largest ears and only the largest grains in the center of the ear are used. The seed sown in the milpa is not germinated first but the tonamil seed is, and is further soaked in petroleum and crinoline to defend it against pests.

The sowing of the milpa is normally done around the middle of May, and may be delayed as late as the final week of June. The Chontalpa farmer is just as preoccupied about the inception of the rainy season as the farmer in the Valley of Mexico and is very unhappy if the rains do not permit a May sowing. One of the folk beliefs about sowing is that if it rains on May 5 it indicates a year of abundant rainfall, and the sowing takes place on the first full moon following that date. The labor of sowing is usually done by 3-4 men, usually relatives, and a hectarea is seeded in 1 day. Here

again the reason for group activity is evidently social rather than economic. The helpers are either paid in maize at harvest time or help given when they plan to sow. Between 12 and 16 kilos are used per hectarea and plants are sown from 1.0 to 1.5 meters apart depending on the quality of the soil, or its condition. Poorer lands or overworked lands are sown at greater intervals than good lands or fresh lands. These distances are estimated by pacing and approximately five seeds are dropped in each hole and the seed covered over by pushing ash over it with the foot. Approximately 2-4 plants germinate from each hole and the first shoots come up within three days after sowing. On slopes the sowing is delayed until June. The tonamil is sown in December.

Between sowing and harvesting the milpa necessitates very limited labor. This includes the 'thapeo" or clearing - the latter is a more correct translation than weeding which in Spanish is "deshierba". The latter term is in use in the Valley of Mexico where the weeds are uprooted. In the Chontalpa they are simply sliced off at the ground level with the machete.

The first chapeo is done approximately one month after sowing and represents 3-4 days' work for one man per hectarea. A second chapeo is given late in July or late in August, followed by the "dobla" or bending over of the maize stalk. This latter technique is practiced all over the east coast of Mexico to prevent the heavy autumn rains from entering the ears and rotting the seed. Hilling is not practiced in the Chontalpa. Very often a land is given but one chapeo, especially if it is a first-year milpa. The succeeding tonamil, however, requires two, as does the second year of milpa.

In the second year of cultivation weed invasion is so strong that a serious reduction in production results and a field is rarely cultivated more than three consecutive harvests (two milpas, one tonamil). Fresh land in the drier hilly country such as at Chicoacan on first-year fields often are not given any chapeos.

The "cosecha" or harvest begins in the humid alluvial riverside lands around October and lasts on through November. The maize is broken off from the cane and left in heaps. It is then collected in nequen bags and hauled to lean-to thatch-roofed granaries in the field itself. Some of it is stored in the attic-like space of the gabled roof thatch dwelling of the family. Usually relatives work together during this period. The problem of storage is an acute one in this area of excess humidity. The limit for safe storage in the type of local granary is but 6-7 months, so that double cropping is not a luxury but a necessity for a balanced economy. For this reason many farmers who hold lands which do not yield tonamil crops or which yield poorly are forced to sell most of their milpa production and then buy maize toward the end of the year for family use. In the less humid, more elevated lands of the Chontalpa the harvest may be delayed until December.

Yields vary enormously according to the quality of the land and the intensity to which it is worked. In the Chontalpa the hectarea is well known so most campesinos can give one yields per hectarea. Maize is sold also by the kilo and tonelada but the campesino also uses a measure called zontli which probably is of pre-Spanish origin. A zontli of maize is a numerical count of 400 ears. However as most farmers sell surplus maize they agree fairly well in the conversion

of zontlis to metric weights. The zontli weights from 55 to 60 kilos of grain and most farmers calculate 18 zontlis to a tonelada.

Local farmers use two series of land classifications which are differentiated mainly on the basis of maize yield. The terms "tierra de primera", "tierra de segunda", "tierra de tercera" and "tierra sabanal" are used frequently. Tierra de primera are lands which give high dependable harvests in both milpa and tonamil. These are always alluvial flood plain lands and are also good for cacao and banana. Tierra de segunda may apply to worn-out tierra de primera or to lands like "tierra nueva" where two harvests may be raised but where cacao and banana do not grow well and in which maize harvests are notably lower than in primera. These are our flat elevated lateritic forest-covered areas.

Tierra de tercera refers principally to transitional savannah-forest lands or low hilly country where only one harvest may be raised. Theoretically tierra de primera can change to tercera by simply overworking. The system is very fluid and is primarily one based on how much the land is yielding at the moment of classification, which may depend as much on management as on natural productivity. Tierra de sabana is, as stated, completely useless for agriculture. Farmers avoid lands on the edges of the savannahs as much as possible even though they may have tropical forest cover. When the Mexican government carried out experiments in the savannah area the plants grew up a few centimeters and then died. Within the savannah where it is crossed by arroyos exist gallery forests which, for example at Mecatepec, are cultivated but yields are low and only one crop can be raised. The same holds true for transitional forest-

savannah or lands on the edge of the savannah but with forest cover.

One of my informants from the Rancheria of Chicoacan received an ejido grant of 20 hectareas facing the Chontalpa highway. The land has a 200-meter front on the highway and extends inland for a depth of 1000 meters. The part nearest the highway has a tropical forest cover but further in it is true savannah. The forested section was in climax forest when he received it three years ago. He has sown milpas every year since receiving it, each in fresh-cleared forest, and has suffered complete loss twice and harvested 5 zontlis per hectarea one year. I noted the land of the first-year milpa, abandoned for the past two years, and the ground is covered by a heavy mat of grassy weeds. On good land it should be covered with a dense thicket of trees 5-6 meters high and be ready for re-cultivation. It seems probable that these marginal lands would easily convert to true savannah by repeated clearing.

The bulk of the Rancherias of Chicoacan and Ostitan are composed of tierra de tercera and are tropical forest-covered broken country. Yields are low and the tonamil crop precarious. Yields vary from the 5 zontlis noted above to 20 per hectarea, with a general average running between 12 and 15. Before reducing these data to the metric system one fact must be noted. When the Chontalpa farmer gives his yield in zontlis he is only counting those ears of fairly large size; the smaller ears or "molcate" are not included and are for home use. His count in zontlis represents approximately 80 percent of what the production would be if we weighed the total production of zontli plus molcate. Taking this into account then our yields in the Chicoacan-Ostitan area range from 350 to 1400

kilos with a general average of 850-1000 kgs. The average is about that of sub-humid northern Yucatan or temporal lands in the Teotihuacan Valley. The normal cycle in the area to maintain these yields is one to three: a land is cultivated two years and then rested five to six. Most ejiditarios upon receiving their parcel divide it up into four equal sections and cultivate each two years and then pass on to another quarter. Tonamil crops are precarious, as stated, and many farmers do not risk them. Most parcels are 12 hectareas and this is about the necessary size to maintain a balanced economy. One case example was a 12-hectarea parcel in which the owner sowed one year 4 hectareas which yielded him 60 zontlis or approximately 1000 kgs per hectarea. He used a two-year cultivation four-year rest cycle.

Tierra nueva in general is mostly tierra de segunda. It is flat elevated forest-covered country crossed by a small stream with a limited flood plain. Both of my informants there have lands bordering on the stream and their lands are considered by others as among the most productive in the rancheria. One of them holds 24 hectareas, of which he sows 6 hectareas every year; in other words he uses a 1:3 ratio cycle. He states that his lands could be managed on a 1:2 cycle of two years in cultivation and four in rest, but for best results he prefers to rest them six years. He sows two harvests the first year followed by a single harvest the second year and then abandons the plot, or in other words harvests 2 milpas and 1 tonamil over the eight years of his cycle. His harvests are very dependable and crop loss rare. His holding is within (in part) a late classic archaeological site and has a topsoil layer of nearly half a meter,

an unusually deep one for the Chontalpa. The following data on maize yield was given by the owner. The owner is well known as both a very good farmer and a very suspicious man and as we shall see later his data may be somewhat suppressed.

He estimates his average production on milpa at 15 zontlis per hectarea and on tonamil 10, or 25 in all for the first year of crops. These figures calculate at 1000 kgs for milpa and 660 for tonamil, or 1660 kgs in all. One of his tonamil lands fell entirely within our archaeological grid plan and his .8 hectareas sown yielded 16 zontlis in 1953. He stated that it was an exceptional tonamil harvest but data from other sources indicate it is probably his average yield. Nineteen fifty-three was not an exceptional year.

Another informant holding lands also on the site grid plan and of the same quality as the lands of the first informant offered the following data:

| | Yield (zontlis) | |
|---|---|---|
| | Milpa | Tonamil |
| Good Year | 30 | 20 |
| Average Year | 20 | 15 |
| Poor Year | 12-15 | 10 |

The same informant in 1953 had a tonamil which fell within our grid plan which measured 1.2 hectareas and yielded 23 zontlis or exactly the same yield per hectarea as informant No. 1 on his tonamil of the same year. When the data compiled from these two informants was shown to other farmers in the rancheria they felt that the data offered by informant No. 1 applied pretty well to most of the rancheria but was low for his own lands, and that the data offered by No. 2 was accurate for those lands lying just off the arroyo.

These riverside lands in the rancheria then yield on the average about 35 zontlis with the two harvests, or 2500 kgs, while the general average over the rancheria for both may be estimated at 1600-1700 kgs. These figures serve for well colonized, moderately productive lands with a 1:3 ratio of cultivation.

The Rancheria of San Fernando, on the other hand, is in an area of partial colonization with small population and abundance of land, where often a field is cultivated for one year and then left to reach climax before being recleared. The yields are correspondingly high. Furthermore only the best lands are selected for cultivation; many of them are arroyoside lands which can be also sown in cacao and coffee. Here there is no parcelling and the farmer may plant where he pleases on the Yucatecan model. In 1950 only 40 to 50 families lived in this rancheria. General yield estimates were 25-30 zontlis per hectarea for milpa and 12-15 for tonamil as an average yield. This calculates at 1750-2100 kgs for milpa and about half that figure for tonamil. In this area tonamil crops are often planted in freshly cleared forests.

In the alluvial flood plain of the Grijalva or tierra de primera the situation is quite different. Maize yields very well and double cropping is universal. Also these are prize cacao and banana lands. Ejido parcels are much smaller, running around 6 hectareas. This area is a center of private land ownership and large holdings are common. Yields vary considerably, mainly due to land management. As there are numerous small holdings some farmers have cut down the cycle to a barbecho one: one year of cultivation followed by one of rest or two years of cultivation followed by two to three years of

rest. The general average is a 1:2 cycle but for best results a 1:3 ratio is necessary.

We find two economic systems in practice. One is fully commercialized agriculture in which all of the holding is converted to cacao or banana cultivation. These farmers may be called big land owners. The classification is not based entirely upon the quantity of land owned but the way it is managed. Many owners of such holdings live in the urban center of Huimanguillo and engage in other activities.

The second system is a combination of commercial and subsistence agriculture. These farmers, whom we may class as small landholders, possess little land in cacao or banana, in general a hectarea or two, the rest being in milpa, acahual or canada. The actual size of the holding may be as high as 30-40 hectareas but the small fraction of it dedicated to permanent plantation classifies the holding as a small one. All levels of gradation occur between these types but it is rare to find a farmer with land in the alluvial flood plain who doesn't have at least half a hectarea of cacao or banana. Holdings may vary from 2-3 hectareas up to 100.

From the Rancheria of El Puente which lies in the flood plain just north of the town the following data were collected.

Informant No. 1. This holding is within a short distance of the Puente de Huimanguillo which crosses a large tributary stream. The land is about 3 kms from the Grijalva river and before the highway was built flooded every fall from the main river. The property is 36 hectareas but the owner must be classed as a small landowner. At the year of my study 6 hectareas were in monte alto, never having

been cultivated since the family had possessed the land (30 years). Four hectareas are in permanent coffee and cacao plantation and the remaining 26 are acahual, canada or milpa. In 1954 six hectareas were in first-year milpa and four in second-year milpa, or 10 hectareas were in maize all told. The labor was done by the father and four sons and 150 kilos of maize were sown. This farmer practices the following system. Acahual is cut in the late spring and the milpa sown in May. The crop is harvested in November and following this the canada cleared out and the tonamil sown. Then in May the tonamil is harvested and the second-year milpa sown. Following the harvest of the second-year milpa the land is rested a minimum of three to four years, but for the best yields five or six years' rest are needed. The yields following a six-year rest period are high and regular. An average harvest from the first-year milpa is 30-35 zontlis, for the following tonamil 25, and during the second year the milpa drops to 20 zontlis. These figures of course do not include molcate. Converting them to kilos per hectarea and correcting for molcate they calculate 2250-2500 kgs, 1800 kgs and 1500 kgs per hectarea. Using these figures he will harvest in 1954, if the yields are average, six tons of maize on the four hectareas of second-year milpa and 25 tons on the two crops of the first-year lands (six hectareas), or a total of 31 tons of maize. These figures apply to lands given a five- to six-year rest. Normally only six hectareas are sown in maize a year but the family needed money that year and decided to sow extra land. Over a normal eight-year cycle then a hectarea of land will give three maize harvests with an average production of 5500-5800 kilos.

The amount of time land is rested is strictly a matter of how

much a family has. Those with large holdings let the land rest for six years as the yields are higher in proportion to labor costs. Many landholders, especially in the La Libertad rancheria (alluvial flood plain area) only hold 3-6 hectareas and follow a barbecho cycle of 1:1 ratio, 1:2 or even 2:1. The yields on such lands drop to 15-20 zontlis as an average. One informant experimented on a piece of monte alto never sown before in the alluvial flood plain and reported a yield of 38 zontlis per hectarea. These two figures give us the range of productivity of these first-class agricultural lands with varying intensity of cultivation. The law of diminishing returns operates very strongly on these tropical soils.

A second informant also owns land in the Rancheria El Puente. This land is about 1.5 kilometers from the Grijalva river. It measures 15 hectareas and the owner has held it approximately 30 years. He has 3 hectareas in cacao and coffee, 2 in pasture for cattle, and the remainder in acahual, canada and milpa. The owner lives in Huimanguillo and a relative lives on the property and takes care of it. The caretaker has milpa rights (that is, he can sow milpa on the land) whereas the cacao and coffee production go to the owner - a common system in the area. There is no monte alto in the holding and the land is more intensively reworked than in the case of the first informant. Land is cultivated for two years as in the first case but is rarely rested for more than 3-4 years. The difference in yield is striking. The first-year milpa yields but 20 zontlis, the tonamil 12-15, and the third-year milpa but 10. The informant stated that what really happened was that the ears become progressively smaller and consequently the zontli count drops sharply

as more and more of the ears fall into the molcate class. The yield in kilos therefore, although it falls sharply, does not decline as markedly as the raw zontli data indicate. He claimed that in the first-year milpas there are 4 zontlis of large ears to 1/2 of molcate but that in the second milpa the proportion shifted to 1:1. His approximate yields in kilos are 1500 kgs, 950-1100, and 900 kgs.

## Other Annual Crops

The number of domesticated plants found in the Chontalpa probably surpasses that of any other part of the Mexican Republic and the wealth and variety of them is truly extraordinary. However the production of most of these minor plants is very low and they do not play an important part in native economy. The economy of the basic staples such as maize, beans and rice gives a clear picture of native economy; the other products, with the exception of the cash crop of cacao and banana, are simply extra exotic foods which relieve the monotony of the local diet, and then only in season. Some crops such as root crops could have served as staples but they are cultivated only as a truck garden vegetable.

A list of those plants used in the Chontalpa was compiled to illustrate the variety. Below I present those which can be classed as perennials: frijol (four classes: negro, pelon, dosmeseno, tresmeseno), rice (three varieties: criollo, zopilote, americana), habas, tomato (criollo and rinon), watermelon, white and green melon, cucumber, squash, chile pepper (nine classes: pimenton, criollo, yamashito, serrano, pico paloma, habanero verde, manzana, dulce, picante), yuca or manioc (three classes: criollo, floreana and americana), sweet potato or camote (five classes: amarillo, caracolillo,

morado, blanco, capa enprestada), name (a root), chayote (six classes: verde espinado, blanco espinado, verde, blanco, jurita and zorro), sugar cane (five classes: criolla, cubana, extranjera, blanca and petenera), papa voladora (a potato-like root), peanut and pineapple.

Frijol is here a staple as elsewhere in Mexico and is second only to maize in importance. The principal type sown in the Chontalpa is frijol negro or black beans. In the rancheria of El Puente the following system is followed. Frijol here is usually sown in canada of a previous maize harvest. One informant stated that beans sown in fresh land produced large vigorous plants but less seed than those sown following maize. For best results frijol should be sown on these lands in November and December when the ground is humid from the fall rains but with the major growth period during the drier growing season. Usually it is sown following the first year of milpa instead of the tonamil. Informants stated that the second-year milpa, if it followed a frijol sowing in the winter, gave excellent results and they considered bean sowing as a sort of fertilization of the soil. Frijol in the Chontalpa is sown the same as maize, except usually the point of the machete is used instead of the macana to open the holes. When asked why this was done one informant stated that the point of the machete opens a smaller hole and that frijol requires sowing that way as the seed is more susceptible to rotting from water infiltration than maize. Four seeds are dropped in each hole and the holes are spaced at 25 cms with the rows spaced 1-1.5 meters apart. Approximately 50 kilos are sown per hectarea. Chapeos are unnecessary in frijol cultivation as the rapidly extending vine quickly chokes out all competition.

Yields from the El Puente area are very high. Test sowings gave the following results: (a) on .25 hectareas 300 kilos; (b) on .5 hectarea 700 kilos; and (c) on 1.0 hectarea 100 arrobas or 1100-1200 kilos. These are yields on tonamil sowings and range from 1100 to 1400 kilos per hectarea. Frijol sowings made during the rainy season are stated to yield only half as much. Frijol is harvested by uprooting the plant and later beating off the seed with poles on mats. Informants stated that frijol resists extra rainy years much more poorly than maize, and that in the Chontalpa the common Mexican technique of sowing with maize does not give good results.

In the less fertile lands of Tierra Nueva bean production is much lower. The average production per hectarea is but 35 arrobas per hectarea or 385-420 kilos. One informant in Tierra Nueva always planted frijol in June on fresh-cut lands. He did not sow a tonamil crop following the frijol harvest but in the second year of cultivation planted a double maize crop.

Rice as in the case with beans is sown alone and the land prepared the same way as maize. This type of rice cultivation is also found in southeast Asia in hilly forested hinterland and is called "dry rice cultivation" to distinguish it from the more intensive plow-irrigation cultivation of the major valleys. In the Chontalpa probably more than anywhere else in Mexico rice is an important staple and farmers may consume it almost daily. It is mainly a subsistence crop but those farmers who hold lands which will not yield banana or cacao often sow it as a cash crop.

Rice is commonly sown in freshly cleared lands in May or June.

Each line of plants is spaced around .75 meter apart and each plant in the line from 25-30 cms. In each hole 10-15 seeds are sown, or as they say "tres dedos". The seed is carried in a jicara and approximately 25-30 kilos are sown per hectarea. Sown this way a month-old rice field looks like a field of regularly spaced clumps of grass. Two chapeos are necessary when sown in acahual, only one in monte alto. The rice is harvested by cutting off the seed-bearing crown with knives and storing them in nequen bags. Then they are thrown on mats and the seed beaten off with poles. On fresh acahual land a crop sown in the rainy season yields approximately 800-1000 kilos per hectarea. A second rice crop may be sown in the winter but the yield drops sharply. Following a two-crop year of rice only a single crop of maize is sown the second year - the milpa - and the yield is very low, an average of but 12-15 zontlis per hectarea. This reduction is surely due to soil exhaustion rather than weed competition as these data are from an El Puente holding which was also studied for maize cultivation (Informant No. 1 in our El Puente study). On that same land the second-year milpa yields 20 zontlis on the average (following a double maize harvest the first year). Rice is universally stated to wear out the land faster than maize. The above data are from our area of best soil, the alluvial flood plain. At Tierra Nueva on poorer soils rice is also planted during the rainy season on freshly cleared land but no winter sowing is made and no second year milpa; the land is only given the single summer rice crop and then rested.

Today the bulk of the rice grown is sown in the poorer lands of western Tierra Nueva, Ocuapan, Macatepec and Tecominuacan, on flat

elevated tropical forest on the edge of the savannah. Rice evidently yields well on soils too acid for good maize cultivation, if the land is thoroughly rested. It is the only productive cash crop on those lands as banana and cacao do not grow well. It is rarely sown as a cash crop in the alluvial flood plain as cacao and banana yield more profit. It does, however, yield well on those lands and is sown as a subsistence crop. However it yields poorly on the true savannah or better drained lomas of Chicoacan.

Rice, beans and sugar cane are the only perennials which are sown alone. Many farmers sow a small patch of cane for home use and large sowings are rare.

The other crops on the list are normally sown in small patches within the maize plot or mixed with maize itself. This is especially true of chile, tomatoes, squash and root crops. Most milpas have small patches of one or more of these plants but the total production is small and mainly for home use. They are sown with either the macana or the point of a machete. Most tropical root crops grow well in transitional forest-savannah lands where maize yields poorly - again probably they resist better soil acidity. Many of the root crops such as yuca or sweet potato are sown with the milpa of the first year and continue producing throughout the two years of cultivation without replanting. These crops may also be sown in frijol lands.

### Perennial Crops

It is in this aspect of agriculture that Tabascan cultivation reaches its climax of richness, both in the variety of products and their commercial value. Also in the case of one of them - cacao -

we find the same solicitous care and continuous attention as that described in truck gardening in the Chinampan. In general, however, this is rare and most cultivates of this class are simply sown and then left to themselves except perhaps for limited pruning.

The following list of cultivates of this class was compiled from informants of El Puente. The list includes cacao; coffee; coconut; sweet oranges; mandarina (like our tangerine); sour orange; cajera orange; sweet lemon; sour lemon; sweet grapefruit; sour grapefruit; nine types of bananas and plantains - beyaco or macho, dominico, barbaro, enano, cien en boca, seda, which are plantains, and manzana, jineo and roatan which are sweet bananas; four types of mangos - criollo, manila, rosa and pajaros; manga, aguacate verde and morado; chinin; papaya criolla and castilla; breadfruit; pataste; chestnut; guanabana; guayaba; anona; zapote, chicozapote; rubber; cojimiquil (a vanilla-like vine); caimito; vanilla; melocoton (a vine) juju; ciruela and homdura. A discussion of each of these cultivates and techniques of cultivation would take us far afield of our objective which is a study of the basic economy. Of this list only cacao, coffee and banana (the roatan type) are sown in orchards or plantations for commercial use. The rest exist as single isolated trees scattered through the farmer's holding although he tends to concentrate his sowing around the immediate area of the house. The typical situation is one in which a farmer sows several dozen trees of the types listed scattered around his house in fairly dense concentration, with several score more in the rest of his holding, most seemingly growing wild in his acahuals. Nearby his house he usually has from 1/2 to 4 hectareas in the case of small landowners, of either cacao or coffee or both

mixed, or banana of the commercial roatan type. Our discussion will be largely limited to plantation cultivates with most attention on cacao as it is a pre-conquest crop in the area.

Cacao Cultivation. Our description of cacao cultivation in the Chontalpa applies to that practiced by small landowners, people who have a semi-commercial economy probably very close to that of pre-conquest times in the same area.

Cacao cultivation, even done in the rustic manner of the farmers of the Chontalpa, represents one of the great achievements of aboriginal agriculture. The native variety of cacao called "criollo" is one of the most delicate food plants in the world and meticulous care must be expended for its growth and productivity. Today it is one of the most lucrative crops in Mexico and the comparative luxuriousness of the town of Huimanguillo and general high level of living of most of the population of the Chontalpa depend to a great extent on the value of cacao in the foreign market.

Cacao requires a climate completely free of frosts with minimal temperatures not below 12°-20° Centigrade. It grows best in areas with an annual mean temperature of at least 27° and with slight seasonal fluctuation. Cacao also requires a deep, permeable, humid, well-drained soil for best results and the loose sandy or loamy, humid soils of the Chontalpa alluvion are well adapted to its growth. The most important requirement, however, is heavy rainfall without prolonged dry seasons. The most productive cacao areas of Mexico lie in one of two ecological zones. The first in our alluvial, flat, humid river flood plains with heavy precipitation. The second type is hilly broken foothill country with excessive rainfall throughout

the year but rapid drainage of the run-off. An example of the first ecological type is the Huimanguillo area, the second, Pichucalco in Chiapas. In general the data indiate that the best production is achieved in the wetter, hillier foothill country at elevations between 50 and 400 meters above sea level.

In the Chontalpa the forest is cleared off and burned as in maize cultivation. Usually, but not always, small landholders run a cycle of two years of milpa before using the field for cacao. Then the "madre de cacao" is sown. Cacao like coffee cannot withstand the direct rays of the sun and must be sown in the shade. The native or criollo variety is very delicate and only a limited number of trees will serve as madres. These include "madre prieta" or "chontal", "cocoite", "chipilcoite", and "amote". If cacao criollo is to be sown the young madres are sown at three-meter intervals.

A month or two after the madre is sown the cacao is sown in seed beds. The coa or straight-angle hoe is used to thoroughly excavate and work the soil - one of the few cases of true soil cultivating in the Chontalpa. The seed bed is usually irrigated by hand before planting, especially if the sowing is to be made in January or February as is often the case. Conscientious cultivators may also irrigate when to be sown in June. These are the two periods commonly selected for sowing. The seeds are sown at 10-cm intervals, thus each plant has a growing area of 100 $cm^2$. As soon as sown the seed bed is covered for a period of 15 days with a layer of banana leaves to protect them. Then what is called the "rancho de cacao" is constructed over the seed bed, which consists of a wall-less thatched roof shelter or "ramada" to protect the cacao seedlings from the sun. The cacao

seedling is left from 6 to 8 months in the seed bed. The commonest system is to sow in January-February and transplant in June-July. Careful farmers keep the seed bed meticulously weeded, in this case by uprooting the weeds. At any rate at least two good weedings are a must. If sown in the winter several irrigations are given the soil.

For transplanting a period of three-quarter moon is usually selected as a favorable date. The plants are taken out with their corresponding cubes of earth as in chinampa transplanting. The soil of the field is not plowed up by small landowners. A careful cleaning is usually given but the madres in one year are usually well enough grown to choke out other vegetation so there is very little undergrowth. Transplanting usually is planned so that the madres have had at least one year of growth. The young plants are inserted midway between each madre in the same line. This procedure leaves a clean space or "calle" in between each line of madres and cacao seedlings. The holes are made with the coa in pits 60 cms deep and in diameter. After inserting the plant the pit is partially filled with soft humus clean of weeds. The seedbed may be given a good irrigation just before transplanting.

Following the transplanting small landowners do little work in the orchard except pruning and chapeo. As one might expect the actual care depends on the individual but all realize that good production depends on careful pruning and thorough and frequent chapeos. The first and most important pruning takes place when the plant is one meter high and consists of trimming off all side branches leaving only four at the crown of the plant. With the criollo variety this is an exceedingly delicate operation and may kill the plant if

improperly done. Some farmers prune the tree every three-quarter moon or once a month.

The cacao criollo starts yielding fruit during the third year and reaches maximum production between the tenth and fifteenth years, and may continue yielding up to twenty years. Following this the trees may be cut down and young ones planted or the orchard abandoned.

Approximately a thousand trees are sown per hectarea. One finds with significant consistency that the average semi-commercial farmer holds from 1 to 2 hectareas of cacao grove. What little data were collected on work schedule suggest that this is the limit in size of a grove for a farmer who also plants maize and other subsistence crops.

Harvest time for the criollo falls in May and June and a single harvest is made. This is done by cutting off the pods with knives. This again must be carefully done not to injure the plant. After the pod or mazorca is cut it is split open with a pole and the seed extracted. The seed is cleaned by tramping over it in water-filled baskets. It is then extended on mats to dry and after three days of sun it toasts a bright reddish-brown; it is then ready for grinding and the manufacture of chocolate.

Yields in both grain and money are very difficult to estimate in the case of cacao as so much depends on the care in which the grove is kept. Criollo plants may yield as high as 3 kilos, this production reported from Comalcalco. It rarely yields so well in Huimanguillo and even in Comalcalco the figure cannot be used to calculate yield per hectarea. In the Huimanguillo area most farmers consider it a very good year if they get an average of one kilo per plant, and over a long period this would be excessive. The criollo

variety is as delicate in this respect as in its growth. Often for no reason at all that the farmer can see the orchard will produce no grain at all one year and then abundance the following year. Government official figures for the Chiapas-Tabasco cacao country as a whole indicate an average yield over a number of years of 400 to 500 grams or 1/2 a kilo per bush. These figures check well with my own general observations. This figure is both a measure of the true productivity of the criollo variety of cacao and of the care to which knowledge of cultivation procedure is actually applied to the grove.

Approximately eight years ago a new variety of cacao called "Ceylan" was introduced to the Chontalpa and farmers are rapidly shifting over to it in favor of the criollo or local cacao. The ceylan is prepared for cultivation the same way as the criollo. Differences lie in that the ceylan is a sturdier, less delicate type, less subject to plagues and fluctuations in production, and produces much more grain per tree than criollo. It is also more tolerant of soils of lower fertility, and produces over a longer period of time. Average production in the Huimanguillo probably is at least twice that of the criollo and about a kilo per plant. Maximum production may reach as high as 5 kilos. The actual production per hectarea, however, is about the same as the plants are normally sown at 5-meter intervals and only 400 plants are sown per hectarea. The trees are larger and more luxuriant in growth and hence need the extra living space. Instead of one, two or three harvests may be made.

The economy of cacao cultivation is also a very variable factor. The price rises and falls with amazing rapidity; in recent years has

dropped as low as three pesos a kilo and jumped as high as eight or even ten. Probably in this lies our chief explanation for the reluctance felt by small landowners to live on an entirely commercial economy. The surest way out seems to be the one they have adopted: a semi-commercial economy, based on maize as a subsistence crop and cacao as a cash crop.

Coffee is a minor plantation crop in the Chontalpa and will not be discussed in detail. The product is much inferior to that from the Jalapa-Orizaba zone and does not seem to thrive in flat coastal plain. Most of that grown is for local consumption either in the household of the farmer or is sold at Huimanguillo itself for community use. Techniques are much more casual than in the true coffee zone of Vera Cruz. Often instead of sowing madres the farmer selects a piece of well developed high forest and cleans out the underbrush leaving the larger trees to serve as madres. A more common procedure is to devote half or a quarter of a cacao grove to coffee or even plant coffee in the "calles" of a cacao grove. When sown alone plants are spaced at 2-meter intervals, and as many as 2000 plants may be sown in a hectarea. One example in which cacao was mixed with coffee was seen at El Puente. The orchard measured .5 hectareas and included 300 cacao bushes and 400 coffee scrubs. In this case the coffee was sown along the line of cacao and also in the calles. In Huimanguillo coffee is not sown in seed beds first but the "hijos" or young shoots which grow naturally at the foot of the mature bush are simply uprooted and sown directly into the orchard. Coffee starts producing in this area in the second year and the yield steadily climbs up to the twelfth or fifteenth year when it drops off. The

bean is harvested during the fall.

Along with rice the banana is an important secondary staple in the Chontalpa. A number of varieties are known, of which the cuadrado, macho, manzano and roatan are most important. The roatan is the commercially important sweet banana, the bulk of which is sold overseas. This is the only variety found in large plantations and most commonly seen in plantations of any size. The manzano is a smaller sweet banana mainly grown for local use. The platano cuadrado is mainly used as a food for pigs and fowl, whereas the plantain macho is a large banana used in cooking and is a staple food. The three last varieties are mainly sown scattered, or in small groves, around the house for home use, or may be sown in a milpa. Our data apply strictly to small semi-commercial holdings, not to large plantations. A very common method is to sow the young "hijos" or shoots (which sprout naturally at the foot of a mature plant) in the tonamil shortly after the maize is planted. As the banana is a rapid-growing herb it soon chokes out weeds. It is sown with the coa. The plants are usually sown at 5-6-meter intervals and a single hijo is sown in each hole. This original shoot soon starts producing secondary hijos and the plant grows as a cluster of shoots collectively called a "cepa". The young banana tree starts yielding in about one year and on clayey soils will yield well for about two years and is then abandoned. On sandy, well drained riverside lands it may produce well for five to six years. In cases where it is sown on corn land we can consider it as one of the many secondary cultivates sown mixed with maize. It ordinarily will outlive the actual use of the field for milpa and continue growing as an apparently natural grove amongst

the natural acahual regrowth. This is the ordinary technique of banana cultivation on soils not strictly suitable. On proper soils small groves, more or less permanent, are sown alongside the house of the farmer. These groves may continue producing for as long as 30 years but normal maximum on the best soils is about 15 years. The plot is usually then abandoned and a new sowing made. Labor in banana orchards is slight. When the plant is a few months old most of the hijos are carefully pruned off leaving the four healthiest shoots to grow. Also in the early stages of growth several chapeos may be needed but once well established the banana soon chokes out opposition.

In the case of large, scientifically managed plantations, of course, techniques of cultivation are more advanced. Trees are usually kept in production from 12 to 15 years, then cut down and two years of legumes planted; following that, banana replanted. Also plowing may be used to prepare the land, true weeding practiced, and even drainage canals dug to prevent flooding of the field. These techniques, however, are rare even on large holdings in the Huimanguillo area and the banana in general is cultivated with slash and burn techniques as described above. One of the great benefits of the banana is the fact that it produces fruit throughout the year, unlike the grains, and often is used to tide the farmer over periods of maize scarcity.

## Demography

Tabasco, along with most of the Tierra Caliente, was almost completely depopulated during the century following the Spanish Conquest, and even up until the end of the nineteenth century was still not well

populated. The population has grown steadily since 1900 and is still climbing. The demographic limit with the present economy has nearly been achieved in certain areas, but there are still vast, almost unoccupied tropical forests, especially in the western part of the municipio of Huimanguillo. The population of the state in 1900 was only 159,834 or approximately 6 per $km^2$; in 1910 it rose to 187,834; and by 1940 had reached 285,659. The last census - 1950 - recorded 363,501 inhabitants with a density of 16 per $km^2$. Of the 1950 total approximately 35,000 or 10 percent live in the one city and capital of the state, Villa Hermosa. The population is overwhelmingly dependent on the two activities of stock raising (cattle) and agriculture; even at Villa Hermosa the bulk of the population live indirectly off these two activities and the limited industrialization there is strictly to supply local needs.

The population density for 1950 of 16 is a mean of the entire state; the variation by municipio was great as the chart below indicates:

| Municipio | Area | Population 1950 | Density 1950 |
|---|---|---|---|
| Balancan | 2960 | 8603 | 3.0 |
| Cardenas | 1750 | 24164 | 15.0 |
| Centla | 2860 | 27053 | 9.0 |
| El Centro | 1916 | 75345 (33587 urban) | 40.0 (25.0 rural) |
| Comalcalco | 420 | 33950 | 80.0 |
| Cunduacan | 660 | 19561 | 30.0 |
| Emiliano Zapata | 510 | 5897 | 11.0 |
| Huimanguillo | 3520 | 24575 | 7.0 |
| Jalapa | 530 | 15248 | 27.0 |
| Jalpa | 320 | 16089 | 50.0 |
| Jonuta | 2110 | 8368 | 4.0 |
| Macuspana | 2012 | 40023 | 20.0 |
| Nacajuca | 770 | 14298 | 20.0 |
| Paraiso | 480 | 17401 | 35.0 |
| Tacotalpa | 940 | 12082 | 8.0 |
| Teapa | 400 | 10240 | 25.0 |
| Tenosique | 1630 | 9804 | 6.0 |

A glance at the population map on page illustrates clearly the distribution of population in the state by municipio. We may note a heavy clustering of population in the Chontalpa or those municipios in the center of the state in the Grijalva drainage and with the Tonala and Usumacinta drainages showing very sparse populations. This concentration in the Chontalpa is due to the overwhelming importance of that region agriculturally. The eastern part of the state is a cattle zone and the western is almost uninhabited tropical forest.

The municipio of Huimanguillo where our test zone is located shows considerable population increase during this century. In 1900 the municipio possessed 14,000 inhabitants and this level was maintained without significant rise until 1940. Then in the decade 1940-50 the population jumped up to nearly 25,000, almost a hundred percent increase.

It would be helpful to be able to break down the population of the municipio by rancherias but areal measurements of the latter are not available. We can, however, be sure that all or most of the following rancherias and communities lie within the nuclear sub-zone. The error cannot be more than ten percent.

| Population Unit | Classification Of Unit | Population 1950 |
|---|---|---|
| Huimanguillo | town | 3084 |
| Caobanal | rancheria | 1186 |
| Chicoacan | rancheria | 356 |
| Desecho | rancheria | 452 |
| Guiral y Gonzalez | rancheria | 512 |
| La Libertad | rancheria | 426 |
| Monte de Oro | rancheria | 636 |
| Los Naranjos | rancheria | 803 |
| Ostitan | rancheria | 595 |

| Population Unit | Classification Of Unit | Population 1950 |
|---|---|---|
| El Puente | rancheria | 485 |
| Rio Seco y Montana | rancheria | 855 |
| Tierra Nueva | rancheria | 788 |
| Villa Flores | rancheria | 657 |
| Ocuapan | nucleated village | 625 |

This sub-zone is the only part of the municipio which is well populated and the demographic limit is not far off with present agronomic techniques. Our total population for the nuclear sub-zone is 11,462 and the density 37 per $km^2$. This is an excessive density for a Tierra Caliente region and offers a startling contrast to the average population density of but 7 for the municipio as a whole. Approximately one-half of the population of the municipio of 3500 $km^2$ lives in a riverside strip of 300 $km^2$.

The strictly rural population of the nuclear sub-zone is approximately 8000, the average size of a rancheria about 2300 hectareas, and the average rancheria is composed of 650 inhabitants or 130 families. Each family today has theoretically at its disposal 18 hectareas of land. Of course the situation for the small farmer is not quite so favorable. A sizable chunk of land is in large holdings, not all the land is productive, and numerous families living in the town hold land.

A sharp contrast is also offered by comparison of the nuclear sub-zone with the rest of our test area. The remainder of our test area includes 600 $km^2$ and includes just three rancherias (Tierra Colorada 192, San Fernando 208, Arroyo Hondo 1782) and two nucleated villages (Mecatepec 250 and Tecominuacan 744), or a total population

of 3176 or slightly over 5 per $km^2$. Actually all but Tierra Colorada are in sub-zone 2, an area of 250 $km^2$. The density of this sub-zone calculates at 12 per $km^2$.

These differences are due to the following factors: (a) varying productivity of the land; and (b) the variability of the intensity of colonization.

Our total test area of 900 $km^2$ has a population of 15,000 people with an overall density of 17 per $km^2$.

## Zonal Settlement Patterns

To bring into sharper focus our economic, demographic and settlement pattern data we can do no better than take a tour of our test area analogous to our tour of the southern Valley of Mexico and the Valley of Teotihuacan. Both of the previous tours were on a 28-kilometer stretch of highway. We are going to make our trip along a similar highway paralleling the Grijalva river for approximately the same distance. Our highway runs from Estacion Chontalpa to Puerto Ceiba by way of Huimanguillo, Cardenas, Comalcalco and Paraiso. Our tour will embrace the first 29 kms of it and will take us through the nuclear sub-zone.

The highway runs from Estacion Chontalpa due north paralleling the river and running about 5-6 kilometers from it. The first 10 kilometers take us through the rancherias of Chicoacan and Ostitan. To the west of the highway we get a glimpse of the most unfavorable part of our nuclear sub-zone characterized by the beginnings of elevated flat savannahs which run on to the west for 20-30 kilometers, agriculturally useless lands. Interspersed through this slightly elevated savannah are low swampy bajos and islands of tropical forest.

The former provide lush grazing ground for cattle and the latter are exploited for a limited and unprofitable maize cultivation. To the east of the highway the land is covered by tropical forest. Most of the area between the highway and the river is occupied by low hills and long gentle slopes. The soil profile when exposed by cuts show a typical lateritic profile with almost no topsoil except raw humus and a fiery-red-to-yellow subsoil. This area is exploited entirely for maize and bean cultivation with slash and burn techniques. The forest represents a patchwork of milpas, abandoned milpas, well developed secondary growth, and high forest. These are the poorest rancherias we shall pass through and winter cropping is precarious, the tonamil crop often being a total or near total loss. There are no villages; what we see are stretches of milpa and forest with an occasional house visible from the highway. The total population of this stretch of 100 $km^2$ is but 1000 inhabitants, according to the 1950 census.

The highway then shifts to the east for 3-4 kilometers and swings back north again, where it parallels the river again for 8 kilometers until reaching the town of Huimanguillo, a total distance from the Estacion Chontalpa of 22 kilometers. Where it turns east it crosses the rancheria of Tierra Nueva. Tierra Nueva is a section of elevated flat tropical forest aligned along a small stream to which it owes its moderate productivity. This stream has a limited flood plain and the best lands are located on its edge. However it is not a favorable area for commercial banana or cacao cultivation, and the population consists of subsistence slash and burn farmers who grow maize and beans as staples and rice as a staple and cash

crop. The rancheria is broken up into holdings averaging from 6 to 30 hectareas, of which only a fraction are in production due to the exigencies of slash and burn cultivation. The farmers, however, are in a much better economic condition than those in Chicoacan; they are able to raise double crops and their harvests are regular and considerably higher. The settlement pattern does not change, however. The scattered homestead or rancheria pattern holds here, the main difference being that the area is more heavily settled.

Upon swinging back to the north again we enter the main flood plain of the Grijalva river and get our first glance at tierra de primera. Along this 8-kilometer stretch from the second turn up to Huimanguillo are two rancherias: Villa Flores and Pedro C. Colorado. In general this is not an area of large plantations. We find here a fascinating combination of commercial and subsistence cultivation in the hands of small landholders; our nearest parallel lies with the chinamperos of the Xochimilco area. The holdings are smaller than in the previously described rancherias, running from 3 to 8 hectareas with the bulk of the holdings running around 6. Maize and beans are the staples and at least half the holding is in acahual. The cultivation is of the slash and burn type but the cycle is often very short (on smaller holdings), at times 2 years of cultivation and 2 of rest, or 1 and 1, or even 3 years of cultivation followed by 2 of rest - about that of highland barbecho agriculture. Along with this part of the holding devoted to subsistence grain cultivation most farmers have small (1-2 hectareas) cacao and banana plantations which provide them with a cash income. A characteristic sight is a pole and thatch dwelling, situated hidden among fruit trees, 50-100

meters from the highway, surrounded by milpas, patches of scrub forest and a small cacao plantation. In front of the house are often spread mats with bright red cacao beans set out to dry.

Economically these people seem to be about on the level of the San Gregorian with the same curious combination of subsistence and commercial agriculture. The agricultural technology, however, is of course very different and the San Gregorian does it with much more labor and much less land.

Huimanguillo is the only nucleated community we shall see in our entire tour. In 1950 it possessed slightly over 3000 inhabitants. It is not a village, but a true town, and is the administrative, religious and commercial center of the municipio. It possesses a very regular street pattern laid off in squares, and covers a rectangle 1500 meters north-south by 700 east-west. The only paved street is that which forms part of the Chontalpa highway which forms its main street. The settlement pattern, however, is not typically Mexican as the church is not situated facing the main plaza but stands alone near the south edge of town. Also the main plaza is not in the center of the village and is open on two sides.

It has dry season highway connections to Villa Hermosa, the state capital, and is further linked to that center by daily mail-passenger plane service. A paved highway runs from it to the Estacion Chontalpa and from that point there is railroad service to Mexico City. Upon leaving Huimanguillo the Chontalpa highway connects the town with Cardenas, Comalcalco and the coast, but it is not paved through this section. A number of dirt roads run west from the community connecting it to nearby rancherias, but these are only

passable during the winter and spring.

The bulk of the houses in the center of the community are large, well furnished, brick and masonry structures joined wall-to-wall with shops interspersed between the houses. The community has a movie, several hotels, a telegraph office, mail service and numerous shops of the general store type.

A very low percentage of the population of the community are farmers, that is, people who work their own lands. Land ownership and agricultural production, however, are the bases of its existence and most people live directly or indirectly from them. It is a small urban center collecting the production of the neighboring rancherias and fincas for foreign exportation. It is full of specialists: merchants, carpenters, bakers, tailors, seamstresses, masons, mechanics, bar and restaurant operators, stevedores, barbers, beauticians, etc. An extraordinary percentage of the population, if not to be classed as millionaires on Mexican standards, certainly would be put in the middle class or lower upper class in Mexican society. The basis of this wealth lies in land, cattle and wholesale handling of rural production plus retailing of consumer goods to the townsmen and farmers of the rancherias. Most of the wholesaling of production is in the hands of three cooperatives, one of "ganaderos" or cattle owners, and the other two banana and cacao growers. The wealthiest people have achieved their status mainly by a combination of several or all of the mentioned activities and the most vicious and common technique of doing so is by exercising the monopoly principle. A very sharp class system on three levels exists with the basis being a combination of family origin and capital wealth. The area offers

an extraordinary opportunity for such an economic and social system due to the high value of its products for the international market.

Continuing our tour of the Chontalpa to the north the highway continues paralleling the river for the remainder of our 29-kilometer trip through the prize agricultural region of the municipio. The highway passes entirely through the Grijalva flood plain and the utilization of it is a combination of true commercial agriculture based on extensive holdings of cacao and banana, or a combination of small plantations with subsistence maize cultivation as at Villa Flores. Holdings run from 3 or 4 hectareas up to the theoretical legal limit of 100. The difference between big or small landholders, however, does not lie in the size of the holding but in its management. Many farmers with 30-40 hectareas must be considered as small landholders. A big landholder is one who has converted all of the holding to cacao or banana while a little landholder is one with but a few hectareas of permanent plantation who cultivates the rest of the land with maize based on slash and burn cultivation. Of course a big landholder must have at least a moderately large property but it need not exceed 20 hectareas if it is all in plantation. The situation is complex and all combinations and levels are found. There are three huge sugar cane plantations also in this stretch. The settlement pattern is similar to that noted in the other rancherias except that there is greater variation in the level of living. The wealthier owners may have a masonry house with a flower garden in front, their own electric plant and water pump along with such items as refrigerators and radios. Most of the wealthy landholders, however, live in the town and have a caretaker living on the property. In the

cases of the largest holdings of all, where a large crew of permanent workers are needed, a small hamlet of pole and thatch dwellings may cluster around the owner's house - a relic of a common pattern in Mexico before the agrarian revolution.

## Community Settlement Patterns

Within our test area of 900 $km^2$ we find three basic types of individual community patterns: (a) the urban town; (b) the nucleated village; and (c) the rancheria. This situation is characteristic of most of Tabasco except that in the east a fourth type, the isolated cattle ranch or rancho, must be added.

In the state as a whole we find one large city, Villa Hermosa, which is the capital. Within the state are 16 municipios other than that of the capital itself (El Centro). Each of these municipios has a municipio center which is a small urban town of from 1500 to 4000 inhabitants. They are true towns with a mainly non-farming population, and are religious, commercial and administrative centers for the municipio. Approximately 10-15 percent of the municipio population lives at these centers. Huimanguillo is one of these centers. If we were to continue our tour from Estacion Chontalpa to the coast we would find the following communities of this type along the highway. Leaving the station we arrive at Huimanguillo at kilometer 22; from Huimanguillo to Cardenas is 20 kilometers. From Cardenas to Comalcalco, the next community, is a distance of 40 kilometers. From Comalcalco to the last urban community, Paraiso, is 18 kilometers, and the latter is situated a few kilometers from the beach. These four communities in 1950 possessed from 3000 to 4000 inhabitants and all were of the same type as described for Huimanguillo

in the preceding section.

The Rancheria. This is the most important settlement type in the Chontalpa and throughout most of Tabasco. It cannot truly be called a community since it lacks the cohesion and function of a true community. The rancheria is an administrative unit and nothing more. There is no real center other than an occasional pole-and-thatch or masonry school house, perhaps a small general store, and in some cases a pole-and-thatch church. We may find a slight clustering of houses, a dozen or so, but as each individual lives on his own agricultural holding these cannot be numerous. A similarity in general pattern can be seen to a unit such as the rancheria of Palapa in the Teotihuacan Valley, with the difference that as the holdings are much larger here the population is less dense. Each man has his house on his land and as most farmers hold from 6 up to 30 hectareas the pattern is very scattered. The population of a rancheria forms a very diffuse, extremely unstable social unit. As has been stated, the only symbol of social unity is the office of "comisario" whose main function is to act as the mouthpiece of the Presidente Municipal at Huimanguillo. He may on occasion, following orders from the town authorities, organize the adult males of the rancheria for construction of a trail or bridge, but such communal activities are rare. He is also the representative of "law and order" such as it is in Tabasco. This means principally the reporting of the frequent homicides which take place in these exceedingly diffuse, individualistic "communities". There is a near lack of community spirit either for ingroup activities or versus outsiders. The ejido system is in vogue as elsewhere in Mexico. Most farmers are ejiditarios

and hold ejido lands. Most farmers who have private land are those who descend from big landowners of pre-agrarian revolution days or who have purchased land from such people. The ejido may or may not correspond to the rancheria.

Within our test area we noted a total population of approximately 15,000, of which about 3000, or 20 percent, live in a single urban town, 70 percent live in rancherias, and the remainder, a scant 10 percent, live in nucleated villages of the Valley of Mexico type. There are three of these: Tecominuacan, Mecatepec, and Ocuapan (with populations of 744, 250, and 625 respectively). The second was an important pilgrimage center because of its sacred arroyo but has declined sharply since the revolution; only a fraction of the 250 inhabitants now live at the center so it really is now a transitional village-rancheria. The remaining two, however, are true villages, with a typical plaza but very irregular street pattern. These villages are of great historical interest. All have Nahuat names and a generation ago the Nahuat language was in common use. They, along with San Miguel further west, were ancient Indian villages probably dating from the Spanish regrouping and centralization policy of the sixteenth century. San Miguel, with the decline of the church in this century, has shifted to a rancheria type settlement pattern and Mecatepec is in the process of doing so. Evidently without the strong authority of the church these artificial villages automatically break down into the scattered homestead pattern, which is better adapted to slash and burn agriculture.

It will be interesting to see how much longer Ocuapan and Tecominuacan maintain the village pattern. One of the factors which

helps to prevent a breakdown of nucleated settlement is the same factor which operates in Yucatan. Both of the Tabascan villages are in the poorest agricultural section of our test area and there is still much room for demographic expansion. As a result the villages have open ejidos as in Yucatan, that is, the farmers cultivate where they please and do not have parcels. There is no particular advantage, then, in living in the forest. As soon as parcelling does occur the possibility that these villages will break up seems strong.

Another possibility must be mentioned, that is, that these villages are remnants of an ancient pre-conquest settlement pattern, which with the parcelling of lands and private holdings is changing into a rancheria pattern. Their marginal position seems to justify this. However the archaeological data suggest that the latter hypothesis is incorrect and that the villages are more probably of Spanish origin.

# CENOTES AND PEDREGALES - NORTHERN YUCATAN

## General Description

The most striking fact about the Peninsula of Yucatan is the scarcity of both soil and water. The most important determinants of human occupation are the locations of the natural wells or "cenotes" and the variation in quantity of soil for agriculture.

Yucatan is a vast limestone shelf jutting out into the sea separating the Gulf of Mexico from the Caribbean Sea. The northern half of it almost completely lacks relief with the exception of the chain of hills known as the Puuc. The latter is a great arc of low rounded hills with an average elevation of some 130-160 meters. The apex of the arc lies in the southern part of the state of Yucatan and the two great wings sweep southwest and southeast into Campeche and Quintana Roo respectively. These hilly ranges are of great significance in the agricultural exploitation of northern Yucatan. The fertile valleys and pockets nestled amongst the slopes and hills are natural deposition areas and we find here a deeper soil cover than is characteristic of most of Yucatan, and the soils are of great productive capacity compared to most of the peninsula. The hilly ranges also evidently trap more water, in spite of their low elevation, than areas to both the north and south, and in general northern Yucatan is a water-hungry area.

Most of the northern peninsula except for the upper slopes of the Puuc range is below 100 meters and the peninsula as a whole is the greatest extension of lowland in Meso-America (some 250,000 $km^2$).

Although Yucatan has little real topography it certainly cannot be labelled "level". The surface is pitted and scarred by depressions

and ridges which produce one of the most truly "broken" land surfaces in Mexico. It is an area of exceedingly complex micro-relief.

Soil cover is very scanty, especially in the center, west and north of the state of Yucatan where it is confined mainly to pockets in the pitted surface. From the air nequen fields show more white from the surface limestone than they do soil. The only areas where we get a really respectable soil cover occur around Tizimin, and in the valleys of the Puuc range. Soils are evidently quite fertile in northern Yucatan; the main factor which reduces their productivity is the quantity, not the quality.

Surface hydrography is almost completely non-existent. Most of it seeps down through the limestone and forms underground streams and lakes. The most important hydrographic feature, and which to a great extent conditioned the location of settlements and degree of exploitation of a locality, is the cenote, an opening in the limestone, or natural well, which taps the underground drainage system and provides the Yucatecan farmer with his main source of water. Today this supply is augmented by the perforation of artificial wells.

Most of the area is climatically sub-humid or even semi-arid. At Progreso with but 448 mms of annual rainfall maize cannot be grown. Most of the interior and north is devoted to the cultivation of the drought-resistant nequen, a relative of the maguey. Rainfall in this central area runs between 800 and 1000 mms a year, or slightly higher than the Meseta Central. However we are here in Tierra Caliente with an annual temperature some 12 degrees hotter than in the Valley of Mexico, and the rainfall effectivity is much lower due to the increased evaporation. The scanty soil cover further cannot

hold what rain does fall and much of the rainfall is rapidly lost to the subterranean drainage system.

Combined with these unfavorable climatic and orographic conditions the lack of surface drainage makes irrigation uneconomical and can be applied only to such lucrative crops as oranges or vegetables.

One factor ameliorates the humidity situation somewhat. As we are in Tierra Caliente, crop sowing may be delayed until June or even July when the rains are well under way. Frosts present no problem with respect to late sowings.

In the Puuc area and around Valladolid and Tizimin rainfall is generally above 1000 mms, and along with the heavier soil cover we have more favorable conditions for maize cultivation. In fact this area is called "La Zona Maicera" or the Corn Belt of modern Yucatan. None of the stations, however, record over 1200 mms of rain and the margin of safety is a slim one. The rains in this area are sharply seasonal and winter cropping is impossible. There is an almost complete drought between November and April, with the rainfall maximum falling between July and October. Of great interest is the fact that the Puuc, where one of the great regional Maya Classic sub-cultures fluoresced, is not only within the area of higher rainfall but also is in the area in which 80-90 percent of the rain falls during the maize growing season. Of interest in this connection is the fact that the east coast of Quintana Roo receives about as much rain as the nequen zone in the center of the state and furthermore only 60-70 percent of this falls during the growing season; the situation along this coast is highly unfavorable for agriculture.

In most of the world along with the rainfall pattern we find in Northern Yucatan we also get a savannah vegetation cover. Yucatan, however, is covered by a xerophytic mixed low bush in the north and a dry scrubby zapote jungle over the rest of the area. Woody rather than grassy plants predominate; Lundell feels that the thin calcareous inhibit grass growth. This factor made occupation of the peninsula by digging stick, slash and burn cultivators possible.

Today the agricultural pattern of Yucatan revolves around two plants and two systems. First we have the permanent nequen plantation which occupies first place in the areas which receive less than 1000 mms of rain annually. Second, in the wetter hinterland to the south and east we find maize is the central crop and is cultivated by the slash and burn technique by Maya-speaking native population.

## Yucatecan Agriculture

Most of the published data on Yucatecan agriculture deal specifically with maize. There is some justification for this emphasis since Steggarda estimates that from 75 to 85 percent of the diet of the village Yucatecan consists of maize in one form or another. The average Yucatecan probably consumes more maize than the chinampero or Teotihuacano or his fellow costeno of Tabasco. In the highlands this is due to the substitution of pulque for pozol, and in Tabasco the consumption of rice reduces the total maize intake. A simple statement of the importance of maize, however, gives one a false impression of the complexity of Yucatecan agriculture, as the total list of cultivated plants indicates only slight inferiority to the Tabascan in this respect. We might briefly state the situation by saying that Maya agriculture is characterized by great variety of crops but

that Maya diet is characterized by a poverty of variety.

The most complete study of Yucatecan maize cultivation was done by Steggarda sponsored by Carnegie Institution.[1] In our discussion we will first review the data gathered by him - mainly from Piste - and then compare it with other published data and with data gathered by myself at Kantunil Kin in Quintana Roo. His data refer to Piste and surrounding villages within the Valladolid district.

## Seasonal Round

Technology. The Yucatecan Maya use four principal tools in maize cultivation. These are the axe for chopping down the larger trees, the short curved coa or machete for most of the clearing, the digging stick with a metal point for planting the seed, and the "sabucan" or nequen bag for carrying the seed. All of the labor is by hand with the additional aid of fire for final clearing.

Locating the Field. This is one of his most important tasks in milpa cultivation, due to the highly variable quality of the land in Yucatan. A number of factors determine his choice: (1) color of the soil - reddish soils in general are overworked soils, the darker soils indicating fresher soils with more humus content; (2) height of the bush - low stunted bush indicates that the land was cultivated within a few years in the past, higher bush indicates that it has been in rest longer; (3) nearness to water supply in the form of cenotes. I would also add (4) the quantity of soil cover - some areas in Valladolid yield very low due to a near absence of soil; and also (5) drainage. Upon selection a tract of

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1. Steggarda, 1941.

forest is then measured off into mecates. A mecate is a cord 21.5 meters long used for measuring, and a mecate of land is one square mecate or about 462 $m^2$. There are approximately 22 mecates in a hectarea, 9 in an acre. Each corner of the mecate is marked off with a pile of stones.

Clearing. This is the heaviest task in milpa cultivation in Yucatan. Clearing is usually done by mecate, that is each mecate of 462 $m^2$ is cleared as a unit. First the Maya clears out the shrubs and small trees, then the larger trees are cut down with the axe, and the third operation consists of chopping up the cut-down vegetation and heaping it to facilitate burning. High forest (5-6 meters) can be cleared fairly early; any time between August and March may be selected for this task. If the clearing is to be carried out in a field sown in maize the previous year, then it is delayed until March and April to prevent weeds from taking over the plot. With high bush a man can clear approximately 2 mecates a day or 11 days per hectarea. For second-year fields this time can be cut in half.

Burning. Following the clearing the plot is then fired as a final clearing operation. This is done in March or April just before the rains begin. Aside from clearing the function of burning is to kill weeds and provide ash for fertilizer. Actually as I pointed out in my discussion on the Chontalpa, burning is of dubious value in creating soil fertility. In the thickly settled Valladolid area there is an ejido law which makes it obligatory to clear a 2-meter wide guardaraya or fire prevention trail around the field before burning, and fires rarely escape into the neighboring forest.

Fence Building. This is done for milpas near cattle ranches or villages to protect the field from livestock.

Planting. This is the same simple operation we described for the Chontalpa. The soil is not worked over with a hoe before planting. The farmer simply pokes holes in the ash and soil with his metal-tipped digging stick, drops seed in the hole, covers it over with his foot and proceeds to the next hole. Sowing is done by mecate and not by rows, each plant being spaced about a meter from all neighbors. Three to six seeds are dropped in each hole along with some beans and squash seed. Steggarda estimates that about 233-286 holes are made per mecate and that approximately 2-3 stalks grow from each. Often small patches of the field are set aside for other cultivates. A milpa often has a ragged uneven appearance due to the broken terrain and spotty distribution of soil pockets. Sowing takes place in May after the first heavy rainfall. Approximately 9.4 pounds of seed are sown per acre or 10-11 kilos a hectarea.

Weeding. This is done according to the age of the field. On fields freshly cleared from high forest only one weeding in July is necessary; on second- or third-year fields at least 2-3 thorough weedings are necessary plus extra labor in between. Weeding is done with the coa, the plants sliced off at the roots and not uprooted. Aside from more frequent weedings in second- and third-year fields the weedings are more laborious.

Bending of the Stalk. In September and October this is done after the ears have matured. This is a common technique in the tropical lowlands of Mexico and consists of bending over the stalk just below the ear. It is then left to dry the grain for a month before

the harvest. This procedure has the following functions: (1) keeps the rain out; (2) protects ears from birds.

Harvest - Middle and Late Fall. Actually in Yucatan no sharply defined harvest season is recognizable; as the dry season is almost rainless the maize is often left in the field and gathered casually throughout the fall and winter. It is harvested by breaking off the ears and hauled off in baskets and tump lines.

Storage. A rectangular crib is constructed in the milpa with a raised floor. Later on it is shelled and hauled to the house in grain form.

Hauling. This is mainly done today by pack animals, 2 cargas a trip, or less frequently by human back, in this case with 1 carga (about 100 pounds) as the normal load. Most fields are so situated that a pack animal can make approximately 2 loads a day.

## Economic Aspects of Maize Cultivation

Labor. Most of the labor in the milpa is carried out as a family affair; there is little need for cooperation on any larger scale. Most of the milpas are worked by the same man who will use the produce but men with capital often cultivate larger fields and hire workers. In Yucatan private ownership other than solar plots is rare and the tracts of forest are held by ejidos and are open to all ejiditarios. Steggarda estimates that approximately 102 days of labor are necessary to produce 50 mecates of maize, and divides up the time as follows:

| | |
|---|---|
| Selecting the field | 1 day |
| Measuring the field | 2 days |
| Clearing bush (first year) | 25 days |
| Burning | 1 day |
| Seed selection | 1 day |

| | |
|---|---|
| Planting | 6 1/4 days |
| Weeding (once) | 14 1/4 days |
| Bending of stalks | 8 1/3 days |
| Harvesting | 12 1/2 days |
| Building of granary | 6 days |
| Storing in granary | 2 days |
| Shelling | 5 2/3 days |
| Hauling by pack animal | 15 |
| Total | 102 days |

For second-year and third-year cultivation on the same plot clearing is reduced to approximately 12 1/2 days, and three days can be reduced also by the fact that locating and measuring the field are unnecessary. However this is counterbalanced by the labor of 1-2 extra weedings or 14 1/4 to 28 1/2 days extra for this operation. The net result may be more labor needed for second- and third-year milpas than for first.

Size of Fields. Steggarda estimates that the 638 fields studied by him over a five-year period averaged 99.23 mecates in size or 9.8 acres or 4.5 hectareas. This evidently is the size field necessary for maintaining a balanced family economy in which maize must serve not only as the main subsistence but as a cash crop as well. In more fertile areas fields are evidently smaller, or in areas where there is enough high forest a higher percentage of the field may be in this type of vegetation (higher yields), thus indicating that there is a close relationship between family needs and the size of a field cultivated. Assuming that a third of the nearly 100 mecates were in first-year fields and the rest in re-used land and using the production figures to be given later, the 100 mecates would yield in the neighborhood of 75 cargas or about 3.5 tons of maize. According to this data a village of 100 families would have to sow about 450 hectareas in milpa a year to maintain itself in a balanced

subsistence-commercial economy.

Family Labor and Consumption. To maintain the average field of 100 mecates Steggarda estimates some 190 days of labor are necessary, of 8-hour working days, or 1520 man hours of labor. His tables indicate that the average Yucatecan Maya consumes 1.31 pounds of maize daily, the family of five 6.55, and that an extra 3.5 pounds are needed for livestock with a total of 9.8 pounds a day per family or 64 bushels a year. Converting this to metric data for comparison with our other areas this calculates at 4.5 kilos a day or about 1650 kilos a year. The maximum production for 100 mecates would be 100 cargas (actually somewhat less) or 168 bushels. My own feeling is that this is too high and that the production is closer to 3.5 tons. At any rate he produces a surplus of at least 110 percent and possibly 160 percent for a cash crop.

Maize Yields. Steggarda presents the following charts which I summarize and convert production to the metric system.

Yield - First-Year Milpas

| Village | Number of Milpas | Average Yield Per Mecate (cargas) | Kilos per Hectarea |
|---|---|---|---|
| Piste (1927-38) | 61 | 1.119 | 1100 |
| Chichimila (1933-34) | 28 | .584 | 574 |
| Xocenpich (1932-34) | 46 | .795 | 792 |
| Pencuyut (1935) | 84 | .899 | 880 |

One of the most important facts about slash and burn cultivation is the reduction of yield when the same plot is cultivated 2-3 years in succession.

Further on Steggarda presents the following chart on yield reduction between first- and second-year crops:

| Town or Village | First-Year Milpas Number | First-Year Milpas Average Yield | Second-Year Milpas Number | Second-Year Milpas Average Yield | Ratio |
|---|---|---|---|---|---|
| Chichmila (1933-34) | 28 | .584 | 17 | .494 | .845 |
| Xocenpich (1932-34) | 46 | .795 | 28 | .633 | .796 |
| Pencuyut (1935) | 84 | .899 | 31 | .669 | .841 |

Aside from these general village yields he gathered specific field yields from whom he considered were especially trustworthy informants from Piste and Pencuyut which indicate a somewhat higher yield than the general village averages. He doesn't, however, give the year so it is possible that these estimates are based on more prosperous years. His data are summarized below.

| Informant | Mecates | Cargas | Cargas per Mecate |
|---|---|---|---|
| **Piste** | | | |
| Facundo Ceme | 50 | 60 | 1.2 |
| Bonifacio Tec | 140 | 280 | 2.0 |
| Eugenio May | 40 | 67 | 1.68 |
| Eugenio May | 50 | 62 | 1.24 |
| Eugenio May | 50 | 75 | 1.50 |
| Victor Dzib | 54 | 84 | 1.56 |
| Average | | | 1.64 |
| **Pencuyut** | | | |
| Miguel Pool | 200 | 251 | 1.26 |
| Teodocio Cab | 89 | 93 | 1.04 |
| Average | | | 1.19 |

Distances of Milpas from Villages. This is one of the interesting aspects of slash and burn cultivation, especially with respect to the transport problem of moving production to ancient urban centers by human back. Steggarda offers the following data based upon

162 milpas from 5 villages. All of these villages are small except Chichimula and the distance some farmers go to select good milpa land is quite significant.

| Village | Distances of Milpas (kms) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-3.4 | 3.5 | 7 | 10.5 | 14 | 17.5 | 21 | 24.5 | Total |
| Xocenpich | 7 | 15 | 4 | 10 | | | | | 36 |
| Piste | 2 | 3 | 1 | 4 | 3 | | | | 13 |
| Chan Kom | 4 | 8 | 8 | 2 | | 1 | 1 | 2 | 26 |
| Chichimula | 7 | 8 | 3 | 1 | | 2 | 2 | | 23 |
| Pencuyut | 25 | 38 | 1 | — | — | — | — | — | 64 |
| Total | 45 | 72 | 17 | 17 | 3 | 3 | 3 | 2 | 162 |

Cycle of Cultivation. Steggarda states that following an average of two years in cultivation the milpa is then rested for an average of 8-12 years. He estimates that today with modern commercial economy each family needs six plots of milpa land, each plot being of 100 mecates, to maintain himself permanently, or 600 mecates in all or approximately 27 hectareas. This is about twice that we estimated for tierra de segunda in Tabasco, or that of Palerm and Kelley for the Tajin Totonac, and gives us a theoretical population density limitation of about 15-20 per $km^2$, exactly the present density of the central part of the state and the same as our potential estimate of the Valladolid district in the section on Demography. These figures will serve for most of the state of Yucatan except the fertile Puuc. This is assuming, of course, that all land in the village territory will produce a maize crop, and of course this is highly dubious. These figures more than any others point out the deficiencies of the system and why even with a density of but 9 per $km^2$ we have evidence for a real population pressure in the Valladolid area. A village of even modest size,

say 100 families, needs 2700 hectareas of milpa land - more land than the 1100 families at San Gregorio need for subsistence in the Chinampan.

Before analyzing my data from Kantunil Kin in Quintana Roo we will summarize a second excellent study of Maya agriculture, that of Villa Rojas in the delegacion of Felipe Carrillo Puerto, also in the Territory.[2] This is our area of refuge Indian population discussed in our section on Yucatecan Settlement Patterns. His data are based on the villages of the X-Cacal sub-tribe.

In this area lands may be cultivated up to three years before declining yields force the farmer to shift his milpa, and for best results at least seven to eight years of rest are needed. Virgin forest is called "chacben" here, canada or land in maize the previous year is called "zakab" and secondary forest is called "hubche". The general feeling of the Maya is that chacben yields best, zakab poorest, and hubche intermediate. Selection of fields for clearing is based on the condition of the forest and character of the soil as at Piste. Ordinarily a man clears a piece of chacben and one of previously worked land each year. This system of course cannot work anywhere except in the sparsely populated territory with very small scattered settlements and abundance of land.

The general cycle of cultivation is very similar to that followed in Piste. The plot is measured off in mecates first and cleared with steel axes and curved machetes of the Piste type. Clearing begins in December and continues on until March. The field is burned over

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2. Villa Rojas, 1945.

in April and following the first rains in May is sown with the digging stick shod with a metal point. Seed is selected from the centers of the largest ears and sown mixed with beans and squash. The weeding schedule is similar to that of Piste, and the stalks are doubled as in central Yucatan. Also sown in the milpa are chile, jicamas, sweet potato, macal (yam), cassava, tomatoes, watermelon and pineapple. The last two, plus henequen and chaya, are sown also in the house lot, and on raised pole platforms in the solar they sow epazote, onions, marjoram and parsley. A number of fruit trees are also cultivated, including papaya, chirimoya, guanabana, mamey, guayaba, banana, sour and sweet oranges, tamarinds and limes. Fruit trees are usually solar cultivates. Summarizing agricultural technology we might state that it is simply our Yucatecan system carried out under a much more favorable demographic setting but not probably a more favorable geographical one. As we can see below only those yields on chacben exceed our Yucatecan ones, that the hubche yields are very similar. Below I present a series of charts from Villa Rojas which summarize his data very well.

| Type of Milpa | Average Size | Average Yield (cargas) | Cargas per Mecate | Kilos per Hectarea |
|---|---|---|---|---|
| Chacben | 43.3 | 63.4 | 1.46 | 1500 |
| Zakab | 28.1 | 22.3 | .75 | 760 |
| Hubche | 39.4 | 43.0 | 1.09 | 1100 |
| | 38.1 | 45.1 | | |

| Type of Milpa | Number of Families | Average Milpa Size Per Family | Average Cargas Per Family |
|---|---|---|---|
| Chacben | 52 | 33.3 | 48.7 |
| Zakab | 52 | 14.6 | 11.5 |
| Hubche | 52 | 39.4 | 43.0 |
| | 52 | 87.3 | 103.3 |

| | |
|---|---|
| Average size of family | 6.4 persons |
| Average mecates cultivated | 87.3 |
| Average cargas harvested | 103.3 |
| Average number of pigs per family | 5.3 |
| Average number of chickens per family | 19.5 |

There is a definite tendency to cultivate chacben and hubche rather than zakab as the chart clearly indicates. Evidently lands are often sown but a single year and then abandoned. This quite obviously relates to the sparseness of population and lack of land pressure, and is probably universal in the first stages of colonization of new lands by slash and burn techniques. There is a centrifugal tendency in land use by slash and burn cultivators even from the beginning of occupation.

The data of land needs per family check beautifully with the data from Piste and suggest quite clearly that the amount of land cultivated by a family in either Piste or Tusik is the amount of land needed to maintain a balanced semi-commercial economy. The average family at Tusik needs somewhat less than at Piste due to the slightly higher average yields. Aside from this, chicle is an important cash crop in the Quintana Roo area and cuts down on the amount of maize needed for a cash surplus.

Villa Rojas also presented data on time and labor in agricultural

activities which check very closely against that from Piste. His data are summarized below.

Average Annual Labor of a Family Head - 87.3 mecates

| | |
|---|---|
| Agriculture (milpa) | |
| Locating and measuring | 5 days |
| Felling bush | 49 days |
| Sowing | 15 days |
| Weeding (one) | 21 days |
| Bending of stalk | 5 days |
| Harvest | 15 days |
| Construction of granary | 6 days |
| Hauling milpa to house | 25 days |
| Total | 141 days |
| Miscellaneous Economic Tasks | |
| Chicle extraction | 10 days |
| Hunting | 24 days |
| Honey collecting | 11 days |
| Total | 45 days |

## Agriculture at Kantunil Kin - Introduction

In 1940 Kantunil Kin was a small agricultural village of some 600 people. It is situated on the border between Quintana Roo and Yucatan. The area is dense tropical forest, still but slightly altered by man. The basic climate and soil conditions are typical for northern Yucatan although somewhat more favorable than most of the northern part of the peninsula.

The village itself is today less isolated from the rest of the world than it was in 1940, but communications still are not very good. A mule trail leads out of the village to the north and connects it with Solfarino, a small village 32 kilometers away. Over this route there are no intermediate settlements. A second mule trail goes due east to El Diez, the western terminal of the Leona Vicario-Puerto

Morelos tramway. El Diez is approximately 24 kilometers from Kantunil. From the former one can travel by tramway to Leona 10 kilometers further east. Here again there are no intermediate settlements between Kantunil and Leona. A dirt road runs south to the new Merida-Puerto Juarez highway, the junction being some 20 kilometers from Kantunil. A second dirt road runs from Kantunil due west to Tizimin in Yucatan, a distance of 80-90 kilometers. Today there is a bus service with one bus a day leaving Tizimin for Kantunil and vice versa. About 30 kilometers from Kantunil along this highway is a big lumber center with the name Colonia de Yucatan. All along the highway between the two points there have grown up in the last ten years a large number of ranchos or hamlets. These people come mainly from Kantunil and are subsistence farmers. All of the satellite hamlets of Kantunil are strung out along this highway due principally to the advantages in transport. In 1955-56, the time of the field study, the population of the village and its ranchos had probably passed the thousand mark but no accurate figures are available.

We may estimate that about 250 families now live in the village plus the satellites. There is no private land in Kantunil except the village house lot. We have here the common Yucatecan system of "ejido abierto" or open ejido. The size of the ejido given the village is enormous. To the north it extends at least 4 leagues, to the east 2.5, to the south 2.5, and to the west 4.5. This roughly covers an area of nearly 70,000 hectareas. I was unable to secure the exact measurement; the estimates are based on informants who actually showed but a vague interest in the size and limits. There is so much land and so few people that borders are purely legal rather

than functional problems. The best part of the ejido lies west of the village, an area of many flat depressions and heavy soil cover, being part of the rich maize belt of the Tizimin area. Here yields are highest and production most dependable. To the north the ejido is of the typical stony, shallow-soil Yucatecan type and is moderately productive. To the east and south there are huge stretches of scrub bajo savannah which during the rainy season are converted to lakes and swamps. The average villager has but a very general knowledge of the potentiality of this huge area and today can freely select only the best lands for sowing. Some informants estimated from one-third to one-half of the ejido as being first-class agricultural lands and about one-third as being agriculturally worthless. However one must be cautious as under the present demographic set-up many lands which would be considered as worthless may actually produce some crops. My own feeling wandering over the area is that possibly 30 percent of the ejido could be classified as first-class land, some 20-25 percent as swamp bajo or otherwise useless land, and the remainder of the ejido presents the same general quality as most of Yucatan.

## Milpa Agriculture

The basic system of cultivation practiced in Kantunil Kin is the slash and burn system employing axe, long straight-bladed machete of the Tabascan type, and digging stick. The soil is not turned over and fields are never planted more than three successive years. Often fields are planted only once, as virgin forest always produces the highest yields. This of course parallels the situation at Tusik and is probably characteristic of slash and burn cultivators with steel

tools and an abundance of land. Maize is the main crop, being a local subsistence crop as well as a cash crop. The Kantunil farmer often produces a considerable surplus for sale.

A number of varieties of maize are sown. One called "ttelnal" of "maize de gallo" matures in seven weeks. It is sown mainly as a quick crop for late summer consumption to tide the farmer over until the main crop of slow-maturing maize is ready. Especially this is sown in cases where a farmer feels that his previous year's harvest will not hold him over. He may also sow it for "elotes" or corn on the cob which he may consume himself or sell in Tizimin. The ears and grain are small and production by weight very low. This type in some areas of Yucatan may be sown in April if the rains come early, harvested in June and followed by a second crop of long-maturing maize; this is the so-called double cropping carried out in some areas of Yucatan.

A second variety is called "bacal delgado" and a third "tuxpeno"; both are introduced types of slow-maturing maize with a growing season of 3-4 months. A third local type "maize negro" or "chob" is little sown.

The most commonly sown maize, however, is the "maize amarillo", a local slow-maturing variety which produces a heavier seed than the others.

The larger ears of maize are set aside for sowing and the seeds actually sown are from the center of the ear. They are sown without germination.

The same principles mentioned in milpa selection at Piste and at Tusik are applied here in Kantunil. Important in selecting of

land are the color of the soil, quantity of soil, topography and drainage, and the height of the forest. Many villagers have large numbers of pigs plus some cattle which may affect their choice also. Villagers prefer to select land at least a league from the village to prevent the livestock from damaging the crop. Evidently they prefer to walk a little further than to go to the extra labor of building fences. A second factor which inhibits the use of nearby lands is the fact that the immediate area has long since been converted to scrub secondary forest and extra weeding must be done on these lands. Another cultural factor is the presence of trails which can be used by the ejido truck, thus facilitating transport. This is one of the reasons why ranchos have proliferated along the Kantunil to Tizimin highway. Even with the abundance of land some farmers may go as far as 12-16 kilometers from the village for milpa land.

Villagers who intend to clear relatively small milpas usually start the clearing operation in December and the period from this month to March is generally occupied by clearing forested lands for milpa. Men who plan on larger sowings or who plan on hiring others to make a big milpa may start as early as August. In the latter case the trees are chopped down but they are not slashed up and heaped until April or March when the burning is to take place. Before they burn they cut down a wide swath of forest all the way around the main milpa, chop it up and heap it. This is then fired first and evidently will produce a hot enough fire to burn off the green weeds which have sprung up in the main field. Only virgin forest can be felled so early. Ahuamil or secondary growth should

be cleared a few months before burning as the weed growth is very dense when left longer. Canada or land in maize the previous year is cleared last of all as it is generally well choked up by weeds and the soil full of weed seeds. An early clearing here would result probably in complete weed dominance and the field would be lost. In summary then, virgin land is cleared as early as August and generally in late fall-early winter, ahuamil in late winter-early spring, and canada just before burning in March or April and sometimes as late as May or even June, although the latter is rare.

Clearing is done by mecate as in Yucatan. Informants estimate that high forest can be cleared at a rate of about 1.5 mecates a day, ahuamil 2.0 mecates, and canada 3-5, the latter figure only under conditions of poor weed growth such as might occur in second-year fields if the dry season was exceptionally rainless. Most villagers sow some monte alto or virgin forest and some canada every year. Yields on the former are higher, weeding easier, and harvest is more certain as a general rule. The only disadvantage is the heavy labor of clearing, although that is compensated by the reduced weeding. Most men clear an average of 60-70 mecates each year altogether. When asked as to the limit a man could prepare working by himself the informants stated that working steadily, clearing from December to April, they could clear as a maximum 60 mecates of monte alto and about 50 of canada, or 110 in all, but that actually this much land was rarely cleared personally; usually when a man intended to sow more than 60-70 mecates he hired help.

Theoretically a farmer must ask permission from the ejido to burn and an ejido official should be present to enforce the guardaraya

rule. This is a cleared trail cut around the milpa 2.5 meters wide to prevent the fire from escaping. Today the rule is more strictly enforced than a few years ago when forest fires from escaping milpa burning were quite frequent. I have seen areas ten to twelve kilometers long along the trails burned over by accidental fires. Evidently as the population climbs up the enforcement of fire control rules becomes stricter until we get the careful control characteristic of central Yucatan and the Chontalpa. One man can cut the guardaraya and burn off his field in a single day's work.

Most villagers sow maize in May following the first heavy shower. If May rains are poor he may wait till June, but this is rarely done as there is a feeling that maize sown in June never does very well. This is probably due to a climatic factor as the rains fall off sharply in September and maize needs abundant moisture during the period just before fruiting. If sown in May the heavy rains of August exactly time with this growth point. Sowing is done with the digging stick as elsewhere in Yucatan. Approximately 8 mecates may be sown with one "almud" of maize amarillo, 10 with bacal delgado. An almud of maize weighs between 3.5 and 4.0 kilos according to the type, the bacal type weighing less. A hectarea then requires about 11 kilos of maize for sowing. Five or six seeds along with seeds of squash and beans are sown per hole and plants are usually spaced about a meter from each other in all directions when possible. A single man can seed 50 mecates or 2.3 hectareas in about 6 days. Sowing is by mecate.

Following the sowing, lands in high forest are often not given any weedings at all, but even the one weeding sometimes given is a rapid operation as weed growth this year is very slight. Informants

stated that they could weed up to 10 mecates a day with machete and garabato. On other than virgin land, however, the labor of weeding increases enormously. In canada following a harvest on monte alto or virgin forest at least two good weedings are necessary and this increases to three if the field is planted a third year. Under these conditions the daily weeding decreases to 2-3 mecates a day, more commonly the former. On freshly cleared land which was in ahuamil or secondary forest at least two chapeos are necessary, and in the second year of cultivation this must be increased to three. The difference in labor may be summarized below.

Per 50 mecates (2.3 hectareas)

| | |
|---|---|
| Land in monte alto when cleared | |
| First year | 5 days (one weeding) |
| Second year | 50 days (two weedings) |
| Third year | 75 days (three weedings) |
| Land in monte bajo or ahuamil when cleared | |
| First year | 50 days (two weedings) |
| Second year | 75 days (three weedings) |

By comparing these data with that from Yucatan we can see that in this more humid deeper soil area weed growth is an even more serious problem than in Yucatan, and we can see clearly why no more than two and sometimes only one crop is sown in a field before abandonment. It also shows clearly why there is such a high price on monte alto over other types of land. Three weeds especially are difficult to handle. One is a fast-growing herb called platanillo or little banana which has leaves similar to the banana, another is a fast-growing vine called camotillo or little sweet potato, and the third and worst from the point of view of the cultivator is the pica-pica, a prickly shrub which sheds hundreds of tiny spines on contact.

When questioned about the amount of time a piece of land must be left resting to permit recutting, there was a wide range of opinion and little agreement. My belief is that the answers they gave were based on their experiences in central Yucatan (many villagers are colonists from outside) rather than their knowledge of Quintana Roo in particular. The fact is that with the abundance of land the problem does not arise. All agreed, however, that within 2-3 years the woody trees began to dominate the underbrush. They agreed, however, that if the young forest were cleared at this time the pica-pica, plantanillo and camotillo along with the scores of minor weeds would come back in full force and only by frequent weedings could the land be kept clear. Regrown forest as young as 8-12 years is rarely cleared. If cleared at this stage of regrowth at least two weedings are necessary to keep the natural vegetation in check. We might consider this as a minimum for effective cultivation. Climax forest seems to re-establish itself in about 15-20 years over most of northern Quintana Roo except in pockets of deep soils.

Yields in general are much higher than in central Yucatan, as is true of the Tizimin area in general. Virgin forest or monte alto often yields between 1.5 and 2.0 cargas per mecate, or approximately 1500-2000 kilos per hectarea. The higher figure is quite common, especially in those lands lying west of the ejido. Freshly cleared ahuamil or canada from monte alto yields somewhat lower, between 1 and 1.5 cargas or 900-1500 kilos. Lands cultivated for more than two years in a row usually drop to a carga per mecate so we have the typical picture of declining yields under successive cultivation. The important feature is the premium placed on virgin forest for

milpa land with high dependable yields. Some informants disagreed with this summary, stating that they often harvested the same the second year as on first. Actually this is easily possible if, for example, the first year was a poor one due to uncertain rainfall and the second an exceptionally good one.

This in part explains the disagreement. In Piste also and elsewhere in Yucatan informants pretty generally agreed that second-year crops were three-fourths of first year and third-year crops dropped to half. The actual data by milpa indicate a definite decline but not as drastic as the general data indicated; here again climatic variation may affect the picture although in a large series of milpas observed over a longer time this error should iron out. I believe that weed competition resulting in greater labor possibly plays a more important part in field abandoning than crop reduction, but both factors are probably operative.

In the scantier soil regions as around Tulum just behind the coast, yields are much less, with 1 carga per mecate the maximum yield and dropping to 1/2 on second- or third-year fields or on first-year milpas in the poorer lands. Most of northern Quintana Roo presents a picture similar to that of northern Yucatan with generally scanty soil, broken topography, and with limited areas of deeper soils such as the area west of Kantunil, around Coba, and between Solfarino and Chiquila.

Aside from maize a number of other crops are also sown in the milpa. These include sugar cane (for home use, papaya, manioc or yuca, camote or sweet potato, macal - a type of yam, tomato, banana (barbaro, manzano, macho, hembra and Kurro - the roattan is rarely

sown), squash (four varieties - mensejo, grande, X-Ka, and Ixkum), chile peppers (four types - habanero, largo, Kat ik, Kum ik), papa voladora, beans (sam ah, soya, ip, espelon, holibul, loch), pine-apple and watermelon. The list is impressive but only a few of them are extensively sown: squash, beans, tomato and chile, squash being more important than the rest.

Frijol Cultivation. The exact way frijol is sown at Kantunil depends on the variety. "Sam ah" is generally sown in the milpa around the middle of August, being sown in holes made near each maize stalk. Two to four seeds are inserted in each hole and approximately .5 kilos are sown per mecate. A thorough weeding is usually given the milpa before sowing the sam ah and a second weeding may occur about the time the maize is harvested, around November-December. This frijol is harvested in January following the maize harvest. In general sam ah is sown only in first-year milpas - the yield declines rapidly the following year if sown. In a two-year cycle then only one frijol harvest as compared to two maize harvests are made. On good lands from 1.5 to 2 cargas of frijol sam ah may be harvested per mecate. This is the most common frijol at Kantunil and is our typical Maya black bean or "bul". Harvesting frijol is more time-consuming than maize, a mecate requiring four days to harvest.

In recent times the "soya" or soy bean has been adopted and is frequently sown but usually is sown alone in special fields.

"Ip" is a small white bean sown in very minor quantities in Kantunil. It is sown the same way as sam ah but ordinarily only a mecate or two in a milpa are occupied by this plant.

Holibul frijol is often sown mixed with the maize seed in May or

mixed with ip in August. This frijol is also called "frijol de milpa".

Squash is always sown mixed with the maize seed in May but maize, beans and squash are never all sown together. Part of the milpa may be sown with mixed frijol and maize, another part with squash and maize. Two to three seeds are generally sown with each maize hold. The different squash varieties are often sown mixed. Some squash may be harvested green in August as a vegetable but most of it is allowed to dry and is harvested in December and November.

Often several mecates in a milpa are set aside for other crops, no maize being sown. Watermelon usually is sown this way, the small 1-2-mecate patches often surrounded by papaya trees. Tomato and chile are often sown together in special sections of the milpa. These two plants are usually sown in seed beds in the solar first and later transplanted to the milpa.

Root crops include cassava or yuca, camote or sweet potato, and finally macal or yams. The sweet potato is sown in a reserved patch as the fast-growing vine might choke out the maize or other crops. Macal and yuca on the other hand are often sown between the rows of maize. The latter two are often sown late in the summer or early fall. The sweet potato is rarely sown in quantity, mainly because the farmer considers it a sort of mixed blessing, being both a food plant and a weed, and he greatly fears its spreading ability. One informant stated that if an abandoned milpa containing sweet potato was cleared again within a four or five year period the plant sprouts out again and continues to produce. Jicama, a fourth root crop, is also sown in August in between the maize rows.

The cucumber is ordinarily sown in a separate patch.

In milpas occupying deep soil bajos a few banana trees are often sown in the field. When the milpa has been cultivated the normal 2-3 years it is sometimes completely sown in bananas.

During its two to three years of cultivation then a milpa often produces a great variety of crops other than maize although only squash and beans are sown in any quantity. I have seen numerous milpas sown with maize, two or three varieties of beans, squash, chile peppers, tomatoes, sweet potato, yuca and papaya or banana plants.

If we total the full production of food plants on a two-year milpa then we find that maize yields do not give a full picture. Also Steggarda and Villa Rojas's data on milpa labor do not give us a really accurate idea of the amount of free time the average Yucatecan Maya has over necessary agricultural activities.

For Kantunil Kin the average 50 mecates of milpa would yield the following crops:

First Year

| | |
|---|---|
| maize - 46 mecates at average of 1.5 cargas per mecate | 3174 kilos |
| frijol negro - 23 mecates at 1.5 cargas | 1564 kilos |
| frijol ib - 2 mecates at 1.5 cargas | 138 kilos |
| squash - 18 mecates, yield not ascertained | |
| watermelon - 1 mecate | |
| chile and tomato - 2 mecates | |

Second Year

| | |
|---|---|
| maize - 46 mecates at 1.0 cargas per mecate | 2116 kilos |
| chile and tomato (same plants) - 2 mecates | |
| root crops - 3 mecates total (planted first year) | |
| papaya - a few trees planted first year | |

Over the two-year period of cultivation this milpa produces approximately 5 1/4 tons of maize, 1 3/4 tons of beans, plus undetermined amounts of squash the first year, root crops and papaya the

second year, and chile peppers and tomatoes the entire two-year cycle.

When we consider the extra labor of sowing of these odd crops along with harvesting and hauling, my impression is that Steggarda's estimates of milpa labor must be increased at least 25-50 percent. On the test milpa drawn above 50 percent would be closer. Often frijol is sown separately at a later date on the same mecate maize has been sown. It must be harvested apart and hauled to the village and perhaps the milpa must be given an extra weeding. In chile and tomato cultivation the seed must be planted in the solar first and transplanted; yuca and macal are sown as extra labor in fields already sown in maize and must be harvested separately.

The average milpero at Kantunil starts harvesting crops in August and is continually doing so on until January.

Aside from the milpa a second sphere of agricultural production is the house lot or solar. The following cultivates are found in house lots: sweet and sour oranges, orange cajera, sweet lime, sour lime, royal lime, sour grapefruit, guanabana, guaya, papaya, aguacate or avocado, chayote, guayaba, "ciruela" (three types: tuxpana, kantun, chiabal), hondura, nequen, mango, mamey, zapote. Most solars in Kantunil have a large number of these cultivates.

## Demography and Settlement Patterns - Introduction

That part of the Yucatan Peninsula which lies within the modern borders of the Mexican republic comprises slightly over 140,000 $km^2$. Within this extensive area live approximately 665,000 people or less than 5 per $km^2$, one of the poorest settled regions of the nation. Of the above totals the state of Yucatan includes roughly 2/7 of the area and 5/6 of the population with an average density of 13.4 per $km^2$.

(1950). The very low overall density is due to the fact that the state of Campeche and territory of Quintana Roo are almost uninhabited. A comparison of these three political divisions is given below:

| State | Area ($km^2$) | Population | Density |
|---|---|---|---|
| Yucatan | 38,508 | 516,899 | 13.4 |
| Campeche | 50,952 | 122,098 | 2.5 |
| Quintana Roo | 50,843 | 26,967 | .5 |
| | 140,283 | 665,964 | 4.7 |

The chart shows clearly that the territory of Quintana Roo is one of the last demographic frontiers of modern Mexico, a huge tract of almost unpopulated tropical forest used mainly for chicle and lumber extraction and with little real human occupation. This is even more dramatically illustrated when we note that almost half the population it does have lives in the two communities of Chetumal and Cozumel. Campeche is somewhat more populated but most of the state is still undisturbed wilderness. The state of Yucatan on the other hand has a sizeable population, especially in the central and northern areas where the rural population has evidently reached a saturation point with present agricultural techniques and economies. The peninsula in general offers fascinating possibilities for a study of population expansion in tropical lowland areas, as it possesses a fairly uniform environment and all stages of the colonization process may be observed together.

Before discussing further the latter point I present the following chart which summarizes population data by small areas. In Yucatan the area is the distrito (a cluster of municipios, the cabacera

of one serving as an administrative center and giving its name to the distrito); in Campeche the municipio (in Campeche of large size and comparable to the distrito of Yucatan in area); and in Quintana Roo the delegacion:

| Political Unit | Population 1900 | 1910 | 1940 | Area ($km^2$) | Density |
|---|---|---|---|---|---|
| Yucatan | | | | | |
| Northern Area | | | | | |
| Motul | 18756 | 19001 | 20791 | 963 | 22 |
| Tixkokob | 14072 | 16652 | 15871 | 813 | 19 |
| Central Area | | | | | |
| Acanceh | 22677 | 23456 | 21290 | 1537 | 14 |
| Izamal | 21358 | 23218 | 22201 | 1586 | 15 |
| Western Area | | | | | |
| Hunucma | 18656 | 22354 | 20059 | 2328 | 9 |
| Maxcanu | 19673 | 21612 | 18156 | 2810 | 6 |
| Southern Area | | | | | |
| Peto | 7335 | 7450 | 13019 | 2716 | 5 |
| Tekax | 19757 | 20160 | 25063 | 3012 | 8 |
| Ticul | 25057 | 24633 | 27586 | 3052 | 9 |
| Eastern Area | | | | | |
| Espita | 10489 | 12498 | 14486 | 2692 | 6 |
| Sotuta | 9855 | 10825 | 12410 | 2342 | 6 |
| Temax | 17058 | 16437 | 20543 | 2710 | 8 |
| Tizimin | 9174 | 8523 | 14468 | 6330 | 2 |
| Valladolid | 24740 | 26399 | 37431 | 4449 | 9 |
| Urban Area | | | | | |
| Merida | 60156 | 79426 | 118411 | 961 | 123 |
| Progreso | 8832 | 6909 | 13782 | 316 | 44 |
| Campeche | | | | | |
| Campeche | | | 28894 | 2922 | 10 |
| Calkini | | | 16898 | 786 | 21 |
| Carmen | | | 13986 | 15603 | .9 |
| Champoton | | | 7178 | 17128 | .4 |
| Hecelchakan | | | 7725 | 1237 | 6 |
| Hopelchen | | | 8045 | 5151 | 1.5 |
| Palizada | | | 4580 | 7266 | .6 |
| Tenabo | | | 3154 | 863 | 3.6 |
| Quintana Roo | | | | | |
| Isla Mujeres | | | 2259 | 14347 | .2 |
| Cozumel | | | 2905 | 2541 | 1.1 |
| Felipe Carrillo Puerto | | | 4388 | 6693 | .7 |
| Chetumal | | | 9200 | 27262 | .3 |

The most densely populated part of the state aside from the urban area is the north where nequen is more important than maize in the economy. This area in general is too dry and stony for effective maize cultivation. The western area is also a nequen region, under perhaps even more unfavorable conditions for agriculture than in the north, and the population is much less.

The central area with an average density of 14-15 is a mixed maize-nequen region; and the south and east together form what is today called "La Zona Maicera" or the Corn Belt of Yucatan. Especially favorable for maize cultivation is the Southern Area plus the distrito of Tizimin in the east. The rest of the eastern area is generally about as productive as central Yucatan with a scanty soil cover but somewhat heavier rainfall.

The census data period by period offer some interesting tentative conclusions. We discover a large continuous zone in the center, north and west of the state in which the demographic climax seems to have been reached with present subsistence patterns (pure nequen and mixed nequen-maize). This includes the districts of Acanceh, Izamal, Maxcanu, Motul, Tixkokob, Hunucma and the rural areas of the districts of Merida and Progreso. In some of these distritos the population has actually declined slightly since 1900-1910. This continuous zone may be considered then to be at its climax of occupation of the Yucatecan type and is the present demographic center of the peninsula. This situation undoubtedly dates from the post-conquest period and even more probably from the Nequen period, and probably was never true at any phase of aboriginal history.

For slash and burn maize agriculture it is the poorest section

of the entire peninsula. Its present status is probably due mainly to three key factors: (a) the development of nequen cultivation and henequen industry; (b) its relative freedom from malaria; and (c) the urban growth of Merida, built by the Spaniards.

Hemming in this solid block of densely settled distritos to the east and south lies a continuous belt of distritos we can call the present Yucatecan demographic frontier. It is in general an area of heavier rainfall, more ample soil cover, higher maize yields and slash and burn agriculture. The population is moderately heavy, running from 5 to 9 per $km^2$ but is steadily increasing every census period. Individual municipios within the region have almost reached population maximum; and we can guess from their densities that it will support a concentration of 15-30 people per $km^2$ with slash and burn maize agriculture. The main obstacles to more intensive colonization have been the lack of transport facilities, and malaria.

Beyond this frontier region to the east and south lie the vast, almost untouched future frontier lands of the Territory of Quintana Roo and state of Campeche. Today the interior is mainly utilized for chicle gathering and lumbering with a few small villages of slash and burn maize cultivators. The only part of the two entities heavily exploited by man is the coastal beach which is a center of coconut cultivation and fishing activities.

Actually, looking at the demographic growth of the state of Yucatan as a whole, it is unimpressive if we consider rural increase only. The population has grown from 309,652 in 1900 to 418,210 in 1940 but 47,000 of this increase was urban, leaving but 30,000 increase in rural population over a 40-year period or but 12 percent.

One-third of the population of Yucatan and Campeche and one-half of that of Quintana Roo live in the five urban centers of the peninsula (Merida, Campeche, Progreso, Chetumal and Cozumel).

In the analysis below I have selected the state of Yucatan plus the northern part of Quintana Roo for more detailed analysis of demography and settlement patterns. My selection is based on several factors: (a) the region delimited captures Yucatecan occupation patterns in all three of our levels of colonization; (b) I have considerable personal familiarity with the region; and (c) we have abundant published data on agriculture for the area.

In terms of settlement we can select four smaller areas for intensive analysis within the large region. These are (a) Izamal-Acanceh, (b) Valladolid, (c) Ticul, and (d) Northern Quintana Roo.

## Izamal-Acanceh

These two districts lie in the demographic center of modern Yucatan, in a region where demographic growth since 1900 has come to a standstill. They are contiguous and are characterized by moderate rainfall (between 800 and 1000 mms), scanty soil, and scrubby bush cover. The region is ideal for nequen cultivation and is marginal with respect to slash and burn cultivation. It is the only part of the demographic center of the state where maize can be effectively grown and the economy is characterized by two sub-types: (a) fully commercial plantation nequen economy; and (b) village economy based on ejidos with both nequen and maize.

The two districts together in 1940 comprised 3100 $km^2$ and had 43,000 people with an average of 14 per $km^2$. They include the following municipios:

| | Area | Population | Density | Population of Cabacera |
|---|---|---|---|---|
| Acanceh | | | | |
| Abala | 264 | 2747 | 10 | 632 |
| Homun | 245 | 2634 | 11 | 1783 |
| Tecoh | 396 | 5654 | 14 | 2709 |
| Cuzama | 161 | 1563 | 10 | 960 |
| Seye | 188 | 3543 | 19 | 2496 |
| Acanceh | 207 | 3867 | 10 | 2293 |
| Timicuy | 76 | 1868 | 25 | 1212 |
| Izamal | | | | |
| Tahmek | 99 | 1792 | 18 | 1544 |
| Hoctun | 116 | 2402 | 21 | 1868 |
| Xocchel | 70 | 1322 | 19 | 1227 |
| Tekanto | 88 | 2831 | 32 | 2067 |
| Izamal | 358 | 8737 | 24 | 5305 |
| Tepakam | 108 | 1824 | 17 | 1210 |
| Sudzal | 497 | 1007 | 2 | 498 |
| Kantunil | 250 | 2286 | 9 | 1350 |

The region is one of two basic settlement types, the nucleated village and the hacienda. The usual pattern is for each municipio to be composed of a single large village with over 1000 inhabitants, which serves as the cabacera or center, and with the rest of the population living in nequen haciendas. The latter split up sharply by size into sub-types; those with less than 50 inhabitants and those with 100-500, a few giants even exceeding the latter figure. In general small haciendas are owned and worked by people from the neighboring village; the bigger ones are owned by families who live in Merida.

In the chart below almost all the communities with an excess of 1000 inhabitants are nucleated municipio cabacera villages and almost all those communities with less than 1000 are nequen plantations. The exceptions are indicated in the chart. The other types of communities present in Yucatan, such as parajes, ranchos, rancherias

or small villages, are very rare in this area.

In the entire region but one community can be classed as a true town: Izamal. This lack of local urban development is due to the virtual monopoly that Merida, the state capital, holds on the nequen industry, thus aborting incipient urban development in the smaller communities in the nequen area. In 1950 Izamal possessed 5305 inhabitants making it one of the eight largest communities of the state.

Community Size By Population

| | Below 50 | 50-100 | 100-500 | 500-1000 | 1000-2000 | 2000-3000 | Over 3000 | Depopulated |
|---|---|---|---|---|---|---|---|---|
| Abala | 2 | 0 | 5 | 2(1-V) | 0 | 0 | 0 | 6 |
| Homun | 25 | 0 | 3 | 0 | 1(V) | 0 | 0 | 19 |
| Tecoh | 7 | 2 | 7 | 2(1-V) | 0 | 1(V) | 0 | 0 |
| Cuzama | 7 | 1 | 2 | 1(V) | 0 | 0 | 0 | 10 |
| Seye | 22 | 1 | 4 | 0 | 0 | 1(V) | 0 | 10 |
| Acanceh | 10 | 2 | 4 | 1 | 0 | 1(V) | 0 | 1 |
| Tahmek | 3 | 0 | 2 | 0 | 1(V) | 0 | 0 | 25 |
| Hoctun | 8 | 0 | 3 | 0 | 1(V) | 0 | 0 | 5 |
| Xocchel | 12 | 0 | 0 | 0 | 1(V) | 0 | 0 | 4 |
| Tekanto | 4 | 0 | 4 | 0 | 0 | 1(V) | 0 | 1 |
| Izamal | 21 | 4 | 2(1-V) | 4(All V) | 0 | 0 | 1(T) | 3 |
| Tepekan | 5 | 2 | 3 | 0 | 1(V) | 0 | 0 | 11 |
| Sudzal | 13 | 3 | 2(1-V) | 0 | 0 | 0 | 0 | 4 |
| Kantunil | 4 | 0 | 0 | 1(V) | 1(V) | 0 | 0 | 8 |
| Timicuy | 0 | 1 | 2 | 0 | 1(V) | 0 | 0 | 2 |
| | 143 | 16 | 43(2-V) | 11(8-V) | 7(All V) | 4(All V) | 1(T) | 109 |

Key: 2(1-V) means one is a village, the other a hacienda
1(V) means all are villages
(T) means town

All those communities not indicated as villages are in the main nequen haciendas with a few ranchos and parajes. In our selected area then we find 143 small haciendas, ranchos and parajes; 57 large nequen haciendas; 3 giant haciendas (over 500 population); 2 small villages (under 500 population); 8 medium sized villages (500-1000); 11 big villages (over 1000); and one town, Izamal.

By comparing the number of communities in each category one might assume that the bulk of the population lives in small and medium size nequen haciendas. Actually this is not the case if we compare the actual total population living in these divisions. We summarize these data below:

| | | |
|---|---|---|
| Live in town of Izamal | 12% | |
| Live in 11 big villages | 46% | |
| Live in communities with more than 1000 inhabitants | 58% | |
| Live in 10 small and medium villages | 15% | |
| Live in nucleated villages or towns | | 73% |
| Live in 41 large haciendas | 20% | |
| Live in 159 small haciendas, ranchos etc. | 7% | |
| Live in haciendas, ranchos etc. | | 27% |

Approximately 75 percent of the population lives in villages and well over 50 percent in villages with over 1000 inhabitants.

Approximately 63 percent of the population lives in the 15 municipio cabacera villages.

In general we find that each municipio consists of a single big village with over 1000 inhabitants and a constellation of small and large nequen plantations. Of the 15 municipios only Tecoh, Kantunil and Izamal possess more than one village, and of the 7 extra villages 5 are in the single municipio of Izamal.

A glance at the final column of our chart offers some interesting data for speculation. Some 109 small ranchos, haciendas and parajes were abandoned between 1930 and 1940. It indicates clearly that even in this area of permanent nequen cultivation the smaller population units are extremely fluid. The villages themselves are permanent

and the larger Merida-owned plantations, but in the case of the smaller communities the restless, shifting character of Maya farming is even present here in the center of the state. People are constantly moving out of the villages, forming temporary settlements, and returning. We shall see later on in the true slash and burn area that this is a fundamental trait of Yucatecan settlement.

## Valladolid

This distrito falls in our Eastern Area, which is part of our modern Yucatecan frontier. It is an area of predominant slash and burn maize agriculture with little development of commercial cropping. The population are maize farmers and chicle gatherers (the latter being obtained mainly from the neighboring forests of Quintana Roo). This area is of special interest for two reasons: (a) Chichen Itza, one of the largest Maya centers, is within it; and (b) we have excellent data on agricultural techniques and economy gathered by the Carnegie staff from Piste and Chan Kom. The district is probably the most unfavorable part of the Zona Maicera of the state although it represents the general condition of most of northern Yucatan; the Tizimin and Puuc zones are definitely above the peninsular average. Rainfall is somewhat heavier than in the center of the state but soil cover is very scanty.

The people of Valladolid are undoubtedly the most nomadic in spirit of all Yucatecans; they are colonists by nature and chicleros by inclination. The distrito has an area of approximately 4500 $km^2$ and in 1940 possessed about 40,000 inhabitants or 9 per $km^2$. It probably has not yet reached its demographic limit but the basic instability and restlessness of the population indicate that the

pressure is beginning to be felt. The probable maximum is between 15 and 20; some municipios have reached that point such as Chan Kom, Valladolid and Chichimila. Most of the distrito has been converted to scrubby bush by continuous clearing and fallowing, and the area in spite of the low population density gives one the impression from both the air and ground to be well populated. The distrito includes the following municipios.

| | Area ($km^2$) | Population 1940 | Density | Population of Cabacera |
|---|---|---|---|---|
| Valladolid | 943 | 15,749 | 18 | 6402 |
| Tixcacalcupul | 325 | 1,534 | 5 | 775 |
| Chan Kom | 80 | 1,614 | 20 | 270 |
| Kaua | 154 | 1,063 | 7 | 772 |
| Tinum | 291 | 3,028 | 9 | 1360 |
| Uayma | 144 | 1,225 | 8 | 975 |
| Cuncunul | 301 | 922 | 3 | 502 |
| Tekom | 411 | 2,175 | 5 | 807 |
| Chichimila | 182 | 3,079 | 17 | 1797 |
| Chemax | 813 | 4,103 | 5 | 1573 |
| Temozon | 806 | 4,263 | 5 | 1060 |
| Total | 4450 | 38,755 | 8.7 | 16293 |

The Valladolid district unlike the rest of the state is characterized by having its rural population in general dispersed in small settlements; villages, ranchos and parajes. In most Yucatecan municipios at least 1/2, and more commonly from 3/4 to 7/8, of the population lives in a single nucleated village with but a small fraction of its population living in outlying settlements. In Valladolid, the reverse is true, the municipio cabacera is often rather small and contains on the average but 1/3 of the population of the municipio. For example if we subtract Valladolid, an urban town, from the above totals we find that of the 32,000 or so rural population

in the distrito only 10,000 live in the central villages. Six of the 10 rural municipios have central villages with under 1000 inhabitants.

One is reminded of the pattern in the Chontalpa but the resemblance is only superficial. In Tabasco we have a small city as the center of the municipio with the rural population scattered in rancherias or ranchos. In Valladolid the municipio center is simply a medium or large sized village and the rest of the population lives in smaller villages, or hamlets. The nucleated community is the basic population unit in the Valladolid district although usually of very small size.

Several types of these nucleated settlements may be noted. First we have the "paraje" which is simply a clearing in the forest with 6-12 huts. These settlements are extraordinarily impermanent, often disappearing from one 10-year census to the next. The population usually consists of a number of discontented families who have left their parent village and often stay a few years and then return, or move to another village or establish a new paraje. There is an inherent centrifugal force in Valladolid economy which lies behind this instability. The term rancheria is usually used for the larger parajes and the term rancho theoretically refers to cattle ranches or other permanent agronomic establishments. Actually the latter is often used in place of paraje.

Below I present an analysis of community size for the district.

| Municipio | Below 50 | 50-100 | 100-250 | 250-500 | 500-1000 | 1000-2000 | Over 2000 |
|---|---|---|---|---|---|---|---|
| Valladolid | 262 | 6 | 7 | 6 | 3 | 1 | 1 |
| Tixcacalcupul | 18 | 1 | 3 | 0 | 1 | 0 | 0 |
| Chan Kom | 19 | 5 | 3 | 1 | 0 | 0 | 0 |
| Kaua | 15 | 1 | 0 | 0 | 1 | 0 | 0 |
| Tinum | 25 | 5 | 1 | 1 | 1 | 1 | 0 |
| Uayma | 14 | 0 | 0 | 0 | 1 | 0 | 0 |
| Cuncunul | 9 | 5 | 0 | 0 | 1 | 0 | 0 |
| Tekom | 17 | 3 | 2 | 0 | 2 | 0 | 0 |
| Chichimula | 42 | 4 | 2 | 0 | 0 | 1 | 0 |
| Chemax | 53 | 6 | 4 | 1 | 0 | 1 | 0 |
| Temozon | 113 | 5 | 2 | 1 | 1 | 1 | 0 |
| | 587 | 41 | 24 | 10 | 11 | 5 | 1 |

Only 6 communities in this large area possess populations of over 1000 inhabitants and of these only one may be classified as a true town, the others being large villages. The rest of the population lives in small villages and hamlets. Of the total population of the district only 1/3 lives in these 6 large communities and this high percentage is due to the inclusion of the urban town of Valladolid. If we subtract the latter we can say that only about 1/4 of the rural population lives in large villages. Approximately 1/2 of the population lives in communities with less than 500 people and fully 1/3 in communities of less than 100 inhabitants. The data may be summarized then:

| | |
|---|---|
| Urban town of Valladolid | 16% |
| 5 large villages (over 1000 population) | 16% |
| 11 medium villages (500-1000 population) | 18% |
| 34 small villages (100-500 population) | 16% |
| 628 hamlets (below 100 population) | 34% |

Of especial interest is the extraordinary number of what we are calling hamlets: over 600 of them.

Several times during our discussion of Yucatecan population I have pointed out a basic restlessness and instability. In our area

of slash and burn maize cultivation this is especially evident and I present here a special analysis of the municipio of Valladolid to illustrate the point.

The municipio of Valladolid occupies some 95,000 hectareas of scrub forest. Within it are one urban town - Valladolid itself - and the 12 villages of Dzitnup, Ebtun, Kanxoc, Pixoy, Popola, Tahmuy, Tesoco, Tikuch, Tixhualahtun, Xocen, Yalcoba and Yalcon. These communities may be considered as the permanent settlements of the municipio. Only one possesses over 1000 inhabitants, 3 between 500 and 1000 and the remaining 8 between 100 and 500. On our community distribution chart above we noted 13 communities falling between the bracket 100-500, but only 8 are classified as true "pueblos" or villages; the others are rancherias. We classified them along with the true small villages purely on a scale of population size. Actually there are two important differences between big rancherias and small villages: (a) the village has a plaza and a masonry church, both lacking in the rancheria; and more important (b) the village or pueblo is a permanent settlement - no modern cases of actual abandonment of a village are known - whereas even large rancherias may disappear and appear frequently. These 13 communities then - Valladolid and its 12 satellite pueblos - are permanent communities and the sources from which colonization proceeds.

A few families from one of these communities or even one family may decide, either because of dissatisfaction in personal relations or more frequently due to lack of nearby land, to cultivate milpa at a considerable distance from the village in fresher lands. After a few years of experiment he discovers the land to be more productive

than the overworked land nearby and will decide to live there for a while. He may be joined by others until the population may reach as high as a hundred or so. Within a period of 10-30 years depending on the number of colonists the land becomes overworked to the same degree as around the mother village and a number of families may return to the mother village or found a new rancho or paraje. Often the entire population move and the spot is abandoned. After 10-20 years the spot may be reoccupied and resettled and the pattern recurs again. The result is that numerous satellite communities are in a constant state of population shift, some are newly founded, some are increasing in population, others decreasing, others being abandoned and others being reoccupied. The whole pattern quite obviously relates to the technique of cultivation and the important fact about it is the presence of a restless shifting rural population with a relatively stable general demographic picture. To explain further: the population of the municipio in 1940 was 15,749; in 1950 it rose to 18,225 but most of this growth was due to urban growth in Valladolid. The rural population in 1940 was 9,349; in 1950 it rose to only 10,060, an increase of but 8 percent. Even in the permanent villages actual increase was slight from a total of 5637 to 5982; and important for our observations some villages declined, others grew in population, undoubtedly related to going and coming colonists from the hinterland.

Of those communities which we can class as impermanent the following chart summarizes their demographic history:

Impermanent Communities

| | | |
|---|---|---|
| Occupied 1940, still occupied 1950 | | 137 |
| Show population increase | 82 | |
| Show population decrease | 55 | |
| Occupied 1940, abandoned 1950 | 132 | |
| New settlements 1950 | | 86 |
| Occupied 1930, abandoned 1940 and 1950 | 40 | |
| Occupied 1930, abandoned 1940, reoccupied 1950 | | 20 |
| Villages (Permanent Communities) | | 12 |
| Showing population increase | 8 | |
| Showing population decrease | 4 | |

Today the pressure has reached the point where the Valladolid district population as a whole is beginning to move out into the hinterland of the Quintana Roo-Yucatecan border. Most of the new communities are of the rancheria-rancho-paraje type; there are very few cases of foundations of true pueblos in the classic Yucatecan sense, suggesting strongly that these smaller units which we can call hamlets are the natural settlement type with slash and burn agriculture in this type of environment. I wish also to point out for the archaeologist's benefit that a deep continuous ceramic stratigraphy at the small site does not necessarily indicate a continuous occupation. We may have a case of repeated cyclic occupation and abandonment and the periods of such are too short to be detected by the present Maya ceramic stratigraphy; a refinement of the degree attained in the Southwest is necessary.

## The District of Ticul

The district of Ticul is an excellent representative distrito for the southern area. It is an area basically of slash and burn agriculture but with a secondary development of permanent agriculture

based on nequen, citrus fruit orchards, sugar cane and tobacco plantations along with industrial development at the town of Ticul itself (pottery, shoes, hats). In spite of this secondary development the Ticul district along with the neighboring districts of Tekax and Peto have as their economic base slash and burn subsistence maize cultivation. The district of Ticul covers an area of approximately 3000 $km^2$ and in 1940 possessed slightly over 27,000, or roughly the density of Valladolid. The population is considerably below its potential as this is one of the most fertile areas in Yucatan and should be able to support at least three times its present population. It includes the following municipios.

| | Area ($km^2$) | Population | Density | Population of Cabacera |
|---|---|---|---|---|
| Santa Elena | 1106 | 1430 | 1.2 | 1234 |
| Muna | 468 | 4223 | 9.0 | 3798 |
| Sacalum | 152 | 1703 | 11.0 | 1371 |
| Ticul | 518 | 10039 | 14.0 | 9034 |
| Chapab | 186 | 1966 | 11.0 | 1568 |
| Dzan | 86 | 1219 | 14.0 | 1186 |
| Mani | 84 | 2196 | 26.0 | 1723 |
| Mama | 134 | 1687 | 13.0 | 1577 |
| Tekit | 318 | 2923 | 9.0 | 2548 |
| | 3052 | 27586 | 9.0 | 24039 |

In general the district is fairly well populated although the only municipio which has even approached the demographic limit is Mani. The latter possibly represents a theoretical comfortable population limit for the area. The density for the district as a whole is considerably reduced by the inclusion of the municipio of Santa Elena, an almost uninhabited tract of some 100,000 hectareas. This portion of the district today plays an important secondary role

in the general economy of the district and of the town of Ticul in particular. Although if we subtract Santa Elena the population density is still but 13, that concentration has evidently created sharp population pressure and Santa Elena today serves as a demographic safety valve. Numerous farmers, especially from Ticul itself, rent lands in Santa Elena to counteract the land shortage at home. They travel to and from the fields by bus, getting off along the way. This new transport medium has enabled Ticul to reach its gigantic size today of nearly 10,000 inhabitants.

The district lies in a region known as the Puuc after a range of low hills which traverse it from southwest to northeast. It is an area of abundant and dependable rainfall, good soil cover in the valleys and depressions, and in Yucatecan terms high maize yields often permitting extended periods of cultivation, probably the most favorable part of the peninsula for slash and burn agriculture.

The distribution of communities by size differs strikingly from the district of Valladolid:

| Municipio | Below 50 | 50-100 | 100-250 | 250-500 | 500-1000 | 1000-2000 | Over 2000 |
|---|---|---|---|---|---|---|---|
| Santa Elena | 7 | 0 | 1 | 0 | 0 | 1 | 0 |
| Muna | 8 | 1 | 2 | 0 | 0 | 0 | 1 |
| Sacalum | 8 | 1 | 1 | 0 | 0 | 1 | 0 |
| Ticul | 16 | 1 | 0 | 1 | 1 | 0 | 1 |
| Chapab | 4 | 0 | 0 | 1 | 0 | 1 | 0 |
| Dzan | 9 | 0 | 0 | 0 | 0 | 1 | 0 |
| Mani | 20 | 0 | 0 | 1 | 0 | 1 | 0 |
| Mama | 16 | 0 | 0 | 0 | 0 | 1 | 0 |
| Tekit | 34 | 1 | 0 | 0 | 0 | 0 | 1 |
| | 122 | 4 | 4 | 3 | 1 | 6 | 3 |

As we can see we are in a district of big villages. Although

the population and area are but 2/3 of the Valladolid district we have 9 communities with over 1000 inhabitants as opposed to 6 in Valladolid and Ticul; the largest community possessed over 9000 inhabitants as compared to 6400 for Valladolid. The real difference between the two areas may be better summarized in the chart below.

| | Ticul | Valladolid |
|---|---|---|
| Urban town | 33% | 16% |
| Large villages | 55% | 16% |
| Medium villages | 2% | 18% |
| Small villages | 7% | 16% |
| Hamlets | 3% | 34% |

In Ticul no less than 88 percent of the population lives in villages and towns exceeding 1000 inhabitants, in Valladolid but 32 percent. At Ticul but 9 percent of the population lives in medium and small villages and 3 percent in hamlets. At Valladolid this rises to 34 and 34.

In the district of Ticul, furthermore, the bulk of the population of each municipio lives in a single village; of the 27,586 inhabitants of the district approximately 24,000 live in the 9 municipio cabaceras, or 8/9 of the population.

The southern area in general is an area of big communities. Of the 8 communities in Yucatan (excepting Merida and Progreso) which possessed populations exceeding 5000 in 1940, 4 are in this zone (Ticul, Tekax, Oxkutzcab and Peto) and the southern area comprises but 1/5 of the total land area of the state and possesses but 1/8 of its total population. Oxcutzcab is a true village but its size is due to the great development of permanent agriculture in the form of orange orchards; the other three are towns with local industry and sugar cane processing as secondary activities.

## Northern Quintana Roo

No other entity in the Mexican Republic is as sparsely populated as the vast broken plain of tropical forest called Quintana Roo. The population density figures indicate an average of about 10 $km^2$ of land per family but even that figure is deceptive for almost half the population of the territory lives in the two coastal towns of Cozumel and Chetumal. Here we will discuss in some detail the northern half of the territory or that which is included in the delegaciones of Isla Mujeres, Cozumel and Felipe Carrillo Puerto (formerly Chan Santa Cruz).

This large area may be subdivided into two divisions on the basis of population type, one to the north including Isla Mujeres and Cozumel and one to the south including Felipe Carrillo Puerto.

The northern segment embraces an area of nearly 17,000 $km^2$ and in 1940 possessed slightly over 5000 inhabitants, or approximately 17 $km^2$ per family. At the time of the conquest the area was thickly populated, at least the coastal strip was, but evidently the epidemics of the sixteenth century finished off the population quite early. During most of the colonial period the region has remained a huge unpopulated wilderness. It was entered and occupied periodically as a refuge area by Indians fleeing first the Spaniards, later the Mexicans, but was never thoroughly colonized. The Yucatecan population during the colonial period was low enough so that there was no immediate need for true campesino colonization movements.

During the nineteenth and early twentieth centuries a number of nequen and sugar haciendas were established along with cattle ranches by Yucatecos, but most of these have vanished along with the upheaval

following the agrarian revolution and land reforms.

In discussing the population today we must differentiate two types of settlement. First we have the coastal strip and off-shore islands (Holbox, Cancun, Mujeres and Cozumel). This is the only part of the area with a respectable population. The bulk of the population here lives on the islands and exploits the neighboring mainland beach and off-shore waters. The mainland beach is used mainly for coconut plantations on the beach itself and slightly further in for cattle ranches. The owners of these holdings usually live on one of the islands and leave a man or family as caretaker to guard them. The mainland population consists in part of these coconut plantation guardians and their families. They receive little pay and most of them sow small milpas just behind the beach to help out their family income. These few milpas represent the sum total of agricultural exploitation of the hinterland. These people live scattered along the coast, each one occupying a single house site on the cocal he is taking care of. There is an almost continuous cocal extending from Holbox to Tulum (actually this could be extended on to Chetumal and Progreso) and coconut cultivation is the only thorough agricultural exploitation of the territory. Cocal headquarters are often chicle gathering centers as well from which point expeditions are fitted out to enter the interior. Some of the large cocal-chicle centers may have up to a dozen families living in a small village.

In the vast interior of our area there are exactly 3 villages with a total population of less than 1200 people. This fact more than any other gives an idea of the emptiness of the area.

The colonization of the mainland coast has been sponsored mainly

from Cozumel and Isla Mujeres, two of the few communities which escaped extinction following the conquest. The population of the three inland villages of Kantunil Kin, Solfarino and Leona Vicario has come from the west. Kantunil Kin is another surviving colonial village but its present population is of many origins. Evidently in Yucatecan history such surviving ancient communities formed a nucleus from which colonization proceeded and to which it came from more settled areas. Only a fraction of the present population is of ancient stock; the rest come mainly from Valladolid, but some are from Tizimin and even from as far off as Izamal and Campeche. Furthermore this population is fluid and unstable. Migration is an individual or family affair and usually based on private quarrels or dissatisfactions or perhaps due to the fact that a man arrived for the chicle season, married in Kantunil and settled there. Leona Vicario on the other hand is composed mainly of Vera Cruzanos who came to work for the Banco de Londres y Mexico Chicle Company and when the company went bankrupt they stayed on as farmers and chicleros.

The colonization of the northern part of Northern Quintana Roo then proceeds from two directions, the offshore islands and Yucatecan border communities, and in both cases ancient communities serve as collection centers and as jumping-off spots for further movement.

The area is one of the future frontiers of Yucatecan expansion. The government has recently completed a new highway from Valladolid to Puerto Juarez (on the coast opposite Mujeres) and the next twenty years should offer a fascinating study of colonization and demographic expansion on a grand scale.

The 5000 inhabitants of the area live in 54 settlements, including

villages, cocal plantations, chicle depots, cattle ranchos, lighthouses, and one town. The population by community size breaks down as follows:

| Delegacion | Over 1000 | 500-1000 | 100-500 | Below 100 |
|---|---|---|---|---|
| Cozumel | 1(town) | 0 | 1 | 29 |
| Isla Mujeres | 0 | 2 | 4 | 17 |
| | 1 | 2 | 5 | 46 |

| | |
|---|---|
| Live in town of Cozumel | 40% |
| Live in 2 medium sized villages | 20% |
| Live in 5 small villages | 25% |
| Live in hamlets | 15% |

Cozumel itself is a true town and may be considered as the economic capital of the area. The medium sized villages include Kantunil Kin, an interior slash and burn agricultural community, and Isla Mujeres, an island fishing village and administrative center. The small villages include Solfarino, an inland community with slash and burn agriculture; Leona Vicario, primarily a chicle gathering center but with slash and burn agriculture, also in the interior; and the coastal fishing villages Holbox and Chiquila. The hamlet classification includes all those communities not classified as "pueblos" in the census but also includes some very tiny "pueblos". The latter are El Cedral (on Cozumel island), Puerto Morelos and Playa del Carmen, the latter two on the mainland coast. All of those communities classed as hamlets are situated on the coast.

The history and character of the population of the delegacion of Felipe Carrillo Puerto to the south is quite different.

At the time of the conquest it seems not to have been densely populated as none of the large centers noted by the Spaniards was

located here. During the colonial and early republican periods of Yucatecan history it served as a vast hideout for rebellious Yucatecan Maya who have during that period established "cacicazgos" or native states in the area. The present population is almost if not 100 percent Maya in language and all are slash and burn subsistence farmers who also collect chicle for a cash crop. They are the remnants of the powerful cacicazgos set up by the Maya fleeing from the Mexican soldiery during the War of the Castes. Immigration from central Yucatan in recent times has been discouraged rather than accelerated due to the hostility of these refugee Maya. The area offers excellent data for an understanding of pre-conquest patterns of colonization and settlement during its early stages.

The colonial Maya social organization was based on the cacicazgo-tribe-sub-tribe-village in descending order of size. Each cacicazgo, tribe and sub-tribe possessed a capital village. The capital of the local cacicazgo was Chan Santa Cruz, today called Felipe Carrillo Puerto and serving as the delegacion administrative center. It had a population in 1940 of 652 inhabitants and was the largest community in the delegacion. The total population of the delegacion was 4388 and the area 6693 $km^2$, or 7.3 $km^2$ per family. The population was scattered in some 76 tiny settlements with an average population per settlement of 58. Community sizes break down as follows:

| Population | | |
|---|---|---|
| Below 100 | 100-500 | 500-1000 |
| 66 | 8 | 2 |

| | |
|---|---|
| Living in 2 medium villages | 27% |
| Living in 8 small villages | 27% |
| Living in 66 hamlets | 46% |

The importance of the hamlet as a settlement type is even greater than in the Valladolid district.

With very few exceptions the settlements are all tiny nucleated settlements of subsistence farmers. Felipe Carrillo Puerto itself may be classed as transitional from village to town. Its size and transitional character are due to three factors: (a) it is the political center of the delegacion; (b) it is the religious center; and (c) it is a shopping center for such indispensable items as machetes, cotton cloth, salt and others. The lack of heavy outside trade and small hinterland population along with complete isolation have aborted its development into a true town. It is really no more than a modest sized village.

Villa Rojas did a careful ethnographic study of one of the sub-tribes, the X-Cacal, and offers a good example of zonal settlement patterns of one of the subdivisions of our area.[3] The largest village and capital of the sub-tribe was X-Cacal with 206 inhabitants. Dependent on it were 8 villages: X-Maben, 140 inhabitants; Tusik, 116; Senor, 71; Chuncunche, 54; San Jose, 45; Chanchen, 42; Yaxkax, 26; and Chanchen Laz, 20.

## Community Settlement Patterns

No aerophotos are available for most of Yucatan so a careful analysis of community settlement patterns is not possible. The data collected from Quintana Roo, along with published maps of a few Yucatecan communities, and general observations on Yucatecan villages by the author provide the raw materials for the analysis below.

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3. Villa Rojas, 1945

In Yucatan the most common overall settlement type is the village and this type of community is invariably laid out in the typical Spanish grid pattern; even such small villages as Chan Kom possess this overall plan. The streets cross each other at right angles and generally enclose 100-meter square blocks. In the center is the typical open square or plaza surrounded by church, municipal buildings, a few shops and masonry houses of the wealthier families. In small villages there may be no private homes of masonry or shops. In larger communities the streets just off the square may be occupied by masonry houses almost shoulder to shoulder but in general the pole and thatch house with a good sized solar or house lot around it makes up the bulk of the constructions in any Yucatecan community. When there is a larger area in the center of masonry houses, more shops, restaurants, a movie or two, perhaps even a hotel, we can call the community a town, and in general it has a large number of part-time specialists. In Yucatan even in the largest towns most of the artisans are also farmers. One of the most important absences in Yucatecan centers is the aboriginal type of market. Markets do occur in the larger towns but they are mainly for the use of the townsmen themselves, and even here most of their buying occurs in shops.

Most Yucatecan solars are large, as an average at least 50 meters square, and population density therefore low compared to that in the Highlands. Kilmartin has published two community maps, one a small village, Chan Kom, the other a large village, Dzitas.[4] Chan Kom covered at that time 10 hectareas and had a population of 197 people

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4. Kilmartin, 1933.

or just about 2000 inhabitants per $km^2$. Dzitas covered 80 hectareas and possessed 1177 inhabitants or about 1500 per $km^2$. Kantunil Kin, studied by the author, covers 30 hectareas and has a density of about 1800 (population 570, 1940, in the village itself).

The Yucatecan communities are similar in organization and population density to our nopal cultivation villages in the Teotihuacan Valley. In general, my impression is that these Yucatecan villages adhere much more rigidly to the Spanish grid pattern than villages in the Valley of Mexico. The basic reason for this less compact settlement here is the tendency of the Yucateco to have a small orchard around his house.

Aside from the village and town a high percentage of the population also live in the small hamlet type of settlement, called variously in Yucatan the rancho, paraje or in the case of larger groups the rancheria. Unlike Tabasco, however, the houses although not in order are generally within a few score meters of each other, although the settlement may be quite scattered and spread out. There is here no incentive for houses to be very widely spaced as land is not parcelled. The main feature which sets off these communities from the village is the lack of plazas as centers of social orientation. If we were to extract the plaza and associated buildings from the scattered village of the Teotihuacan Valley and further reduce the size to less than 100 inhabitants we would have the Yucatecan rancho or paraje. These settlements are generally colonies from nearby villages and very impermanent. In the following section they are discussed in detail.

Haciendas are common in the central part of the state, or were

before the agrarian reforms. Many place names are still listed as Haciendas in the censuses whereas they are actually now villages or combination hacienda-villages. The typical old style nequen hacienda consisted of a large central house of the owner with a small compact village type settlement of workers nearby. The plan of the latter was the same as a village and today they are legally villages. With the reforms the new village received part of the old hacienda as ejido but the original owner still holds part of his original holding and many families in the village work as seasonal laborers for him.

Down on the Quintana Roo coast some of the smaller villages like Puerto Morelos have a settlement pattern of a different type. The community is strung linearly along the beach along one main street, each house being surrounded by a fairly large solar planted in coconut trees. It does, however, have the typical plaza just off to the landward side of main street toward one end of the village.

## A Trip Through Northern Yucatan

To more clearly visualize the pattern of settlement over the northern part of the peninsula as a whole we can do no better than apply the technique used in our previous three areas, that of the observant tourist. Our trip this time will be somewhat longer than the previous one and to facilitate comparison with the others we will discuss it in terms of smaller laps, each lap being approximately equal to our trips through the Chinampan, Chontalpa and Teotihuacan Valley.

At the time of the field study there was a paved highway running from the state capital, Merida, to Valladolid in eastern Yucatan.

Merida at the time studied possessed a population of slightly

over 100,000, or over 1/4 of the total population of the state. It is the only true city in all of Yucatan and all Yucatecan industry is concentrated there. The basis of its economic wealth is the international nequen market.

The first 34 kilometers of our trip along this highway carry us through an almost continuous nequen plantation. Almost the entire natural vegetation has been clipped off by continuous machete weeding and is almost 100 percent sown in nequen. This is our area of permanent cultivation in Yucatan and at the time of the agrarian reform was entirely in large haciendas or plantations. Following the land reforms each hacienda was reduced in size and the lands are now operated as communal ejidos by the former workers. Most of the former large plantations have preserved their names although the modern population that lives there should more properly be considered as living in villages. I refer specifically to such large centers as Ticopo and Holactun which in the 1940 census are still classed as haciendas. Most of the men still work part time for the reduced hacienda but they are also ejiditarios with their own lands. At any rate over the first 34 kilometers of our tour we find 6 large village-haciendas and true haciendas: San Pedro, 46 inhabitants; Teya, 163; Sahe, 185; Ticopo, 522; San Bernardino, 47; and Holactun, 274. Holactun and Ticopo are hacienda-villages and the rest are true haciendas. Aside from these major centers there are a large number of small haciendas along the route. The hacienda system, in this area applied in its most intensive form, seems to result in a thorough denucleation of population. No large centers are noted. This is mainly due to Merida's dominating role in Yucatecan urban

development.

From Holactun to Kantunil is approximately another 34 kilometers. Over this stretch one goes through 3 villages and 1 giant nequen hacienda. These are in order Tahmek (km 42, population 1544); San Jose (hacienda, km 51, 213 population); Hoctun (km 48, population 1868); and Xocchel (km 53, population 1411). This region is simply an extension of the nequen zone except that with the greater distance from Merida we get large villages mainly with nequen as their economic base. This is especially true of Tahmek and Hoctun; Xocchel has a mixed economy based on nequen and maize cultivation; we may consider the latter as our rough limit of the nequen belt. All three villages, however, cultivate maize, often in rested nequen land. There is a gradual increase in forest over cultivated land as one goes from west to east, with a few patches of scattered scrubby growth around Tahmek, gradually increasing until on the Valladolid side of Xocchel nequen is definitely minor and slash and burn cultivation with its typical effects more in evidence. The definition is actually very sharp. On the Merida side of Xocchel most of the land is in nequen with only occasional patches of milpa and scrub forest. On the other side the landscape offers a typical patchwork pattern of milpas, very low scrubby bush, and higher, older scrub forest. Most of the bush runs 2-3 meters in height but some patches may go up to as high as 5-6 meters.

From Kantunil at km 68 to Valladolid, km 160, a distance of approximately 92 kilometers, we pass through the eastern type of the Zona Maicera where permanent agriculture is rare and the hacienda almost non-existent.

The general settlement through this zone is one of widely separated small and medium sized villages and numerous small ranchos, parajes and rancherias. The average distance between villages is about 12 kilometers. In order one passes through Kantunil (village, km 68, population 1577); Holcah (village, km 80, population 1214); Libre Union (village, km 94, population 685); Yohdzonot (rancheria, km 102, population 519); Piste (village, km 118, population 820); Chichen Itza (ruins and rancho, km 120, population 95); Xcalakop (rancheria, km 130 (approximately, population 164); Kaua (village, km 140, population 772); San Diego (rancheria, km 148, population 70); Cuncunul (village, km 152, population 502); Ebtun (village, km 156, population 300); and finally Valladolid (town, km 160, population 6402).

Valladolid is a true town with hotels, restaurants, movies and many shops and is the commercial center for a large number of smaller communities. The list above does not include, of course, the scores of small ranchos and parajes met with along the route.

This area from Kantunil to Valladolid is an area of an extensive application of slash and burn subsistence maize cultivation. There is probably no virgin forest left, the vegetation representing a complex pattern of milpas, recently abandoned fields, and secondary scrub forest which rarely exceeds 5-6 meters in height and most of it is much less. It is amazing how thoroughly the moderate population of the area has altered the natural vegetation.

Beyond Valladolid the occupation is much less dense. From Valladolid to Chemax is approximately 30 kilometers; the intervening space is occupied by but three nucleated villages aside from those

settlements I call collectively hamlets. These are Tikuch, population 44; Xalau, population 322; and finally Chemax, population 1573.

Between Chemax at kilometer 189 and Xcan on the Quintana Roo-Yucatan border at km 225 we are in the final frontier of Yucatecan settlement. Only two communities lie between these points - Catzin, population 189, and Xcan, population 194. The latter is the final outpost and also possesses the distinction of being one of the few newly formed pueblos in modern Yucatan. Even ranchos and parajes are rare here and exceedingly impermanent. In 1954, the first year the author worked in Yucatan, there was a dirt highway from Valladolid to Xcan, which ended at the latter point. In 1955, the final year spent in Yucatan, the government paved this stretch and the highway was extended on to Puerto Juarez on the east coast as part of a new plan of a Merida-to-Miami tourist route based on highways and ferries. I journeyed on this road as far as Leona Vicario in Quintana Roo. From Xcan to Leona Vicario is 50 kilometers of almost untouched zapote jungle with no permanent settlements at all and only temporary chicle camps. Leona Vicario itself is a small village of 386 inhabitants who live mainly by gathering chicle and secondarily practicing maize agriculture of the slash and burn type.

From Leona Vicario there is a mule-drawn tranvia which runs east for 40 kilometers to Puerto Morelos on the coast. This tramway gives a good cross section of life in northern Quintana Roo. It was built by the Banco de Londres y Mexico Chicle Company to connect their headquarters at Leona Vicario to the port at Puerto Morelos, and possessed a network of branch lines running off into the bush for collecting chicle. Today the system is still in use for chicle and

maize transport. The trip from Leona to Morelos can be made in about 4 hours by using the tramway with mule and platform. Over this distance of 40 kilometers there is but one intermediate settlement - Vayarta - a chicle collecting depot just about half-way to the coast, with a population of some half a dozen families during the off season. These people also sow some milpas. Puerto Morelos on the coast is a village of perhaps 63 people. Both the villagers of Leona and Morelos practice a little milpa cultivation but the total effect on the landscape is almost zero, being almost untouched zapote jungle broken now and then by more open scrub-covered swamp-savannahs. Puerto Morelos is mainly a coconut agricultural community.

# MODERN ECOLOGY AND ECONOMY OF MESO-AMERICA

## Ecological Types

In a previous section we defined a series of fifty-one ecological subdivisions or areas of Meso-America. Each of these areas is in effect an ecological type and in a specific sense presents a unique combination of geographical features. Each of them should be studied and analyzed in terms of the history of its utilization by man as a separate unit. However such a study would provide only the raw material for an establishment of a science of human ecology as it allows for no further theoretical generalization.

Many of these ecological areas are basically similar and can be discussed in larger groupings which we may call Ecological Types. One of the fundamental divisions in Meso-America is that between the Lowlands or Tierra Caliente on one hand and the Highlands or Tierra Templada-Fria on the other. The Tierra Caliente may be defined as all land lying below 800 meters above sea level. In general the Tierra Caliente is an area of high annual rainfall and invariably of high temperatures. The combination of these two factors produces a vigorous natural vegetation growth which has limited agriculture to two basic types: (a) Plantation Agriculture, in which the cultivator replaces the forest with an artificial forest of economically useful plants; or (b) Slash and Burn Grain Cultivation in which he makes a compromise with Nature with the balance much in favor of Nature in division of dominance over the landscape. Above 800 meters on the other hand, most of Meso-America must be classed as sub-humid or semi-

arid or even arid, especially above 1600 meters. Much of the Tierra Templada, however, is humid and has abundant rainfall. Even in the more humid areas the higher altitude evidently reduces the growth of natural vegetation to the degree where Man can either completely dominate it or he makes a more equal compromise.

Within the Highland ecological type with a more permanent system of grain agriculture we find a fundamental division in all Mexican agronomic classifications between the Tierra Fria and the Tierra Templada. This important subdivision is based on two factors:(a) Above 1600 meters there are frequent winter frosts which limit the agricultural cycle for most crops to approximately seven months and early frosts may reduce this period and even cause heavy crop loss. Below 1600 meters in the Tierra Templada frosts are rare and all-year cropping is possible. In the Tierra Fria only especially frost-resistant crops such as wheat may be sown in the cold season. (b) Also many Tierra Caliente crops may be sown in the Tierra Templada such as cotton, rice, sugar cane, citrus fruits, bananas, coffee, tobacco, and in the lower part even cacao.

Almost all areas above 1600 meters and especially above 2000 meters in Meso-America have sub-humid or semi-arid climates, and in some cases truly arid ones. Rainfall varies from approximately 300 mms in the more arid areas up to 1250 mms in the more humid, with most areas receiving from 500 to 1000 mms of rainfall. Exceptions are those municipios lying high up on escarpments which receive rainfall often well in excess of 1250 mms. These municipios occur in Guatemala, the southwestern part of the State of Mexico, and in the high escarpment of the Vera Cruz side of the Sierra Madre Oriental

and probably the high valleys of Chiapas. The Tierra Fria includes three important ecological sub-types on the basis of rainfall: (a) Those areas with less than 500 mms of rain a year and in which agriculture is exceedingly precarious without irrigation, and often impossible, such as the East Puebla Plain, Western Hidalgo, and some of the higher valleys of the Mixteca. (b) Those areas which receive 500-1000 mms of rainfall. Most of the Tierra Fria falls in this division and it includes the Meseta Central, most of the Michoacan Highlands, most of the highlands of Oaxaca, and some highland valleys of Guatemala. In this type rainfall is ample for good summer crops but the possibility of early frosts combined with a delay in the inception of the rainy season makes irrigation, if not a necessity, at least a very desirable technique. Furthermore irrigation in this zone increases production at least 50 percent and enables double cropping with frost-resistant crops. (c) Small isolated zones which receive over 1000 mms of rain, where irrigation is present or necessary only when all-year cropping is desired and especially developed where truck gardening is carried out. The location of these small areas has already been pointed out.

In the Tierra Templada between 800 and 1600 meters we find a more equal division between the dry and wet sub-types. The rainfall effectivity, moreover, is reduced due to the higher temperature, and I doubt that efficient agriculture without irrigation may be carried out with less than 700 mms of rain. We may therefore again see three sub-types within this type based on precipitation: (a) Areas which receive less than 700 mms of rain and where irrigation is a necessity; this would include such areas as the Tierra Templada of

Meztitlan in eastern Hidalgo, parts of the middle Balsas drainage system, the Upper Papaloapan and Middle Motagua. (b) Areas which receive 700-1200 mms of rain; the major distribution of this type is in the Middle Balsas and its tributary system and the Valley of Oaxaca and lower mountain valleys of Oaxaca. Irrigation here may be important. (c) Humid Tierra Templada found chiefly on the east escarpment of the Gulf Coast and Pacific escarpment of Oaxaca, Chiapas and Guatemala along with much of highland Guatemala. Irrigation in general is not found in this belt except in certain Guatemala valleys (Atitlan), where we have a pronounced dry season and irrigation is needed for such crops as coffee and for all-year truck farming.

Aside from temperature and rainfall a further factor may modify the situation in the Highlands: that of local topography. As an example we may compare the Mixteca Alta with the Meseta Central in Mexico. Both are Tierra Fria areas inhabited by intensive grain cultivators; yet the population density in the Meseta is several times as high as that in the Mixteca Alta. Here the answer lies in topography. The Mixteca area is one of continuous, almost denuded mountain ranges broken at intervals by small fertile valleys. The population density in these valleys may be higher than most of the Meseta Central but the percentage of valley to mountain is so low that the overall population density and size is sharply reduced. The Mixteca Alta offers close parallelism to the Peruvian Highlands in this respect. The Meseta Central on the other hand is broken up by ranges into four large extensive plains (Puebla, Mexico, Toluca, and Bajio of Michoacan-Jalisco) and population is generally dense over a high percentage of the total area. The Meseta Central is unique in

Meso-America as a Tierra Fria area with extensive quantities of arable land. The Mixteca Alta type of ecology is characteristic of most of the Tierra Fria of Meso-America outside of the Meseta Central.

Almost all of the Tierra Templada is of this general Mixteca Alta type. It occurs as small mountain valleys, very broken escarpment or sloping dissected plains in which fertile bottoms are separated by ranges of barren rocky hills.

The Lowlands or Tierra Caliente on the other hand offer important contrasts to the Tierra Fria-Templada or Highland type. In general these are humid lands and the problem of competition between natural and artificial vegetation is the central theme of agriculture. The great advantages of this area lie in the greater diversity of crops, possibility of all-year cropping in some areas, abundance of land in terms of the present demographic situation, and finally many of the crops are important in the international market and are financially rewarding. Higher yields are often given as another characteristic but we shall see later that this is too complex a factor to include in the above comparison. The great disadvantage demographically is that with the slash and burn system only a small fraction of the potential of the area may be utilized at one time. Intensive agriculture is exceedingly difficult in this type of ecology because of the double problem of generally poor soils and intensely fast weed growth. Within the Tierra Caliente we find important ecological sub-types which present different problems to the cultivator.

Most of the Gulf Coast receives over 1000 mms of rain a year, and much of it over 1500 mms. We may consider here 900-1000 mms as

a minimum for effective maize cultivation without irrigation. A number of areas receive less than this minimum figure. The peninsula of Yucatan north and west of Merida receives less than 1000 mms of rain and is mostly a nequen raising area. The Maize Belt of the state of Yucatan in general receives 1000-1200 mms of rainfall and production is much below that of most of the Gulf Plain. For best results in the Tierra Caliente with the slash and burn system 1300-2000 mms of rain offer the optimum condition for maize cultivation. Another Gulf Coast area with less than the minimal or bordering on the minimal rainfall is the dry zone of Central Vera Cruz; here the rainfall ranges about that of the state of Yucatan, with a drier central zone with rainfall about that of northwestern Yucatan, and surrounded by stations with a precipitation cycle like the Maize Belt of Yucatan.

A third dry or marginal area lies in the Vera Cruz Plain north of Tuxpan and that part of the Tamaulipas Plain which lies within Meso-America.

In discussion of this arid-humid borderline we come across one of the most crucial themes with regard to slash and burn cultivation: that of the Forest-Savannah relationship. In a normal tropical lowland situation most areas which receive below 1200-1400 mms of rainfall will develop a savannah cover rather than a tropical forest. In the Amazon basin there are huge areas of grassy plains of this type. Applying this principle to Meso-America we would expect to find most of the Peninsula of Yucatan, or at least the northern half of it, occupied by savannah, and therefore almost impossible for utilization by slash and burn cultivators. In contrast we find scrub

forest, or in areas not yet worked over by cultivators high zapote jungle with very little grass, and the area is one of the most densely populated slash and burn areas in Meso-America. Lundell points out that the soil here plays an important role, that the calcareous shallow soils favor a woody vegetation rather than a grassy one.[1] Today pastures are sown only with great cost and difficulty of maintenance for cattle raising; grasses just don't yield well on Yucatecan soils. The combination of the soil plus lower rainfall reducing the natural weed growth is probably the most important factor in selection of the Peninsula in ancient and modern times for extensive occupation by slash and burn cultivators. Another factor which sets off northern Yucatan from all other Gulf Coast areas is the lack of surface drainage. These factors, combined with the fact that the Peninsula offers the largest continuous region of Tierra Caliente in Meso-America, set it off as a distinctive ecological sub-type within the Tierra Caliente.

The rule of Savannah-Forest transition applies very neatly to Central Vera Cruz where we have a deeper soil and savannah vegetation. In parts of Campeche in the Peninsula of Yucatan also, where we find deeper soils, savannahs occur.

The southern half of our Ecological Area Number 4 also, following the general rule, should possess savannahs but is instead clothed by a dense tropical jungle. The answer here does not lie so much in soils as in the distribution of the rainfall seasonally. In most of the Tierra Caliente from five to eight times as much rain falls in

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1. Lundell, 1937.

the six wettest months of the year as in the six driest; in other words the dry season is a real dry season. In the area in question the dry season on the other hand receives enough rain to produce good crops and we have a more equable distribution, the rainy season receiving only three times as much rain as the dry season. With this spreading out of the precipitation forests evidently develop. North of Tuxpan true savannahs occur with the further reduction of rainfall.

Local stretches of savannah also occur in our wetter Gulf Coast region. In Tabasco we find them in elevated zones in between flood plains where soils are exceptionally leached and infertile. They also occur in deltas of such major systems of the Papaloapan and Grijalva where they are called swamp savannahs. Of great interest and of crucial significance is the fact that above 800 meters in the Tierra Templada savannahs are rare even when the precipitation cycle favors their development. Instead we have a curious vegetation type best called a low scrub jungle in which Tierra Caliente shrubs occur in association with cacti.

By far the greater part of the Gulf Coast is clothed by tropical jungle and this vegetation type limited grain cultivation to the slash and burn type. Today we can point out an important distinction in land use between the flat forested river plains and areas of hilly broken topography and perhaps define them as ecological sub-types. Plantation agriculture is generally concentrated in the former when possible, but as yet the problem of flooding has not been solved and these lands are in only partial use and the areas of flood plain sparsely populated. Most of the population is concentrated in either the drier, drainageless northern Yucatan Peninsula, or in rolling

broken topography like the Sierra San Martin or Northern Totonacapan. In the latter areas agriculture is mainly slash and burn subsistence type.

On the Pacific coast the situation is entirely different. In the first place rainfall in general is much lighter, running 800-1200 mms on the average. In a number of areas as the Lomas of Putla-Jamiltepec in Oaxaca, around Acapulco in Guerrero, and especially the stretch of coast from Tonala in Chiapas east to include the entire coast of Guatemala, rainfall is much heavier, running often above 1500, but it rarely passes 2 meters anywhere. Aside from the generally lower rainfall, however, the rainfall is often quite erratic and ranges very greatly from year to year. The Pacific monsoons evidently lack the clockwork regularity of those coming in off the Gulf and Caribbean Sea. The combination of lower rainfall and lack of regularity mean that for effective maize cultivation irrigation is a must in much of the Pacific coast plain. Published data is rather spotty on the vegetation of the west coast but what we have indicates a range from tropical jungle through savannahs to hot steppe. Most of the area is evidently savannah with gallery forests along the numerous streams. Even for the wetter Guatemala coast, McBryde indicates this as the basic vegetation type.[2] Hot steppes occur in the drier segments of the coast such as around Tehuantepec, the Michoacan Coast, and the Lower Balsas-Tepalcatpec Valley. In general soils are more fertile than on the east coast because of the torrential character of the hydrography, increasing sedimentation

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2. McBryde, 1945.

and alluviation and due to the reduction of leaching as a consequence of more broken topography and reduced rainfall. The importance of the Pacific coast in the cultural history of Meso-America cannot be estimated at present; it depends on whether an intensive system of agriculture was practiced or one of slash and burn type. If the latter it must have been a distinctly unfavorable area; if the former it may have played a very crucial role. Shook's data from Guatemala indicate that the former was true, at least in the Guatemala section of it.[3]

In summary we can group our Ecological Areas into a number of Ecological Types and Sub-Types which are summarized below:

Highland Ecological Type

Tierra Fria
Sub-humid to arid plateau - Areas 5, 6, 7, 9, 10, 37, 41
Sub-humid to arid mountain valley - Areas 31, 35, 36, 39, 49 (part of it)
Humid escarpment-mountain valley - Areas 3, 17, 28, 38

Tierra Templada
Sub-humid to arid escarpment and mountain valley - Areas 8, 11, 19, 25, 26, 29 part 1, 32, 33, 42, part of 49
Humid escarpment and mountain valley - Areas 2, 16, 29 part 2, most of 49

Lowland Ecological Type

Gulf Coast
Rolling forest - Areas 13, 15, 34, 46, 47, 48, southern half of 4
River flood plain - Areas 12, 14, 50
Savannah - Area 1, northern half of 4

Yucatan scrub forest - Areas 43, 44, 45

Pacific coast
Hot steppe - Areas 22, 27, 40
Savannah - Areas 18, 23, 24, 30, 51
Forest - Areas 20, 21

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3. Shook, 1951.

## Agriculture in Meso-America Today

### Technology

Tools used in agriculture in modern Meso-America vary enormously from ecological area to ecological area.

Throughout the Tierra Caliente or lowland ecological type the main system of grain cultivation is slash and burn and basic tools are very similar. They include the axe for cutting down the larger trees and machetes or bush knives of various sizes and shapes for lighter vegetation. All of these tools or at least the working part is bought from the international or national market, mostly coming from the United States. In rainier, more heavily vegetated areas the straight-bladed full-sized machete is used; in areas of scrub forest such as in Yucatan a shorter curved type is in use. The latter is also used in the highlands in some parts of Meso-America for weeding or clearing off fallowed lands. For planting the simple digging stick is almost universal. In areas where the soil is hard or impregnated with loose stone it may be shod with an iron point. To this basic tool kit one might add the use of the garabato for collecting the scrubby growth and holding it for slicing with the machete, the nequen bag for carrying seed, and use of fire for final clearing.

A more complex or efficient technology than this is very rare for Lowland Meso-America. In certain drier sections such as Northern and Central Vera Cruz the plow is now in use but these are savannah areas. The Mexican government has attempted plow agriculture in other areas of the east coast but without much success.

In cultivation of crops other than grains a few extra tools may be added but even here the technology may not be changed. For example

in Tabasco plantation crops may be sown by excavating pits with the coa or straight-bladed hoe, but the intervening soil areas are not broken and the clearing and consequent weeding and pruning is done mainly with the machete. Root crops may often be sown with the coa, but here again it is used as a digging stick or simply to open a larger hole to insert the tuber; the land as a whole is not worked over with the coa. Often in sowing tubers the pit is excavated with the point of the machete.

In the Highlands technology is more varied and more complex. In the Tierra Fria tools sort out into two basic types: those involving animal power and those in which only human labor is involved. On the Plateau the plow and traction animal (ox, mule, horse or even donkey) is in general use where the slope of land permits. As most of the arable land in the Plateau is basin floor or gentle slope this is the most common technique for preparation of the land. Weeding is often done with the hand or animal-drawn cultivator or hoe or even uprooted by hand. Weeding contrasts sharply with that of the Tierra Caliente and it might be of value to adopt the two Spanish terms of "deshierba" and "chapeo" to point out this difference, the former referring to true weeding in which the plant is killed and the latter for cases of machete weeding. Outside of the Plateau in the Tierra Fria the plow is used in mountain valleys in Guatemala and Oaxaca where the terrain permits. In both of the latter areas Indian as opposed to Mestizo culture is stronger than in the Plateau and Indian conservatism may exclude the use of the plow where the terrain otherwise permits it.

On steeper slopes the hoe often replaces the plow, especially

in Guatemala where a special development of contour hoeing occurs, that is, the hoeing is done parallel to the slope as in contour plowing and the net result is the creation of series of miniature earth terraces. The hoe and allied tools as the spade and coa are also universally used in garden cultivation, in the Chinampas in the Valley of Mexico and Tablones of Highland Guatemala.

In the Tierra Templada the same situation occurs, the plow often being used in flat valleys and hoe on steeper slopes. In the more humid slope areas where land is fallowed the vegetation is often cleared first with the machete and burned off before hoeing. This is typical of the forested highlands of Guatemala and Guerrero.

The most important distinction between Highland and Lowland technology is that in the former the soil is broken up and the vegetation destroyed whereas in the latter it is only chopped down. The result is that Highland fields are often in continuous cultivation and in general under cultivation for a much higher percentage of time than Lowland milpas. Furthermore humidity conservation techniques are possible using the Highland technology whereas in the Lowlands they are not.

## Techniques

### Soil Conservation

In terms of techniques we will divide our discussion into two parts: soil conservation and water conservation.

In general lowland soils are not notable for their fertility although they are undoubtedly more fertile than most tropical areas. Most of them fall into the lateritic or rendzina classes and will not support continuous cropping with the small amounts of fertilizer available to the average Meso-American peasant. This basic infertility

is moderated by one factor, that of alluviation. On the east coast the rivers may have a fairly extensive flood plain and may deposit soil annually, thus maintaining soil fertility in spite of the generally adverse climatic situation. Such lands, however, play a minor role in terms of the total Gulf Coast picture, not operating at all for example in the Yucatan Peninsula except in limited favorable areas (in the Puuc for example where soil is washed down into the depressions by rainfall) and the bulk of the plain must be considered as being marginal in terms of soil fertility. In the Highlands there is a great range in soil fertility. Most of the valley bottom soils are classed as chernozems or siernozems and have high natural fertility. Most of them are of volcanic-sedimentary origin, that is the materials were of volcanic origin but deposition was fluvial. On the upper slopes the soils tend to decrease sharply in fertility, especially where rainfall is heavy and leaching increases, and many soils fall into the podzolic class. The most important point about highland valley soils is that the soil fertility can be maintained by simple techniques and moderate additions of fertilizer even under continuous cropping: this is especially true in the Meseta Central where I know of lands which are never rested, never fertilized, and produce about the same as slash and burn fields in northern Yucatan. Mexican agronomists and American anthropologists are fond of overplaying the fertility of coast lands as compared to highland. This is due to the mistaken use of the word "fertility" for "productivity" and to the careless neglect of pointing out the difference in the intensity of cultivation. The high production in the Totonacapan, for example, is due to the fact that the land is

cultivated only 3 years and rested 21 years![4] The soils are not fertile in this area but are characteristically poor soils. Even the poorest soil will produce with that type of cycle. With this brief review of soil difference we will now discuss techniques of soil conservation in modern Meso-America.

Bush Fallowing - Slash and Burn - Roza. This is the system found characteristically in the Tierra Caliente. In part it is a soil conservation technique and in part the only way to handle natural vegetation without an enormous outlay in labor. It consists of clearing the forest, burning it off, and planting with a digging stick. The plot is cultivated for 1-3 years in general; cases of cultivation beyond 3 consecutive years in areas below 800 meters are very rare. Characteristically there is a progressive reduction in yields from year to year either due to weed competition or soil depletion, or both. The field is rested anywhere from 4 to 21 years, depending on the quality of the land, for best results. Theoretically with the use of the machete weeds can be kept down by continuous labor and field use prolonged. On especially fertile soils and under strong demographic pressure the relationship of land use to land rest may be reduced to a 1:1 system, but the reduction in yield is enormous as our Tabascan figures prove. For good results even on the best land only 25 percent of the land should be in cultivation and in poorer areas this is reduced to 16 or even 12 percent. Aside from higher soil fertility the period of rest may also depend on the rapidity with which the forest returns; in Tabasco weeds and grasses

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4. Palerm, 1955.

begin to become replaced by woody trees in 2 or 3 years and in 4-6 years the forest is back. In Yucatan the same height of forest requires at least three times as much time to develop. The bush fallowing system then is a compromise between Man and Nature in which Man controls his ecology only a fraction of the time, no more than 25 percent, and in general for a much shorter time.

Tlacolol. This is basically the same system as the roza or bush fallowing but applied to areas above 800 meters. It is especially characteristic of slope areas in the more humid Tierra Templada, being characteristic of much of the agriculture of Guatemala, Guerrero, and Oaxaca. The bush is cut down and burned. No fertilizers are used but the ground is often hoed for planting and in curbing weed growth. In Guatemala contour hoeing is often used to combat erosion but in many areas (Tepoztlan) no attempts at soil conservation are made and erosion is characteristic.[5] The plots are sown for several years in succession, then rested. The main difference between this system and the coastal bush fallowing is in the ratio between period of cultivation and period of rest. Here weeds are easier to control and fields are cultivated until the soil gives out. In more fertile areas a 1:1 cycle is maintained or a 1:2, and in rare cases of exceptional fertility a field may be kept in production more than it is rested and a 2:1 ratio may be maintained - this however is rare. Even on the poorest soils we find at least a 1:4 ratio is sufficient for good yields. These data apply especially to Guatemala where land pressure is great and erosion control techniques

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5. Lewis, 1951.

common. In Tepoztlan where forests are abundant farmers are careless and erosion is so drastic that fields may be permanently lost. Few communities depend entirely on the Tlacolol technique for their subsistence. The usual pattern is plow cultivation of valley floors and the use of the Tlacolol system on nearby slopes.

Barbecho. This is a term adopted by Palerm for plow cultivation in which the only technique of soil restoration is resting.[6] This is a common system in the humid Tierra Fria of Vera Cruz, and in the highland valleys of Guatemala. Rest periods in general equal the period of production or at most are twice as long and in rare cases only half the length of the cultivation period. Plowing is generally restricted to valley floors or gentle slopes.

Fertilizers. Several techniques of fertilization are known for modern Meso-America and in general it is limited to highland valleys and basins. In the Mesa Central it is in general use and lands are rarely rested. Manures are mainly derived from draft animals and cattle with secondary use of human, corral birds, pigs, sheep and goats although the manure of the latter two is rarely used. The manure is stored several years in the house lot until well decomposed and is never put green on the field. Domestic animals are generally scarce and animal fertilizer at a premium. In general field agriculture most fields are fertilized but once every 5-6 years, and rarely more commonly than every 3-4 years.

Of great interest is a special type of fertilization involving bat guano generally applied to seed beds or in chile and tomato

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6. Palerm, 1955.

cultivation, the material in question deriving from cave deposits in Morelos. The probability of this system being ancient seems great. In some areas the guano is mixed with human fertilizer, again probably a pre-conquest custom. Human fertilizer is probably extensively used in the informal manner I observed at San Gregorio. I know of no other reference to its use in areas outside of the Mesa Central.

Green fertilizers along with lake mud are in general use in the chinampa villages but may be restricted to that part of the Meseta Central. Of significance and possibly invalidating this argument is the fact that it is used in temporal lands as well as on chinampas in the village of San Gregorio. The general custom of plowing under the weeds and rastrojo or corn stalk is widespread. Today many villages, under stimulus from the Federal Government, sow a winter crop of clover which is plowed under as green fertilizer.

Outside of the Meseta Central the use of animal fertilizers in moderate quantities is characteristic of plow agriculture in mountain valleys in Oaxaca, Chiapas and Guatemala. The use of green fertilizers and rastrojo is noted also for Guatemala. In Guatemala sheep and goats provide most of the fertilizer and the commonest technique is to corral the animals on the fields, moving the corral periodically until the entire field is fertilized.[7]

Palerm, basing his observations on the Humid Tierra Fria area of of the Puebla-Vera Cruz border, describes a technique which was probably once widespread in the Highlands, called "calmil". Each house is surrounded by a large solar. Into this solar is thrown the

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7. Stadelman, 1940.

garbage from the house; domestic animals, especially fowl, continually roam the solar and the human occupants use the area generally for excretory functions. The result is that the plot is under continual daily fertilization, production of maize is very high, and the plot is never rested. The owner usually has other lands outside of the village which he cultivates with the barbecho technique.[8] Stadelman describes the same system for Guatemala.

Crop Rotation. This is mainly limited to the highlands where we have sustained land use over long periods. Most farmers in Highland Meso-America seem to know the value of crop rotation, especially in the Mesa Central, but it is not in widespread use except among those farmers with substantial holdings. Most farmers have just enough land to supply the family with maize and cannot afford to rotate to other crops. We noted one system of crop rotation in San Gregorio Atlapulco involving only aboriginal cultivates and it may be an ancient system. This system includes one year of maize cultivation, followed by huauhtil, followed by mixed chile and tomato or jitomate, and then reversion to maize. This system is of utmost importance especially in view of the importance of huautli as a food staple in ancient times. In the Chinampas the seriation of crops is more apt to be conditioned by the expected market value of this or that crop rather than the effects for soil maintenance. However as the crops sown cover a great range of types and include several legumes it is in effect a crop rotation system. The substitution of maize every three years or so may be more properly considered as a sort of productive

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8. Palerm, 1955.

fallowing rather than true crop rotation and indeed the chinampero considers it so.

In the Teotihuacan Valley we found a crop rotation system in both the Middle and Lower Valleys. In the Middle Valley barley and maize are alternated; in the Lower Valley corn is first sown as a summer crop followed immediately by winter wheat and then either alfalfa or barley are sown the following summer. Sometimes a crop of clover is sown as a winter crop instead of wheat. The third year maize is again sown and the cycle repeated.

Outside of the Meseta Central we find crop rotation in the following areas:

Guatemala. Reported by Stadelman in three villages; in one type wheat and maize are alternated; in another maize, tobacco and beans.[9] Bunzel states that it is practiced in the Quiche area and at Chichicastenango but does not give details.

Highland Michoacan. West describes the same system noted for Guatemala and the Teotihuacan Valley of rotating maize with wheat or barley.[10]

I suspect that the huauhtli-maize alternation of the Valley of Mexico is an ancient system and was replaced by the colonial wheat-maize or barley-maize alternation, as those cereals in general replaced huauhtli in Mexican agriculture. Huauhtli is a small grain like the European grains and we know it was cultivated in the Teotihuacan Valley as late as 1579, yet today there is no huauhtli cultivation.

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9. Stadelman, 1940.

10. West, 1947.

The suggestion of replacement is strong and this general replacement was probably carried over in crop rotation as well.

Mixed Farming. This is a general system in both Lowland and Highland Meso-America. It includes mixed sowing of several crops in the same field, usually maize, beans and squash. The seed may be sown mixed in the holes or maize sown first and the other two sown either in between the maize plants, in the spaces between the rows, or in the same hole with maize.

Irrigation and Enlame. Irrigation in general along with its function in humidity regulation also is a soil fertility maintenance technique, as irrigation water in general has mineral salts in solution. As a matter of fact one of the problems in irrigation is the prevention of salinization of the soil due to excess irrigation. Of especial value is the use of flood water for irrigation. These fast-running torrential arroyo currents generally carry a good load of soil as well as minerals in solution, and repeated irrigation of this type obviously may be considered as a fertility restoration technique and indeed is considered as such by the farmer in the Teotihuacan Valley. Many of the colonial haciendas had permanent spring water for irrigation but still dammed up arroyos and flooded their fields to fertilize them, a technique called "enlame". Lewis describes the same system in Tepoztlan carried out by the small farmers.[11]

Aside from artificial sedimentation most of the highland basins are natural zones of sedimentation and have been so throughout their history. Even in broad open plains such as the Valley of Mexico

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11. Lewis, 1951.

sedimentation by way of the arroyos is an important soil-producing mechanism. In small mountain valleys in Oaxaca and Guatemala soil building by natural sedimentation is probably a key factor in the fertility of these highland soils.

## Humidity Conservation

Lowlands. Contrary to popular opinion the timetable of rainfall in the tropical Lowlands is as much a crucial factor in crop production as in the Highlands. In the Huimanguillo area the sowing of maize for the summer crop must not be done any later than June or early floods in the fall may destroy the crop. The winter crop must be sown no later than December or the plant will not survive the April drought. In a few favored areas such as Area 15 sowing can theoretically be done all through the year. However the factor of burning complicates the problem even here, as wet bush cannot be effectively burned off, so that the sowing is actually limited to those short dry spells of late spring and early winter. Crop losses from drought do occur in the lowland areas, especially in tonamil or winter sowings in areas generally which receive less than 1500 mms of annual rainfall.

There is a general tendency for Mexican agronomists and American anthropologists to think in terms of a simple 1:1 relationship between maize production and rainfall, and the feeling is that the more rain you have the higher the yield. This is a false perspective and a highly unrealistic one. Any crop needs water but most crops including maize suffer as much from too much water as they do from too little. Further, maize is a complex food plant with hundreds of races adapted to many ecological zones; some species are exceedingly

drought-resistant as the Pueblo Indian varieties. The area of the United States which produces the highest yields in maize is the area known as the Corn Belt, where annual rainfall runs from 30 to 40 inches a year. This is about the rainfall of the wetter regions of the Mesa Central but we must consider also the fact that in the Meseta most of the rain falls during the growing season for maize, in distinction to the Corn Belt, and therefore a region in Meseta Central may have somewhat lower annual rainfall and still present optimum climatic conditions for maize cultivation. In general climatic conditions in the Mesa Central are optimum for maize.

One of the important facts about maize cultivation with respect to humidity needs is the timetable, not only for sowing but throughout the plants' growth. In general maize needs only a small amount of moisture during the early stages of growth, needs a maximum just before earing, and then once the ears are formed a period of consistent well-spaced rainfall, with plenty of sunshine for final maturation. The pattern of rainfall in the Meseta Central is ideal for this cycle, all other factors being equal (as we shall see they are not). May and June are months of light rainfall, July and August are rainfall maxima months, and the fall is a period of lighter precipitation with many sunny days. In the Lowlands the rainfall maxima often fall too late in the season - August to October - and the maturing season in many areas is one of sunless steady drizzle. Statistics from the American Corn Belt show that if 5 inches or more of rain falls during the crucial month of July maize crops are abundant. Few stations in the Mesa Central receive less than 5 inches.

Of key importance in the rainfall cycle is the critical period

called the "canicula" which falls often in July or August just at the period when maize needs humidity most. This is a cessation of the rains, normally not extended beyond 5-7 days, which may delay longer and adversely affect the maize crop.

In the Lowlands in general no humidity regulation techniques are used and the farmer in general is at the mercy of the elements. In areas with over 1500 mms of rain, in humid river flood plains, or in Tierra de Humedad crop loss by drought is rare. In Tierra de Temporal, or slope lands, or level lands above the flood plain, drought is more serious and in areas with less than 1500 mms of rainfall may be a real problem as in northern Yucatan, the Central Vera Cruz coast, or the Pacific coast.

Highland Area. Above 1600 meters and especially above 2000 meters the ordinarily favorable climatic conditions are complicated by the problem of winter frosts. I am completely convinced that if the Meseta Central farmers could delay their maize sowings until the end of June or beginning of July, crop loss from drought would be very rare as rainfall in general is ample. Below 500 mms of annual rainfall would, however, produce a true drought situation, but most of the Meseta has a higher precipitation than this. However the normal late fall frosts can and often do occur in October and even September, so a July sowing is out of the question. In normal years when the first showers fall in May, followed by a few good ones in June, farmers can expect a good crop without water conservation techniques and without fear of frost dangers; the trouble is that early frosts are rather frequent and in recent years the rainy season has often delayed its inception. There is a strong cyclical suggestion

about the rainfall pattern as in Northern Yucatan.

Irrigation or other soil conservation techniques are therefore important for maize cultivation in the Tierra Fria to enable early sowing and avoid fall frosts. Also even in normal years irrigation may boost crop production up at least 50 percent.

In discussing the significance of irrigation in Highland Meso-America we can set up a three-scale system:

1. Ecological areas in which irrigation is a necessity for maize production

   Central Hidalgo, Part of East Puebla Plain,
   Northern Hidalgo Tierra Templada, Mixteco-Atoyac Tierra Templada,
   Upper Papaloapan Tierra Templada, Middle Motagua Valley

2. Ecological areas in which irrigation is of value to prevent danger of crop loss by frosts or results in an important yield increase but in which dry farming can be carried out

   Jilotepec, Michoacan Plateau, Part of Guatemala Highlands Tierra Fria, Valley of Mexico, Puebla-Tlaxcala Plain,
   Morelos-Puebla Tierra Templada, Part of East Puebla Plain,
   Tlaxcala-Hidalgo Plain, Comitan Tierra Templada,
   Middle Balsas Basin, Oaxaca Valley,
   Eastern Oaxaca Area 1 Tierra Templada,
   Southern Oaxaca Tierra Fria, Both Areas Mixteca Alta,
   Toluca Valley

3. Ecological areas where irrigation is unnecessary except for winter or dry season cropping

   Central Vera Cruz Tierra Templada, Central Vera Cruz Tierra Fria,
   North Chiapas Tierra Templada, Chiapas Tierra Fria,
   Mixe Highlands, Eastern Oaxaca Part 2 Tierra Templada,
   Oaxaca-Vera Cruz Tierra Templada, Southwestern Mexico,
   Most of Guatemala Highlands

Certain lands in the Highlands irrespective of annual rainfall are naturally humid and do not need artificial techniques of water conservation. In general these lands are rare and limited to lake shore plains. Most valley bottom soils are, however, capable of moisture storage by dry farming techniques. If the soil is at least

a meter in depth the series of techniques we described in dry farming for the Teotihuacan Valley give excellent results. The main technique consists of thorough pulverizing of the soil following the rainy season, and in each case the surface of the field is carefully smoothed down to prevent evaporation. The system enables early sowing, is the lifesaver for many Tierra Fria farmers and to a great degree reduces losses due to frosts. In the Teotihuacan Valley, the Texcoco Plain, and the Mixteca Alta this is combined with the use of the sowing technique known as "cajete" in which the sower excavates pits down into the humid subsoil to sow the seed and then carefully covers the humid soil over with dry soil to prevent further evaporation. The overall distribution of this technique over Meso-America is unknown and may be important in terms of pre-Spanish technology.

Flood Water Irrigation, or Caja y Presa. This is the type of irrigation we described for the Teotihuacan Valley in which rainy season streams are dammed up and the water diverted into canals for irrigation. Generally fields are completely flooded; often earth walls are constructed around them to hold more water. The system is irregular but, as irrigations are heavy, normally very effective; even in the most unfavorable phases of the climatic cycle good crops may be raised at least three-quarters of the time, and during most of the cycle crop losses are very rare using this flood water irrigation. The system as far as I know is limited to the Meseta Central.

Perennial Irrigation. This type of irrigation is common throughout Meso-America in all of our Highland zones where springs or permanent streams are found. In the Meseta Central the most important river system for permanent irrigation is the Balsas, especially the

upper tributaries. The water comes from melt water off Popocatepetl and Iztaccihuatl or springs in the Ajusco range. The second key river system, which feeds the fertile Bajio, is the Lerma-Santiago. The rest of the irrigation is based on local springs; examples are those back of Texcoco, San Juan Teotihuacan and those which feed the Chinampa area.

Outside of the Meseta Central local springs today feed small irrigation systems in the Oaxaca Highlands and in Highland Guatemala. In the latter area they are used mainly for truck gardening, especially for dry season vegetable crops.

Fields may be flooded as in the Teotihuacan Valley or each plant may be irrigated separately by buckets as in Tablon irrigation in Guatemala or Chinampa irrigation in the Valley of Mexico. In the Highlands of Michoacan canals are excavated from the lakes, the water then dipped by hand from the landward end of the canal, into a sloping artificial canal raised up on masonry terraces on the lake side, and run into lake shore vegetable plots; the amount of land which can be brought under irrigation by this means is very small.[12]

A special type of irrigation, chinampa, we will not discuss in detail here as we have made a special study in a previous chapter, It is limited in its restricted sense to the southern Valley of Mexico.

Terracing. This aside from a technique for combating erosion is also a humidity conservation technique, as terracing reduces run-off and increases soil depth so that water storage is possible. In

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12. Foster, 1948.

especially dry areas terracing may very effectively preserve humidity, as at Nochixtlan in the Mixteca.[13]

## Miscellaneous Techniques

Erosion Control. In the Lowland areas no techniques of erosion control have been reported. In hilly slope country erosion does occur but in general slash and burn cultivation with its chapeo system of weeding combined with the rapid weed recovery cuts down erosion to a minimum. In the Highlands it is an important problem; with the more permanent system of agriculture natural vegetation is destroyed and the soil laid bare to erosional forces. As far as techniques of control are concerned they are well known all over Highland Meso-America, but today are often only half-heartedly carried out.

In the Valley of Mexico where a dense population has lived continuously for at least 3500 years, even including the colonial period, erosion has in general been carefully controlled except in the north. Two techniques are used: the "bancal" and the true stone-faced terrace. The bancal is used in gentle slopes or low hills or ridges and consists of levelling off the slope in a series of flat wide terraces followed by sowing maguey at intervals along the edges to prevent erosion.

On steeper slopes stone terraces are constructed of the Peruvian type. The bancal type is found all over the Meseta Central. The true terrace in the Mesa Central, as far as I know, is used today only in the southern and eastern valley of Mexico but is probably

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13. De La Pena, 1950.

more widespread. In the Tierra Templada of Morelos they are in common use in wet rice cultivation. In Oaxaca terracing is widely spread, both types being in use. In Guatemala terracing is evidently rare; instead contour hoeing is practiced, in effect converting slopes into thousands of minute terraces. The same system is found in highland Michoacan.

Hilling. The hoeing up of earth around each maize plant or hilling of the maize is almost universal in Highland Meso-America. It probably has a two-fold function: to give support to the plant and to increase the food supply.

Doubling of Maize Stalk. This is a common procedure in Lowland Meso-America, the purpose being to prevent water from seeping into the ear and rotting the grain, and to defend the plant against birds.

Economy of Maize Cultivation in Modern Meso-America

Most Mexican agronomists and American anthropologists are fond of stressing the great agricultural richness of the Tierra Caliente or Tropical Lowlands of Meso-America. This picture is based principally on the following observations: (a) the great richness of the natural flora; (b) the great variety of crops which can be grown; (c) the possibility of double cropping in some areas; (d) the relatively higher standard of living of the average costeno; and (e) the generally high yields on sown fields. All of these statements can be proven as true yet the conclusion drawn from these observations is completely false as we shall demonstrate shortly. The productive capacity in the Tierra Caliente in general is far below that of Highland Meso-America as we shall clearly demonstrate on the base of my

data and that of other published data.

In our comparison we will set up a model economy with maize as the subsistence base and with maize or some other crop as a cash crop.

Highland Economy -

The Teotihuacan Valley and the Chinampa Area

San Pablo Izquitlan, Humedad Area. This village is entirely a seed producer - maize, frijol, barley and with some production of pulque. An average family of 5 will consume, with the average number of domestic animals, approximately 1500 kilos of maize a year if maize is an important staple. On Tierra de Humedad a farmer can expect an average of at least 1200 kilos of maize. With a maize cash crop a farmer to maintain a standard of living approximating, say, that of the Maya of Yucatan needs to produce another 2 tons to sell, or 3.5 tons of maize in all. The village of 70 families then would have to sow approximately 210 hectareas of Tierra de Humedad to meet its expenses for a typical year, or about 3 hectareas each. As land is not rested at San Pablo on Tierra de Humedad this is also the total amount of arable land needed. The data offered by the Secretario Ejidal indicate that most of the present land held by the village is Tierra de Humedad and totals about 120 hectareas. The actual economic situation at San Pablo where the village doesn't have sufficient land to maintain itself to begin with is further aggravated because the land is all held by 11 families, who cultivate most of it as Tierra de Temporal due to lack of time. That the land and technique result in high productivity is evident when we consider that 350 people theoretically can support themselves on 2.1 $km^2$ of land or nearly 170 per $km^2$.

San Martin de los Pyramides. This village had 2629 inhabitants in 1950 or about 526 families. It again is situated in a Tierra de Humedad area, and is a grain-producing village. My data from this community indicate a higher yield than at San Pablo but are mainly based on a single informant whose lands are favorably situated for irrigation. We will assume an average production then similar to that at San Pablo, of 1200 kilos per hectarea. The 526 families would need then 1578 hectareas of Tierra de Humedad to support themselves as lands here are not rested either. The data offered by the Secretario Ejidal indicate that the village actually has 1500 hectareas of land, of which 1250 are Tierra de Humedad. If we were to include the village nopal orchards as a cash crop, combine this with the production of the 250 hectareas of Tierra de Temporal and the pulque production of the magueys which surround each field, then we can see that San Martin has reached the maximal population in terms of our model economy. Actually the standard of living is lower than our model economy as lands are not divided equally nor is the land as efficiently managed as might be possible with local technology.

In all, our data from the Humedad communities indicate a productive capacity enabling it to support at least 170 people per $km^2$, and suggests that the present population is higher than desirable for a standard of living equivalent to that of the Yucatecan Maya. Actually the situation is both worse and better than it seems - worse because of the factors named, better because we have not considered the production of pulque in the nearby slopes of the mountain ranges.

In the "Temporal" Area of the Middle Valley the situation is much less favorable. Our data are mainly from the last ten years

which were poor ones, but using them gives us a certain advantage as we can estimate the productivity of the area at its minimum. Barley sells about the same or slightly higher than maize so we need not change our technique of assessment of production for the family economy. My data suggest that over a ten-year period and including years which were total losses we cannot estimate an average annual production much over 500 kilos per hectarea. This also applies for barley. The average family then should have at least 7 hectareas of land to keep itself going, sowing all 7 every year without rest, say half in barley and half in maize and rotating fields from one to the other. Under this situation the population limit drops to 70 per $km^2$ of arable land. Utilizing this area are three villages: Santa Maria Coatlan, San Francisco Mazapan, and San Sebastian, with a total population of 275 families. An unknown number of residents of the town of San Juan also own part of the land and there are several large haciendas still operating sizeable chunks of land. The three villages theoretically can get along on 1925 hectareas of land. The average villager has much less today and if it were not for the tourist trade the standard of living would be down to subsistence levels. Also these villages specialize in nopal production or in crafts as brick manufacture and pottery manufacture which ameliorate the situation. In fact there is enough Temporal to support considerably more people than live in the area, and much of it is capable of higher production with an improvement of the irrigation system.

Santiago Atlatongo. Here with an abundance of permanent water for irrigation enabling the sowing of winter wheat the demographic possibilities are greatly increased. A single hectarea here over a

two-year period will yield about 2000 kilos of maize, 2000 kilos of wheat and 1400 kilos of barley. Wheat often sells considerably higher per kilo than maize but varies considerably from year to year in price. Here we will count it as maize in terms of earning power. If we assume each farmer to cultivate two plots, one in which a double crop of wheat and corn are to be produced and another of equal size to be sown in a single barley crop, and the fields alternated back and forth each year, then the average farmer would need about 1.5 hectareas of land to support himself permanently. The demographic limit under this economy soars to approximately 335 inhabitants per $km^2$. The village of Atlatongo in 1950 had 220 families and would then need about 330 hectareas of Tierra de Riego to maintain our model economy. It actually has 235 hectareas but in addition possesses 95 hectareas of Tierra de Humedad in the neighboring hills and 235 more hectareas of Tierra de Temporal on the nearby slopes. The data suggest strongly that the village has enough land to absorb another decade of normal population growth. The actual situation is very different - the average villager holds from .25 to 1.0 hectarea of irrigated and temporal ejido together, each, and the balance is in private holdings monopolized by some 30 families. The result is a low standard of living and there is a "land shortage" and many people "must work outside in the Mexico City labor market" in spite of the fact that the supply of land in terms of population is ample.

Down in Calvario Acolman the productivity of the land is less as most land is "medio riego". A hectarea of land there will produce in two years but 1350 kgs of maize, 1100 kgs of wheat and about 900 kilos of barley. The average family here would need 2.5 hectareas of

land to maintain itself and the population density drops to 200 per $km^2$.

## The Chinampa Area

San Gregorio Atlapulco. Our various data from San Gregorio give us a good cross-index to the productivity of the Southern Valley as our data cover several ecological sub-zones and different agricultural systems.

Chinampa Cultivation. If we first assume a model community with an entirely chinampa economy as Mixquic today, and Tlahuac say thirty years ago, we may summarize the situation as follows:

(a) In which the chinampero operates on a modern commercial truck garden basis. The average worker in Mexico City in 1953-54, the period of our study, gets along on a salary of 10-12 pesos a day. In normal years .1 hectarea of chinampa will yield a man 1000 pesos of truck garden crops. A chinampero could theoretically get along on but .36-.43 hectareas of land providing a demographic limit of nearly 1200 people per $km^2$ of chinampa.

(b) If we assume a maize subsistence and maize cash crop situation a family then needs .875-1.0 hectarea of chinampa. Accepting the latter figure this allows for a population maximum of about 500 people per $km^2$. A semi-commercial economy would range between these two extremes of .36 to 1.0 hectarea.

Temporal Cultivation. On the best lands, really Humedad lands, canadas with careful use of green fertilizers, a man can maintain our model standard of living on about 1.25 hectareas of land; without fertilizing but sowing maize year after year he would need about double that amount or 2.5 hectareas. The demographic potentialities are about those of the irrigated Lower Teotihuacan Valley. In general the total area of these lands in the Southern

Valley must be very small.

The data collected from the Loma milpas probably gives a good general average for most of the temporal lands of Xochimilco province with very broken topography. Under careful cultivation these lands will yield a maximum over a three-year period of 2250 kilos of maize, 1500 cuartillos of huauhtli, about 1000 kilos of chile peppers plus tomate in unknown quantities. If we maintain the described rotation system we can make a gross estimate of the three rotated fields of 2-2.5 hectareas for family needs. If carefully fertilized and rotated then these lands are capable of supporting 200-250 inhabitants per $km^2$. This reduces to 100-125 without heavy fertilizers, and by cultivating only maize without rotation or fertilizers and resting one year, cultivating the next we can estimate the needs of a family at 6 hectareas and demographic limit 80 per $km^2$. The latter data is useful as a theoretical minimal capacity of the land.

Taking San Gregorio Atlapulco as a community with its 1100 families we can on the basis of our data on landholding estimate the average size land held per family. It runs as follows: chinampa .36 hectareas, ejido humedad .36 hectareas, llano .07 hectareas, temporal-hillside 1.0 hectareas, or slightly less than 2 hectareas per family. Theoretically the chinampas plus the llano alone could feed the population and the remainder serve as marketable surplus. Actually the theoretical situation is even more favorable as the Chinampas are almost entirely a truck garden producing area and the total output translated to cash must come to nearly half a million pesos a year. If we considered the hill lands as the maize producing element the

hectarea allowed per family would easily provide enough maize to feed the community even without completely efficient use of all local agricultural knowledge.

In fact the village is entirely agricultural and is supported by but 2000 hectareas of land with a density per $km^2$ of farm land of over 270 persons, and the data suggest that the population is still capable of expansion.

## Lowland Economy

Applying our model economy to the two coast areas analyzed we get the following picture.

### Huimanguillo

Chicoacan. The average production of maize in this area is 850-1000 kgs per hectarea sown. In order to maintain this production the typical system is one in which a land is sown two years in succession and then rested six years when it is again brought into cultivation. Taking 1000 kgs as an average yield a man must sow 3.5 hectareas each year to support his family, or a little more than our Humedad farmer in San Pablo. But whereas in San Pablo this is all the land the farmer needs to maintain a balanced economy, the Chicoacan farmer needs at least 14 hectareas. The demographic potential of the area as a whole is then sharply reduced and the area can support but 35 persons per $km^2$. There are approximately 4000 hectareas of land of this type in our nuclear area and a population of only 200 families (Rancherias of Ostitan and Chicoacan), or about 20 hectareas of land available per family. Actually a fair percentage of that total is almost worthless transitional savannah or swamp but even so there is

as yet no population pressure. The surprising thing about the area is the fact that in spite of the abundance of land (and here it is almost all ejido with no large holdings) the standard of living is no higher than in, say, Atlatongo where the unequal land distribution has caused demographic pressure. The answer probably lies in a combination of the debilitating effects of malaria plus the fact that 3.5 hectareas of clearing in slash and burn cultivation in Tabasco means a heavy outlay in labor, and most farmers don't sow that much land.

Tierra Nueva. Tierra Nueva presents a more favorable picture for agriculture. In the first year of milpa two harvests may be made and production is higher per milpa than at Chicoacan. In the first year on the better lands about 2500 kgs of maize is harvested on the average with the two harvests, about 1500 in the milpa and 1000 kgs in the tonamil. During the second year a single sowing is made and then the land is rested for about 6 years, or we have a 1:3 cycle system. If we estimate the second-year milpa at 1000 kgs, approximately the tonamil of the first year, we can then postulate that a man, to maintain a balanced economy based on maize, would need exactly one hectarea of fresh milpa and one second-year milpa. Using the 1:3 ratio he than needs to have 2 hectareas of producing land plus another 6 hectareas in various stages of rest to maintain a balanced economy, or 8 hectareas in all. The demographic potential then would be about 60 per $km^2$. The Tierra Nueva farmer is in general a more prosperous individual than that from Chicoacan, as aside from high yields he can in some cases sow more productive crops such as rice and coffee and his crops are in general more dependable. In my

test area I estimated some 95 $km^2$ or 9500 hectareas of this class of land which is theoretically capable of maintaining 1187 families or 5935 people. It is difficult to estimate the actual population holding this land as most of the rancherias in this area include several types of land.

El Puente. This rancheria lies entirely within the Grijalva flood plain and presents ideal conditions for slash and burn or commercial agriculture, both the banana and the cacao yielding well here aside from sugar cane, coffee and rice.

First of all we will assume an economy based entirely on maize. Here we find the same productive cycle as at Tierra Nueva: two harvests the first year followed by a single harvest the second year, or three harvests over a two-year period. With a 2-years-of-cultivation-6-years-of-rest cycle the first-year fields, both harvests together, will yield 4050-4300 kgs of maize and in the second year 1500 kgs, or a total of 5500-5800 kgs for the two years. In our model economy he needs but 3500 kgs annually to support himself. He would then need to sow .6 hectareas of fresh land and .6 hectareas of second-year land to provide himself with 3.5 tons of maize a year. Multiplying this by four we estimate he needs just short of 5 hectareas to maintain a balanced economy.

If we utilize the data from our second informant who maintains a 1:2 cycle system our result is almost exactly the same. As he gives his land less rest his yields for a two-year period reduce to 2500 kgs and 900 kgs. If he were to sow one hectarea of new milpa and another of second-year milpa he would just about harvest 3.5 tons of maize. He then needs 2 hectareas in production and another 4 in

rest, or 6 hectareas in all, and we see that the law of diminishing returns begins to operate immediately in these tropical soils.

To carry this even further some farmers in La Libertad sow milpa in alternate years, one year in production, one year in rest. Cultivating intensively they produce a single harvest with an average yield of but 1200 kgs on the average. He then needs to sow about 3 hectareas to harvest 3.5 tons of maize and needs a total of 6 hectareas to keep his production going.

Our data indicate strongly that a farmer with holdings in the alluvial flood plain needs 5-6 hectareas to maintain himself permanently with a maize economy. If we include cacao cultivation or banana cultivation he can get along on even less but at any rate the alluvial flood plain is theoretically capable of supporting 80-100 persons per $km^2$. The municipio of Comalcalco actually achieves this density with a semi-commercial economy based on maize and cacao.

Using these data we can make a good guess at the demographic potential of our nuclear area and of the larger area of our Huimanguillo map. This however is but a theoretical limit, as not all of the area can be considered as productive.

| Nuclear Area | Area (hectareas) | Demographic Limit |
|---|---|---|
| Grijalva Flood Plain | 12,500 | 10,400 |
| Hilly Tropical Forest | 4,000 | 1,500 |
| Transitional to Savannah | 4,000 | 500 |
| Level Tropical Forest | 9,500 | 6,000 |
| | 30,000 | 18,400 |

The actual population of this nuclear area is just below 12,000, so that we can estimate that with a maize subsistence-commercial

economy the area is capable of supporting about 50 percent more people than it did in 1950. The theoretical density is about 61 per $km^2$.

Taking the map area as a whole the picture is not as rosy, as our nuclear area includes most of the first-class land.

| | Area (hectareas) | Demographic Limit |
|---|---|---|
| True Savannah | 15,000 | 0 |
| Transitional Savannah | 20,000 | 2,500 maximum |
| Small Flood Plains | 5,000 | 4,200 |
| Elevated Forest | 20,000 | 12,500 |
| | 60,000 | 19,200 |

Density 30 per $km^2$

Total area about 900 $km^2$
Demographic potential 37,600
Density 41 per $km^2$

The actual population of the area is but 15,000 so that the population is only about 40 percent of our estimated possibility.

The standard of living of the average Chontalpa farmer is much higher than that of a Teotihuacano and the reasons have nothing to do with the productivity of the soil. The population density of the Teotihuacan Valley floor today is about 150 people per $km^2$; that of our Chontalpa test area about 18; even the densely populated nuclear area has but 37. Wholly aside from the greater demands slash and burn cultivation make on zonal requirements, there is an abundance of land. The area is only 40 percent occupied in terms of its potential. In the Teotihuacan Valley some expansion is possible in local areas but under the present landholding set-up it certainly is undesirable. Second, although there are big fincas in the Chontalpa

most farmers have more than the minimum requirement of land for a completely maize economy, and as most alluvial flood plain cultivators have small holdings in cacao, a very productive cash crop, they are in an immeasurably superior position. Here again this has nothing to do with land productivity; he is able to take advantage of a fortunate set of international circumstances which set a high price on this particular product. In the Valley of Teotihuacan, however, there is a very uneven division of what land there is available and many farmers have none at all.

Our agricultural data fail to support in any way the commonly stated assumption as to the great "fertility" of the Tierra Caliente. Even the best lands in the Chontalpa do not produce more in terms of sown fields than the irrigated lands of the Teotihuacan Valley, and when we consider that the latter are in continuous production while the former are producing but one-fourth of the time, we can see slash and burn cultivation in its true perspective. Taking the Chontalpa as a whole and comparing it to the Teotihuacan Valley we see that the Valley is capable of supporting at least four times the population density as the Chontalpa, and this is a conservative estimate as the population of the Teotihuacan is not yet at the limit, and for comparison I am using the actual density whereas here I am using our theoretical marginal figure for the Chontalpa.

If we were to compare the Chontalpa with the Southern Valley of Mexico the overall zonal productivity of the latter would be even more striking.

Even in the field of commercial cropping the extremely productive cultivation of cacao in the Chontalpa cannot compare with truck

gardening in the Chinampa area. No hectarea sown in cacao will yield 10,000 pesos of produce annually as is earned on a hectarea of chinampa.

## Northern Yucatan

When we compare our highland data with that of Yucatan our argument becomes even more convincing.

In the Piste area Steggarda estimates the average milpa size at 4.5 hectareas. This will produce but 3.5 tons of maize according to his data, yields varying as they do everywhere. In most favorable parts of the Piste area a man may harvest as much as 1.5 cargas per mecate or 69 kilos per mecate, or about 1500 kgs per hectarea, but on poorer land, especially second-year land, production may drop to only .6 cargas or 600 kilos. He estimates an overall average of .75 of a carga per mecate or 700-800 kgs per hectarea.

The net result of his calculations is that a single family must sow 4.5 hectareas of milpa to maintain our model economy. Lands are cultivated from 1 to 3 years, in general running around 2, and are rested from 8 to 12 years. He assumes a 1:5 cycle as a good average assessment of the situation and estimates a family needs 600 mecates of land to maintain this cycle. Six hundred mecates of land calculate at about 27 hectareas. The theoretical population limit here under this system is but 18.5 persons per $km^2$. Kempton has estimated the average production of maize over Yucatan as 1 carga per mecate. If true our overall picture is somewhat better, increasing the demographic limit to 24. These figures are in close agreement with his estimate of a potential population of 60 per square mile. In the more fertile Puuc where the average production seems to be double this general estimate, our theoretical limit will need doubling. The

actual situation is not quite as favorable, however, as not all land is usable. In our study of Yucatecan demography we postulated a probable maximum of 15-20 per $km^2$ for the poorer areas and 30 for the fertile Puuc. In much of modern Yucatan the population has reached or is reaching this theoretical maximum and there is considerable colonization of lesser populated areas from these pressure areas, as we have shown.

## Comparative Data from Other Areas

That our comparisons of the economy of the Valley of Mexico with that of the Tierra Caliente are not overweighted in either direction, and to demonstrate that although the Valley of Mexico is more fertile than many highland areas, it is still representative, I will now present data from other sources to compare with my own.

Our first analysis will be that of Palerm.

Kelly and Palerm studied the economy of the Tajin Totonac who live in our Area No. 4. This is an area of hilly tropical forest, in which double cropping is possible, actually more productive than in the Chontalpa as the tonamil crop yields almost the same as the milpa. Slash and burn maize cultivation is characteristic combined with small vanilla plantations. We quote his assessment of the economy of the system below:

"On the average each Tajin family cultivates a milpa of 1 1/2 hectareas, which yields two annual maize harvests. During the initial two or three years the yields are good. After that the milpa is frequently replaced by the vanilla patch which requires the growth of some selected trees. After ten or twelve years the field is abandoned and it enjoys a complete rest for ten or twelve additional years. We thus have a cycle: milpa - vanilla patch (with partial)

return of the forest) - complete rest. This cycle lasts twenty-four years.

"The existence of this cycle implies that twelve hectareas of cultivable land are needed for each hectarea and a half in actual cultivation. These requirements would be smaller in the absence of the maize-vanilla rotation. On the other hand, the vanilla period also allows for the partial regeneration of the soil and the forest, and vanilla growing, by improving the economic condition of the cultivators, decreases the size of milpa required per family."[14]

Calculated yields are not given so we have no way of knowing whether the Totonac average milpa produces more or less than our 3.5 tons in our model economy. Also Palerm uses 6 people as an average family; we use but 5. The Pena study gives as an average production in the Papantla area 1500 kilos in milpa and 1500 in tonamil, or 3000 kgs in all.[15] This is presumably for first-year fields; again Kelley and Palerm present no data on second-year yields but we can assume a decrease as this is universal in other slash and burn areas. Even so the model family would need somewhat less cultivated lands than he indicates, probably 1.2 hectareas. The cycle is about twice that of our Chontalpa area, probably due to poorer soils and less rapid weed growth and forest regeneration. We can estimate at any rate that a Totonac farmer with a maize economy of our model production would need at least 10 hectareas of land to support himself.

Palerm then compares Totonac economy in the Tierra Caliente with

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14. Palerm, 1955, p. 28.

15. Pena, 1946.

that of the village of Eloxochitlan on the upper escarpment in humid Tierra Fria, our ecological Area No. 3. He states as follows:

"We find two kinds of milpa in Eloxochitlan: The garden or calmil (the milpa of the house) and the milpa proper. Both yield only one crop a year. Productivity per harvest of the fallowed milpa is pretty much the same as that of a slash and burn milpa. It is cultivated usually for two or three years and left to rest for about the same period. The calmil is harvested annually; it is fertilized with garbage, the dung of domestic animals and with dry leaves and twigs. The yield per harvest from a calmil is double that of a slash and burn or fallowed milpa.

"According to our figures (which naturally take into account annual yields as well as productivity per harvest) an Eloxochitlan family needs two hectareas of milpa and half a hectarea of calmil in order to reach the annual yield of maize which can be harvested in Tajin from 1.5 hectareas. But while the cultivation cycle in Tajin demands 12 hectareas of cultivable land per family, in Eloxochitlan it requires only six hectareas and a half.

"Obviously the agricultural system of Eloxochitlan allows a greater density of population (almost double) than that of Tajin. In addition the permanent nature of the calmil (which lives in symbiosis with the house and acts as its pantry) and the almost perennial 'fallowed' milpa encourage, if they do not impose, a stability of residence."[16]

Finally Palerm compares both of these economies to that of

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16. Palerm, 1955, p. 29.

Tecomatepec in the sub-humid plateau area of the state of Mexico.

"Productivity of irrigated agriculture (combined at Tecomatepec with a more consistent use of fertilizers) justifies these efforts. The yield is two and a half times greater than that of fallowed land. Also the same field can yield two crops annually: one with irrigation, the other without. Cultivation proceeds continuously; there is no need to 'rest' the soil.

"According to our figures the one and a half cultivated hectareas needed in Tajin and the two and a half required at Eloxochitlan can be reduced in Tecomatepec to .86 hectareas. The decrease is even more impressive if we compare the cultivable surfaces needed per family: twelve hectareas in the slash and burn system; six and a half in the fallowing-and-calmil areas; .86 hectareas in those where it is supplemented by irrigation."[17]

One of the most thorough studies of Highland economy in modern Meso-America was the study carried out by Sol Tax at Panajachel.[18]

Panajachel is a municipio lying on the north shore of Lake Atitlan. The lake is situated at approximately 1560 meters above sea level, thus falling in our upper belt of Tierra Templada. The village is situated at the strategic midpoint between the Tierra Fria to the north and the Tierra Templada to the south, the center of Guatemala's coffee country. The lake is almost surrounded by volcanic slopes, and the scarcity of land combined with the strategic position has had two major effects on the economy of the population:

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17. Palerm, 1955, p. 30.

18. Sol Tax, 1953.

(a) forced them into an extremely intensive system of agriculture based on the restricted amount of lake shore plain and almost equalling Chinampa agriculture in its productivity; and (b) development of trade as a specialized activity. The lake and its shore villages present in miniature the situation in the province of Xochimilco in the southern Valley of Mexico. Rainfall is heavier than the southern Valley, 1443 mms of rain a year, but here again the difference is not as great as it seems because of the lower altitude and increased evaporation. The rainfall cycle is similar to that of the Xochimilco-Chalco area with most of it falling between May and October and an almost complete drought the rest of the year. In total rainfall it compares most closely with Jalapa in Vera Cruz but in the latter the rainfall is distributed all year and double cropping may be carried out.

The central problem in the Atitlan area is the scarcity of first-class alluvial lake shore lands. The lake itself is evidently too deep for chinampa cultivation. Panajachel itself stands in one of the few fairly extensive alluvial pockets and has developed a fully commercialized type of intensive agriculture based on truck vegetables as at San Gregorio and Coffee. All-year cultivation is characteristic, along with the use of seed beds and fertilizers in the truck gardens and irrigation based on a central stream resorted to during the dry season.

The village in 1936 had a total population of 1200 (800 indios, 400 ladinos). The average family was composed of about 5 persons, or about the size we have used in our studies, and there are then approximately 240 families in the village.

The village holds two basic land types: hill or slope land

cultivated by temporal techniques and largely devoted to milpa, and delta or lake shore plain devoted to coffee and truck vegetables. Sol Tax's estimate of the holdings is as follows:

| | |
|---|---|
| Delta | 232 hectareas |
| West Hill | 168 hectareas |
| East Hill | 212 hectareas |
| Total | 612 hectareas |

In terms of land use the holdings break down as follows:

| | | |
|---|---|---|
| East Hill, 212 hectareas | | |
| Corn field | | 96 hectareas |
| Coffee | | 2.4 hectareas |
| Pasture | | 20 hectareas |
| At rest | | 70 hectareas |
| Unusable | | 23.6 hectareas |
| West Hill, 168 hectareas | | |
| Corn field | | 18 hectareas |
| Unusable | | 146 hectareas |
| Pasture | | 4 hectareas |
| Delta Land, 232 hectareas | | |
| River bed, unusable | | 52 hectareas |
| Occupied by constructions etc. | | 22 hectareas |
| Agricultural land | | 158 hectareas |
| Truck gardens | 58 | |
| Coffee | 78 | |
| Maize alone | 6 | |
| Pasture only | 6 | |

Delta land is intensively used and almost never rested, often in almost continuous cultivation. Tax summarizes a number of systems in vogue in using what we have called truck lands and are as follows:

1. Rotation of corn with garlic, in this case continuous use without rest. Usually garlic is followed by corn which is followed by a different crop and then the farmer returns to garlic again, the cycle being repeated.

2. One season of corn followed by beans and repeated the following year. In this case the land is rested 2-3 months each year.

3. A season of corn followed by onions or other vegetables, then repeated. Here again the land receives a few months' rest each year.

4. Continuous cropping of vegetables in rotation using seed beds. If timed right the land is never idle as in the chinampas but often land may periodically be rested 1-2 months a year.

5. A crop of corn or maize and then pepino or cucumber following it in the dry season, usually being sown during the ripening of the corn.

6. A single crop of cucumbers with a long growing season.

Corn is invariably a rainy season crop, most of the others irrigated dry season crops. For vegetables the raised bed of soil or "tablon" which we noted in the chinampas is used.

Maize is in general a hill crop although it is important in delta cultivation as well; at the time of the Tax study he noted 40 percent of truck gardens with maize during the summer season. On the hillsides it is sown mixed with beans and is not fertilized except by hoeing under weeds and stalks. The scrubs and weeds are first cleared with the machete and then the soil thoroughly worked over with the hoe. Delta land is of course fertilized. One of the interesting facts about hillside cultivation here is the cycle of cultivation and rest. On gentle slopes lands may last 12-25 years without rest, on steeper slopes only 10. In the latter case he was told the lands were then rested 6 years, and then could be brought back under cultivation.

In delta truck lands (coffee lands of course being a different category) in terms of annual production we can safely say that no rest is given the land, that is some crop comes out at least once a year. In hillside we can only guess but the data from Tax along with his estimate of land actually in cultivation indicate that at least 62 percent may be actually sown each year, the balance kept in rest. In terms of utilizable land his data indicate that out of a total

612 hectareas held by the village 221 hectareas are unusable for agriculture, or about one-third.

Maize Production. On delta lands yields are high and dependable. One informant sowed maize 15 consecutive years and harvested an average of 46 bushels an acre, or 2875 kilos a hectarea. On an experimental milpa in a bad year Tax harvested 25, and he feels that 20 is a minimum yield for these lands and takes 46 as a maximum. He estimates a probable average yield of 30-35 bushels an acre or 1950-2275 kilos per hectarea. On hill land I quote Tax's summary:

"If such records are typical the yield of hillside land corn rarely if ever reaches 30 bushels per acre. The range in cases reported is from 29 down to 11 bushels per acre, the average of good and bad years about 20 bushels per acre. In the long run bad years may be less frequent and the long time average yield closer to 30 than to 20 bushels as the Indians believe....It should be emphasized that Panajachel hill land is not exhausted as quickly as reputed here and elsewhere using the same system of agriculture. The land of cases 3, 4 and 5, in use continuously since 1914 yielded 22.5 bushels per acre of yellow corn in 1940, compared with the yields of 28 and 25 bushels per acre for second and third year land (cases 1 and 2). Cases 7, 8 and 9, in continuous use since 1924, show a yield of 25 bushels per acre in 1940..."[19]

If every family at Panajachel possessed an equal share of agricultural land it would hold .66 hectareas of delta land and .9 hectareas of hillside land, of which we will estimate he can keep .6

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19. Sol Tax, 1953, p. 51.

hectareas in continuous production. On these holdings he would be able to harvest approximately 53 bushels on his delta land and 30 bushels on his hillside milpa, or 83 bushels of corn in all, with a total production of 2158 kilos of maize. He would be able to feed himself but would not be able to produce the amount of surplus that our model family needs. This is doubtless the reason he has turned to intensive horticulture and small coffee plantations for his commercial crop and is really a commercial rather than subsistence farmer. My own impression is that if all had equal holdings the village could maintain a standard of living equivalent to our model families with commercial agriculture. The actual situation is of course highly pressurized by the uneven distribution of lands. There are 30 absentee Ladino land owners who hold 150 hectareas of land. Of the land held by the village residents, the Indian population which makes up 160 of the 240 families own but 18.7 percent of the total land area of the community.

To maintain a model economy based entirely on maize we might estimate that the average family of 5 would need 1.75 hectareas of delta land or 3.9 hectareas of hill land (of which 2.3 hectareas actually are in cultivation), or a combination of both hill and delta land in whatever combination you care to make. The demographic potentialities of even a commercial maize economy are very high even in the Atitlan region where we have a high percentage of unusable land. The actual present density at Panajachel is 200 per $km^2$ of total village land.

Lewis's study of Tepoztlan gives us a good representative example of Highland agriculture in the less favorable type of

ecological setting, that of the rugged escarpment.[20] In general these areas have heavier rainfall (Cuernavaca just above Tepoztlan has slightly over 1000 mms of annual rainfall) than the mountain valleys or the open plains of the Meseta Central. Crops rarely suffer from drought; the main defect in this type of ecology is the small percentage of good land and overwhelming quantity of marginal or unusable rocky slopes. Teopztlan is situated in the 1600-2000-meter band or the lower zone of Tierra Fria and suffers rarely from frosts, and sowing may even be delayed until well into July.

The municipio of Tepoztlan includes one large central village and seven smaller satellite villages. The total population in 1940 was 6034 inhabitants, of which 3230 live in the central community. The area covered by the municipio is 25,910 hectareas or 259 $km^2$ with an overall density of but 17 inhabitants per $km^2$. The municipio lands were divided up in the agrarian census in the following way:

| Type of Land | Area (hect.) | Percentage of Total |
|---|---|---|
| Monte Alto (high bush) | 11,400 | 44.0 |
| Monte Bajo (low bush) | 5,750 | 22.0 |
| Hill, not useful for agriculture | 3,010 | 11.0 |
| Temporal Lands, first class | 675 | 3.8 |
| Temporal Lands, second and third class | 5,075 | 19.1 |
| | 25,910 | |

The 22.9 percent of lands classed as Temporal are mainly plow agricultural lands. In terms of actual land use he breaks down the municipio as follows:

20. Lewis, 1951.

| | | |
|---|---|---|
| Monte | lumber, firewood, charcoal | 45% |
| Texcal | tlacolol cultivation, firewood | 10% |
| Terrenos Cerriles | grazing, tlacolol, firewood | 18% |
| Cerros | some grazing, tlacolol, but generally of little use | 12% |
| Terrenos de Temporal | plow agriculture | 15% |

Texcal refers to a recent volcanic flow covered by scrub forest. Terrenos Cerriles are rolling hills covered by scrub forest. Cerro refers to scrub forests on steeper slopes.

Of the land classified as Tierra de Temporal he estimates that first-class land produces 2 cargas per cuartillo of corn sown, and comprises 3.8 percent; second-class land yields but 1 carga and accounts for 45 percent, and third-class land which yields but .5 cargas accounts for the remainder. The latter is land on steep slopes, which is terraced by stone terraces and has a high stone content. Some of it is evidently cultivated by plow, some by hoe, but it may be classed as permanent land.

Utilizing Lewis's figures we may estimate the production of maize on the permanent cultivated land. Lands are not fertilized and rarely rested. His yields are in cargas per corn on the ear and to be reduced to 2/3 for calculating production in grain. The 675 hectareas of first-class land then will produce an average of 13.2 cargas per hectarea (1980 kilos per hectarea) or approximately 1359 tons of maize. The second-class lands will yield some 6.6 cargas per hectarea or 2537 tons of maize, and the third-class lands will yield some 1268 tons of maize (.3 cargas per cuartillo, 3.0 per hectarea, 450 kilos).

The total production would be 5,155 tons of maize. With our balanced economy of 3.5 tons of maize per farmer these lands will provide for some 1473 families or slightly more than the present

population of Tepoztlan.

Yet Lewis's study indicates a definite land shortage in Tepoztlan today. Here again the explanation rests with the landholding system, not the productivity of land. The land produces more than that of northern Yucatan, and without the necessity of resting it for 8-12 years after 2-3 years of production.

Sixteen percent of the municipio is privately owned and this includes most of the plow temporal lands. Eighty percent of the municipio is communal land which consists mainly of the texcal, monte, cerros and terrenos cerriles. Ejido lands constitute 5 percent and are mainly plow agricultural lands. Of the land in private holdings only 36 percent of the villagers actually possess land, most of these holdings running less than 9 hectareas. Furthermore only 31 percent of the families have ejido lands. Even more important is the fact that of the 267 holders of ejido parcels, 109 also hold private lands. Over half of the village population holds no land at all. If the lands were divided up equally amongst the 1207 families of the municipio, each would receive .55 hectareas of first-class land, 2.0 hectareas of second class, and 2.0 hectareas of third-class land. He could produce annually some 1105 kgs on his first-class land, 2010 kgs on his second-class land, and 1005 on his third-class land, or 4120 kgs in all, more than our model family needs. Lewis makes the statement that "The large number of landless people and the small size of landholdings result from shortage of tillable land, rather than from concentration of land ownership in the hands of a few individuals."[21] His own data do not support this statement,

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21. Lewis, 1951.

which more correctly should be worded the reverse.

The lack of an equitable land division, however, has produced a demographic pressure and the landless families exploit the village communal lands for tlacolol cultivation or for forest products. Some 50 percent of the tlacoloros depend entirely on these lands, others who hold very small amounts of ejido or private lands also resort to tlacolol cultivation. Techniques of cultivation are similar to those described. The lack of real demographic pressure is indicated by the lack of use of green fertilizers, use of machete rather than true weeding, and finally lack of soil erosion techniques, all of which are commonly used techniques in nearby areas. The indications are that, as yet, there is no heavy land pressure, Lewis to the contrary. Yields on tlacolol lands are high as one might expect, as fields are only cultivated one or two years; first-year fields yield at least as high as first-class plow lands. On steeper slopes erosion may be devastating upon abandonment of the field. In tlacolol cultivation at Tepoztlan it is meaningless to speak of cycles as there is as yet no real land pressure in these lands.

Today tlacolol cultivation is carried out in some 40 percent of the total municipio lands. How much of the remaining 45 percent of municipio land classed as "monte" would be good for tlacolol cultivation he doesn't estimate, but a good part of it, if covered by conifers, is probably not very good for farm land; at any rate a relatively high percentage of the municipio will produce maize, at least 55 percent and probably at least two-thirds.

The lack of land pressure is clearly indicated by the fact that but 189 families or 21 percent of the population cultivated tlacolol

land in 1944 in spite of the unbalanced ownership system. The average field was only about 1 hectarea. Only 189 hectareas then were actually utilized of the certain reserve of some 8000 hectareas.

In summary we may state that at present there is no land shortage in Tepoztlan. It undoubtedly will result if the present uncontrolled tlacolol system is extended; some technique of erosion control is essential and if carried out will enable a considerable demographic growth. Yields on permanent lands are higher than in northern Yucatan.

Another way of comparing the productivity of the Lowland as contrasted to the Highland area is by estimating the production of a given field over a long period. In this way the cycle differences are eliminated. The below charts summarize the data very well.

Comparative Crop Production Per Hectarea
Highlands and Lowlands

Highlands

| Community | Land Type | Annual Production | Production for 24-Year Cycle |
|---|---|---|---|
| San Pablo Izquitlan | Humedad, Irrigated by Flood Water | 1.2 tons maize | 28.8 tons maize |
| San Francisco Mazapan | Temporal Lands | First Year: .5 tons maize | 6.0 tons maize |
| | | Second Year: .5 tons barley | 6.0 tons barley |
| Santiago Atlatongo | Perennial Irrigation | First Year: 2.0 tons maize, 2.0 tons wheat | 24.0 tons maize 24.0 tons wheat |
| | | Second Year: 1.4 tons barley | 16.8 tons barley |
| Calvario Acolman | Perennial Irrigation | First Year: 1.35 tons maize 1.1 tons wheat | 16.2 tons maize 13.2 tons wheat |
| | | Second Year: .9 tons barley | 10.8 tons barley |

Highlands, continued

| Community | Land Type | Annual Production | Production for 24-Year Cycle |
|---|---|---|---|
| San Gregorio | Chinampas | 4.0 tons maize | 96.0 tons maize |
| San Gregorio | Fertilized Canada | 3.0 tons maize | 72.0 tons maize |
| San Gregorio | Unfertilized Canada | 1.5 tons maize | 36.0 tons maize |
| San Gregorio | Fertilized Loma | First Year: 2.25 tons maize<br>Second Year: 15 cargas huauhtli<br>Third Year: 1 ton chile plus tomate | 18.0 tons maize<br>120 cargas huauhtli<br>8 tons chile |
| San Gregorio | Unfertilized Loma | About one-half of Fertilized Loma | |
| Eloxochitlan | Barbecho | 1.5 tons maize | 18.0 tons maize |
| Eloxochitlan | Calmil | 3.0 tons maize | 72.0 tons maize |
| Tecomatepec | Irrigated Tierra Templada | 3.75 tons maize | 90.0 tons maize |
| Panajachel | Delta | 2.0 tons maize | 48.0 tons maize |
| Panajachel | Hillside | 1.2 tons maize | 17.0 tons maize |
| | | Lowlands | |
| Chicoacan | Forested Hills | 1.0 ton maize | 6.0 tons maize |
| Tierra Nueva | Flat Forested | First Year: 2.5 tons maize<br>Second Year: 1.0 ton maize | 12.0 tons maize |
| El Puente | Alluvial Flood Plain | First Year: 4.3 tons maize<br>Second Year: 1.5 tons maize | 17.4 tons maize |
| Piste | Sub-Humid Scrub Forest | .8 tons maize | 3.2 tons maize |

Lowlands, continued

| Community | Land Type | Annual Production | Production for 24-Year Cycle |
|---|---|---|---|
| Tajin | Forested Rolling Country (double harvest) | 3.0 tons maize | 6.0-9.0 tons maize |

## Double Cropping

This term in general refers to the practice, mainly in the Tierra Caliente, of raising two maize crops in the same year on the same field. There are probably more extravagant statements about this aspect of cultivation in the Tierra Caliente than any other. Often we hear about three and even four annual maize harvests. Most of these data are from areas where we have no pronounced dry season, and the local population may actually sow maize at four different periods in the year and give each harvest a separate name equivalent to the term milpa or tonamil. In the cases of three or four harvests they cannot be carried out on a single plot of land - the growing season of corn, in spite of some fantastic claims of 60-day maize, is too long. The extra sowings are made on different plots and obviously have nothing to do with the demographic potentiality of the area. There is a variety of maize which does produce grain in approximately 7 weeks, commonly sown in the Tierra Caliente, but it produces small ears of lightweight grain which is eaten in elote form and the production per hectarea in weight is very low; we certainly cannot include it as an extra "harvest". All of the so-called double cropping in Yucatan is of this type. In a few years it may rain in April, the fast-maturing maize is sown, harvested in late June, and then the true milpa is sown at the end of June or beginning of July. Farmers often risk a sowing of this type of maize

if they fear the previous year's harvest will not hold them through.

The typical pattern of true double cropping in the Tierra Caliente follows the system we have described in Tabasco and Kelley and Palerm described for Tajin. We have two full crops, the summer crop called "milpa" and the winter called "tonamil." In general tonamil yields much less than milpa; at Tajin evidently they yield equally well. In most of the Tierra Caliente the addition of the winter crop does not double the annual maize production, it increases it by some 40-70 percent.

Double cropping can effectively be carried out in the northern Totonacapan, in the Tuxtla Ranges, along the lower escarpment of the Sierra Madre Oriental, and finally over most of the Tabasco Plain and neighboring lower escarpment of the Chiapas mountains. On the Pacific coast double cropping without irrication is very rare.

One aspect of double cropping has never been pointed out, and that is its effect on the generally poor soils. It seems to me very probable that the reason for the much longer rest period given abandoned plots by the Totonac as compared to the Maya (especially considering that forest regeneration is faster in the Totonacapan) may be not so much due to vanilla cultivation but to soil exhaustion following double crops for 2-3 years. If true then double cropping, far from increasing the zonal production of lowland areas, may actually reduce it or a real increase may be slight. I am tempted to think of double cropping in terms of arising from a situation of abundance of land and low population density. In support of the soil exhaustion idea, in Tabasco where the cultivation cycle is short, even on the more fertile river flood plain double cropping is possible

only for the first year, and second-year milpas yield very low following the two harvests of the first year.

Above 800 meters double cropping is in general impossible without irrigation, except for a few narrow strips of Tierra Templada escarpment. In the 800-1600-meter band where we have permanent irrigation, double cropping is almost universal; irrigated lands are rarely rested during the dry season as long as water is available. Above 2000 meters double maize harvests are impossible even with irrigation due to the winter frosts. Such grains as wheat and certain European truck vegetables can, however, be grown as we have observed in the Teotihuacan Valley and in the Chinampa area.

One of the characteristics of Highland double cropping, especially in connection with truck garden, is the use of the seed bed.

## Crop Variety

One of the characteristics of Lowland agriculture as compared to Highland agriculture is the comparatively richer variety of crops. Outside of the Chinampa area or other local areas of truck gardening, the variety of crops cultivated in at least the Tierra Fria zone is very limited. The Teotihuacan Valley is a good representative area in this respect. In contrast, in Tabasco and even sub-humid Yucatan we find one of the most varied agricultural complexes in the world. This is one of the features which gives the Tierra Caliente its appearance of greater agricultural wealth. This is a rather deceptive feature and has been much overplayed. Most of these extra cultivates are fruits, not basic foodstuffs, produce entirely in one season and cannot be stored. Furthermore Coastal people characteristically eat little fruit in spite of its variety in the area and

the average farmer possesses only a few of most of the fruit cultivates. The Maya eat more maize than the Mestizos of the Valley of Mexico. Even root crops are rarely sown in quantity and make up but a minor item in the diet of the people. In Tabasco rice and plantains are important dietary items, but both are Old World cultivates.

In the Highlands, although the variety of crops is less, what is produced is more generally consumed as basic foodstuffs. Pulque for example is a daily item in most households, produces all year, replaces maize in the making of pozol, and therefore reduces the daily maize requirements. Nopal is the only fruit in abundance but it produces most of the year and is another important foodstuff.

The great variety of crops in the Lowlands, in summary, is interesting from the point of view of crop technology but is a minor factor in terms of agricultural economy; the situation is actually reversed - the farmer of the Mesa Central undoubtedly consumes less maize daily than the Maya of Yucatan.

## Percentage of Land Use

In terms of land usable for agriculture we find a number of separate ecological types in Meso-America. In the case of such areas as the Oaxaca Highlands or Hidalgo the great predominance of denuded slope over valley must certainly reduce sharply the overall demographic potentialities of the area. Oaxaca in spite of its overall greater intensity of the agricultural system is about as densely populated as the Vera Cruz Tierra Caliente where slash and burn agriculture is in vogue. The mountain valleys of Oaxaca are very densely populated but there is so much uncultivable land that the overall density is low. In areas of similar topography

but with more rainfall the overall density may be higher, as in the case of the Tierra Templada of Vera Cruz and the Guatemala Highlands. In these more humid areas we find more soil and vegetation on the slopes, and even the steeper slopes may be cultivated.

In the Meseta Central the situation is different, and the population, although it tends to be much denser in the more productive areas, is dense in an overall sense as well. Most of the Meseta can be used for some agricultural crop. In the drier, scantier-soiled slopes maguey, frijol and barley are cultivated; in the valley bottoms maize and wheat are most common. Mountain slopes above 2800 meters are unproductive for agriculture but only a small fraction of the area occurs at this altitude. Sanchez Colin for example estimates on the basis of government statistics that in the districts of Texcoco, Chalco, Otumba, Cuauhtitlan and Zumpango there are 365,000 hectareas of agricultural land. The total gross area of these five distritos is 469,000 hectareas; 78 percent of the total land area is then classed as agriculturally productive.[22] The Meseta Central is probably unique in Highland Meso-America in terms of the percentage of the total area which is cultivable.

Contrary to popular opinion, a substantial percentage of most tropical lowland areas is not productive agriculturally. In our Chontalpa study we discovered that some 11 percent of the total map area is uncultivable savannah, and approximately 26 percent more is transitional savannah-forest and of limited demographic potentiality.

In Yucatan it is not possible to completely estimate the

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22. S. Colin, 1951.

percentage of maize land, but if we can use the data from the Uaxactun settlement pattern study as typical of the Peten, then some 30 percent of the area is swampy bajo unsuitable for cultivation. Some of the steeper slopes of the upland area are undoubtedly marginal also in agricultural potential. My own estimate of the ejido of Kantunil Kin is 20-25 percent swamp bajos and scrub savannah.

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# ANCIENT AGRICULTURE IN MESO-AMERICA

One of the reasons an ecological approach to the historical problems of Meso-America can be a very effective and fruitful one is because of the exceedingly simple equipment with which the ancient farmer faced the problems of this extraordinarily complex region.

During most of Meso-American history he managed with a stone axe, a planting stick, a net container for carrying seed and with one ally - fire - tried to tackle the problem of agriculture in the forested Lowlands. Although it has been argued and reasoned that the slash and burn technique now so characteristic of the Lowlands could never have supported a civilization of the richness of the Maya, there is no evidence from the period of the conquest, or from the archaeology, of a more complex technological system. Relaciones of the sixteenth century are quite definite on this point. Ponce, speaking of Yucatan for example states:

"It seems impossible that this maize, of which we speak, is able to yield in that province because the Indians sow it among the rocks, where it seems there is no moisture whatever, and nevertheless the land is so good and fertile, that without any other tillage, plowing or spading, but with only the timely burning of the bush the land is left so well cultivated by the fire and so well prepared

for sowing that, sown thus, it produces very tall and stout stalks and on each of them, one, two and even three ears: and the more and better burned the milpa is, the more and better corn it produces because the fire and the ashes from it serve as dung that burns the insects and roots of the weeds, and when the milpa has been recently burned and the maize sown thus and the rains approach (of which the Indians keep careful count), it sprouts quickly and grows with the showers and when the weeds start to grow, they find the maize already up, so that they cannot grow well before they are crushed and smothered, and the maize prospers and grows very fast till it reaches full size."[23]

Throughout the Relaciones Geograficas de Yucatan we find enough sporadic data on slash and burn agriculture to indicate that at the time of the conquest at any rate it was the basic system.

The system was probably widespread throughout Meso-America in areas below 800 meters above sea level. Theoretically intensive agriculture could have been developed in this area but the difficulties involved are enormous. Aside from poor soils and the lack of techniques of restoring them, the main problem in the Tierra Caliente is the continual battle with the grassy and herb-like weed vegetation. The data on this aspect of milpa cultivation is unusually convincing. On first-year lands all over the Lowlands weed competition is slight; as each year of cultivation passes it becomes more and more severe. The studies of Carnegie Institution in Yucatan clearly established this fact.

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23. Ponce, 1932.

Morley postulated that the ancient Maya may have uprooted the weedy growth rather than simply cut it down as is done in modern machete chapeo, and therefore prolonged field use. Carnegie's test milpa from Piste indicates this is true to a certain extent. The main reason the modern Maya abandons a field in 1-3 years is because of decreasing yields, mainly caused by weed competition; if weed growth could be controlled then field use could be prolonged until the soil would give out, as in West Africa today where weed growth is controlled by careful and thorough hoeing with iron-bladed hoes. Even this, however, doesn't solve the problem and may even aggravate it. Normally in the calcareous soils of northern Yucatan grasses do not grow very well and cannot compete with other weeds in the normal 1-3 years of cultivation 8-12 years of rest system. However, by prolonging the period of cultivation in the way Morley postulates, grass will evidently come in and completely dominate the plot. For example in an experimental milpa at Chichen Itza, Morley sums up:

"For the first four years the annual yield of corn rapidly decreased under the modern method of weeding, that is cutting rather than pulling up the weeds by their roots. The fifth year the experimental milpa was weeded the ancient way, by completely pulling up the weeds, removing even their roots. Under this more thorough method of weeding, the yield slightly exceeded even the first year's crop, but lost more than half the next year (the sixth year). It gained again in the seventh year....But grass, the undefeatable enemy of milpa agriculture, eventually crowded out the bush...in the closing three or four years (that is, from the fifth or sixth through the eighth)...grass everywhere invaded this...tract of land so that it

became more and more covered with a thick grassy mat, through which even weeds, to say nothing of cornstalks, could not push their way."[24]

If Morley is right, and in the densely populated Peten during the Late Classic Period, demographic pressure had reached the point where say a barbecho type of cycle was resorted to, one can imagine the general effect carrying it out on a grand scale, and we have here a potent argument for an ecological basis to the collapse of the Classic Maya Civilization in that area.

At Tulum I conducted an experiment in terms of labor involved in true weeding of a third-year milpa, that is one in which weed growth was beginning to make itself evident. The most a worker could clear in a normal working day by weeding this way was half a mecate. To keep weed growth completely in check even in Tulum with a climate and soil similar to Central Yucatan a weeding would have to be given at least once every two months and a monthly weeding would be more effective. This means that if the farmer weeded this way he could not control weed growth on more than .5-1.0 hectareas of land. In most of Yucatan this land would not even support his family or barely do so, if he managed to keep the entire hectarea under cultivation. This refers to weed competition in a third-year milpa in a sub-humid area. If it were the sixth, seventh or eighth year as in the experimental milpa at Chichen, and if we move to the Totonacapan or Tabasco under humid conditions, the possibility of intensive agriculture in the coastal Lowlands becomes fantastic. We will refer back to this problem in a later discussion.

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24. Morley, 1947

The description by Kelly and Palerm of the intensely difficult problem of weed competition in the more humid Lowlands of the Totonacapan give one the impression that the Totonac suffer from a sort of Weed Paranoia. The whole family must participate in an almost continual struggle with weeds over most of the growing season, and exaggerated precautions are taken such as carrying out of the milpa seed-bearing crowns of especially troublesome plants and washing of the feet before entering the milpa to prevent accidental carrying of seeds into it. Of extreme interest is her following statement:

"As might be expected, several grasses are troublesome in the maize field....However it is said that they do not make serious inroads in a milpa unless the monte is removed by root. In that case they are able to establish themselves and may form a grass covering so thick that other plants have difficulty in penetrating the sod..."[25]

Slash and burn farming with a good lengthy rest period is evidently the only effective way of controlling weed and especially grass invasion and without much doubt has been the basic agricultural system in Lowland Meso-America throughout most of the history of the area.

In the Highlands, especially the sub-humid portions of them above 800 meters, weed competition, as has been pointed out, is a minor problem. Even the primitive coa, a sort of all wood shovel, can easily cope with weed growth combined with true weeding by hand. Today in much of the sub-humid highlands a much more intensive use

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25. Kelly and Palerm, 1952, p. 114.

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of the land is characteristic, as we have noted. An important problem in this respect is the maintenance of soil fertility and it is met in several ways. How many of these soil restoration techniques were known and utilized by the pre-Spanish peoples is an important problem. Data is disappointingly scanty and most of my conclusions are based on demographic arguments rather than data on soil fertility maintenance as such. However there is enough data to warrant certain conclusions.

In our study of modern Highland agriculture we have pointed out a number of techniques.

1. Tlacolol. This is simply short-term resting and the technique as described involves several years of cultivation, followed by a generally equal period of rest and then return to cultivation. Burning is resorted to for primary clearing and the hoe for preparation of the soil. This system is undoubtedly very ancient and probably the basic Highland system from the period of earliest agricultural occupation, the coa being used of course instead of the steel hoe, but this is the only change.

2. Barbecho. Unknown as plows and draft animals were absent; the tlacolol is the aboriginal counterpart.

3. Fertilizers. We have no definite data on animal fertilizers except Bernal Diaz's famous statement with respect to the Valley of Mexico in his Tlatelolco market catalogue:

"I must apologise for adding that boat loads of human odure were on the borders of adjoining canals for the purpose of tanning leather which they said could not be done without it. Some may laugh at this, but I must assert the fact is as I have stated it

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and moreover upon all public roads, places for passengers to resort to were built of cane and thatched with straw or grass in order to collect this material!"[26]

I don't doubt that the Aztecs were using it to tan leather but Diaz's concluding statement indicates in my opinion that the actual volume of collection must have far exceeded the needs of the tanning industry. An extensive use of this item must obviously be combined with some more effective system of transport than the human back, and the lakes undoubtedly played a key role in the movement of it from market to farm.

That some fertilizers were in use I have no doubt; Sahagun gives us a fascinating classification of types of agricultural land which could have been written by a modern San Gregorian peasant, and includes several types of fertilized lands; one is evidently the calmil type, another describes the use of green fertilizers as used today in San Gregorio and the third is not clarified. I quote in full below.

"A la tierra fertil para sembrar, y donde se hace mucho lo que se siembra en ella, llaman atoctli, que quiere decir tierra que el agua ha traido; es blanca, suelta, hueca y suave, es tierra donde se hace mucho maiz o trigo. Hay otra manera de tierra fertil donde se hace muy bien el maiz y el trigo, llamanla quauhtlalli, que quiere decir tierra que esta estercolada con maderos podridos, es suelta, amarilla y hueca.

"Hay otra tambien fertil que se llama tlalcoztli, que quiere decir, tierra amarilla, el cual color significa fertilidad. Hay otra

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26. Bernal Diaz, 1927.

manera de esta muy fertil que llaman xalatoctli, porque es tierra arenosa que el agua la trae de los altos, y es suave de labrar. Hay otra manera de tierra fertil que se llama tlazotlalli, es tierra donde las yerbas se convierten en estiercol, y sirven de abono enterrandolas en ella. A la tierra arenisca y escasa, y que da poco fruto, la llaman xalalli, que quiere decir tierra arenosa y esteril. Hay otra pegajosa buena para hacer barro de paredes, y suelos para los tlapancos, es fertil, pues se hace bien el maiz y trigo.

"Otra manera de tierra fertil hay, que se llama callalli, o sea tierra donde ha estado edificada alguna casa, y despues que se cava y se siembra es fertil. A la tierra estercolada la llaman tlalauiac, que quiere decir tierra suave, porque la han adobado con estiercol. Hay tambien tierras de riego que las llaman atlalli, que quiere decir de agua o tierra que se puede regar. A la ladera, repecho o falda de algun monte o collado, llaman tepetlalli que quiere decir tierra de cuesta. En los repechos de las cuestas hay unas tierras pedregosas o cascajosas, asperas y secas, llamanlas tetlalli, que quiere decir tierra pedregosa o cascajosa, hacese en ellas bien el maiz.

"Hay unas tierras que tienen much en si la humedad del agua, y por esto son fertiles; tambien hay otras que son humedas por naturaleza por ser bajas, y aunque no llueva, conservan la humedad y son fertiles, y cuando llueve se pierde lo que en ellas se sembro. Hay otras como en la letra esta bien explicado."[27]

In the Chinampa areas of course aquatic vegetation was in wide

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27. Sahagun, Vol. II, 1946, pp. 476-7.

use for fertilization along with fresh soil from the lake bottom. It is entirely possible that lake vegetation was also used on lake shore lands as fertilizers also.

If we combine human fertilizer with the production of such domestic animals as the turkey and the izcuintli and add aquatic and terrestial green fertilizer as a sort of compost, I do not believe that the total volume of fertilizer production would be much below that of the average farmer today. Fields in general are fertilized only once every 5-6 years and if all materials were carefully hoarded and applied, as do the modern Chinese (who in general also lack large domestic animals and do just this), by plant rather than spread over the entire field, I suspect that the actual effectivity of the use of fertilizers in ancient times was greater, in at least the Meseta Central, than today. Buck estimates that an adult male human produces 400 kilos of excreta a year; in a family of five the total would be at least 1200 kilos and if we add domestic animal production and green fertilizers a farmer could theoretically make a compost annually of some two tons of fertilizer. In modern China fields are maintained in constant production with mainly fertilizers from small domestic animals combined with human excreta.[28]

Crop Rotation. We cannot prove the utilization of crop rotation in pre-Spanish times, but of great significance is the rotation cycle described for San Gregorio involving only aboriginal cultivates. It is especially important as two of the rotated crops are basic cereals: maize and huauhtli. Data from the sixteenth century, especially the

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28. Buck, 1930.

Mendoza Codex and Matricula de los Tributos indicate clearly that chia and huauhtli were as important as maize or almost so as basic foodstuffs and all three were used in making tortillas, tamales and pozoles, the basic food types consumed by the peasant class. In the Tropical Lowlands today crop rotation is not only not known but there is only one staple, maize; and crop rotation is uneconomic (obviously rotating maize with non-staples cannot solve your problem as they are not consumed in comparable quantities). A truly economic system of crop rotation in the Highlands based on three staples was theoretically possible, perhaps adding a mixed sowing of non-staples every three or four years as a cash crop, but we have no definite proof that crop rotation was known.

Mixed Cropping. This is so widespread that it undoubtedly was pre-conquest and was used in both Lowland and Highland areas. We have a mention of this technique in Acapixtla in Morelos.

Irrigation. We will discuss this in more detail at a later point in the section on humidity conservation. It was undoubtedly of great significance in the maintenance of soil fertility as well as humidity conservation.

In the aspect of humidity regulation our data is much more abundant.

Of great importance in the economy of the Valley of Mexico itself was the development of chinampa agriculture. Armillas has discussed the modern technology and has indicated clearly that most of it is pre-conquest.[29] Our problem here will be restricted to its

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29. West and Armillas, 1950.

areal extent and feeding potential.

Today the Chinampa area covers at least 5000 hectareas. The same communities today which depend on chinampa agriculture were clearly chinampa villages at the time of the conquest as the sources on Aztec history and description of the Spanish soldiers indicate. Aside from the modern communities chinampa agriculture is mentioned for Xaltocan, Tenochtitlan, Chalco, Coyoacan, Ixtapalapa, Culhuaccan, Huitzilopochco and Maxicalcingo. Today there are no chinampas in these areas.

From Tierras, Vol. 67 in the Archivo General de la Nacion I have copied a map of the Chinampa area of Mixquic which dates from 1579. The map indicates that the ancient Chinampa area of Mixquic was at least as extensive as it is today and further shows chinampas owned by the neighboring village of Ayocingo; today there are no chinampas at Ayocingo.

In Tlahuac we find interesting proof of this former greater extent of the Chinampa area on an archaeological basis. East of the village there are no chinampas today although there were during the nineteenth century. A local hacendado somehow got control of the entire area, filled up the canals and converted the area to tierra de labor. Today it has been returned to Tlahuac as ejido and is still cultivated as temporal lands. When the hacendado took over he set up a rectangular grid of drainage canals over the entire lake bed to prevent flooding, each rectangle on the grid being 500x1000 meters. Time did not allow careful examination of this entire area but I followed a number of the north-south running ditches, examining carefully the sides for refuse deposits. An unpaved road, remains

of old railway, runs due east to the volcanic island of Xico 6 kilometers away and divides the lake area into two equal longitudinal belts. Pottery of the Aztec period can be picked up nearly 3000 meters north of this road in the sides of the ditches. Between 2000 meters and the point where the canals and the old railway intersect, Aztec pottery occurs in relatively dense deposits almost without a break. South of the railway pottery thins out rapidly beyond 500 meters.

Of extreme interest is a map of the entire Central Chinampa area discovered by the author in Tierras Vol. 1631 in the Archivo General de la Nacion dating 1752-53.

I have reproduced the map on the opposite page. The map indicates clearly that most of the old lake bottom was worked into chinampas except for a few patches of open water especially along the north shore. The data check neatly with my archaeological survey. The entire area between Tlahuac and Xico with a few exceptions was in chinampa at that time and the west Chinampa area ran continuously on to Xochimilco as it does today. In fact the map indicates that the old Chinampa area was much wider than it is today. The aerophotos of San Gregorio indicate clearly that what today is ejido was once occupied with chinampas and this checks with the 1752 map.

One might object that the map is very late to serve as a gauge of the pre-conquest distribution of chinampas but this argument is not tenable. In 1753 the population of the Valley of Mexico was at the very bottom of the post-conquest depression and it hardly seems likely that the Chinampa area had expanded, it seems much more likely

that it had shrunk.

I believe on the basis of the data that we can estimate that most of the old Lake Xochimilco-Chalco was converted to chinampa agriculture, certainly the southern chinampa area must have covered some 10,000 hectareas at the time of arrival of Cortez. The size of the Chinampa area in western Lake Texcoco and around Xaltocan cannot yet be estimated but I think we can set a minimum total area of chinampa cultivation in the valley as 10,000-15,000 hectareas.

The demographic capacity of this size area of chinampas is enormous. With a year-after-year production of maize with an average yield of 4000 kgs of maize per hectarea, and the average person consuming 1.4 pounds a day or .6 kilos, a hectarea will provide maize for some 18 people, and the 10,000-15,000 hectareas will feed 180,000-270,000 people.

In our survey of Ecological Types we noted that in most of Highland and Pacific Coastal Meso-America irrigation is either necessary or reduces crop loss or increases production. It is of interest to note that Palerm's study indicates without any doubt that over this entire area during the sixteenth century irrigation was used and well established and in many cases is proven to antedate Spanish contact.[30] It was of especial significance in the Meseta Central. This irrigation refers strictly to the perennial type. In many cases the sources of water were small and size of land irrigated limited. We need a thorough survey of the entire Highland area on all levels of anthropological research to determine its significance

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30. Palerm, 1954.

in each of our defined Ecological Areas. In the Meseta Central it was a crucial factor in the economy; in many areas it may have been too limited to consider as of basic importance.

In the Valley of Mexico important centers of irrigation, following Palerm, were south and west of Mexico City (where the system evidently supported 20,000 "vasallos"), the Teotihuacan Valley, Texcoco, and Cuauhtitlan. To this we must add the Chinampa area. I cannot estimate the pre-conquest size of the areas of perennial irrigation except for the Teotihuacan Valley. Today the irrigated zone covers some 3600 hectareas. The Relacion of Teccistlan with accompanying map dated 1579 indicates clearly that the ancient irrigated zone was at least as extensive; I think we can safely say the water was used to the limit of its irrigating capacity.[31]

In the Meseta Central, outside the Valley proper we find extensive irrigation systems around Tula and in the areas tributary to the Balsas river tributaries, Atoyac, Nejapa and Amacusac.

The distribution and importance of flood water irrigation is not known and I have located no references to it. Armillas in a personal communication reports a small archaeological system of this type north of Atlatongo in the Teotihuacan Valley which evidently dates from the Aztec Period. I suspect that the system was in general use all over the Meseta Central during at least the Aztec Period and probably from even earlier times.

Of great importance in modern Highland agricultural technology is the humidity storage technique described for the Teotihuacan

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31. P. N. E., Vol. VI-VII.

Valley. It is today closely linked to the plow and use of draft animals but need not be. The effectivity of the system depends on the thoroughness and depth to which the soil is pulverized, and contrary to general opinion a plow is no more effective in this sense than a metal hoe. I quote McBryde with reference to working of the soil with the hoe in Guatemala:

"Before planting milpa in the Highlands of the southwest, the Indians do as good and often even a better job of furrowing with a hoe than they could do with a plow and animals, though the labor involved is enormously greater. Furrows as deep as 12 to 18 inches (30.5-45.5 cms), about 3 feet (91.4 cms) apart, extremely even and straight (and on irregular slopes, always contoured) are made with a giant, heavy hoe about a foot wide and almost square, having about a 5 foot handle, and used like a mattock, cutting deeply. Probably this was a Spanish Colonial introduction to replace pre-Columbian types, doubtless of bone and wood".[32]

On the soft alluvial valley soils of the Highlands I believe that the coa would be just as effective an implement as the Guatemalan hoe.

Actually Sahagun gives an interesting description of cultivation techniques perhaps representing the system. He states:

"El labrador es dispuesto, recio, diligente y apto para la labranza. El buen labrador es fuerte, diligente, y cuidadoso, madruga mucho por no perder su hacienda, y por aumentarla deja de comer y de dormir, trabaja mucho en su oficio, conviene a saber,

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32. McBryde, 1945, p. 20.

en romper la tierra, cavar, desyerbar, cavar en tiempo de seca desmontar, allanar lo cavado hacer camellones, mollir bien la tierra, arreglarla en su tiempo hacer linderos y vallados, y romper tambien la tierra en tiempo de aguas, saber escoger la buena tierra para labrarla, hacer hoyos para echar la semilla y regarla en tiempo de seca; sembrar derramando semillas, agujerar la tierra para sembrar los frijoles, cegar los hoyos donde esta el maiz sembrado, o acohombrar o allegar la tierra, a lo nacido: quitar el vallico, entresacar las canas quebrandolas, y apartar las mazorquillas, y quitar los hijos de estas y los tallos, porque crezca bien lo nacido, entresacar a su tiempo las mazorcas verdes; al tiempo de la cosecha, quebrar las canas cogiendolas, recoger el maiz cuando esta ya bien sazonado, desollar o desnudar las mazorcas, y atar las unas con otras, anudando las camisillas una con otra, y hacer sartales de mazorcas atando unas con otras, y acarrear a casa lo cogido y ensilarlo; quebrar las canas que nada tienen aporreandolos, trillar, limpiar, aventar, levantar el viento lo trillado."[33] (Italics are mine.)

The system is obviously the one we have already described and I wish to call special attention to Sahagun's use of the Spanish word "cavar" meaning to dig rather than the word "arar" or to plow.

I suspect strongly that the flood water system was in general use, and that fields were given a post-harvest irrigation, thoroughly worked over with the coa several times to store the water, followed by rastrillos, and finally that the cajete system was in universal usage for sowing. It involves an enormous outlay in labor but

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33. Sahagun, Vol. II, 1946, pp. 201-2.

hardly more so than chinampa cultivation. We will refer to this problem of labor shortly.

Terracing in the Meseta Central of both defined types is definitely a pre-conquest system. All of the stone terraces I've examined in the Xochimilco area have considerable concentrations of sherds of the Aztec Period, and the basic outline if not the actual wall construction must date back to that period. Back of Texcotzingo there are hundreds of eroded terraces with heavy Aztec sherd deposits which are not in use today. This also applies to the extensive bancal systems which are even more widespread in the Meseta Central.

Cook in his population studies seems to have entirely ignored the importance of erosion control mechanisms in the Highlands and his conclusions are unsound about the relationship between erosion and population decline.[34] In his demographic studies he points to widespread erosion in some areas of the Meseta although he exaggerates greatly. This, he says, is an ancient factor in population decline, and states that the Indian population contributed as much to the present-day erosion as the post-conquest Indians and Mestizos. Actually this conclusion is unacceptable since we would expect as a result an archaeological record of initial population growth followed by a long steady decline up to the conquest period, yet data overwhelmingly suggests a population peak at this time. Actually the erosion dates mostly from the sixteenth century following the population depression. As we shall see shortly the population of the valley was cut down by epidemics from a high of nearly 1,500,000 to

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34. Cook, 1949.

500,000. With this decline and the Spanish policy of grouping the outlying aldeas or villages into centralized towns many of the marginal hillside lands were abandoned. The carefully built terrace system then fell into disrepair and erosion followed soon after; today some of the ancient terraced lomas behind Texcotzingo are almost devoid of soil.

From our data on pre-conquest cultivation techniques I think we can clearly state that our generalizations about the zonal productivity of modern Meso-American ecological areas in a general sense applies for the pre-Spanish period as well. In some cases, and our demographic data to be presented indicate this, as in the Valley of Mexico and other adjacent areas, the production was higher than today due to the extension of terrace agriculture and of irrigation, especially the chinampa type. Our data suggest strongly that the present slash and burn system is the only method practicable under the ecological conditions of the Lowlands.

Palerm's description of the calmil system for the humid Highlands of the Puebla-Vera Cruz border is of great interest. Stadelman describes it for the department of Huehuetenango as well.[35] In Highland areas where irrigation was not possible I suspect that a combination of the calmil and tlacolol systems were the characteristic agricultural system, just as today in Guatemala and Puebla we find the combination of calmil and barbecho systems. One of the most important ecological research jobs of the future will be to determine the comparative importance of the calmil-tlacolol systems and the

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35. Stadelman, 1940.

intensive system with irrigation, fertilization and terracing.

Of great interest in connection with the calmil system at Eloxochitlan is the fact that at least one-half of a hectarea can be kept in continuous production without rest or rotation with maize. Half a hectarea of land in this community will feed an entire family and its domestic animals but allow no surplus. At Huehuetenango, studied by Stadelman with the same system, he calculates an average yield of 24.8-33.0 bushels of maize a year per acre or 31-40 bushels per .5 hectarea. The yield in kilos would be 800-940 kilos and would almost feed a family, exclusive of animals.

# MODERN AND ANCIENT SETTLEMENT PATTERNS AND DEMOGRAPHY IN MESO-AMERICA

## Settlement Patterns in Modern Meso-America

In our four sample studies we noted sharp differences in site settlement patterns. We shall now review these differences and present comparisons with other published data.

### The Valley of Mexico

In the Teotihuacan Valley we noted a number of settlement types. These include the town; the village of which we noted three types, the compact, the spaced and the scattered; the rancheria and the hacienda or rancho.

We define the town as a community with an excess of 1000 inhabitants, in which at least two-thirds of the population earns a living by activities other than agriculture, and finally, it is a market or shopping center. They are almost invariably administrative centers as well. In the Teotihuacan Valley there is no sharp social division between "Ladino" and "Indio" as in Guatemala so we cannot utilize McBryde's method for separating small towns from big villages. In the Teotihuacan Valley there are two towns, San Juan Teotihuacan and Otumba.

The village is defined first of all as inhabited by mainly farmers although a few specialists may also be present. Second, it must have spatial unity, that is it is definable as separate from other nearby communities in terms of the distribution of the dwellings. Another way of putting it is that most of the lands of the

inhabitants lie around it and we have a definite smaller residential area in the middle. Furthermore it must have a social center in the form of a plaza surrounded by public buildings. The pattern of settlement of the houses themselves varies but sorts generally into two main types: (a) those with no ordered street pattern in which houses are connected by winding paths; and (b) those communities in which the main streets at least are ordered on the Spanish Colonial grid pattern.

The density of population in the residence area of a village varies enormously. In general it is very low in the Scattered Village or type (a), running in the Teotihuacan Valley from 500-1200 per $km^2$. In the cases of the type (b) or Ordered Village our valley villages sort out sharply into two sub-types in terms of population density. One we can call the Compact Ordered Village has densities running from 3300-5000 per $km^2$. The other we can call the Low Density Ordered Village, with densities running from 1100-2500 per $km^2$. In the latter we find each house surrounded by a small nopal orchard; in the Compact type the house lots are very small and contain few cultivates; this type occurs in the irrigated Lower Valley.

In some of the bigger villages (San Martin de las Pyramides) and generally in all towns we find a more strict adherence to the Colonial grid pattern but in the smaller villages it is consistent only for the main streets.

The Rancheria in the Teotihuacan Valley differs from the village in three ways (a) it lacks a plaza or social center; (b) the houses are more dispersed - most farmers live on a sizeable chunk of their holdings if not the entire holding; and (c) as a result of (b) the

population density is very low dropping below 500 per $km^2$.

The final type, the Hacienda or large private holding, is a small compact settlement including one large house - the residence of the hacendado - the work buildings attendant on it and cluster of smaller dwellings of permanent workers. Numerically hacienda populations have always been a minor factor in the settlement pattern of the Valley.

We have noted further the presence of compound communities. The history of these compound communities is a complex one and varies in detail from one to the other. In general the old pre-conquest main centers or towns were originally divided up into barrios or wards each with its own social center, and such modern communities as Texcoco with its six barrios preserve an ancient settlement pattern. Sometimes the Spaniards to facilitate conversion formed compound communities from separate villages or separate rancherias and ordered them as compact new communities. For a long time, and in some cases until today, the original social units maintained their separateness in a social if not a spatial sense and had their own plaza. Most of the compound villages of the Teotihuacan Valley are of this type; the parts were originally separate communities. In general in the northern Valley of Mexico compound villages were of this origin; compound towns probably were originally so although the Spaniards in some cases added to an originally complex barrio division by joining on extra nearby farming villages.

Approximately 15 percent of the population of the Teotihuacan Valley live in the two towns, about 5 percent in rancherias, haciendas or ranchos, and the remainder in farming villages.

In the Chinampa area we find almost all of the population living in the Compact Ordered type of village, with one gigantic town, Xochimilco. Densities run even higher than in the Teotihuacan villages with irrigation; all the lake shore villages have densities running between 6600-10,200 persons per $km^2$. Furthermore the Lake Shore villages are mainly big villages with few communities having less than 1000 inhabitants and many with populations in excess of 2000 inhabitants.

In the Valley of Mexico in general the village is the typical form of settlement for the rural population and the typical economic sub-world consists of a town or market center ringed by satellite villages. These towns usually possess over 3000 inhabitants and include today such centers as Chalco, Amecameca, Milpa Alta, Xochimilco, Texcoco, Teotihuacan, Otumba, Zumpango and Cuauhtitlan.

The Chontalpa

Here the settlement pattern is quite different. The typical pattern is one in which a small city (in this case almost the entire population is made up of non-farmers) or town which serves as a collection center for agricultural produce, a shopping center for the rural population and as an administrative center or municipio. These small cities have populations running from 1500-4000 and there is generally one in each municipio. Approximately 10-15 percent of the population of the municipio live in these centers. The balance live scattered in the rural settlement type we call rancheria; each farmer's house is surrounded by its field. The rancheria itself is simply an administrative unit, not a residence unit, and certainly does not function as a community in a socio-economic sense. It is

a legally defined area with a comisario in charge for administrative purposes. In some cases it may have a small center which includes the comisario's house, a school, perhaps a small shop and often a pole and thatch church. There may be a minor clustering of dwellings of say a dozen houses. Thus we can define a center of sorts but not all rancherias possess even a center of this complexity. Villages are very rare in the Chontalpa.

Yucatan

We have dealt exhaustively with Yucatecan settlement patterns in another section and will but briefly review our conclusions here. The rancheria is rare in Yucatan and the small city-rancheria pattern absent. In areas based entirely on slash and burn maize cultivation the dominant settlement types are the hamlet (a tiny nucleated village) and the small-to-medium-sized village. Village density is about that of our Ordered Low Density Village in the Teotihuacan Valley, and each house is surrounded by a small orchard. Village population densities as far as we can tell from the few cases studied range from 1000 to 2000 per $km^2$. Characteristically in the slash and burn areas there are few true towns and most of the population is rural and concentrated in very small communities.

In the Nequen Area we find larger villages and fewer hamlets in response to the more effective economy based on intensive cultivation of the nequen ejidos.

In the slash and burn area of the richer, more productive Puuc we find the typical population unit is a big Ordered Low Density Village; 88 percent of the population live in villages and towns with an excess of 1000 inhabitants. The factors behind this emphasis

on big villages here is not known. Certainly in some cases the combination of local industry, commercial agriculture and motorized transport have played a significant role in community growth as in the case of the biggest communities (Ticul, Tekax, Peto and Oxkutzcab).

The Papantla Area

I have already pointed out the significant economic pattern of this area, one of slash and burn maize agriculture combined with small patches of vanilla, and will now analyze the settlement pattern.

The municipio of Papantla in 1940 covered an area of 1184 $km^2$ and possessed a population of 34,257 people with an overall density of 28.93 persons per $km^2$.

Six thousand six hundred forty-four people lived in the small city of Papantla which in mode of living, settlement pattern and function corresponds closely to our urban community of Huimanguillo. The rest of the population, or 82 percent, live in two settlement types, the rancheria of Tabascan type, or the "congregacion" which is simply a modified rancheria. Ranchos and haciendas are rare, in 1940 only 9 in all. In the municipio in 1940 there were listed 1 ciudad (city), 63 "congregaciones", and 35 "rancherias". The latter needs no redefinition.

A typical congregacion is that of Tajin, studied by Kelly and Palerm.[1] The data presented below is from their study.

The life of the modern congregacion of Tajin may be said to have really begun in 1875. Before that date there were few inhabitants in the area. In 1876 as part of a general federal policy of coastal

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1. Kelly and Palerm, 1950.

colonization the government opened up an area of over 6000 hectareas, divided up into parcels of some 31 hectareas each, to settlement and offered the parcels for sale. Most of the buyers were native Totonac culled from a large number of neighboring communities. The sale provided for two large areas to be set aside for villages where the buyers were supposed to reside. The actual results are fascinating. One of the areas has never been occupied as a community and the other is the modern Fondo Legal of Tajin. The latter community was divided up into regular blocks and streets, has a plaza, a school, jail, municipal office and two small shops. Although this center was set up originally as a future village only 20 percent of the population of the congregacion actually live there; the rest of the population live scattered, each house surrounded by its fields. The Congregacion in all includes some 186 families, of which but 35 live in the Fondo Legal or nucleated center of the congregacion. The Fondo Legal itself is spread over an area of some 50 hectareas and the density of population but 400 per $km^2$ or about that of our Teotihuacan Valley rancherias.

The settlement pattern described for Papantla is characteristic of the slash and burn areas of the Gulf Coast Plain. At Santiago Tuxtla for example in the San Martin area in southern Vera Cruz we find a municipio population of 16,064, of which 5392 live in the small city or center of the municipio and the remainder, the rural population, which makes up roughly two-thirds of the total population, live scattered on 17 congregaciones of the Tajin type, 28 rancherias, and 6 ranchos. The census of 1940 listed for the state of Vera Cruz 28 ciudades or cities, 1541 congregaciones, 57 ejidos,

81 haciendas, 135 villages or pueblos, 3315 rancherias and 2150 ranchos. The highland state of Mexico for comparison, with three-fourths of the population of Vera Cruz, boasted 634 villages to the 134 in Vera Cruz. We must consider also that the higher percentage of the villages or pueblos listed in the 1940 census of Vera Cruz occur in the Tierra Templada-Tierra Fria zone of the state.

## Highland Michoacan

In Highland Michoacan West defines two settlement types which he calls rancho and pueblo.[2] Ordinarily the term rancho in Mexico refers to an isolated livestock ranch, but here as in Yucatan it is often applied to small hamlets or villages of farmers.

Rancho type settlements occur mainly in the slope and mountain areas, and consist of scattered dwellings which lack orderly street patterns and are quite widely spaced. It is not clear in West's text whether these settlements possess plazas or not. His plan of Uringuitiro indicates that they did not but he only gives one rancho plan. Approximately 287 people lived there at the time of his study and were scattered over an area of about 50 hectareas or about 577 per km2. The density and pattern of settlement is typical of our scattered village type of the Teotihuacan Valley although in this case the plaza is lacking as in the Teotihuacan rancheria. The size and pattern resemble closely those of Santiago Tolman or Cuauhtlancingo in the Teotihuacan Valley or of the Fondo Legal of Tajin.

The other type of community is the pueblo or village, differing from the rancho in its generally larger size (varying from 200-3400, rancho 9-900) in its regular grid street pattern and in the presence

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2. West, 1948.

of the typical plaza. In the broken areas the village is of our low density type; in the lake shore plains and valleys it runs to our high density or compact type. Ahuiran is a good example of the first; although the streets are regularly laid out in a checkerboard pattern the houses are widely spaced. Ahuiran had 593 inhabitants in 1940 living in an area of 25 hectareas with a density of 2400 per $km^2$. Tirindaro is representative of the compact type and here 1252 people live on 22 hectareas of land or a density of 5600 per $km^2$.

Our settlement types in Highland Michoacan then duplicate the types we defined for the Teotihuacan Valley. In terms of the frequency of the two basic types, rancho and pueblo, by ecological area we can analyze West's data in the following chart:

| | Pueblos | Ranchos | Villas or Ciudades (Towns) |
|---|---|---|---|
| Sierra | 44 | 61 | 3 |
| Lake Area | 20 | 32 | 3 |
| Northern Plateau | 8 | 6 | 3 |
| La Canada | 11 | 2 | 1 |
| Tierra Templada | 4 | 2 | 1 |
| | 87 | 103 | 11 |

Aside from these units there are next to no communities of the hacienda type. Highland Michoacan then is an area of villages. Most of the population live in the pueblo type of settlement and many of the settlements are of large size (over 1000 inhabitants). The following chart summarizes the range of settlement sizes in numerical proportion and also by size of the population.

| Size of Population | Number | Percent |
|---|---|---|
| Under 100 inhabitants | 57 | 2 |
| 100-500 inhabitants | 61 | 9 |
| 500-1000 inhabitants | 41 | 20 |
| 1000-2000 inhabitants | 25 | 23 |
| 2000-3000 inhabitants | 8 | 12 |
| 3000-4000 inhabitants | 4 | 9 |
| Over 4000 inhabitants | 5 | 25 |

Summing up, nearly 69 percent of the population live in big villages and towns, 89 percent live in communities exceeding 500 inhabitants and only 2 percent live in what we are calling hamlets in our Yucatecan study.

Aside from West's analysis of Highland Michoacan we have no studies of overall settlement patterns of the Highlands similar in scope to my study of the Valley of Mexico. Most village studies include community maps but we cannot get a good idea of the overall pattern from them. We can say, however, that our basic village types and villages in general are spread all through the Mexican Highlands, especially in the mountain valleys of Oaxaca and the Tierra Templada, and the predominant rural settlement pattern is the nucleated village. There is the same general range in population density and variation in street patterns we have noted for the Central Plateau.

## Highland Guatemala

McBryde in his study of southwestern Guatemala discusses settlement patterns in a general way and indicates a basic pattern similar in part to that of the Mesa Central.[3]

In his study he separates communities first into Towns and

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3. McBryde, 1945.

Villages. Towns are communities with over 1000 inhabitants and with over 500 Ladinos, the latter evidently being the town building elements. Towns functionally differ in the occupation of the population; they are evidently centers like our towns in the Meseta Central which are inhabited by large numbers of craftsmen, have big markets and are administrative centers. The term village he restricts to purely agricultural communities regardless of size. Santiago Atitlan for example at the time of his study had over 5000 inhabitants, about the size of San Gregorio Atlapulco, and yet is still a village.

Larger villages and towns in his area tend to adhere pretty closely to the Spanish grid pattern of streets; villages in general, especially the smaller ones, have a central plaza and a few streets just off the plaza in the typical colonial arrangement, but beyond this the regularity breaks down and we get winding paths. The same generalization holds for the Teotihuacan Valley. Even some larger villages may have this more aboriginal street pattern. One of the interesting statements made by McBryde about Atitlan is that the population density of the residential area is approximately 8000 per $km^2$, or about that of our lake shore villages in the southern Valley of Mexico. Atitlan is a lake shore village also and preserves mainly the aboriginal street pattern in spite of its large size.

In Guatemala, however, the unit of settlement, unlike the Meseta Central, is the municipio rather than the village or town. In the Valley of Mexico we find the presence of municipios but they are administrative units, not settlement units. Usually they include a town or big village as the cabacera or administrative center, plus

several small villages as dependent communities, but each of them is a separate, permanent residence unit.

In Guatemala the situation is evidently different. In some municipios we find the Mexican pattern; in others the center, whether village or town, partakes of the character of a ceremonial center. We find a central town or village laid out on the grid plan, occupied by a small Ladino resident population who are craft, political or trading specialists. The Indian population which makes up the bulk of the population live scattered on isolated farms in our typical rancheria pattern. The rural population gathers in the center for trade or religious ceremonies. The Indians often have houses in the nucleus which they use during these visits but reside there only a fraction of the time. Tax calls these "Vacant Towns". There are communities which one might class as intermediates, that is most of the Indian population live in the centers permanently, some migrate from town to farm.

In southwestern Guatemala McBryde points out that these vacant or dispersed towns are common in the high valleys of Totonicapan and Quetzaltenango. Typical of the Mexican type of village and town are those communities situated on the shores of Lake Atitlan. In general the highland population of Guatemala tends toward the dispersed type of settlement.

Factors pointed out by McBryde as affecting the nucleated or Mexican type of settlement are: (a) water supply; (b) surface features; (c) situation with respect to trade routes; (d) specialized occupations including truck gardening; (e) availability of remunerative employment; and (f) historic precedent. Atitlan for example combines

all of these factors: it is located near one of the main water sources, is clustered on a small terrace on the volcanic slopes, is on one of the major trade routes, the population are specialized horticulturists, canoemen, middlemen and craftsmen, the village is within a short distance of the escarpment coffee plantations, and finally there has always been a clustered settlement there even in pre-conquest times.

The Quetzaltenango and Huehuetenango valleys are flat extensive plains and McBryde feels are natural areas for the dispersed pattern of settlement. I cannot agree with this conclusion as the same conditions are met in the Meseta Central and the dispersed type of municipio is completely absent there. Even in these more open highland valleys in Guatemala we find a number of factors such as water supply, trade route position and craft specialization which cause the development of nucleated communities, at any rate of the town, if not the village type.

In summary, within the Highland area of Meso-America we find two basic settlement types: the central town ringed by smaller villages, all communities being defined separate spatial units and in general densely concentrated; this type we can call the Mexican and it is widely distributed in Mexico above 800 meters above sea level. The second type is that of a town with a rural dependent population scattered in isolated homesteads and small hamlets, and this type we will refer to as the Guatemalan type.

In the Lowlands in general we find the small city with an economy based on the international market and with the rural population scattered in the typical rancheria pattern. In northern Yucatan

this pattern is absent; instead we find the town or village as a central community ringed by small villages and hamlets in the slash and burn area and large villages in the areas of commercial agriculture.

## Ancient Lowland Settlement Patterns

Maya scholars stress the fact that the great centers were not cities in the strict sense of the word and that truly nucleated centers were not characteristic of Classic Maya settlement patterns. I quote below from Morley:

"Some objection has been made to calling the ancient Maya ceremonial and governmental centers cities and towns, on the ground that they were not concentrations of population in relatively limited areas like our modern urban centers; but Landa's account of a New Empire settlement is so clear that there can be little doubt that he is describing a town, even in the modern sense of the word. Two important differences, however, must be admitted: First, Maya centers of population were not so concentrated, not so densely packed into congested blocks as are our modern cities and towns. On the contrary, they were scattered over extensive, more lightly inhabited suburbs, fringing out into continuous small farms - a suburban, as contrasted to a closely concentrated, urban type of occupation..."[4]

This pattern of lack of nucleation of large masses of people evidently carries over to the smaller centers as well. In 1939 Thompson, speaking of the site of San Jose, states:

"The surrounding country is fertile with a minimum of useless

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4. Morley, 1946.

land. Its present appearance, a patchwork quilt of milpa, guamil and forest, probably reproduces fairly closely conditions prevalent during the ancient occupation. Nonetheless, the small number of residential type mounds indicates that the actual population of the site can never have been great, and possibly at no time exceeded twenty-five or thirty families. Villages such as San Jose, with a small resident population and constituting religious and, perhaps, market centers for the district within a radius of 5-15 kms appear to have been very numerous in all parts of the Maya area."[5]

For the Maya area we have several test studies of settlement patterns which I will now analyze.

Uaxactun. This study gives an excellent idea of the settlement pattern of a major center. I quote in full.

"On February 25, Mr. Enrique Shufeldt was given the task of mapping the country surrounding the six main groups at Uaxactun. The purpose of this work was to ascertain the number of house mounds and chultuns in the vicinity of the civic center, in order to make an estimate of the ancient population.

"The following method was used in making the map: two main lines of sight were cut, one east and west, the other north and south, crossing each other at a point 625 yards southwest of the main aguada. The north-south line runs through Groups A and B and the east-west line through Groups D and E. Additional lines were then cut parallel to the two main lines and 100 yards apart and other lines intersecting these at right angles at intervals of 100 yards.

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5. Thompson, 1939.

The area thus divided into squares is cruciform, each square being 100 yards on a side. The arms of this cross, each 400 yards wide, extend 1400 yards to the north, 1800 to the east, 1600 to the south and 1000 to the west of the point of intersection.

"After the squares were cut they were numbered and searched. They were purposely made small, because the density of the jungle made it difficult to see the house mounds, and the search of each square had to be accomplished with a minimum of bush cutting.

"The eastern arm consists of 72 squares, or 720,000 square yards. Of these squares 24 were not searched as they lay in Group E which had already been mapped. Twenty-nine squares were bajo or low swampy land and 19 were high ground. Nineteen house mounds and 3 chultuns were found. The house mounds were usually elliptical in shape and were found standing alone, 2 together in an L shape, or 3 or 4 around a court. Sometimes a single house mound was in the shape of an L. The chultuns were not always found in connection with house mounds. All of the house mounds in the eastern arm occur on high ground except in two cases, where large artificial mounds had been built in the bajo and house mounds placed on top of them. In the extreme eastern tip of the mapped area a small aguada or water hole was found.

"The western arm consists of 40 squares, or 400,000 square yards. Of these 39 were high ground and 1 bajo. On the high ground 8 house mounds and 4 chultuns were found. In this area the chultuns were not connected with house mounds.

"In the northern arm there are 48 squares, or 480,000 square yards. Of these 18 are high ground, 14 are bajo and 16 are in Group A.

On the high ground 14 house mounds and 4 chultuns were found.

"In the southern arm there are 56 squares or 560,000 square yards. Of these 38 are high ground and 18 bajo. On the high ground, 24 house mounds and 17 chultuns were found. Of the chultuns Chultun 3 is the most interesting...."[6]

The total area surveyed was 2,160,000 square yards of which 620,000 were swampy bajo, 400,000 occupied by palaces and temples and the remainder hillier, more elevated ground containing all of the house mounds. The 63 house mounds then were scattered over some 114 hectareas of suitable settlement area or 176 hectareas of gross area around the public buildings. Taking the former area, just land suitable for habitation, a congested compact community like a chinampa village would have a total population of some 10,000-12,000 people. It is not known, of course, how many people lived in a Maya house at Uaxactun. We can be sure, however, that the 63 housemounds did not house 10,000-12,000 people. This would mean an average of 160-195 people per house! Taking our compact communities of the irrigated Teotihuacan Valley the area would support some 4000-6000 people. Even our nopal villages would have produced a much denser community population than the 63 house mounds at Uaxactun indicate, some 1100-2500. In fact the only highland community type we studied which has a community population density as low as Uaxactun is the rancheria of Palapa. Ricketson estimates an average of 7 people per Maya house or a total of some 441 persons, or about 387 persons per $km^2$. I must point out that I am assuming all house mounds were occupied at one time, and this Smith did not prove. Actually Wauchope in his study of the house

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6. Ricketson and Ricketson, 1937.

mounds doubted this was true.[7] Whatever Uaxactun is, it is not a city in the sense Teotihuacan is.

The population is too dense to have been rural, at least with slash and burn agriculture. I would call the population suburban, probably farmers who sowed small milpas but depended mainly on government support and who were part-time laborers for the center. We find a similar pattern in the Chontalpa today. Often farmers' houses are packed closer together just outside the modern town (in the case of Uaxactun a ceremonial center, not a true town) and are part-time farmers, part-time laborers.

Willey discovered an almost identical pattern in British Honduras. On a flat alluvial terrace set amongst hilly broken terrain on the shore of the Belize river he notes some 350 house mounds spread over an area of 2 square miles or 5 $km^2$.[8] The house mounds are scattered over the terrace with no apparent plan and there are three small ceremonial plazas 1 km apart which served as social centers. The density here calculates about 70 house mounds per km or only slightly above that of the habitable area at Uaxactun. Here again we have a community density equivalent to our highland rancherias. In the Barton Ramie site the factors for more congestion than expectable for slash and burn farming may be topographical, and we may assume that each farmer cleared a milpa on the terrace and probably others on the neighboring hilly slopes.

On the east coast of Quintana Roo, I did a thorough settlement

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7. Wauchope, 1938.

8. Willey, 1955.

pattern study of a medium-size center at Tancah. Here the data suggest a more scattered settlement pattern than even at Uaxactun. We have at Tancah two plazas surrounded by public buildings of the temple type, each plaza separated by some 60-80 meters and with 23 structures in all. To the west are scattered at least some 50 structures ranging in size from small altar-like platforms to small pyramids up to huge platforms up to 60 meters long. The only structures which could have been used as dwelling platforms are the latter and some of them have small temples on top. There are no small house mounds of the Uaxactun type in the vicinity of the ceremonial center. It looks very much as though Tancah were a ceremonial center of the classic type with a small elite resident population; I doubt if the latter ran to a total of more than a few hundred. Tancah is the largest site of the Classic period for the entire east central coast area. If urbanism in settlement pattern is to be found on the east coast it should occur here. Extending outward from this center to the west (inland) we find small clusters of true house platforms, often with a small pyramid accompanying the group, on into the hinterland for at least 5 kilometers, I noted at least a dozen of these groups each with from 6 to 15 house mounds. They are probably rural settlements of the hamlet type.

To facilitate mapping, a huge rectangle 280 by 360 meters was divided up by trails into a grid pattern of 40-meter squares. Furthermore five extra trails were cut toward the north from the north edge of this rectangle for a further distance of 120 meters, one trail cut east of it for 120 meters, one to the south 120 meters and finally four

trails cut to the west for 120 meters. Where the 40-meter lines intersect small test trenches were excavated down to bed rock in each case to determine the distribution of refuse over the site, some 182 trenches being excavated in all.

Some interesting facts about Maya Classic settlement patterns resulted from this test, which was combined with stratigraphic testing all over the site and which may be reviewed below:

1. Ceramic refuse is very thin over the site as a whole in spite of the fact that the site covers the whole Classic period, possibly has a Late Formative level and was still being used during Post-Classic times. Most refuse deposits did not exceed a meter in depth.

2. Heavy sherd concentrations all occur just off or around Plaza A where our longest stratigraphic record is also located. They presumably represent refuse gathered and transported as fill to level off the terrain for the construction of the plaza and do not represent habitation refuse in situ. There are no house mounds in this area and the soil is full of loose rock evidently used as fill also. To the east the pottery deposits stop altogether within 20 meters of the east edge of Plaza A. To the south pottery deposits end within 100 meters and pottery in general, where it is found, is pretty scarce. To the north of Plaza A pottery occurs only in abundance up to 80 meters from the north edge of the plaza; most of the trenches north of this point yielded less than 10 sherds. To the west pottery is more abundant just off the big platforms but fades out quickly when you move north or south of them.

3. The ceramic distribution ties in closely with the

architectural data and indicates that the surface constructions represent the total permanent population of the site. Aside from these big platforms, obviously (if they were houses) used by a wealthy class, there is no evidence of a dense nucleated urban population of artisans and workers in the vicinity, only scattered rural hamlets. A modern Yucatecan village with as many large public buildings as the ruins of Tancah would at least have a clustered population numbering several thousand people, who would reside in a residential area extending at least a kilometer in all directions from the center.

If we were to take modern Izamal with its plaza, move all of the clustered population except the "Gente de Vestido" out to outlying hamlets and leave just the plaza with its public buildings and the masonry houses for one or two blocks off it, we would reproduce the settlement pattern of Tancah.

At the site of Tierra Nueva in the municipio of Huimanguillo the general "top-heaviness" of Maya sites is again evident. That is, the ceremonial zone is large in proportion to the settlement area around it. Just east and adjoining the main plaza at Tierra Nueva is a small area of concentrated pottery and house mounds; its total size cannot be over 3-4 hectareas. The same technique of grid corner test trenching was applied here and over most of the site pottery and house mounds were very rare. Tierra Nueva is the largest center in the Huimanguillo area.

At the smaller site of Sigero nearby we find the following pattern. In the center on a terrace overlooking the Rio Grijalva is a small plaza with an earth pyramid to the north, a ball court

bordering it to the east, two low platform mounds to the south and a big rectangular earth platform to the west. Within a hundred meters in all directions from this plaza are some dozen or so small low earth mounds which are presumably house platforms. Extensive trenching all over the site failed to uncover any heavy sherd deposits. We evidently have a small ceremonial center-noble residence unit with no nucleated commoner population at all. Most of the smaller sites in the Chontalpa are of this type and we find the same lack of heavy refuse deposits. Along with these more formal centers are large numbers of sites which include perhaps a single conical mound and a half dozen to a dozen house platforms - a typical hamlet-type settlement.

The findings at Tancah, Tierra Nueva and Sigero check closely with Drucker's observations at La Venta, one of the major Olmec centers. I quote:

"In the course of the season an even 40 test trenches were dug in various parts of the site. For the most part they were dug in groups in localities where sherds were abundant on the surface or could be seen exposed in stream banks. It is well to make clear here that there is no uniform sherd-bearing layer covering the island, but that sherd deposits have restricted distributions and require considerable search....

"The site of La Venta itself appears to have been a major ceremonial center occupied for a rather long period by a small resident group and presumably maintained by the population of the entire district round about...."[9]

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9. Drucker, 1952.

In 1952 I published an analysis of sites in the Vera Cruz Coast Plain along the Rio Cotaxtla and came to the same conclusion.[10]

Documentary data confirm this pattern of scattered settlement.

Torquemada after describing the cities of the Meseta Central states:

"Ya se ha dicho, en uno de los capitulos pasados como estas gentes indianas estaban pobladas en estas tierras, en pueblos y ciudades (referring to the Meseta Central), y declaramos tambien el modo de la ciudad, y la intencion, que al principio tuvieron, los que las fundaron, pero no todos los moradores de estos larguisimos e inumberables reinos, guardaron, inviolablemente, este orden y modo; porque como las tierras no son iguales, asi no todos pudieron seguir un parecer. Por lo cual vemos, que si los de la tierra llana guardaron el orden de ciudad y congregacion concertada, no lo pudieron guardar, ni seguir por este modo, los que poblaron sierras y montanas y otros lugares cenagosos y humedos; y asi vemos que en algunas provincias y regiones, tenian estos naturales a trechos, como a manera de barrios, de la misma manera, que en nuestra Espana estan esparcidos y derramados, en las provincias de Galicia y en las montanas. Este modo de poblar se ha hallado en los reinos de Guatemala y provincias Totonacas y Meztitecas que caen en las serranias de la Mar del Norte, y en otras partes semejantes a los dichos; pero hace de advertir que en algunas de estas dichas provincias usaron que los pueblos, que hazian cabeza, y metropolis de la nacion o provincia tenian algun mas concierto, que las otras poblaciones o congregaciones,

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10. Sanders, 1953.

sujetas y perteneciente a esta dicha senoria o reino. En esta principal congregacion y cabeza acustumbraban a tener sus templos y culto lo tenian por divino. Aqui asistia el senor y rey y tenian sus casas muy suntuosamente labradas; acompanabanlas otras casas de gente principal y noble; y aunque no en calles formadas, al menos en orden concertado, conforme el lugar les daba mano, y larga a su deseo. Y esta congregacion era su numero de ciento y doscientas casas, y en partes mas, y en partes menos: El otro pueblo (digo los demas de esta nacion o senoria) que era como miembros de esta cabeza, estaban derramados por los cerros y serranias, por valles y quebrachos, y que hacian un numero cuantioso y de grande exceso...."[11]

The Reine de Guatemala at this period included Guatemala plus the Yucatan Peninsula.

In Yucatan, Roys interpreted some of the statements of the Spaniards to indicate a nucleated town but most of his quoted statements are not explicit enough and are capable of other interpretation. For example one of the largest conquest period towns, Chauaca, is described:

"Within a few hours, two or three leagues further on the Spaniards approached 'a town so large that even though they began to enter it at noon they did not reach the palace of the cacique ... until the hour of vespers, even though they halted nowhere, and at no point passed outside its limits.'"[12]

This is obviously not a description of a concentrated settlement

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11. Sanders, 1953.

12. Chamberlain, 1953.

and Landa's statement quoted by Roys probably refers to the Chuaca type of settlement.

"Before the Spaniards conquered that country, the natives lived together in a very civilized fashion. They kept the land well cleared and free from weeds, and planted very good trees. Their dwelling place was as follows: in the middle of the town were their temples with beautiful plazas, and all around the temples stood the houses of the lords and the priests, and then those of the most important people. Thus came the houses of the richest and of those who were held in highest estimation nearest to these, and at the outskirts of the town were the houses of the lower class. And the wells, if there were but few of them, were near the houses of the lords; and they had their improved lands planted with wine trees and they sowed cotton, pepper and maize, and they lived thus close together for fear of their enemies, who took them captive and it was owing to the wars of the Spaniards that they scattered to the woods."[13]

This final statement, as the Relaciones make clearer refers not to a shift in settlement pattern but to the attempt of the Indians to flee into the forest from Spanish attempts at congregating them into true towns or nucleated communities. The description could fit Tancah or Uaxactun and doesn't necessarily indicate a nucleated center. As a matter of fact there are definite statements throughout the Relaciones Geograficos de Yucatan, especially the Relacion de Merida which indicates clearly that the bulk of the population lived in a rural hamlet pattern of 8-10 houses each. Not only that but

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13. Roys, 1943.

most of the relaciones of the sixteenth century blame the population decline on the Spanish project of grouping the scattered rural population into large villages and towns. The sources state that this caused the population to die out; I suspect the actual effect was to cause many Maya to migrate into uncontrolled areas such as Quintana Roo. Most of the modern Yucatecan towns and villages date from the sixteenth century and are Spanish Colonial in origin; all conserve the Spanish grid pattern in contrast to villages in the Valley of Mexico where we find many which still conserve the aboriginal pattern. The implication is that the true village is not a natural unit in Yucatan.

I think the data suggests clearly that the basic form of settlement pattern in the Tierra Caliente was the ceremonial center-hamlet or possibly rancheria type and that nucleated centers of either the city or village type were rare. This type of settlement was perhaps the only adjustment possible in terms of slash and burn agriculture over most of the coast plain. Even in the Chontalpa with a higher zonal productivity the archaeological evidence clearly suggested this lack of congestion of population centers.

The only exception seems to be Mayapan, and Mayapan is a Mexican rather than a Maya center. Mayapan differs from true Maya centers in that it is surrounded by a wall. Pollock states:

"The survey of the building remains in Mayapan is nearing completion. It is now clear that within the urban area of the city, approximately 5 sq. km., lie over 4000 structures, the vast majority of them dwellings and their associated buildings."[14]

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14. Pollock, 1952-53.

These structures are mainly low stone platforms grouped in clusters of 2-3 around small courts, each cluster evidently forming house platforms for a single family unit, comparable to the modern solar with its component structures. We can make an approximate estimate that the architectural remains indicate some 1500 family units as the population of the city, or about 300 per $km^2$. This is exactly the density of a modern Yucatecan village.

Mayapan was the capital of the entire northern half of the Peninsula, yet we cannot estimate a population for it of more than some 1500 families, or about the population of say modern Valladolid, Motul or Ticul; and this is the largest community for the time period without much doubt.

One of the interesting problems about this single nucleated center is its function. Landa is clear on this point:

"In this enclosure they built houses for the lords only, dividing all the land among them....

"After the departure of Kukulkan, the nobles agreed, in order that the government should endure, that the house of the Cocoms should have the chief power....This being done, since within the enclosure there were only temples and houses for the lords and the high priest, they ordered that other houses should be constructed outside, where each of them could keep some servants, and to which people from their towns could repair, when they came to the city, on business. Each one then established in these houses his mayordomo, who bore for his badge of office....He (the mayordomo) kept account with the towns and with those who ruled them; and to them was sent

notice of what was needed in the house of their lord...."[15]

The "enclosure" refers to an inner wall, no remains of which exist; the large number of small house complexes around the central palaces and temples at Mayapan were evidently occupied by the personal servants and mayordomos of each lord. What we have here is a residence center of the nobility on a grand scale, and based upon the preeminence of Mayapan in the political set-up of northern Yucatan; it is significant that Landa mentions no barrios of craftsmen and laborers and no elaborate market system.

## Ancient Settlement Patterns in the Meseta Central

I will begin this discussion first with a study of the settlement pattern of the larger centers.

One of the features which contrasts most sharply in the surface archaeology of the centers in the Meseta Central as compared with the coastal centers is the dense concentration of occupational debris, mainly pottery. Surface sampling in this area is highly productive and in many of the sites I have picked up more sherds on surface areas of comparable size than had turned up in my test trenches at Tuncah, even in cases where the entire period of occupation on the highland site covers but a single short time period (as at Huexotla where it is entirely Aztec 2-3). In many cases one can map the urbanized area by simple surface observation as I was able to do in Xochicalco in 1951. The urbanized areas surrounding ceremonial precincts are often of enormous size and the characteristic "top-heaviness" of Maya centers is absent. Xochicalco for example has

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15. Landa, 1941.

an urbanized settlement area covering 200 hectareas, Teotihuacan 750 hectareas and Cholula at least 300-400 hectareas. Ceramic deposition in and around these extensive areas is almost always uniformly dense; there are few areas with low yields; there is no necessity to search for refuse dumps, as at La Venta - the site itself is simply the center of one huge refuse area.

Very few good studies of site patterns have been made, and actually no true settlement pattern study has been made; our data have come as a by-product of stratigraphic or architectonic reconstructive archaeological studies.

Armillas made a careful study of the overall settlement pattern of Teotihuacan in the Valley of Mexico based upon excavation, a review of published data and considerable surface reconnaissance.

He has not published in full his findings but in 1951 he stated:

"Ademas de los templos de los dioses, palacios, y conventos para los nobles - sacerdotes y los novicios y canchas para el sagrado juego de pelota, habia lugar en esos centros ceremoniales para los muertos ilustres, en tumbas suntuosas construidas bajo las plataformas de los templos o agrupados en extensas necroplis, el mejor ejemplo de las cuales es Monte Alban. Pero la extension urbanizadacon calles y plazas pavimentadas y conductos subterraneos de desagueen esos centros es, en algunos de ellos, enorme (en Teotihuacan pasaba, probablemente, de 750 hectareas); no hay duda en tales casos de su caracter plenamente urbano."[16]

According to the same author the evidence conclusively shows

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16. Armillas, 1951, p. 26.

that during its 1500 or so years of existence the city grew steadily in area, expanding gradually outward from the main ceremonial center; in the center the stratigraphic trenches show material from the entire sequence, on the edges just the final phases. There is no question here of contemporaneity of parts of the site by period.

The overall plan of the city may be summarized as follows. The center is ordered on a single axis which is the Calle de los Muertos and is a sort of main avenue or street at the two ends of which are the Pyramid of the Moon and the Ciudadela. The Sun Pyramid fronts on the main street on the east side. Almost at exactly regular intervals this main street is intersected by side streets which evidently do not run very far before ending. Each separates a residential palace or small pyramid and the entire main street is bordered by these public buildings for some 2 kilometers. The Viking group is a good example of this residential building type. Scattered in all directions from this center are local ceremonial precincts with small pyramids and palaces like Tepantitla, Tetelco Xolalpan; they look like the remains of the barrio or ward centers mentioned by many Spanish sources.

So far our description could pass for any Maya Center, except for the main street. The difference here is that the entire area in between these precincts, over some 750 hectareas, is covered by a dense ceramic concentration, remains of floors and broken-down walls. Linne in his Tlamimilolpa excavation cleared a small section of the urbanized area and found a complex maze of alleys and room groups and patios in extremely dense concentration; there are some 175 rooms in a space 50x75 meters, or about 500 per hectarea!

We don't know of course how many rooms were occupied by a family or how much of Teotihuacan was occupied by this dense a settlement concentration. Surface examination fails to show a significant difference between the area around Tlamimilolpa and the rest of the site; surface indications of occupation are equally heavy elsewhere and the implication is strong that most of this area was occupied by this type of settlement pattern.

Although we cannot make an exact estimate there is no doubt that the population density over the site is at least as heavy as in a modern Chinampa village. We would have to estimate the urban population of Teotihuacan at at least 60,000-70,000 inhabitants, and it is a true city by any definition you wish to use.

Another center for which we have at least documentary data is Tenochtitlan and here we also have an idea of the economic base of the city.

I cannot here review the bulk of data pertinent to the settlement pattern of Tenochtitlan but in terms of our modern settlement pattern studies of Chinampa villages we will discuss mainly the Maguey Map and its significance.

This famous map, called "Plano en Papel de Maguey", is in the Museo Nacional de Mexico and is a map of part of the city made by native artists sometime during the mid-sixteenth century. It pictures the colonial city but the fragment we have is of the Indian residential section and almost surely is representative of the pre-Conquest pattern. The area of the map has been localized by Toussaint, Orozco and Fernandez and covers some .233 kms of the ancient

city.[17] The map shows rectangular plots surrounded by canals in a perfect checkerboard pattern. Each of the rectangles is divided up into narrow strips which are definitely chinampas and on most of the plots we find a house. On the fragment we have there are some 400 houses with an average plot size of about 600 $m^2$. The population density is exactly that of San Gregorio Atlapulco, about 8,000 per $km^2$, and thus conforms exactly to our compact chinampa type of community.

The same source estimates the total size of the ancient city at 7.5 $km^2$, or about the same as Teotihuacan, and the total population at some 60,000 inhabitants.

One point should be brought out with respect to these tiny chinampas: they are of very small size and obviously could not have produced very much food; most Spaniards state that each house was surrounded by a flower garden but I suspect that some truck vegetables were also sown. I bring this up because the evidence is overwhelmingly in favor of reconstructing the economy of this gigantic community as completely urban, that is, non-food-producing craftsmen, warriors, priests, merchants, laborers and nobles.

With respect to this point I quote from the Arzobispado de Mexico a description of the economy of the Indian population for the same time period as the map.

"Primeramente digo que el barrio de Sant Pablo es uno de los cuatro principales de esta ciudad de Mexico y respeto de los otros barrios este al levante. Tiene doce tlaxicallis que son como doce

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17. Toussaint, Orozco, Fernandez, 1938.

barrios pequenos, y en todos ellos hay mill y doscientos y setenta y cuatro casados....

"Estos indios de Sant Pablo viven de ser mercaderes y tratantes y oficiales de todos oficios y pescadores, y tambien siembran los mas, aunque poco."[18]

The general data on Tenochtitlan clearly indicate it was a true city with an urban settlement pattern and economy. A few points might be reviewed briefly here:

1. The Spaniards never seem to tire of describing the great Tlatelolco market but there has been little analysis of these data; it met daily, a feature only found in fully urbanized communities; it handled all technology known to the Aztec of 1519 indicating that specialization, at least of the Guatemalan peasant type, was characteristic of all crafts; it emphasized basic foodstuffs indicating a large non-food-producing population; and finally aside from the main market food markets were scattered through the city like neighborhood grocery stores.

2. The Spaniards make special mention of the problem of feeding the city by canoe transport and indicate extremely heavy traffic continually entering and leaving the city; Cortez states that the city had to be provisioned from outside as little food was grown within it and later he finally defeated the Aztec by starving them out.

3. Cortez describes porters, craftsmen and laborers waiting in the market places for employment; labor was evidently an open commodity and craft skills operated in a free competitive system as

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18. Montufar - Arzobispado de Mexico, 1897.

in modern capitalistic economy.

4. Several sources (Motolinia, Sahagun, Ixtlilxochitl) state that the big centers were occupied by "barrios", each of which had a craft specialty; Texcoco had some 30 of them, the Osuna Codex lists at least 60 for Tenochtitlan; these are the Tlaxicalli of the Arzobispado de Mexico quotation.[19]

My impression of these major Altiplano centers differs drastically from the picture I see in the Maya area. In the Highlands we find the big ceremonial center but here it is the center for a city with an enormous, densely concentrated urban population of non-elite craftsmen, laborers and merchants, who live in a capitalistic competitive market economy and what is most important are producers of industrial products not only for the consumption of an elite class of priests and nobles but also for the peasant rural population as well, and here the city becomes a cell in a greater world of economic symbiosis which includes scores or even hundreds of rural villages and smaller urban communities. The village here cannot exist without the city and vice versa. We might use the term Symbiotic Urbanism here as distinct from the type of urbanism we find in the Maya area which I prefer to characterize by the term Parasitic Urbanism. In the Maya center the priest-noble class with their staff of artists have no economic function, they are purely an exploitive class; the peasant relationship here is purely one of contribution in labor and raw materials. In the Highland city aside from this parasitic class we have the industrial specialists who produce craft goods for the

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19. Sanders, 1949.

farming population.

Aside from Tenochtitlan there were a number of these true cities in the Mesa Central in 1519: Texcoco, Xochimilco, Ixtapalapa, Azcaputzalco, Tacuxba, Cholula and Tlaxacala.

One of the major problems with respect to Highland settlement patterns is that of the rural settlement, and our data are not yet conclusive.

If we assume a calmil system of cultivation for the pre-Conquest period then the best choice for the general pattern is one of the Scattered Village type with a density of some 1000-2000 inhabitants per $km^2$. Our scattered communities of the Teotihuacan Valley such as Tolman probably represent the general pattern in communities with the calmil-tlacolol type of economy. Salazar perhaps refers to this type when he says:

"Pueblan los indios de la Nueva Espana muy diferente de las otras naciones, porque por las idolatrias que tenian y por hablar con el demonio mas secretamente ni buscaban riberas ni costa de mar, ni lugares llanos donde hiciesen sus poblaciones, y las que hacian era en lugares altos, asperos y monstruousos, sin orden ni continuar casa con casa, por manera que un pueblo de mil vecinos venia ocupar cuatro leguas de tierra. Decian que el hacer su asiento en tales partes era por fortalecerse contra los enemigos comarcanos, y el estar tan apartados los unos y otros, por tener cado uno la sementera, o milpa a par de su casa, y..."[20]

In the irrigated areas or chinampas I suspect the basic pattern

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20. Salazar, 1914.

was the more concentrated village; modern Acolman and Mixquic probably are close to the aboriginal pattern.

The Relacion de Teccisistlan gives us a good idea of aboriginal settlement patterns in the Teotihuacan Valley. The Relacion dates from 1580 but evidently the Spanish regrouping policy had not yet affected this area.[21]

In the Lower and Middle Valley at this time there were three towns or town-villages: Tepexpan, Acolman (now vanished - the Convent is all that remains of it) and San Juan Teotihuacan.

Acolman at this time counted along with its dependent rural village some 1990 tributaries or nearly 10,000 inhabitants. These were scattered over 27 small villages aside from the central town. The average village had a population of 300 people at that time. About half of these villages are located within the confines of the valley; the rest lie to the north. Most of these villages are still villages today and without much doubt occupy in most cases the same spot and cover roughly the same area, and have the same general plan of settlement. As we have clearly indicated a drastic population decline from the conquest to 1580 it follows that the average village was much larger at the time Cortez visited Acolman. The data suggest strongly that the present pattern of village settlement and size goes for the pre-Conquest period as well.

San Juan with a total population of 8000 possessed 17 dependent villages, of which all but three lie inside the Valley itself; the average size here is slightly higher, probably about 400.

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21. P. N. E., 1905.

Tepexpan with 4750 inhabitants in 1580 had 13 dependent villages but all of the villages are outside the valley; only Tepexpan itself is within it.

It is unfortunate that we do not have a census of this area as thorough as the Arzobispado de Mexico, which gives the population of all of the smaller communities as well.

Unfortunately the published data from this source are mainly from areas in the northern Valley where irrigation was not as intensive and general ecological conditions less favorable. The data do, however, give us perhaps a more accurate general picture of the Meseta Central as a whole and some are reviewed below.

The data on the Partido de Tezayuhcan (Tezayuca) in the northeastern part of the Valley give us a good idea of sixteenth century settlement patterns.

The partido (a judicial unit) included five Cabaceras or central villages and towns, each with its dependent villages. These were independent political units or city states in pre-Conquest times.

One of these cabaceras was Tizayuca which had a population of 2800 people in 1569 and was a true nucleated town or more probably a town-village. Dependent to it were some 7 small villages. Quauhtlalpa had a population of 500 people and was situated 1 kilometer to the south. Huitzila with 585 people was 2 kilometers south of Tizayuca. Oztotipac had a population of 580 and lay 2 kilometers east of the cabacera. Tetetzontlilco with 480 inhabitants was situated 4 kilometers to the northeast, and Xicalhuacan with 425, 4 kilometers northeast. Finally, Tzitzipic and Acatitlan had 415 and 80 inhabitants and were situated 4 kilometers northwest and 1 kilometer

north respectively. The total population of this cabacera state was then 6235 inhabitants and all lived in nucleated centers of the village type, which type of village cannot be ascertained yet.

Also in the partido was Tolcayuca, 5750 inhabitants; in this case almost none of the population was nucleated and the source stated that they lived scattered through ravines and on slopes, evidently with a rancheria type settlement pattern, but with a ceremonial center (plaza, church, municipal buildings) at which resided a small fraction of the population.

At Temazcalapa we revert to the nucleated type of settlement. The cabacera itself possessed 1985 inhabitants. The cabacera state here included the following estancias or subject villages: Teopancalcan 250 inhabitants, 1 km southeast; Atolpantonco 350 inhabitants, 2 kms northeast; Teyacalco 375 inhabitants situated 2 km southeast; Tula 120 inhabitants, 2 1/4 kms to the southeast; Maquixco 515 inhabitants, 4 kms southeast; Calhuacatzingo 370 inhabitants, 4 kms southeast; Santa Ana 515 inhabitants, 3 kms to the south; and with a total population of the cabacera state of 3535 inhabitants.

The partido also included a number of isolated villages.

We may note that both the rancheria and village are habitation types as today in the Teotihuacan Valley with the village as a more common unit.

In the northern Valley in general the rancheria is common in that part where Otomi rather than Nahuatl was the most important language. The Otomi in general seem not to have lived in nucleated centers; the Nahuatl-speaking peoples generally did. Tizayuca for example was populated mainly by Nahuatlaca.

Carrasco in his study of the Otomi states:

"Los Otomianos vivian en establecimientos de tipo disperse. Esto debia ser la regla general pues algunas fuentes lo dan como caracteristico de los otomies....esta situacion era mas notable en el Acolhuacan donde los otomies, gente advenediza, no llego a fundar ciudades sino que se establecio como labradores tributarios en tierras de pueblos naua anteriores."[22]

Tepozotlan offers fascinating proof of this dichotomy in settlement pattern type between Nahuatl and Otomi-speaking groups.

Tepozotlan in the northwestern part of the Valley was in 1570 the capital of a partido, and was a nucleated town of 3595 inhabitants, mainly Mexicans or Nahuatl-speaking people.

The rest of the population of the partido was Otomi and scattered in rancherias. Each rancheria had a central church, the exact counterpart of our Maya ceremonial center with a small resident population. Only a small number of families resided nearby; the rest lived scattered over the countryside. As in ancient times we find also smaller dependent ceremonial centers within the area made up of a single little chapel.

One of these main ceremonial centers was Santiago which had four dependent ceremonial centers. The 2952 inhabitants lived scattered in a rancheria pattern.

San Mateo was a second with one dependent ceremonial center; here again the total population was scattered, some 3050 in all,

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22. Carrasco, 1950.

without order over ravines and hills.

San Andres with no dependent centers and 505 inhabitants, San Martin with one dependent center and 695 inhabitants, and San Francisco with two dependent centers and 2230 inhabitants reproduce this scattered pattern.

All of these dependent ceremonial centers were populated by Otomi-speaking people.

Down in the central and southern parts of the Valley of Mexico the rancheria was entirely absent and the nucleated community was the basic population type.

In general the data from the relaciones indicate that in the valley floors where Nahuatl-speaking people dominate, in the Mesa Central, the nucleated community whether village, town or city was the basic population unit. In rough broken mountainous country, especially on slopes and where Otomis tended to dominate, the rancheria-ceremonial center was more typical.

The general distribution of settlement types today in the Valley approximates their distribution in ancient times.

## Demography and Zonal Settlement Patterns in Modern Meso-America

In Map we have shown the general distribution of population by areal density throughout Central and Eastern Mexico and Guatemala or the general area of Meso-America. The data are based on the census of 1940 which is by distrito in Mexico and departamento in Guatemala. These units do not coincide exactly with ecological zones but are rough approximations.

In general the picture may be summarized as follows:

There are two major areas where densities run over 100 per square mile or 40 per $km^2$. One is the western two-thirds of the Meseta Central including the Valleys of Mexico, Puebla, Toluca and the Bajio of Michoacan. A second is the highlands of Guatemala with the bulk of the population of that nation living above 800 meters. In Oaxaca we find small centers of population at the Valley of Oaxaca and Tlaxiaco but here, even with intensive agriculture, the overall densities are low due to the high percentage of high mountain slope and scarcity of agricultural land. In a general sense the Highlands hold the greater part of the population of modern Meso-America. Another secondary center of highland concentration is the upper escarpment of Central Vera Cruz.

The Tierra Caliente in general, whether the Pacific or Gulf Plains are examined, today is poorly populated. We have minor concentrations only around big cities such as Vera Cruz and Merida. The only exception is the dense rural population around Comalcalco in Tabasco based on a full-scale commercial exploitation of cacao on first-class lands.

Within the Tierra Caliente we find a huge area including most of Campeche, all of Quintana Roo, British Honduras, Eastern Tabasco, northeastern Chiapas, the departments of Peten and Izabal in Guatemala - some 200,000 $km^2$ with an overall population of approximately 300,000 inhabitants - a vast, almost unexplored tropical jungle, the last frontier in Meso-American demographic expansion.

To get down from the general to the more particular I will now, to illustrate in more detail the differences in zonal settlement pattern and demography of the Highland and Lowland areas, present a

comparison of the three major areas studied in this dissertation: the Valley of Mexico, the Chontalpa and the state of Yucatan. The census data are from the census periods 1940-1950 (1940 for Yucatan and the Valley of Mexico, 1950 for the Chontalpa).

For Yucatan we will use our data from the distrito of Valladolid where we have a pure slash and burn economy under conditions fairly typical of the state of Yucatan as a whole. Valladolid district covers 4450 $km^2$. For a comparable size area in the Valley of Mexico we would have to join the following delegaciones and distritos, all inhabited by a predominantly rural population:

| | |
|---|---|
| Delagaciones Xochimilco, Milpa Alta | 400 $km^2$ |
| Distrito of Chalco | 1606 $km^2$ |
| Distrito of Texcoco | 1100 $km^2$ |
| Distrito of Otumba | 652 $km^2$ |
| Distrito of Zumpango | 734 $km^2$ |
| | 4492 $km^2$ |

For the Chontalpa if we combine Huimanguillo with Cardenas we get a total area of 5270 $km^2$, as close as we can get to our model area, but the difference is not great enough to change the overall picture. The total populations in the period in question were as follows:

| | Area ($km^2$) | Population | Density |
|---|---|---|---|
| Valladolid | 4450 | 38,755 | 8.7 |
| Chontalpa | 5270 | 48,743 | 9.3 |
| Valley of Mexico | 4492 | 266,086 | 60.0 |

In the Chontalpa test area we find the population distributed as follows: Towns, 2 - Huimanguillo with 3084 population and Cardenas with 3010; Villages, 4 - Ocuapan with 625 people, Tecominuacan 744, Gutierrez Gomez 647 and Sanchez Magallanes with 1008; or a grand total

of 6094 in the towns and 3024 in nucleated villages. The rest of the population live in rancheria type settlements; the data is summarized below:

| | | |
|---|---|---|
| In 2 towns | 6,094 | 12% |
| In 4 villages | 3,024 | 8% |
| In 76 rancherias | 39,625 | 80% |

The average size of the rancheria is 521 individuals.

In the case of Valladolid and the Valley of Mexico almost the entire population live in nucleated centers and we can make a careful comparison by community size and function from one area to the next.

| Community Size | Valladolid | Valley of Mexico |
|---|---|---|
| Over 10,000 | 0 | 1 |
| 5000-10,000 | 1 | 3 |
| 3000-5000 | 0 | 8 |
| 2000-3000 | 0 | 8 |
| 1000-2000 | 5 | 56 |
| 500-1000 | 11 | 72 |
| 100-500 | 34 | 133 |
| Below 100 | 628 | 14 |
| | 679 | 295 |

The Valladolid district with less than a sixth of the population of our Valley area has its population spread over more than twice as many settlements. The Valley has 20 communities with over 2000 inhabitants as compared to 1 in Valladolid and 76 with over 1000 inhabitants as compared to 6 in the Valladolid. Of extreme interest is the fact that in the Valley only 14 communities possess less than 100 inhabitants and fall into our "hamlet" class as opposed to 628 at Valladolid.

## The Demographic History of the Meseta Central in the Sixteenth Century

Throughout this paper I have stressed the importance of demography as a statistical technique for evaluating the effectiveness of the ecological adjustment of a group. Furthermore both Tax and McBryde emphasize population density as a factor in the rise of intensive trade and village specialization, along with special institutions to handle them. (Their conclusions are reviewed in the following section).

For these reasons I believe that we must make at least a calculated guess as to the demographic situation for the Pre-Conquest periods. For purely archaeological periods this is an enormous job and full of problems as to techniques and methods.

For the immediate Conquest period and the sixteenth century Colonial periods we have an enormous amount of statistical data based on estimates by Cortez and his soldiers of sizes of armies and communities; estimates of priests after the Conquests on conversions, and later on official ecclesiastic and government taxation censuses.

In 1948 Cook and Simpson wrote a study of population history of Central Mexico during the sixteenth century.[23] In 1950 I wrote a criticism of this study and presented an analysis of the data.[24] We will here simply summarize some of my conclusions and then present some specific data which are of importance in terms of our reconstruction of human ecology for the pre-Spanish period.

1. I suggest that the estimates of the Spanish Conquistadores of the period 1519-21 be used with extreme caution; there is considerable

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23. Cook and Simpson, 1948.

24. Sanders, 1949.

disagreement internally, some of the statements are obviously gross exaggerations. Finally the Spaniards of that period were not always clear just what spatial unit their data referred to - whether a city state or a town or even a province. Cook in many cases interpreted the data as pertaining spatially to the post-conquest cabacera states and in some cases the text clearly refers to a single community.

2. There is abundant statistical data from the period 1550-1580 and much of it is extremely detailed and cross checks with data from other sources of the same period. It is theoretically possible to reconstruct the demographic and settlement pattern picture for the entire Meseta Central for that period.

3. Some tax data must be used cautiously as in some cases a small encomendero exaggerated the number of his vassals as a defense against their claims of being overworked. Some big encomenderos suppressed population figures to distract attention from their rich holdings and finally in the Mesa Central itself many Indians fled into tax-free Tlaxcala to escape taxation.

4. The evidence is inescapable that there was a sharp and drastic population decline following the conquest. The main causes were three disastrous smallpox and measles epidemics dating from 1520-21, 1540 and 1578-79. Aside from this, enforced labor, and the decline of irrigation undoubtedly played key roles.

5. I estimate that the 1519 population was, in general, in the Meseta, twice that of the decades 1550-1570 and probably three times that of 1580-90. The Valley of Mexico for example in the decade 1560-1570 had a population of 600,000-700,000. The modern population leaving out Mexico City is approximately 800,000 but this includes

the suburban areas in the Distrito Federal around the city. The modern rural population is approximately that of the mid-sixteenth century.

6. These figures of the middle and late sixteenth century are of great value as they give us a minimum population for the Aztec period and indicate clearly that agriculture was not only as intensive then as it is today but the evidence strongly suggests that the system was even more intensive than in the twentieth century. The answer undoubtedly lies in an extension of irrigation and probably even lower standard of living than is characteristic of the area today, and probably the need for a lesser market surplus than our model economy.

To illustrate the latter point I will review some specific data which refer to the more densely populated sections of the Plateau area.

The demographic record of Cholula is unusually full and offers a good guide to the curve of population decline for the sixteenth century. From the "Relacion de Texcoco" by Gabriel Rojas we get the following picture.[25] In 1581 after the last of the great epidemics swept through the Meseta Central the city state had a population of 9000 vecinos. In 1565, just about mid-point between the two greatest epidemics of the sixteenth century it was 12,500. We have several estimates from the latter period for Cholula and they are all in essential agreement. In 1541, one year after the great epidemic of 1540, Rojas estimates the population at 15,000. In the E. N. E. Volume 15 we find an estimate of 20,000 hombres de guerra for 1531.

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25. Gabriel Rojas, 1941.

Projecting the curve backward we might estimate the population at approximately 100,000 (25,000 vecinos) for 1519. The area involved includes almost exactly the modern Distrito de Cholula, an area of just short of 800 $km^2$. The recent population history of the Distrito runs as follows: 1900 - 49,231; 1910 - 49,827; 1930 - 60,897; 1940 - 68,703; and 1950 - 85,216. The district today is a rural one based on grain cultivation but some of the increase is undoubtedly related to the urban growth of Puebla, a few minutes away by bus. On the other hand the ancient irrigation system of Cholula was undoubtedly more extended than is irrigation today and furthermore there was a huge urban center at Cholula in the sixteenth century and today there are only small villages and few towns. The estimate of 100,000 would include both urban and rural population and does not look excessive in view of the modern demography. The population density calculates about 125 per $km^2$.

In Volume XIV of the Epistolario de la Nueva Espana we find an extremely interesting document, number 825, which discusses the demography of parts of the Meseta Central.[26] It is evidently an examination as to the accuracy of the tax lists. The author of the document, Ochoa de Luyando, attempts to show that the official census made by Velasco in the mid-sixteenth century suppresses the actual population and Luyando gives us his estimates as compared to the official data. The figure he gives for Cholula, taken from the Velasco census, is 13,000 tributaries, whereas Luyando's own estimate is 25,000 or nearly double. My own feeling is that the Velasco census

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26. E. N. E., Vol. XIV, 1939.

here was undoubtedly correct as it checks with at least half a dozen estimates of Cholula from different sources over roughly the same period, 1550-1570 A.D. Interestingly enough Luyando's estimate of 25,000 is the same as ours for 1519; I suspect strongly that he was using some earlier census, probably made shortly after the conquest. His motivation for using this data may have been to gain favor with the crown by giving a higher estimate of tributaries and yet at the same time he could refer to an actual census (although out of date) and thus cover himself legally. Or possibly he was unaware of the degree of the population decline; actually many encomendados continued to use out-of-date censuses to tax their subjects throughout the sixteenth century.

If we use his estimates to serve for the immediate post-Conquest decade we can then estimate the probable population of a few test areas in the Meseta Central for 1519.

His data can be arranged in the following chart:

| Province | Velasco Census (1550-1560) | Luyando Estimate |
|---|---|---|
| Cholula | 13,000 indios | 25,000 tributarios |
| Chalco | 22,000-23,000 indios | 45,000 tributarios |
| Huetjotzingo | 11,325 indios | 25,000 tributarios |
| Tlaxcala | tax exempt | 50,000 tributarios |
| Texcoco | 12,000-13,000 indios | 25,000 tributarios |
| Xochimilco | 12,000-13,000 indios | 20,000 tributarios |

The provinces of Chalco and Xochimilco just about cover the southern Valley of Mexico. In 1900 this area had a population of 120,503; in 1910 - 118,291; in 1930 - 116,666; in 1940 - 141,598; and finally in 1950 - 181,572. During this period the population has remained basically rural although some of it is part-time urban labor

for the City of Mexico. The total population for the decade 1550-1560 was 34,000-36,000 families or 170,000-180,000 inhabitants; for the conquest period 325,000. The principal factor in this lesser population today undoubtedly is the decline of chinampa agriculture, and the conclusion is inescapable that agriculture in ancient times, even of the temporal type, was even more intensive than today. The density of population for the conquest period is approximately 155 per $km^2$.

The figure for Texcoco refers only to the "province" of Texcoco which includes roughly the modern municipios of Texcoco, Atenco, Tezoyuca, Chiconcuac and Chiautla, a total area of approximately 600 $km^2$. Modern censuses of this area recorded 31,276 people in 1900; 29,268 in 1910; 34,231 in 1930; 40,062 in 1940; and 48,607 in 1950. Our estimate for the mid-sixteenth century is 60,000-65,000 and for the conquest period 125,000. Today many of the irrigated terraces behind Texcotzingo have eroded away. Also in 1519 a large percentage (probably at least one-fourth) of the population was urban as Texcoco was the second largest city on the Meseta Central. (On the basis of the sixteenth century data approximately half the provincial population was living at Texcoco and its immediate dependent villages, the rest in the city states of Chiautla Huexotla, Coatlinchan and Atenco.) Even taking into account these two factors our modern rural population seems considerably below the ancient one, and we must assume a much more general use of irrigation for the Aztec period than is used today and probably a generally lower standard of living. The density of population would run to slightly over 200 per $km^2$.

The Relacion of Teccisistlan gives the total population for the

three centers (including tributary villages) of Acolman, San Juan Teotihuacan and Tepexpan of 4540 tributaries for 1579, of which approximately 3000 lived within the modern municipios of Acolman San Martin de Los Pyramides and San Juan Teotihuacan. The 1519 population would be presumably about three times as high to use our rates of sixteenth century decline, or 9000 families or 45,000 inhabitants. The population in 1950 was 22,488 and the area 219 $km^2$, the density for 1519 running to approximately 200 per $km^2$. The population figure is only possible if we assume that the pre-conquest population used the hydrographic resources of the valley almost to the maximum.

What these figures clearly prove is that agriculture in the Meseta Central was at least as intensive as it is today. The censuses of the mid-sixteenth century after some 30-40 years of epidemics and steady population decline in general are about the same or only slightly below or above modern populations in the same area. I cannot prove that land use was twice as intensive as I strongly believe but there is little doubt that it was at least comparable to the level of 1950.

## The Sixteenth Century Demographic History of the East Coast

The mid- and late sixteenth century demographic picture for the Tierra Caliente of the Gulf Coast and Yucatan Peninsula on the other hand is almost useless for our purposes. Population decline was so fast and so drastic that by the time we have good censuses the population was so low that the figures do not help as a minimum estimate. In 1953 I analyzed the situation in the Vera Cruz area. In 1580 there were only 125,000 people in all of Vera Cruz and most of them

were living well up on the escarpment in the Tierra Templada.

We do have some data referring to the Conquest period which I quote from my 1953 study:

"The only other data from the state also seems quite reasonable. Papantla for example is stated to have had 16,000 indios in its partido, by Juan de Carrion, or 64,000 people. The province seems to have included the following municipios: Papantla, Tecolutla, Coatzintla and Gutierrez Zamora. The total area is about 2200 $km^2$ and had 53,364 inhabitants in 1930 and 62,771 in 1940, another close check with the 1519 estimates....The density here would be about 30 per square kilometer for 1519. This figure provides a test figure for the prize zones of the Tierra Caliente with hilly, well drained tropical forest areas....

"For the province of Coatzacoalcos we have a figure from Canga y Quinones for 50,000 indios or 200,000 people. The area covered roughly corresponds to the old canton of Minatitlan an area of about 12,000 $km^2$. The density here would be about 17....the figure provides a test density for most of the Zona Sur, low-lying inundated plain, with tropical forest cover."[27]

I today would increase the population data slightly by calculating the size of the family as 5 instead of 4 persons. The total for the Papantla area is then 80,000 and density 36. For Coatzacoalcos the figures are 250,000 and 21.

Another approach to the problem of the demographic capacity of the Lowland areas is by modern census histories. In the Papantla

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27. Sanders, 1953.

area the municipios of Papantla, Coyutla and Coxquihui, Tancoco and Misantla show next to no population increase since 1900. The general densities run between 27 and 31, or slightly below our 1519 estimate. Around Los Tuxtlas both San Andres and Santiago seem to have reached a state of population stability with a density of 28 and 36. For Yucatan we have already analyzed the situation. The suggestion seems clear that in a real sense the capacity of slash and burn cultivation runs between 15-40 per $km^2$ according to the local area. Our ideal figures based on milpa yields are only slightly higher - 50 for Papantla and 20 for northern Yucatan.

Tozzer quotes a 1549 census referring to the province of Mani in which the tribute was set at 13,480 mantas, one manta per family. This reduces to a population of some 67,400. On the basis of Roy's study of the Mani Land Treaty of 1557 we can come to a reasonably accurate estimate of the size of the province.[28] It seems to have covered almost exactly the modern distritos of Ticul and Tekax, an area of some 6000 $km^2$ and a 1940 population of approximately 53,000. The 1549 density was approximately 11 per $km^2$. Of great interest is the fact that then as today most of the population was concentrated in the northern half; the area around Uxmal and Santa Elena was very poorly populated and the density around Chumayel, Ticul, and Tekax must have been at least 20 per $km^2$. These figures are of some value as Yucatan suffered no devastating epidemics as elsewhere in the Tierra Caliente in the sixteenth century, and the factor generally stated as responsible for the population decline, according to the

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28. Landa, 1941.

Relaciones, that of the Spanish regrouping policy, was not yet operative by 1549. Granted, the fifteenth and early sixteenth centuries were periods of constant war and probable demographic decline, yet the figures suggest strongly that our data on the relationship of slash and burn agriculture and demography are pertinent for ancient times as well as today.

MARKETS AND SPECIALIZATION IN MODERN MESO-AMERICA

One of the most interesting aspects of modern Indian economy within the area of ancient Meso-America is that of the market system and local specialization. Fortunately we have a number of excellent studies from different areas within Meso-America.

Today market economy of the Indian type survives in its most intense form evidently in Southwestern Guatemala. Sol Tax gives an excellent summary of the features of the system in this area.[1] We will first briefly summarize it here and then discuss the system from the point of view of its ecological basis.

Specialization of production of both agricultural and handicraft goods by village is characteristic of the system. Most villagers are also maize farmers and carry on the specialty on the side.

Community specialization, following Tax, is based on the following factors:

1. Variation in altitudes of villages result in varying agricultural products and divide the area into broad agricultural areas.

2. Differences in natural products, by local ecological zones, i.e., carpentry specialties in forested sections, making of mats where reeds are available, stone for metates, etc.

3. Differences in quantity of land for agriculture; this is a forcing situation; the community must have another specialty in order to live.

4. Cultural tradition of the municipio; some communities in forested areas only make planks, others furniture, etc.

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1. Tax, 1952.

5. The custom of craft endogamy or fixing of skills in family lines.

6. Shift in market values of crops, such as truck vegetables, may cause a community to specialize entirely in one single or a few limited crops, another village to specialize in other crops; prices are then maintained higher, and this specialized agriculture becomes more profitable.

Specialization in Southwestern Guatemala takes several forms:

1. Special crops - some communities produce wheat and potatoes, others vegetables, others maguey, others fruits, others sheep, etc.

2. Industries - pottery, furniture, lime baskets, mats, rope, blankets, metates, etc.

3. Trades - house building, plastering, masonry, carpentry.

4. Merchandising - there are whole communities which specialize in trade, buying and reselling in the regional markets.

5. Labor - especially in the coffee plantations on the Tierra Templada escarpment.

6. Maize - some municipios with abundant land produce a maize surplus for trade.

Along with the local specialization of production we find the extraordinary development of markets for the distribution of these surpluses.

McBryde gives an excellent summary of the market system in Southwestern Guatemala which is quoted below.

"Towns may be well developed even where Ladinos are numerically unimportant, if the Indians are town-dwelling craftsmen, as at Totonicapan. The daily market depends upon a large number of buyers living

close within the orbit of attraction of the trade center. Only in a populous town or village where the inhabitants are well nucleated are there enough consumers to support a sizable daily market, in which most goods are retailed in small quantities.

"The three most important factors favoring a strongly developed market seem to be as follows: (1) A high population density in the tributary area, (2) situation on major trade routes, and (3) an intermediary location between contrasted areas of production. Though no single market depends solely on any one of these factors, the first is of primary importance in such a metropolis as Quezaltenango; the second is well exemplified in Santo Tomas la Union; and the third accounts largely for the extraordinary weekly market of San Francisco el Alto.... All three factors contribute somewhat to every important market. The general relationship between markets and areas of dense population may be seen by comparing maps 8 and 19, which show that most of the large plazas are in the well settled portions of the Highlands, such as the Quezaltenango-Totonicapan Valley. The alinement of market towns along trade routes is particularly notable in the natural, transverse passageways formed by the gorges and passes between volcanoes, as, for example, along the Quezaltenango-Retalhuleu and Nahuala-Mazatenango routes. The line of piedmont markets, centering along and above the railroads, is equally prominent....The greatest single basis for the contrast between producing regions is the sharp altitudinal difference between Highlands and Lowlands. The products of both are found in variety and abundance in all plazas.

"Wholesaling of goods to itinerant merchants may be observed in many of the large trade centers. San Francisco el Alto is preeminent

in this regard....Some of the more important items sold wholesale in that market are blankets, cotton textiles, ropes, garlic, pottery, incense, hats, chile, panela, Lowland fruit, and young pigs. Except for the first and last, none of these is produced locally. Pottery comes to San Francisco from at least five sources....

"Most of the middlemen's wares are not bought from wholesalers in the market, however. It seems generally true, especially of such manufactured goods as pottery, that dealers who specialize in merchandizing buy up loads of such articles from the makers at their homes...." 2

The distribution of this rural specialization-regional market system in modern Meso-America is of great interest. A general statement of Sol Tax is worth quoting in this respect:

"At the same time there is in Middle America a significant difference in economic organization ranging from the extreme of self-sufficiency wherein the community (and each family in it) produces virtually all that it consumes, all the way to the extreme of local specialization in which even rural communities (and hence the families within them) produce chiefly for market and buy most of what they consume. Accompanying differences in the importance of trade, markets, and money are obvious; probably there are related differences also in ethical systems and perhaps in personality types. These differences are doubtless connected in part with geography. In homogeneous lowland regions each family and community tends to produce what it consumes, and the same thing; whereas in areas of variegated topography and altitude, there tend to be local differences in resources, hence

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2. McBryde, 1945, pp. 82-83.

production. Such considerations may generally explain differences between rural Indian economic life in Yucatan and in highland Guatemala. But within one or another region it would be erroneous to attribute varying patterns of specialization directly to environmental differences; for once a general pattern of trade (for example) is established, factors such as inventive business enterprise and the limitations of customary preference and 'know-how' become important.....

"The extremes of self-sufficiency are reached among isolated tribe-like groups such as the Lacandon and the Indians of Quintana Roo. It is a function of their being tribe-like and isolated, and as such not very interesting. The opposite extreme of mutual interdependence is reached in highland areas of Guatemala, Chiapas, Oaxaca, central Mexico and Michoacan. Perhaps Midwestern Guatemala is the extreme case where there are communities as dependent upon trade for basic needs as are cities. The communities between these extremes partake of the characteristic economies of each. In most places in Middle America the question is the degree to which the local communities enter into a regional market economy. I shall discuss the factors governing this difference in terms of data largely from Midwestern Guatemala."[3]

The same basic system is characteristic of Highlands of eastern Oaxaca amongst the Indian, especially Zapotecan, population. Parsons (1936) describes its functioning in her study of Mitla-Mitla itself being a community of specialized middle men. West (1941) describes the same system for Highland Michoacan.

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3. Tax, 1952, pp. 44, 45.

In the Mesa Central the system was characteristic up until the twentieth century. Today relics of it still exist but modern industrial growth in the cities combined with motor transport have caused its decline. In the Teotihuacan Valley for example we have a first class highway which is but 40 minutes by bus from Mexico City and many farmers make weekly trips to that center for much of their buying. Villages which once had specialized trades can no longer compete with industrial production and those trades have declined. We find a survival of the system in the regional market of San Juan Teotihuacan with its Sunday-Monday market, and Otumba with its Tuesday market. We find some specialization in production - some villages are pottery-making communities, others produce tunas, some maguey products, etc., but the system is in the last stages of decline. There are other regional markets also at Zumpango, Texcoco and Xochimilco. In the latter case the system retains a little of its old vigor and we find a brisk daily market involving thousands of vendors weekly from villages all over what was the ancient province of Xochimilco. Lake shore villages specialize in truck vegetables and maize, communities around Milpa Alta in maguey products and frijol, mountain villages in wood products, pottery is brought all the way from Texcoco, mats and baskets are brought from Lerma in the Toluca Valley by either middlemen or by the artisans themselves.

Of great interest is the absence of the system in the Lowland area or the Tierra Caliente. This not only applies to Mestizo Tabasco but also to the aboriginal Totonacapan of northern Vera Cruz and the Maya area of northern Yucatan.

## CONCLUSION

### Introduction

In my introduction I have stressed the primitiveness of Meso-American technology and transport and emphasized that in such a cultural setting, environment not only limits, but molds and conditions the kind of culture which is to develop, and determines to a great degree the exact stages by which that culture evolves. Before elaborating on this point, which is the central theme of my conclusion, I think a few notes of caution are advisable.

First I do not claim that environment is the only factor involved and in some cases it may not be the major factor. Historical factors entirely independent of the area they affect (though in many cases the product of the area from which they came), in an environmental sense, may well cause a culture to change from a normal course of development. I have in mind a number of specific cases, one of which may serve to illustrate this point. In eastern Brazil, we find at the time of the Conquest a simple folk agricultural society with slash and burn cultivation of maize and manioc as the economic base. One would expect a settlement pattern of small villages and hamlets in such an ecological setting, yet the Tupinamba evidently lived in big villages, some passing the one thousand point. The result was that instead of maintaining a small permanent community with field rotation located at a minimal distance, they ranged farther for fields, rapidly overexploited nearby areas and shifted village location every four years.[1] The reason for

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1. H. B. South American Indians, Vol. 3., 1948.

this is obviously related to the intense war pattern characteristic of the area and the need for grouping in larger units. This does not negate the fact that big villages are not ecologically sound with this type of economy and Tupinamba culture may be said to have possessed an ecological strain or stress in it. Under strong social pressures then, the natural settlement type may be abandoned, but our axiom of ecology-settlement-culture functionalism is not hereby destroyed any more than the Law of Gravity is destroyed by the presence of the airplane.

Anthropologists are fond of pointing out exceptions whenever a researcher attempts to establish universals. The Science of Culture is like any other science and we always find present at the base of any cultural growth a mosaic of factors. Some of these factors may reinforce each other; one may negate or nullify another or simply modify it. This is especially true in an elaborate civilization like that of Meso-America where socio-political factors may be very potent ones and overrule ecological laws. One would not expect to find a brilliant civilization in the Yucatan Peninsula at all but the ruins testify that this was the case. Here we have, I believe, other factors involved, of which the most important ones were probably the presence of an over-populated highland area nearby where ecological conditions <u>were</u> propitious and the occurrence in the Tropical Lowlands of a series of products which were essential to the needs of the highland groups (rubber, copal, cacao, cotton). So the Lowlands <u>were</u> colonized and an elaborate civilization attempted. The latter historical reconstruction is, of course, open to debate and will be discussed exhaustively at a future point.

In a real sense this conclusion is an essay on the different types

of ecological cracks in the fabrics of Meso-American regional cultures and how these were mended or how they ultimately destroyed them.

## Origins

We have seen that today and in the past the peasant populations of Meso-America have adjusted themselves to their environment in two distinct ways, which correlate with the two major life zones of the area. In actuality each of our discussed ecological types presented different problems to the cultivator; the argument may be made stronger: each of our 51 Ecological Areas is unique and should be studied as a unit of cultural history. At our present stage of knowledge, of even basic data, it might seem foolhardy to attempt to conceptualize and generalize on problems and principles, but some stock-taking, I believe, is necessary at each stage of anthropological research and this conclusion is an attempt to do so.

We will discuss two major issues: (a) origins, and (b) the functional relationships between our ecological types and culture sub-types within Meso-America.

In discussions of origins of the Meso-American cultural pattern most specialists think in terms of a single problem, whereas in reality there are a number of distinct and in some cases historically unrelated problems. First of all is the problem of the origin of food production as opposed to food collection in Meso-America. This may be, and probably is, a basic American Indian rather than a strictly Meso-American problem and the data we have at present cannot resolve this problem one way or the other. To a great extent this is a botanical rather than a cultural problem although cultural factors may have played a significant role. By botanical problem I mean simply that cultivation probably began in

the New World where the ancestors of the basic crops grew wild as in the Old World the centers of domestication are in the same areas where the wild ancestors of wheat and barley may still be found. The problem has centered chiefly on maize since maize is everywhere the staple, with the exception of the Peruvian Highlands above 3000 meters, and in parts of Lowland South America. This may be a mistake since in two nuclear areas, Highland Meso-America and Highland Peru, we find two varieties of amaranth which were staples at the time of the Conquest and agriculture may well have started with them rather than with maize. To date no evidence of a pre-maize agricultural stage based on amaranth has been discovered in those areas but we do have the highly significant case of a pre-maize agricultural complex from the Peruvian coast in which the staples were evidently squash and beans. (With respect to the latter point it is interesting to note that squash seed was a basic food in the Valley of Mexico at the time of the Conquest).[2]

However Meso-American civilizations did not really get under way until maize was domesticated and there is some justification for the emphasis placed on this crop in discussions of agricultural origins. The problem has been attacked more from the botanical theoretical angle than the archaeological record. In general, botanists, especially the group working with Manglesdorf, basing their arguments on the tolerances of modern maize, have tried to narrow down the ecological chances to a specific type, the mid-altitude, temperate humid or sub-humid-humid border lands of Highland Nuclear America. The intermediate level highlands of Guatemala or Tierra Templada has been one favorite, the Cochabamba Valley and environs in eastern Bolivia another. Bias

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2. Bennett and Bird, 1949.

has swerved back and forth from the Andean and Meso-American areas and to date the problem remains unsolved.[3]

The Carbon 14 datings we have at hand do not agree with this position at all. The earliest occurrence of fossil corn pollen on record is from the Valley of Mexico which dates back 60,000 years.[4] There is no possibility that this was a cultivated species and I believe seriously damages the previous ecological arguments. Actually as I have pointed out in a previous section maize seems to do best in terms of yield and plant vigor in our own Maize Belt and the nearest parallel to this zone in Meso-America is the Meseta Central. If we were to utilize the present assortment of Carbon 14 dates for the appearance of domesticated maize we would get a neat sloping horizon in which the first occurrence would be in the Southwest (3650 B.C.), to the Tamaulipas Caves (2490 B.C.), to the Valley of Mexico (1360 B.C.) and finally Coastal Peru (860 B.C.), with the strong implication that maize was first cultivated in the Southwest and was gradually moving southward from that center.[5] This possibility, I believe, deserves serious consideration and certain sub-regions in the Southwest such as the Gila and Colorado Valleys offer similar forcing conditions which led to agriculture in the Old World.

Willey has offered an interesting synthesis which I believe provides a conceptual scheme for setting up the problem.[6] We find in Pre-

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3. Sauer, 1950.

4. Manglesdorf, 1954.

5. Manglesdorf, 1954; De Terra, 1951.

6. Willey and Phillips, 1955.

Agricultural times a vast continuous zone of sub-humid to arid elevated tableland running from the American Southwest ot Central Mexico, occupied by a seed-gathering population similar perhaps in basic culture to the historic Paiute and Central and Southern Californians, the culture varying with the richness of the ecology. The area in general duplicates the ecology of the Old World centers of plant domestication and there is an interesting parallel in the fact that in both areas we find a pre-agricultural group dedicated to wild seed gathering as a basic economy - the Mesolithic peoples of the Old World and the Cochise-Chalco peoples of the New. To me this is the natural economy from which true agriculture might have evolved and it is of great interest that our earliest Carbon 14 dates on maize cultivation ranging from 3650 to 1360 B.C. are all from this great region.

To the east of it in both the United States and the Mexican segments stretch a huge lowland humid plain with abundant resources for primitive hunters and food gatherers. In fact, as Willey has pointed out, food resources in the American portion of it were so abundant that they took the place of agriculture well into the Christian era. Fairly elaborate cultures developed, perhaps similar in complexity and organization to the historic Northwest Coast peoples which were supported by a food collecting economy.[7] Evidently such food sources as acorns, shellfish, wild rice and even game were so abundant that the growth of agriculture was aborted until perhaps as late as Mississippian times. In other words I think we can conceptualize the problem as a North American rather than strictly Meso-American one and our defined dual broad

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7. Willey and Phillips, 1955.

ecological settings can be used to point out the probable origin of agriculture in at least North America.

The second major problem of origins is that of the distinctively Meso-American type of agricultural society. The peculiarity of the agricultural system of Meso-America is in general not technological. The same techniques and tools characterize it as they do the agriculture of groups further north. For example, digging and hoeing tools, humidity and fertility conserving techniques (except for a few highly localized and possibly very late inventions such as terracing, animal fertilizers, chinampas) from the Mexican highlands differ but in minor degree from those in the Southwest and the technological equipment of the Lowland Meso-American farmer is a duplicate of that of the farmer in the Mississippi basin. The only differences on the technological side lie in food processing rather than food production, the use of the mano and metate for maize grinding and in techniques of food preparation. The major differences in the agricultural societies of the Meso-American area as compared to agricultural areas to the north lie in another direction. Foremost is the difference in degree of land utilization. In the Mexican and Guatemalan Highlands much more land is cultivable than in the Southwest, and cultivation was more extensive and in some areas more intensive. Even in the Lowlands with slash and burn cultivation the system is much more extensive, although probably not more intensive, than in the Mississippi Valley. In the latter case it seems not to have been a matter of land availability but simply of cultural inclination. A second primary difference is the relative richness of the agricultural assemblage in Meso-America as compared to the maize-beans-squash complex of the north. Diet and

consequently cuisine was much more complex. The results economically of this richer agriculture have been a much denser population and the creation of a substantial surplus which very early led to the development of the stratified society for which Meso-America is famous.

The third problem is historically related to the second and is that of the origin of Meso-American High Culture. By this we mean the type of society stratified in two basic levels, an upper one - the leisure class mainly of religious specialists, and the lower class of farmers and craftsmen. In certain special areas of Meso-America the social system becomes more complex but the more simple form was almost universal over the Meso-American culture area on all time periods from Late Formative on to the Conquest. With it goes a special technological complex - the pyramid temple, the idol, and the calendar.

The final problem is the origin of true urban society in which the special symbiosis of city and village is the central theme. This type of society, I believe, was entirely limited to the Highland Ecological Pattern and perhaps even to the Meseta Central.

In organizing the synthesis of these two major problems, origins and functional ecological-cultural relationships, we will base our discussion on my defined Ecological Types and Patterns.

The Ecological Pattern is a broader, more inclusive level than my defined Ecological Types and I recognize two patterns in Meso-America. One embraces the Tierra Templada-Tierra Fria or Meso-American Highlands - all areas above 800 meters which we can call the Highland Pattern, and the other the Tierra Caliente or Meso-American Lowlands which we can call the lowland or Tropical Pattern. Each embraces a series of Ecological Types which will be discussed separately.

## The Highland Pattern

The general Highland Pattern of ecology may be defined as follows. The data apply to the immediate Conquest period. The Pattern includes two basic agricultural systems - the tlacolol, a semi-intensive system in which from one-third to two-thirds of agricultural land is under cultivation every year, and intensive agriculture in which at least two-thirds and often 100 percent of the land is in production. The major feature which characterizes the Highland Pattern is the use of hand tools for working the soil; instead of just punching holes in the soil it is chopped up, turned over and thoroughly pulverized, thus paving the way for a series of effective weed and humidity control techniques. The basic tools include the coa and probably true hoes.

Crops are limited in variety but include more staples than in the Lowland Pattern. Aside from maize, maguey, huauhtli, chia and squash seeds provide important secondary staples. An important aspect of these extra staples is that some of them are zoned; where maize will not grow maguey will. There is an interesting parallel here to the Mediterranean region where wheat grows in the richer plains and the stony slopes are covered with olive groves. This means that there is a high efficiency of total land surface utilization beyond what would be possible with a pure maize economy.

Other features of the agriculture of the Highland Pattern are true weeding, irrigation (even in the humid segments it is used for dry season cropping), green fertilizers, cajete sowing, and terracing. Such specialized techniques as chinampa cultivation and the use of animal fertilizers were probably limited to the Meseta Central.

One of the characteristics of the Highland Pattern from at least

Classic times and probably earlier has been population pressure; land has always been over-utilized and there has never been enough to go around. Furthermore land division has been characteristically uneven, aggravating the situation. Population is always dense in the areas of cultivation (i.e., mountain valleys), in the arid mountain areas only relatively so in an overall sense. In the Mesa Central and more humid areas it is dense in an overall sense as well. The essential fact demographically is that it is a land-hungry pattern; populations have no room to expand and when they do so it is apt to be explosive; holdings are small and constantly undergoing further fractioning.

One of the major unsolved problems of the Highland ecological pattern is that of settlement patterns. In the Mexican portion, today at least, the nucleated village, often of considerable size, is the basic form, but scattered rancherias occur in areas of rough broken terrain. The compactness and internal population density of the village seem to tie in directly with the intensity of cultivation. In Guatemala settlements seem to have been more dispersed and this was probably true in the humid Tierra Templada of Mexico as well. Towns and cities are important settlement types in the Highlands and have been since at least Classic times.

Also characteristic of Highland Ecology is the enormous development of zonal and sub-zonal specialization in agricultural and industrial production. Trade is intense even on a rural level; each village is a specialized cell in a regional symbiotic area and cannot survive alone. Goods are moved around mainly by human porters through a formally channelled market system and we find the society has a distinctively

commercial, secular cast to it.[8] This is made possible by the micro-geography where dense populations and reduced distances between centers of production enable intense trade even without pack animals.

The latter point is, I think, clearly illustrated by our comparison of zonal settlement patterns. In the Chinampa area we found 14 villages over a 28-kilometer stretch, in Northern Yucatan, over the same distance, but 3. The difference in terms of possible volume of trade and the rise of special institutions to handle it are obvious.

## The Mesa Central

Within our Highland Pattern one of the most important regions, perhaps the most important of all the subdivisions of Meso-America, is the Mesa Central. The Mesa Central possesses a number of unique features which set it off sharply from all other Meso-American Highland regions. In the first place it is the only extensive area consistently more than 2000 meters above sea level. Second it is the only highland area with large extensions of flat plain. The climate is sub-humid and this fact, along with the winter frosts, presents the central problem for the agricultural population. Soils are generally fertile and capable of sustained cereal production with primitive techniques of soil restoration, and cultivable areas are extensive. Add to this an invigorating mountain climate and we have a combination of circumstances which on the one hand are enticing to primitive farmers and on the other hand present problems which can only be solved by a heavy outlay in labor on all levels, familial, village, and regional. In

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8. Redfield, 1941; Tax, 1952.

connection with this a further unique feature which Palerm in 1955 stressed is the fact that it is the only area in Meso-America where irrigation on a grand scale is both a necessity for effecient cultivation and where it is hydraulically possible[9] (i.e., water sources and easily controlled gradients). Palerm stressed the significance of irrigation in the form of large-scale hydraulic projects in state building and state formation.

Most specialists, both archaeologists and botanists, seem to agree that the primary discovery of agriculture did not occur in this area. This may be true but no one has proved the contrary and if my previously stated hypothesis is correct the Mesa Central may well be the first major region in Central and Southern Mexico to receive agriculture. At any rate what is certain is that farmers were cultivating the soil of the Valley of Mexico by at least 1360 B.C., our earliest Carbon 14 date, or the Zacatenco period. I suspect that the first introduction antedated this by no more than a century or two and we will probably not find a more primitive agricultural group than the makers of Arbolillo 1 pottery and associated artifacts.

The following is a brief record of what happened in the plateau following this event and will provide a chronological framework for the later discussion.

Sears in a fascinating paper based on pollen stratigraphy in the Valley of Mexico suggests that the Early Archaic was a period of relatively humid climate, from which point the climate steadily deteriorated through the Late Archaic and Early Classic periods and reached its dry

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9. Palerm, 1955.

maximum toward the end of the Classic. Following this we have a gradual but evidently more rapid return to a wet optimum during Aztec times.[10]

With this climatological history as a background I believe we can visualize the economy of the early Archaic and probably most of the Late Archaic periods as being an extensive tlacolol type with small folk agricultural villages and a relatively light population density. There is no evidence that the Valley was densely populated during this period. Of great interest is the fact that parallel with the long period of increasing aridity we find the rise of urban society and development of religious art and architecture at Teotihuacan, and dense populations in the level areas of the Valley.

The Valley of Teotihuacan today could not support an effective agricultural economy without irrigation, certainly not enough to support a huge urban center of some 50,000 people. It is the driest area in the Valley of Mexico and the modern climate is probably somewhat more favorable than that present toward the end of the Classic period. With the primitiveness of Meso-American transport a substantial portion of the food supply must have come from the Valley of Teotihuacan and its environs to feed this gigantic urban complex. I suspect that permanent maize agriculture was limited to the deep soil plains and that humidity conservation techniques such as the flood water irrigation, perennial spring irrigation, cajete and dry farming, and soil fertility maintenance techniques such as crop rotation, fertilizers, mixed sowing, enlame and bancal type of terracing, were all invented during the Classic period. One of the major tasks of future settlement

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10. Sears, 1951.

pattern studies will be to date the first appearance of some of these techniques on the basis of archaeological data and to date this has not been done. Millon in 1954 came to the same basic conclusions with regard to irrigation at Teotihuacan although he underestimates greatly the capacity of the modern Teotihuacan Valley for unirrigated cropping.[11]

Sears postulates the collapse of Teotihuacan civilization as being a direct effect of increasing dryness, resulting probably in a drying up of some permanent water sources. I suspect that it also caused the abandonment of the flood-water irrigated areas which depend on a substantial rainfall in the nearby mountains. We can visualize the early Post-Classic as a period of small populations concentrated in a few areas where permanent springs kept limited irrigation systems going but which could no longer support urban congregations. There is a fascinating parallel here to modern and colonial Hidalgo and I think the ecological situation in Hidalgo today reproduces what must have been the situation in the Valley of Mexico during this period.

With the Aztec period we find strong evidence that population reached a maximum for the archaeological periods of the history of the Valley of Mexico and probably for the Meseta Central as a whole. As a matter of fact if we subtract the huge urban center of Mexico City the demographic level of 1519 has never been surpassed. The evidence for my conclusion is summarized below:

1. Whereas in Teotihuacan times we have a single urban center of 50,000-60,000 inhabitants, we find one of equal size (Tenochtitlan) plus at least half a dozen smaller ones (Texcoco, Tlacopan, Azcaputzalco,

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11. Millon, 1954.

Chalco, Xochimilco, Ixtapalapa, etc.) during the Aztec period.

2. Chinampa agriculture was probably invented during the Post-Classic period; to date it has not been proved to antedate the Aztec period and my survey work around Tlahuac substantiated this.

3. All stone faced terraces evidently date from the Aztec period and this indicates much heavier land pressure than during the Classic period. I found small village sites of the Aztec period even in the barrancas back of Texcoco.

4. The Spanish documents indicate a population of at least 1,000,000 in the Valley of Mexico and the area could not possibly support any more under the drought conditions of the Classic period.

5. During the Aztec period we find the functional rise of two demographic techniques only feebly developed in Classic times: human sacrifice and war. Although Cooke's statistical data is very unreliable I feel his basic conclusions are justified and suggest a demographic pressure far beyond the Classic period.[12]

During the Aztec period we find a fluorescence of urbanism and a rural population maximum with final perfection of ecological techniques.

The Mesa Central is one of the strong contenders for the origin of the High Culture of Meso-America or what we can call the Hieratic Complex. Personally I would look further south to the Highlands and Pacific Coasts of Oaxaca and Guatemala, preferably the former. Meso-American religion bears striking similarity to Pueblo religion in its great emphasis on correctly timed seasonal ritual in which rain is the

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12. Cooke, 1948.

key symbol and rain-making the key objective. The theme is the dependence of the cultivator on the regular procession of the rainy season and the ceremonies emphasize the petitioning of the gods for rain and the use of sympathetic magic to bring it about. The calendar is simply a tool for ordering these ceremonies in their proper sequence, the temple is the place where petitions are made, and the priest is the specialist who knows how to make these petitions correctly.

With the rise of urban society the system becomes more complex; special classes and craft guilds need special gods, rituals, and ceremonies but from beginning to end all over Meso-America the main theme of the religion revolves around this basic need of the folk and peasant peoples.

Taking a look at the Mesa Central we find an ideal situation for the rise of this Hieratic Complex; timing is all-important in all agricultural activities providing a natural need for an accurate calendar, the mountains shrouded in clouds even during the dry season are natural homes for the rain gods and provide an inspiration for the pyramid temple. We have a folk agricultural group living on fertile soils and capable of supporting specialists to carry on the ritual and build the technological appurtenances that go with it. The increasing drought of the Late Archaic provides an ideal situation for a sudden fluorescence of the cult complex and it is precisely during this period that we find the pyramid temple coming into being.

Wherever in the Highlands this new complex of traits originated, it entered the Mesa Central very early and the first appearance of architecture in that area, as far as the present stage of archaeology indicates, was at least as early as anywhere else except possibly the

Guatemala Highlands. Cuicuilco, the Pyramid of the Sun at Teotihuacan and the entire site of Ameluca at Puebla all date from the Late Formative period, and certainly by 500 B.C. the pattern was already present.[13]

The real importance of the Mesa Central as a great cultural center dates from the Teotihuacan second to third period. We may for the sake of argument assume agriculture and the Hieratic Complex to have entered somewhat later than in most Highland areas but once the area was colonized and its ecological problems solved, the (in Meso-American terms) enormous demographic potential became fully exploited and the area began to exert a powerful influence on the rest of Meso-American cultural growth.

In the face of this sheer economic vitality transformed into a vigorous local Hieratic Culture no other Highland area was able to maintain a regional independence; even such vigorous local cultures as Monte Alban and Miraflores were completely dominated by the religious concepts from Teotihuacan.[14] Areas of lesser vitality such as Guerrero and Southern Puebla became simply provincial dependent cultures.

As a great cultural center Teotihuacan did receive considerable influence from outside; it added them to its own tradition, recombined them, reinterpreted them and enriched its own cultural tradition, but did not become absorbed by them as happened for example at Kaminaljuyu. Later on this vigorous plateau culture shifted its interest from the neighboring Highland area to the Gulf Coast and we find at Tres Zapotes a local culture overwhelmed by foreign influences from this same source.[15]

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13. De Terra, 1951.

14. Caso, 1938; Kidder, Shooks, Jennings, 1946.

15. Drucker, 1943.

During the Classic period, aside from the conquest of Highland Meso-America by Teotihuacan religious concepts, we find parallel with this spread the growth of the true city, perhaps the largest in all Meso-American history.

It was during the Post-Classic period, however, that the full significance of the strength of this area became most apparent. Teotihuacan was an impressive cultural experiment, perhaps the most important of the several regional classic cultures but other areas were producing, in some ways, even more brilliant cultures on the intellectual and aesthetic side, such as the Peten. During the Post-Classic period, however, the Lowland cultures reached a stage of depression almost down to the Late Formative level. Only Cempoalla on the Central coast, and for a brief period Chichen in northern Yucatan Peninsula, show signs of cultural vigor. There are no centers in southern Vera Cruz comparable to Classic Tres Zapotes, no centers in Tabasco comparable to Classic La Venta and Comalcalco. Most of the Yucatan Peninsula was uninhabited or sparsely populated and in northern Vera Cruz nothing replaces Tajin. The two centers in the Lowland areas we have mentioned - Chichen Itza and Cempoalla - represent intrusions of Highland culture. In Oaxaca we find the fluorescence of the Mixteca-Puebla style, but in the rest of the Highlands we find scores of petty states and small centers.

In the Mesa Central during the period, on the other hand, we see a maximum population expansion and final perfection of ecological knowledge, the fluorescence of true urban society and the rise and fall of the first two pan-Meso-American empires, one centered at Tula and the other at Tenochtitlan.

This brief review of the evolution of the more glamorous aspects of the culture of the Mesa Central I think is an impressive record. What impresses me even more is the record of the peasant, and, paraphrasing Hu Shih's words, his "achievement in adjusting himself to his environment". The Valley of Mexico was densely inhabited by a peasant population for at least 2000 years before the Spanish Conquest (I assume a dense population as starting from the construction of the first great labor projects). Farmers had been tilling its soil for at least 1000 years before this period of dense population and it has been the demographic, cultural and economic heart of Meso-America for some 500 years since the Spanish conquest. No other area of Meso-America offers so convincing a record of the peasant's ability to control his environment and make it produce. Some small areas of the Mesa Central such as the Teotihuacan Valley have probably been under continuous cultivation for at least 2500 years with perhaps a single major depression during this entire period (the transitional Classic-Post-Classic).

Intensive agriculture based on the techniques of irrigation, dry farming, fertilization, crop rotation and terracing was probably more characteristic of this area than any other Highland area. It is only here, as Palerm has pointed out, that we find extensive irrigation systems which linked entire strings of city-states into great cooperatives.[16]

What he did not point out, and which should be emphasized, is that this necessity for cooperation goes on down through every level of social organization. The Calpulli, a localized kin group, either a patri-deme or clan according to Murdock's classification, was admirably structured for

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16. Palerm, 1955.

cooperative work projects, being a local landholding unit, a well organized political unit, and large enough for cooperative labor to get results, evidently numbering several hundred people. This unit would serve perfectly in such activities as flood-water dam and canal construction and cleaning. In the modern Teotihuacan Valley the small village is the modern counterpart, and the lack of overall effective political organization today has hampered full exploitation of the agriculture potential of the area. Even within the village today we find group work projects involving all farmers who use a particular branch canal and in the case of smaller canals we get even smaller cooperative groups.

Above the Calpulli, the City State, especially where dependent on local springs for irrigation, or where major flood water dams were to be constructed, must have acted often as a cooperative unit. Most irrigation systems in the Mesa Central, although they are numerous, are small in area and the city state was often the largest work unit based on irrigation projects; the extraordinary vitality of the city state in the Valley of Mexico during the Post-Classic period may in part be due to the integrative effects of this function. Certain areas of the Mesa Central such as the Nejapa Valley and the Upper Attoyac, as Armillas pointed out, required larger groupings, involving a series of city states; and later on Palerm has pointed out the need for even greater aggrupations for dyke building in connection with the extension of Chinampa agriculture.[17]

We have called the system of farming in the Valley of Mexico

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17. Palerm, 1955 ; Armillas, 1949.

intensive. Intensive agriculture as defined by geographers is a type of agriculture characterized by enormous expenditures of energy per area of cultivation. Normal Highland Meso-American agriculture involving the calmil-tlacolol system is not intensive agriculture but the irrigation-terrace type is, as we can easily see in terms of the labor involved. Our data on labor in terms of canal digging, canal maintenance, actual irrigation, humidity storage with the coa, intensive weeding, hauling fertilizer to the field by human labor, and terrace building and maintenance must have occupied enormous quantities of time for each hectarea brought under cultivation, as compared to, say, tlacolol or slash and burn cultivation. This more intensive system was characteristic of most of the sub-humid and arid valleys of Meso-America during the pre-Hispanic period, but especially so of the Mesa Central. The results, in terms of the grain production of a large area, was a demographic growth beyond the capacity of any other region of Meso-America. Even today without the tight organization on the socio-political level of pre-Hispanic days, the Mesa Central is still the demographic center of Mexico. Under the conditions of transport present in aboriginal times and considering the limitations of the agricultural tools there was a premium placed on productivity per unit of land and overall dense populations. Each farmer could produce but a limited surplus and in order to feed such gigantic population units as Tenochtitlan and Teotihuacan large numbers of farmers, in other words dense populations, were essential, and the development of urbanism paralleled the peasants' dedication to production increase techniques.

Of great interest is the fact that during the Post-Classic period in the Mesa Central urbanism reached its maximum development; instead

of the one urban center in the Valley of Mexico we find at least five or six. Also during this period we find the maximum extension of chinampa agriculture and irrigation and probably the invention of true stone terracing. Actually there is no certain evidence that the first two were not also invented during this period.

Intensive agriculture tends to produce two important results other than a great zonal food surplus, which have a direct bearing on the history of an area where it is practiced. One of these is the tendency to overpopulate; it is a circular economy and a highly unstable one as far as the capacity of the land relates to demographic expansion. Intensive farming produces more crops, resulting in a demographic growth which leads to new techniques of increasing crop production, which leads to more demographic growth and finally we reach the stage where the area just cannot be improved much more. The result is warfare, the formation of conquest states, then when the particular mountain valley is united, they set out to conquer the world, as the peoples of the Valley of Mexico did twice. In most of Meso-American highlands the whole situation is aggravated further by the fact that the area is broken up into hundreds of smaller units by mountain ranges, and mountain valleys like islands are natural units of overpopulation. I quote James on this point:

"From this discussion of mountain patterns we see that the space available for human occupance is relatively small. In Japan, the only 'great power' to occupy an exclusively mountainous region, only about 30 percent of the total area is reckoned as productive, and agriculture is limited to about 12 percent.....Increasing populations in these mountainous countries are quickly brought face to face with the problem

of a small productive area. The use of the land becomes intensive; cultivation is very careful, soil is regularly fertilized with manures, and even the smallest bits of land in most isolated positions are forced to yield their quota of food or feed. Every effort is made to increase the agricultural area, even by the costly terracing of the gentler mountain slopes or by the reclamation of shallow seas and lakes. Then the products of the land are supplemented where possible by fish or game. In spite of all these efforts, however, the longer-settled mountain countries are characteristically 'overpopulated'. Emigration from them is a typical feature."[18]

It is of great interest that Vaillant's study of Post-Classic archaeology indicated that the Mixteca-Puebla culture with its aggressive militaristic bent originated in the small mountain Valleys of the Mixteca.[19] Presumably the demographic conditions which would bring about this stage of cultural growth would be first met with in an area of small mountain valleys rather than big ones like the Valley of Mexico, but once the latter areas reached the same stage of occupation the effect on the larger Meso-American culture area would be even more devastating, as the rise of world empires in the Mesa Central indicates.

A second effect of intensive agriculture is on the peasant himself and he upon the ecological history of the area. He concentrates his attention on a very limited piece of the ecological landscape; he learns all about that piece of geography to the detail which no slash and burn farmer is equipped to do. He knows not only the entire plot but he

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18. James, 1935.

19. Vaillant, 1941.

knows the quality of the soil and drainage over every square meter of it. He discovers that the surface slopes slightly, inhibiting good drainage in irrigation; he then proceeds to pare it down or cut it up into small squares to equalize the flow of water. He notices that one edge has eroded down and he has lost a few meters of soil; he builds it back and constructs a stone facing to hold it there, and so on throughout his use of the land. He improves the land, guards it and mothers it to pass on down to his descendants. No slash and burn farmer can know his land like the irrigation peasant, and the latter is in an enormously better position to resolve long range problems of ecological adjustment between himself and his environment.

A further fact about intensive agriculture is the fact that wherever we find it we find unequal land division. Improved land is permanent land and there is a strong incentive to possess more of it. Even under the communal Calpulli system of ancient Mexico this would be true, as lands were parcelled out by family and sooner or later the supply must have run out in terms of Calpulli land resources. Different Calpullec would always be in different stages of demographic adjustment with their holdings. Furthermore many Calpullec must have entered areas already occupied and had to turn to other techniques of earning a living than agriculture or rented extra lands (see Zurita, 1941) from other more fortunate Calpullec. Finally we find that the noble class or Pipiltzin were great private landholders and are the ancient counterpart of our colonial and modern hacendado. This aggravates the already aggravated situation and demographic pressure may occur even before the theoretical population limit of an area has been reached.

There is a striking similarity in the role played by the Mesa

Central in the general history of Meso-America to the role of the Fertile Crescent in the history of the Ancient World. We find in both cases an enticing natural environment, which can only be exploited to its capacity by an enormous outlay in labor and necessitating cooperative groups on several levels. Once the ecological problems were resolved the sheer economic potential enabled the two areas to secure a cultural leadership they never lost. Peoples arrived and departed, or stayed and were absorbed, historic events were fast-moving and dramatic. Both areas were melting pots of peoples moving in from all surrounding areas, and the local peoples themselves periodically expanded and spilled over to fertilize the cultural developments of other nearby regions. The important point is that these are areas into which people come, they are areas of great cultural instability, but the areas themselves economically and demographically are very stable. Although civilizations are born and die, the peasant goes on cultivating the soil in the same way, with the same ecological know-how, and paves the way for the next stage. We find cultural fluorescences and depressions but each depression is always followed by a new fluorescence. In the Near East we have Sumeria, then Akkad, then Babylon, Assyria, Chaldea, Persia, and finally Islam, each separated by periods of turmoil and depression. In the Meseta Central we have first Tlatilco, then Teotihuacan followed by Tula, by Tenochtitlan, then by Mexico City. Between each there is a corresponding depression.

One of the most important problems in Meso-American archaeology is the origin of formal trade (by this we mean middle men, markets, craft specialization) and true cities. To solve this problem, again we must approach it from the peasant level.

In our discussion of modern commercial organization we pointed out that today the intense regional trade with regular markets and specialized production by village is only found in the Highland areas of Meso-America; especially it occurs in its most intensified form in Southwestern Guatemala.

The Relaciones Geograficas and Arzobispado de Mexico indicate clearly that this local specialization on the peasant level was as characteristic of the Conquest period economic system as it is of the modern, in exactly the same areas.

The first three of Sol Tax's list of factors behind the occurrence of the system in modern Guatemala were also operative in the pre-Hispanic period. Of these factors the most important is geographical diversity, and only in Highland Meso-America with its extraordinary zoning of climates and natural products are conditions propitious for an intense development of peasant and folk trade. Tax summarizes the dependence of the Panajachel household on outside markets in the following quotation:

"Panajachelenos are almost exclusively agricultural. The women weave part of the clothing worn; the men build the houses and make a few things like tool hafts for their own use; the women cook raw materials into most of the food that is consumed; but that is as far as industrial technology goes, and none of its products are sold outside the community. All household utensils - pottery, grinding stones, baskets, gourds, china, and so on - and practically all household furnishings such as tables and chairs and mats, must be brought in from other towns. So must many articles of wearing apparel, such as material for skirts and cloaks, hats, sandals, blankets, and

carrying bags, as well as cotton and thread for weaving the other things. So must most of the essential foodstuffs: the greater part of the corn, all lime, salt, and spices, most of the chile, and most of the meat. To buy all these essentials the Indians go to market, either to neighboring Solola or in the local town center. To get the money they depend upon the sale of agricultural produce that is unimportant in their own diet and grown almost solely for the market. Onions and garlic, a number of fruits, and coffee are the chief commodities produced for sale. To produce them consumes the great preponderance of the Indians' productive time, and to take them to market consumes much of the remainder.....

"The Indians of Panajachel, and the people among whom they live and with whom they do almost all of their business, are part of what may be characterized as a money economy organized in single households as both consumption and production units, with a strongly developed market which tends to be perfectly competitive."[20]

What he did not point out is that with intensive agriculture this is aggravated to the degree that even within a single one of our Ecological Areas this zoning is intense. It begins even on the village level. In Tlahuac, for example, in modern times, the uneven distribution of chinampa land and the fact that chinampa agriculture requires complete attention to agriculture, resulted in the specialization of families in house building, fishing, mat making and basketry, and at San Gregorio people with only chinampa land cannot produce pulque or huauhtli. Within a village like San Gregorio with its six types of

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20. Tax, 1953, pp. 11-12, 13.

ecology, each producing different crops, or only partly overlapping crops, we find a considerable amount of intra-village trade. Furthermore as agriculture is intensive there is no local source of firewood, or wood for lumber products, and these things must be brought from outside. This also applies to mats and baskets which come from Zumpango, or did.

Taking the Valley of Mexico, which is a fairly uniform Ecological Area comparable, for example, in its unity to Northern Yucatan, we find two important differences: it is a much smaller area - and this is in general true of our Highland Ecological Areas - and also within it there is considerable ecologic sub-zoning, especially when we combine the natural situation with intensive agriculture. Basing our conclusions on the sixteenth century documents we find the following sub-ecological areas each with its special production. In the north we find a specialization in lime manufacture, maguey products and nopal, and in one small section of it around Pachuca an almost industrial development in obsidian mining. Around the shores of Lakes Zumpango and Xaltocan we find many villages specializing in basketry, mat making and fishing. The Lake Plain of Texcoco along with the Lower and Middle Teotihuacan Valleys and the Quauhtitlan River Plain were all centers of grain production on irrigated land. Around Tenochtitlan were a number of villages specializing in salt manufacture. Some towns specialized in other activities; Texcoco was a pottery making center, Azcaputzalco specialized in goldsmithing. The Chinampa area, aside from being an area of basic foodstuff production, was also the main source for the minor truck garden crops such as tomate, chayote, jitomate, chile, and quilites. Many villages around

Lakes Chalco and Xochimilco along with Xaltocan in the north specialized in fishing. The Chalco Plain was a producer of basic grains and I suspect that the mountainous Xochimilco hinterland specialized in maguey products, huauhtli and frijol production. Further up the slopes we find that villages specialized in lumbering and manufacturing wooden objects; other communities were specialized gatherers and hunters of the natural wealth of the agriculturally useless conifer forests of the high slope areas.

Furthermore almost from the beginning the Valley was linked closely to the Valleys of the Amacusac drainage to the south, and this is an area of Tierra Templada where even the Lowland crops may be grown, such as zapote, mamey, cotton, pineapple, peanut, root crops, tobacco, papaya, guanabana, guayaba, paper and in certain favored localities even cacao and copal.

All groups in the world have some trade and as Coon has pointed out the only way to compare societies in this respect is in a quantitative way - the volume of trade, percentage of people involved in it and the rise of special institutions to handle it.[21]

In terms of volume the local complexity of the Highlands is of crucial importance. Meso-American transport was very primitive; the most a man can carry on his back is some 40 kilos. This means that the volume of trade can be high (with consequent rise of special institutions to handle it) only when the markets are closely spaced, and this can occur only in areas of complex microgeography and dense population. From Pachuca to Puente de Ixtla is only 150 kilometers,

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21. Coon, 1951.

perhaps a week's trip by human porters, and over this distance we can produce almost everything the peasant needs for his technological life. In the interdependent economic world defined by McBryde in Guatemala no point is over 150 kms from any other point. In the 150 miles from, say, Merida to Valladolid, we find no sub-zoning at all and this is characteristic of the entire Gulf Coast-Yucatan Peninsula, except that strip of forested lowlands at the bases of the mountain ranges which has a zonal symbiotic relationship to the nearby highland valleys.

Of great importance in terms of the rise of the special institution we call a market and of the volume of trade in general is the density and total size of the population participating in it. We have quoted McBryde with respect to this fact in a previous section.

Of great interest in this respect is the fact that the Valley of Mexico, the Valley of the Atoyac along with the Nejapa and Amacusac Valleys together not only form a tightly knit economic world, but intensive agriculture and very dense population characterize all segments of it. I doubt that there is any other economic sub-world in Meso-America of the same demographic capacity or intensity of development of trade and, finally, urban centers.

Of importance in the relationship of transport to trade within this area is the role played by the lakes in the Valley of Mexico. From Zumpango to Chalco by direct line is some 70 kilometers, or almost half the distance between the two most widely separated points in our Valley of Mexico-Amacusac economic sub-world. In other words, for about half of the distance, transport is greatly facilitated by the possibility of water transport, and the Spanish records leave us no doubt of the importance of the lakes in feeding the great cities

and in moving goods around.

In my study of San Gregorio and Tlahuac I secured data on canoe transport for the period 1900-1920. During this period the City of Mexico with its half a million inhabitants was mainly kept provisioned with vegetables by canoe-transported chinampa production.

Most of the production went to Mexico City and was carried in two types of canoes, one 7 meters long, another 10-15 meters in length. Both types are described by Bernal Diaz. If we assume that in ancient times most of the burden of cargo-moving rested on the smaller canoes we find that a single man, instead of carrying 40 kilos on his back, can now pole at least 8 cargas, or over a ton, of maize. The trip from Tlahuac to Mexico City with a load of this size involved some six hours; a man theoretically could carry a ton of maize to market, dispose of it and return home the same day! Below I present a brief chart on distances travelled by these early twentieth century chinamperos.

| Place of Departure | Destination | E.T.D. | E.T.A. | Duration (hours) |
|---|---|---|---|---|
| Tlahuac | Mexico City | 5 a.m. | 1 p.m. | 6 |
| Tlahuac | Chalco | 5 a.m. | 9 a.m. | 4 |
| Tlahuac | Xochimilco | 4 a.m. | 7 a.m. | 3 |
| Atlapulco | Mexico City | 8 a.m. | 2 p.m. | 6 |

One informant stated that June to October was the period of heaviest traffic, the average farmer making two trips to Mexico a week, and some 25 canoes were said to have left Tlahuac daily over this period; Tlahuac at that time had but 2500 inhabitants!

Aside from specialization of production by communities we find in the economic world we are describing, at the Conquest period, a number of communities specializing in just moving goods. Chalco, on

the east shore of the lake of the same name, was strategically situated to monopolize the entry of Tierra Templada products from the Amacusac drainage, with its location at the only good pass over the Ajusco range and with its lake shore position.[22] Acapixtla, up on the high escarpment on the other side of the Ajusco range, was another link in the chain and served as one of the market collecting centers for hot country products for shipment to Chalco.[23] I suspect that most of the communities on this Tierra Fria belt of the escarpment - Tetela, Yecapixtla, and Tepoztlan - were involved in this function as intermediaries in the exchange of products between the Valleys of Mexico and the Amacusac.

The presence of the same peasant participation in market economy at the time of the Conquest as well as today in the Meso-American Highlands strongly suggests it is native to that area. Trade is not a luxury, it is a necessity; the geography demands it and the practice of intensive agriculture intensifies that demand. The dense population, and effectivity of primitive transport in these microgeographical areas made for intense volume in trade and resulted in the origin of special institutions to handle it, such as the middle man and the market. Sahagun's list of specialties indicates that, in the Valley of Mexico at least, middle men were active in all spheres of industrial specialization and moving of foodstuffs.

With this picture of economic interdependence we can come to an important theoretical construct in terms of culture history in Meso-America - that of local economically interdependent sub-worlds. I

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22. Palerm, 1955.

23. Bienes de Cortez, 1946.

think the term Symbiotic Region captures the meaning more than any other and we may define it as a region which includes several of our Ecological Areas, each of which produces different crops and industries and which is knit together by a system of markets. The most vigorous of these Symbiotic Regions in terms of the volume of trade, number of people involved and number of special institutions evolved to handle it, is that which includes the Tierra Fria Valleys and Plains of Mexico, Tlaxcala-Puebla, East Puebla on one hand and the Tierra Templada valleys of Amacusac, Nejapa, Upper Papaloapan and Mixteco on the other. Within this Symbiotic Region one could define symbiotic sub-regions, each consisting of parallel strips of Tierra Fria and Tierra Templada such as the Valley of Mexico-Amacusac and the Valley of Puebla-Nejapa.

Other Symbiotic Regions we might suggest are the Oaxaca Highlands-Pacific Coast; the Guatemala Highlands-Pacific Coast-Southern Peten; and the Vera Cruz Escarpment-Coast Plain. I would consider these three as the major ones as they include large Highland and adjacent Lowland areas (or Tierra Templada), but the definition of these symbiotic areas is obviously a very fluid one and they overlap each other and all undoubtedly contain sub-combinations. The role played by these regions of economic symbiosis in cultural development and especially diffusion of culture traits can hardly be overemphasized.

As we can see, very few of the Gulf Coast areas are situated strategically with respect to the formation of these Symbiotic Worlds or Regions. The Olmec area sits behind the Isthmus of Tehuantepec, an area of low hills and ranges, none of which are more than 800 meters above sea level. The Tabasco Coast Plain would be in a strategic position if the Tierra Fria zone of Chiapas was larger but the latter

is so small and its demographic potential so limited that the volume of trade could not have been great enough to give rise to complex formal institutions.

The Northern Vera Cruz Plain is situated just east of the most unfavorable area of the Mesa Central, with a low demographic potential and an exceedingly low standard of peasant living (the Hidalgo section). The Yucatan Peninsula is too far from the Guatemala Highlands to function in the tightly knit trading system we have described; furthermore the center of gravity of the dense populations of Highland Guatemala is Pacificward today and probably always has been. Michoacan had a dense population on the Plateau at the time of the conquest and might have, with neighboring Colima, formed another secondary Symbiotic Region. I say secondary because the development of high culture in Northwestern Mexico was evidently very late.

I suggest that the history of Meso-American trade and urban society is one of constant enlargements of these Symbiotic Worlds. Shook's data suggest a probable origin in the Guatemala Highlands-Pacific Coast and on the Formative level intensive trade was probably limited to these fairly small Symbiotic Regions.

As Meso-American culture grew and especially as States developed this symbiosis extended, although the Region still far overshadowed any larger units in terms of trade volume. When we get to a period like the Aztec, the adjacent Tierra Templada can no longer supply the demand for hot country products and we find imperialistic expansion and trade orbits extending outward to include Guerrero and the Gulf Coast. We will return to the history of trade in the Tierra Caliente at a later point.

With the growth of these States, whether theocratic like Teotihuacan or military like Tula and Tenochtitlan, we finally have with them the rise of true industrial centers or cities. In the Highlands it is easy to see how these cities could have originated. We find the roots in peasant trade - each calpulli or each village already has a specialty; for hundreds of years a local group had been developing its craft skill, passing it on through the generations. As the volume of trade increases the factors pointed out by McBryde come into play and in certain spots big daily markets develop. If one of these market centers is also a great political center, a large class of specialists in war, religion and administration develops, completely dependent on a market economy. As an elite class they develop elite tastes, and a number of types of specialists start residing at the market permanently such as featherworkers, lapidarians and metalworkers. Much of the raw material must come from outside, so the professional merchant comes into being. So in the beginning we have a part-time peasant market combined with a small non-food-producing class and a small group of full-time craft specialists catering to the needs of the latter. From this it is an easy step to the city with thousands of industrial specialists, now not only producing for this ruling clique but for the surrounding peasant population as well, and the urban-peasant society is born.

The important point here is that the roots are present in the peasant culture - the specialized craft skills already evolved on a peasant level; all that is needed is a large clientele and land pressure to force a local peasant group into the city to become an industrial cell in the big urban center. We actually have records

of exactly this situation.

Ixtlilxochitl tells us:

"Recien entrado que fue Quinatzin en su imperio, vinieron de las provincias de la Mixteca dos naciones que llamaban tlailotlaques y chimalpanecas, que eran asimismo del linaje de los Tultecas. Los Tlailotlaques traian por su caudillo a Aztatlitexcan o segun la Historia General Caotlitepan, los cuales eran consumados en el arte de pintar y hacer historias, mas que en los demas artes; los cuales traian por su idolo principal Tezcatlipoca.....Y habian...escogido de la mejor gente que traian y mas proposito, los hizo poblar dentro de la ciudad de Texcoco, y a los demas dio y repartio en otras ciudades pueblos por barrios, como el dia de hoy permanecen sus descendientes con sus apellidos referidos de Tlailotlacan y Chimalpan aunque habian estado estas dos naciones mucho tiempo en la provincia de Chalco."[24]

I suspect that this full urban development was limited to the Central Mexican area, and possibly also evolved in the Valley of Oaxaca, and during certain periods, in the Mixteca Alta. Over most of Highland Meso-America the type of economic organization described for Southwestern Guatemala today was probably more characteristic, that is, specialization by rural community rather than full peasant-urban society.

## Oaxacan-Guatemala Highlands

In terms of origins of the Hieratic Complex and possibly true urban society, and certainly intense regional trade, I think we must

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24. Ixtlilxochitl, 1952.

emphasize the huge rugged stretch of mountain area running from the Rio Balsas to Salvador with its center of balance Pacificward. Guerrero and Oaxaca within this form a unit and possess a number of unique features of ecology: rugged, denuded, almost worthless slopes, separated at intervals by small sub-humid mountain valleys. The overall demographic potential of this area is low but the concentration in some of the most important valleys probably reached a maximum for Meso-America with the exception of small sub-areas in the Mesa Central where large-scale perennial irrigation was practiced (e.g., Lower Teotihuacan Valley, Texcotzingo-Texcoco terraces and plain, Chinampa area, irrigation zone of Cholula-Atlixco-Izucar).

At the Isthmus of Tehuantepec the mountain system breaks down, to reappear again in Chiapas. Chiapas-Guatemala form a second major division of the mentioned great mountain area. In this area we find generally humid climates on rugged escarpments and ravine-like valleys. Extensive flat plateau basins are limited in area and number, and usually are situated well up; some of the higher ones are also sub-humid climates similar to the Meseta Central but in general this is a humid mountain area. As a consequence slopes are wooded and have soil, so agriculture in this area is more extensive. Typical of Guatemala today is the combination of intensive agriculture in the flat valley floor and tlacolol cultivation (here combined with contour hoeing to prevent erosion, and in some areas terraces) on the slopes. The result is a higher overall population density than in the more arid Oaxaca-Guerrero region but valley cultivation was probably not as intensive as in the latter region.

The same general climatic situation applies to the Pacific Lowlands

fronting on these areas. The Oaxaca-Guerrero coasts are more arid with much less dependable rainfall, the Guatemala-Chiapas coasts more humid and with more exuberant vegetation. In both cases the coastal plain is narrow, hilly, and extremely well watered.

Both of the two segments of our mountain areas possess optimal conditions for the development of intense regional trade on a rural level and actually, with the exception of the Tarascan area, all of our modern studies have been made in this area. Southwestern Guatemala seems to represent a climax of some sort in this respect. The reasons are obvious: a dense rural population situated on a series of ecological terraces, each producing only certain products and all compressed into an incredibly small area; trade here must have been extensive even on a pre-agricultural level.

All of our factors pointed out for the Mesa Central in terms of population pressure, the need for organization, the building of the conquest state, are here greatly intensified. If Caso's dating of the Nuttall Codex is correct, military states date well back into the Classic period in the Mixteca and far pre-date their appearance in the Mesa Central.[25] Vaillant came to the same conclusion on the archaeological evidence and I think we can be almost certain that the military state and human sacrifice on a grand scale were both born in the Oaxaca Highlands.[26]

What evidence we have today suggests that the great mountain-

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25. Caso, 1951.

26. Vaillant, 1941.

Pacific Coast region was also the center of origin of the Hieratic Complex. No other region of Meso-America has such a long record of Pre-Classic architecture as the Guatemala Highlands and Pacific Coasts, and the earliest appearance of the calendar, if Caso's chronology is good, was in the Oaxaca Valley where it appears in Late Archaic times.[27] Our climatic picture for the Oaxaca Valley presents an ideal setting for such an invention to come about.

## The Barbarian Frontier

We have in this discussion pointed out the role played by a number of Ecological Types of Highland environment. I have postulated the probable origin of maize cultivation outside of Meso-America, the origin of the Hieratic Complex and Symbiotic Rural Economy in the Mountain-Pacific Coasts of Guatemala and Oaxaca and the final cultural dominance and development of true cities and empires in the Mesa Central and adjacent sub-humid Tierra Templada.

Of great interest are those Highland areas lying just north and west of the Mesa Central which evidently formed a barbarian frontier.

That which played the most important role seems to have been the Hidalgo area just north of the Valleys of Mexico and Atoyac. At least this was true during the Post-Classic period when the nuclear region to the south was repeatedly invaded from this direction. Our modern data from Hidalgo offer interesting explanations for this phenomenon. Hidalgo is an exceedingly unfavorable region for farmers, an area of general drought conditions. Most of the time grains cannot be harvested and the population depends on nopal and maguey and is probably the most

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27. Caso, 1938; Kidder and Shook, 1932.

miserably poor element in Mexico. And yet, paradoxically enough, it is relatively densely populated, about as much as the state of Vera Cruz down on the Gulf Coast. Why this is so is one of the most crucial problems in human ecology in Meso-America. The Spanish tax lists from the sixteenth century indicate that the pre-Conquest situation duplicates the modern, so it is not related to the modern commercial value of maguey products. Hidalgo seems to be one of those areas which is mainly denuded hills and slopes interrupted by small valleys, which under irrigation are extremely productive, as the recent hydraulic projects of the federal government indicate. Furthermore the climate is a borderline type; with a slight increase of rainfall even temporal cultivation is possible. Hidalgo has probably always been an area of intensive agriculture of very limited land surface, with a relatively dense but highly insecure and unstable rural population. The population probably has always been highly sensitive to slight shifts in climate - a little more rain and the demography soars up, a drought cycle and it spills over into the more favored regions southward. If Sears is right about the increasing drought conditions during the Classic period in the Valley of Mexico, what must have been the situation in Hidalgo? I think we can imagine it easily on the basis of the ecology of the area. We can see an initial small population situated in favored spots during the early Formative period; this population steadily grows as the climatic optimum is reached during the early Formative period. As aridity increases in the Classic period, the population gets restless; only the demographic strength of the Teotihuacan civilization holds it in check. Finally this defense breaks down and the barbarians break through into wholesale migration, which

has repercussions as far south as the Peten and Highland Guatemala! I believe this area played a comparable role to that of Central Asia in Old World history, of course here on a smaller scale but we are dealing with, in the case of Meso-America, a much smaller nuclear area.

The barbarian frontier to the west was different: climatic conditions were similar to the Valley of Mexico, over the Bajio and mountain valleys of Michoacan and Jalisco, and populations were probably more stable. Why this area played so minor a role in Meso-American cultural history remains a mystery, although soils seem to be the dominant factor. The fertile Bajio, for example, was almost uncultivable because of its dense, compact, sod-forming soils. We have a parallel here in the use of the American Corn and Wheat Belt by the aboriginal population.

Aside from soil problems it may be a simple case of a late start; the area was densely settled during the Post-Classic period, and one writer even suggests that Tarascan culture was reaching a potential great enough demographically to challenge and possibly replace that of the Aztec on the Mesa Central.[28] Sinaloa presents an ideal situation for primitive agriculture at least equal to that of the North Coast Valleys of Peru, yet Sinaloa remained occupied by a simple folk agricultural society up until the Spanish conquest. The Carbon 14 dates suggest that agriculture entered Meso-America from the northeast. If so, Sinaloa, Jalisco, Nayarit and Michoacan may well have been the last region of Meso-America to have become colonized. The archaeological data confirm this position.[29] There is a final possibility that soils

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28. Hendrichs, 1946.

29. Lister, 1955.

in the overall region limited agricultural use until the invention of metallurgy. In this connection we might note the Tarascan area as unique in Meso-America in the widespread use of metallurgy in basic technology.

## The Lowland Ecological Pattern

In sharp contrast to our Highland pattern we have the system of occupation practiced in the East Coast Lowland area.

Throughout the humid lowlands the only technique of grain cultivation today is that we have described as slash and burn. Our sixteenth century documents indicate clearly that this was true also at the time of the conquest, and I think we are on safe ground in assuming that this has always been the basic system in the area. In pre-Hispanic times I suspect that the use of fire was more important in primary clearing, as the stone axe certainly cannot do the job as efficiently as a steel machete. Fields were probably not as thoroughly cleared and weeding was probably less intense than today for reasons previously stated (i.e., no machete for chapeo and true weeding leads to sod formation). In favorable areas slash and burn maize cultivation was probably combined with small permanent cacao plantations very similar to those of the small farmers in the modern Chontalpa, and this was probably an important cash crop throughout the Classic and Post-Classic periods. We will revert to this point in connection with the rise of markets and small towns shortly.

One of the features of Lowland agriculture which has attracted most attention is the extraordinary richness of the plant inventory. A glance at our cultivated crop list for the Chontalpa will bring out this point. One of the facts we have stressed, however, in this

respect which should be treated again here is the fact that none of these crops, including such root crops as yuca and sweet potato, are important in the diet of the modern Lowland peoples. Maize dominates the diet, supplemented by the post-conquest rice in certain areas. Maize consumption per capita is higher in the Yucatan Peninsula than in the Valley of Mexico. Only one staple then is used over most of the Tierra Caliente. We don't know how much this applies to the Pre-Conquest periods but there is no evidence to the contrary, as we do have in the case of Highland areas.

Double cropping has been extensively discussed in a previous section and I will here simply review my conclusions. First, true double cropping is limited to well-watered escarpment slopes running the whole length of the Gulf Coast Plain; in the Gulf Coast Plain itself it occurs only in Tabasco, the hilly San Martin Ranges, and northern Totonacapan. Triple and quadruple cropping so commonly asserted in the literature is nonsense if referring to the same plot of land. Double cropping even in the areas defined is in general not double in terms of production; winter crops yield much less than summer except in the Totonacapan (and in the latter we must stress the fact that we are dealing with a 24-year cycle with only two to three years of cultivation; in the Chontalpa with short-term cropping even on alluvial soils double cropping is only possible in the first year and with a substantial yield reduction. We may estimate that in terms of production we actually have a 1.6 yield over the area as a whole.

In the Peninsula of Yucatan double cropping is very rare and when present is of the type described, a rapid-growing late spring crop followed by a June- or July-sown main crop, the spring crop producing

less than one-third of the main crop, and it can only be done in exceptional years when the rainy season starts early.

Universally characteristic of the system are high initial yields, especially where high forest has been cleared, with a sharp and steady decrease for each succeeding sowing. The result is a high premium placed on new lands and a strong centrifugal tendency in the ecological system.

With the generally low demography characteristic of most of the area resulting in an abundance of land we find that the Tierra Caliente is a byword for opportunity in modern Mexico. Yields are high as fields are given long rests, there is plenty of room for everyone so a man's economic position is in direct ratio to the energy he wishes to expend, it produces crops which have an extraordinarily high value in the international market and which demand little from the soil as they are not annuals (e.g., coffee, cacao, and banana) so that the essential infertility of Lowland soils is not significant in terms of modern utilization.

To a great degree these conditions apply to the area through much of the aboriginal period. Such cash crops as cacao must have meant prosperity in pre-conquest times as today, and the use of the slash and burn system to a great degree nullifies the demographic conditions and pressures we have described for the neighboring Highland areas. This is especially true in such areas as the Yucatan Peninsula where we get, for Meso-America, an enormous stretch of continuous agricultural land with no important barriers to break it up into smaller units. It is a curious and perhaps highly significant fact that no area of the world today utilized by slash and burn cultivators can be said to be

"overpopulated" in the sense that areas of intensive agriculture are. Land pressures occur, of course, (we pointed out cases in the Valladolid area) but the farmers usually respond to them at an early stage of population pressure and colonization of new areas, rather than intensification of agriculture in the homeland is the usual result. This is typically a frontieristically oriented economy. Even in West Africa with large states and urban centers we find this centrifugal tendency in the peasant culture and hamlets of the Valladolid type proliferate all over the landscape, are equally transitory in nature and bear the same relationship to permanent villages. Nadel's description of Nupe rural settlement patterns is strikingly parallel to that we described for eastern Yucatan.[30]

The modern and ancient data presented on Settlement Patterns suggest the following conclusions:

1. The rancheria is the natural settlement type for this economy looking at it from a purely ecological viewpoint, especially in the better areas of the Tierra Caliente where small plantations of commercially valuable crops intensify this correlation.

2. Aboriginal human groups in whatever ecological zone rarely live in scattered rancherias of the classic type, mainly for social reasons; the desire for living in groups seems to be a universal human trait.

3. Medium and large sized villages are theoretically possible with slash and burn agriculture but ecologically unsound. It means frequent shifting of the community to new sites, increasing labor and

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30. Nadel, 1951.

time in an uneconomic activity. Social pressures may override this, such as (1) warfare; (2) introduction by force of a resettlement policy, such as that introduced by the Spanish. In this case the introduction of the pack animals from Spain, and in modern times the use of motor transport, have given the big slash and burn village in Yucatan the stability it evidently lacked in the sixteenth century (see the Relaciones de Yucatan where the first Spanish-formed communities dissolved mysteriously or reduced in numbers often to one-half to one-eighth of the original community).

4. The hamlet is the most common type of rural settlement with this type of farming and represents a compromise between tendencies 1. and 2.

5. My settlement data on rural communities from Tabasco and Quintana Roo suggest that hamlets were the typical form in those areas. Willey's data from British Honduras suggest a more diffuse, scattered house distribution. This is possibly due to local topographic features, as the overall density is higher than the Tabascan Rancheria (about ten times) but is much lower than a true nucleated village (about one-half the scattered type, one-fourth the low-density ordered type, and one-twelfth to one-twentieth the compact village).

6. The lack of evidence of nucleated population at the big centers (Uaxactun Tancah, Tierra Nueva) indicates that these were not true towns or cities and did not have an urban proletariat or middle class. Today urbanism in the Tierra Caliente is entirely related to international trade.

I think one of the best descriptions of Maya zonal settlement patterns is that given by J. Eric Thompson which is quoted below:

"One has then a picture of this whole lowland area, excluding savannah, swamp and other sections unsuited to settlement, studded with countless ceremonial centers, varying in size from those comprising four thatched hut-temples atop simple platforms enclosing a court scarcely fifty feet in each direction to vast masses of platforms and pyramids, palaces and temples, rising jaggedly like granaries in Iowa or grouped with the architectural harmony of an Andalusian city. The country around, one visualizes as a patchwork of forest, cleared acres, and land reverting to forest, with the first dominant factor, and here and there the thatched huts of the peasants grouped in fours and fives in clearings shaded by fruit trees, those of the priests and other aristocrats clustered on the outskirts of the ceremonial centers. These last might be empty, but should you return tomorrow, you will find them filled with crowds present for some ceremony or for market; and visiting them again a month hence, when the corn needs little attention, you might see files of men, women, and children carrying rocks and earth for the enlargement of a pyramid, and masons and carpenters busy laying yet more stone walls or stairways or cutting lintels or cross ties for yet another temple.....

"What was a Maya city, and how did it function? First, as I have already said, it was not a city at all in our sense of the word, because it was a ceremonial, not an urban, center, to which the people repaired for religious ceremonies, civic functions, and markets. The stone buildings were unsuited for permanent habitation.....

"Then would come the big celebration, and at its conclusion a general exodus from temple and palace back to everyday life. The City would lie deserted except for those who swept the courts and

buildings or stored the masks and vestments, and for priests on tour of duty. Then at the next market day the city would come alive again. Buyers and sellers, their business done, would come to gaze and make their offerings at humbler shrines; persons of rank, borne in litters, would worship secludedly at the great shrines or gather for a council of state....."[31]

All human groups trade and are characterized by some internal specialization of production of goods. In the simpler societies trade is so unimportant in the basic economy of the group that special institutions for handling it are absent, and most specialization is on the basis of sex or age. Even among groups with special institutions for trade and the production of goods, however, there are different levels of complexity, and the main factor responsible is a quantitative one - the volume of trade goods actually handled.[32] We have noted three ecological situations in the Highlands which tended to foster an intensive development of formal organization of the production and distribution of goods: (1) dense populations with intensive agriculture; (2) internal geographical complexity and zoning of agricultural and industrial goods; and (3) the closeness of markets permitting the movement of large quantities of goods by human pack animals.

None of these conditions are met in the Tierra Caliente and we find a lack of Indian market systems and local specialization in those areas today.

Roys mentions markets in the northern Yucatan area at the time of

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31. Thompson, 1955, pp. 57-60, 82.

32. Coon, 1950.

the conquest so the institution was evidently known at that time.[33] The difference between the intensity of local trade in the Highland and Lowland Meso-American area was probably a quantitative one. Actually most of Maya trade was of the international rather than local type; they exported salt, honey and cotton cloth to the big market at Xicalango and brought back cacao and Highland products. Local trade was little developed and we find a surprising and significant dearth of references to markets in both Yucatan and the Gulf Coast areas, by the Spanish sources. Aside from the basic ecological unity of the Northern Peninsula, slash and burn economy tends to spread resources out more generally. For example all villages would have large stretches of high bush within their holdings, so local specialization in lumber products is unnecessary and certainly firewood would never become a trade item as in the Valley of Mexico. We find this situation in the modern Chontalpa where all rancherias make their own wooden tools and these items are not traded. The same thing would apply to such trades as housebuilding - all materials are near at hand and specialists are unnecessary - or in the case of weaving. Cotton yielded equally well all over the area and would not be a factor in regional specialization; probably each household produced its own cotton and sold its own cloth. Contrasting sharply in the latter respect is the fact that in the Valley of Mexico at the time of the conquest cotton could not be grown; large quantities were imported raw, by specialized middlemen who sold it in the market, where it was bought up by urban specialists who wove it into cloth. The latter was then carried by merchants back to the

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33. Roys, 1943.

lowlands for resale! We get actually an industrial specialization of cotton weaving.[34]

The same lack of local specialization or need for it could be pointed out in basketry, mat-making and so on through the farmer's technology. Food crops are even more uniformly distributed than technological media and this is one of the major spheres of specialization in the Highlands. The only possible rural technologies which might, on ecological arguments, have demanded specialization were flint and pottery-making, and in the latter case in Tabasco it is not a specialty. Roys points out the interesting fact that references to markets in documentary sources are very scanty for inland communities in the Yucatan Peninsula as contrasted to the coastal strip.[35] This points out clearly the lack of sub-regional local trade and confirms my argument, to be presented at a later point, that Yucatecan trade was mainly international and these coastal markets were ports of embarkation.

Of interest in terms of trade and the rise of institutions is the fact that nowhere in the Gulf Coast Plain proper or the Yucatan Peninsula do we find the evolution of a professional class of organized middlemen like the Aztec "pochteca". Acosta Saignes in his study of the pochteca in which he carefully studied the distribution of this institution indicates clearly that it was limited to the Meseta Central and Oaxaca Highlands.[36] We find one case on the Tabascan Plain but

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34. Sanders, 1949.

35. Roys, 1943.

36. Saignes, 1945.

these were resident highland merchants sent down as factors for the cacao trade, and we also find a few places on the lower escarpment established for the same purpose. In spite of the long-range trading expeditions of the Yucatecan Maya, we find no pochteca group; trade was a monopoly of the ruling class and the goods moved were mainly luxury products for the consumption of that class. There is an interesting parallel here with Old Kingdom Egypt in which trade was a noble monopoly.[37] The pochteca on the other hand was a true urban middleman moving goods for the open market.

Also of interest is the fact that the daily market is restricted to the Highland centers, and as we have pointed out, the frequency in which a market meets is in delicate response to the volume of trade. No coast market I am aware of was stated to meet more often than every 20 days.

Most markets when they are mentioned for the coast are clearly linked with the international, mainly Highland, trade. They exist as long as the political conditions of the Highlands permit their existence; in other words when societies, especially states, in the Highland reach a certain degree of complexity of organization then the local Tierra Templada sources of Hot Country products no longer can keep up with the demand; the Symbiotic Region becomes enlarged, parts of the Tierra Caliente come under the trading sphere, and coastal markets are established to handle this trade. When these states collapse, trade with this commercial hinterland drops off and the special institutions which handle it disappear also.

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37. Frankfort, 1951.

How else does one explain the complete collapse of the market system of the coastal areas of Meso-America following the Spanish conquest? Although in some areas the near extermination of the population may explain its immediate disappearance, why did not the system reappear following the re-colonization period? Aside from this we have, in some areas, as Northern Yucatan, a population decline no greater than in Central Mexico; Indian language and culture did not disappear, and yet today the market system is absent. The only explanation is that its roots are ecological and it was a peculiar development of Highland Meso-America. Complex trade and institutions may occur in areas of the ecology of Lowland Meso-America but they certainly did not originate there and they are functionally unnecessary.

Redfields neatly sums up the picture, I think, in the following passage:

"The indicated hypothesis is that the secular and individualistic character of highland Guatemala life is a result, in part, of the great regional division of labor and of trade. These features were in turn dependent, we may suppose, on the topographic and geographic diversity. Yucatan does not have this diversity. Yet apparently before the Conquest, Yucatan participated in the trade and was perhaps characterized by greater regional division of productive labor than it now is. Cacao and cotton were grown; the coast people exported salt. Perhaps Quintana Roo was before the Conquest more commercial than it is now because a form of society based on regional division of labor, trade and even money, and characterized by impersonal, hierarchical government, developed in the highlands where the habitat made such development possible, and was then extended to the Yucatan Peninsula.

And perhaps when the Maya broke up before the Conquest and when after that event contact with Guatemala largely ceased, such villages of Maya as remained relatively remote from the later modern civilization of the white man reverted from a secular, individualistic condition to a more sacred, less individualistic condition. In such case the Maya of Quintana Roo have taken two elements from two civilizations - one Christian, the other pagan - and have gone back to the more usual sort of primitive society. The Indians of the Guatemala highlands, on the other hand, according to this view, retain the characters of the mixed society - a secular, individualistic, primitive society - which they began to develop before the Conquest out of the social and technical conventions which their habitat favored."[38]

Because of the ecological features of the Lowlands and especially because of the slash and burn system of cultivation the Tierra Caliente to the Meso-American has probably always been a land of promise, and as Morley stated a land of "milk and honey" - things which a man in the Highlands of Meso-America had to labor and produce a surplus to trade for were within an arm's reach down in the Lowlands. Morley's description I think sums up the situation beautifully:

"This region had everything desired by the ancient Maya, a land truly 'flowing with milk and honey'. The climate was highly salubrious. Extensive areas, admirably adapted to the Maya system of agriculture were everywhere available. A rich and varied fauna and flora furnished food, clothing, medicine, and other useful materials in greatest abundance. The local limestone was one of the best building

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38. Redfield, 1941, pp. 368-369.

materials in all pre-Columbian America; not only was it easily quarried with tools of stone and wood but it hardens on exposure to the elements; further, on burning, it easily reduces to lime.....

"In addition to Indian corn or maize, the great American food staple, other vegetables, fruits, and edible plants were cultivated: black and red beans, two kinds of squash, chayote, tomatoes, breadnut, cacao, and a variety of tubers - sweet potato, jicama, cassava and several kinds of yams. Other economic plants raised were chili pepper, vanilla, and allspice for flavoring; and cotton, tobacco, fibers, and gourds for kitchen utensils. The forest itself yielded many useful materials - poles and withes for the framework of the houses, palm leaf for thatching of roofs, resin of the copal tree for incense.....

"The forests of the Peten literally teem with animal life...."[39]

If we were to compare this description with, say, the Valley of Mexico, we would find that there every item in Morley's list has to be produced and distributed by a whole series of economic institutions.

Aside from the rise of complex economic institutions, the kind of economy in the Highlands also produced a complex class system beyond the normal basic Meso-American pattern of nobles-commoners-slaves. With the unequal landholding system (in the Valley we have landed estates based on military rank as well as inheritance), the creation of a capitalistic trading economy, and warfare, we get the rise of a true middle class based on wealth - the pochteca, amanteca (featherworkers), goldsmiths, lapidarians and tectecuhtzin (military class) all formed a

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39. Morley, 1947, pp. 10, 8.

true middle class in the major urban centers.[40] In the Lowland areas we find this class entirely absent or but slightly developed. The slash and burn system of agriculture tends to create open utilization of land as we find even today in the "ejido abierto" system. Trade was a noble monopoly and furthermore lacked the volume for creating wealth distinctions based entirely on it alone. The luxury crafts had too small a clientele to be numerous enough to produce a true middle class.

I have indicated the lack of need for intense local trade and characterized Tierra Caliente trade as the province of the noble class and entirely devoted to serve that class. True cities of the Mesa Central type, that is industrial centers with a symbiotic relationship to the peasant villages, were absent in the Tierra Caliente area and coastal societies lacked the intense development of commercial, competitive and capitalistic spirit of the Highland civilizations. Instead, as the settlement pattern strongly suggests, we have the elite ceremonial center, a closed economic circle of the privileged few, whose link with the peasant population was purely an exploitive one; we can call this type of urban society parasitic urban society. It obviously could not have had local roots and is simply a modification of the more functional urban society of the Highlands to a new setting.

Longyear, in his study of the culture history of Copan, gives us a fascinating insight into the urban-peasant (under my definition of urbanism really a two-caste folk society) relationships.

"The picture thus presented of the Archaic Copanecos is a fairly

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40. Sanders, 1949.

simple one. Small bands of people were probably scattered through the valley, each living in clusters of thatched huts so situated that both the river and the cornfields were in the immediate vicinity. The men tended the fields, hunted and fished, while the women, in addition to their household duties, gathered wild fruits, edible shoots and fresh water snails. There was little specialization of activity, and none of it, surely, was of a full-time character. Pottery making was presumably the women's task, but not all women were thus engaged, nor did any of them devote their entire time to it. There may have been part-time shamans among the men, but the material evidence of religious activity is too meager to conceive of any organized priesthood.

"Intercourse between the little communities of the valley may have been extensive but trade with outside regions was sporadic and informal. ....

"Early Classic

"Many years after the people described above had entered the Copan Valley and established themselves there, a new invasion took place, this time almost certainly from the west and north. A band of Classic Maya, devotees of the hierarchic cult which was flourishing in the Guatemala Peten, arrived in the valley and proceeded to bind the Archaic peoples to their doctrine.....

"The preliminaries once out of the way, work began in earnest, and the second part of the period opened. The life of the ordinary individual now doubtless underwent a marked change. The men had to apend a certain proportion of their time quarrying and hauling stone and working on the acropolis. As a result their hunting and fishing suffered, and they had to place a greater dependence upon agriculture

to augment their food supply. They also, presumably, were required to raise enough extra to feed the numerous priests and skilled craftsmen who had neither the time nor inclination to supply themselves.....

"Despite all the activity engendered by the establishment of a classic Maya center at Copan, the general level of society in the valley probably rose very little. This was because the majority of the population - the original inhabitants - were essentially spectators of, and not participants in, the new cult. The knowledge of the calendar and the hieroglyphs, the identities and associations of many gods, the lore and paraphernalia of the rituals - all this was the possession of a few foreign priests. The common people labored to erect the temples, courts, and stelae which commemorated and glorified these things, but the results of their labors meant little to them. There were, however, several small scale organizational changes wrought by the new order. Most of the men became part time specialists: some in quarrying, others in construction. Some of the young men may have been selected for participation in the sacred ball games. A few of the brighter boys might have been taken into the priesthood, for training as acolytes.

"Trade with the outside regions increased, both in amount and regularity, but the majority of articles imported into Copan still seem to have been luxury or ceremonial items.....

"Full Classic

"Life in the valley doubtless differed only in degree, rather than kind, from that led in the Early Classic period. The increased building activity probably resulted in more men being assigned to the work gangs for longer periods of time.....There is evidence that certain wares, especially Copador, were decorated or at least designed, by a

special school of artists, possibly drawn from the priest class.....

"Trade was extensive but still confined to luxury items, especially pottery to judge from the evidence still remaining.....

"The small groups (buildings), of which there are a considerable number scattered through the valley, suggest that Maya religion was becoming more and more a part of the inhabitant's daily life, that the Copanecos were increasingly regulated by the various auguries and rituals that embraced every month, almost every day of the calendar. The groups also indicate a considerable increase in the personnel of the priestly class.

"Despite this heightened activity in building, trade and ritual society at Copan was no more complex than it had been during the Early Classic period.

"Post Classic Period

"The Maya hierarchic cult left Copan as it came - suddenly and unobtrusively. At the very height of its glory, the Acropolis, together with its outlying groups, was abandoned by the priests and craftsmen, and most of the common people also moved away from the built up areas, probably to the refuge of the surrounding hills.....

"Back at Copan after the priests had left, the life of the remaining inhabitants underwent a marked change. With the removal of the hierarchy, many of the people's activities became useless and ceased. There were no more elaborate rituals or mass ceremonies; no stelae or altars could be carved or temples erected in the now deserted Acropolis; the making of pottery and other artifacts for ceremonial purposes became largely a thing of the past. Like gods, the priests had come into the valley, the bearers of a wonderful and mysterious

civilization which the populace had slaved and struggled to maintain. Now the priests were gone, taking with them their civilization, and the Acropolis, with all its monuments and temples, became an empty shell, awe-inspiring but useless; sacred, perhaps, but with the meaning of its sanctity soon forgotten.

"There was nothing now, to keep the people in the valley, and absence of post Classic occupational debris in the vicinity of the Acropolis indicates that they quickly moved out, possibly to the foothills. Their milpas were probably already in the surrounding hills, and the hunting was better up there, away from the buildings and the flat lands which had been kept cleared for so many years. Soon the thatched huts sprang up, in groups of two or three, all through the uplands, and the Copanecos settled into the routine of tending their fields, hunting and fishing. They had, in fact, returned to their Archaic mode of existence."[41]

A number of important points may be made with respect to Longyear's reconstruction of the Copan Valley sequence:

1. Although Copan is a special case in that it was a frontier area colonized by an already flourishing Maya center in the Peten, there is still a fascinating possibility here that the story applies to the origin of the Peten Maya culture itself. We can picture the same thing happening toward the end of the Pre-Classic period in the Peten, possibly with the "missionary" group coming from the Guatemala Highlands (where we have a long sequence of Pre-Classic hierarchic cults) and with a less specialized religious cult of a general Meso-

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41. Longyear, 1952, pp 67-71.

American type.

2. In spite of the partial integration of the local population into Maya society we find that in the Copan Valley the two groups throughout, to a great extent remained two separate social worlds. This applies especially in the field of economic institutions.

3. The basic agricultural population possessed a very simple folk agricultural society which persisted from beginning to end. Longyear suggests that they never passed Coon's Level 3. Economic institutions remained very simple, trade of minor value in the economy, and we find no great industrial symbiotic society.

4. The fact that the ritual complex vanishes with the departure of the priestly group shows quite clearly how much real integration occurred between the two social units of the society.

5. The complete breakdown of the Copan ritual culture immediately after its collapse in the Peten is a clear indication that even the stability of the hierarchic group itself and their culture depended on outside contacts, and cannot be considered as functionally adaptable to the Lowland area.

Aside from the lack of function of true cities in Lowland ecology, the obstacles in the way of their support with slash and burn farming are almost insurmountable.

Excluding the city of Merida and its port, the city of Progreso, which depend for their existence upon international trade and for their subsistence upon most of the Mexican republic, urban centers in the state of Yucatan are few and far between and there are no urban congregations beyond the 10,000 mark. Kempton argues that slash and burn agriculture can support large urban congregations, and cites Merida with its 100,000 inhabitants as a case in

point.[42] Actually only a fraction of Merida is supported by the production of the state. A sizeable portion of the population are not heavy maize consumers, but eat such items as bread and potatoes which come from the Mexican Highlands, and even part of the maize supply comes from outside. Aside from this the modern population are machete and steel axe wielders and undoubtedly can clear and cultivate much more land and produce a greater surplus than the ancient Maya farmer could with fire and stone axe. Aside from the difficulty of producing a substantial surplus with Pre-Conquest technology, the major difficulty lies in another direction. Slash and burn cultivation for permanent and effective land use needs plenty of room, and rural populations must be spread out over a vast land surface. Combine this with human transport and the system is seen in its true perspective in terms of feeding urban centers.

In most modern aboriginal urban societies such as the Yoruba in Nigeria for an effective exchange economy rural farmers outnumber urban craftsmen by a ratio of 3:1.[43] This means that a city the size of Tenochtitlan with its 60,000 inhabitants needs a trading rural reservoir of some 180,000 people to maintain itself. One hundred eighty thousand rural farmers in Yucatan with slash and burn cultivation would need at least 9,000, and in some areas as much as 12,000, kms of space to maintain themselves. With Chinampa agriculture it could be done with 200 kms of land, with irrigation agriculture 550 kms. The differences in problems of transport I think are apparent. Some farmers

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42. Kempton, 1934-35.

43. Forde, 1951.

in the Maya area would have to move maize and other bulky goods regularly over distances up to 50-60 kms; in the chinampa area this is reduced to 7 kms, in the irrigated areas 11 kms.

The situation in other parts of the Tierra Caliente, such as the Chontalpa, is theoretically more favorable for supporting urban congregations. In our Huimanguillo sector, for example, the demographic capacity is much higher (about three times) than that of northern Yucatan, and the river offers the possibility of water transport. I say theoretically because that type of lowland ecology was precisely the one least utilized in the pre-Hispanic periods. Comalcalco is the only major Maya center in the Tabasco Plain, and it was a frontier post of a civilization whose center of balance was further east in the hilly, broken Puuc and Peten ranges. The center of Olmec culture seems to have been in the forested San Martin range rather than the theoretically more productive Papaloapan and Coatzacoalcos basins. (See Stirling, 1943.) Likewise Tajin, the most impressive Classic center in the northern Gulf Coast Plain, is situated in hilly riverless terrain.

We have a curious parallel here to the Highlands. The most productive part of the latter is undoubtedly the Bajio which was largely unused during the pre-Hispanic period. The most productive part of the Tierra Caliente today is the alluvial plains of the great rivers, yet the centers of ancient culture were in rugged, broken foothills or low coastal ranges.

I suspect that the rapidity of weed regrowth on these more humid riverside lands inhibited their full utilization by hand weeders and the original density of the forest cover must have discouraged them

more than that on the better drained slopes. Finally, the really favorable areas of the river plains in Meso-America are limited to relatively small alluvial zones and most of the area is occupied by infertile highly laterized soils. Leaching is undoubtedly less intense in the hillier sections. The small size of the alluvial fans is brought into sharper relief when we consider the fact that even under a short term slash and burn cycle the actual productivity zonal-wise is reduced to one-third or one-fourth of the theoretical potential.

In summary, those Lowland areas which seem to be most favorable for the support of true urban centers are precisely those of least significance in the development of aboriginal cultures, and the conditions we have described for northern Yucatan apply for most of the Tierra Caliente of the Gulf Coast.

If my conclusions with respect to the role played by the variously discussed sub-regions are correct and my analysis of the two Ecological Patterns has validity, we can come to some significant speculations as to the source of, character of, and history of the Meso-American occupation of the Tierra Caliente. The following is an attempt to postulate probable stages in the occupational history of the Lowlands and tie it into the archaeological record.

Stage A would represent a period when agriculture was unknown in Meso-America. We have archaeological evidence of this stage only in Central Mexico but it seems certain that most of the area was occupied by food collectors at some stage in the prehistoric record. The basic diversification of products must have created symbiotic patterns in the Highlands and immediate Lowlands (lower escarpments of the ranges), of a less intense type, even before the invention of agriculture.

Stage B. Assuming that agriculture began in the Southwest-North Mexican area under sub-humid conditions we can postulate a rapid movement of agricultural concepts and groups into the richer Central Mexican and South Mexican-Guatemala highlands at a comparatively early date. Ecological bias must have led most of the groups to select the drier, more elevated portions of Meso-America for primary colonization, and must have led them to avoid the heavily forested Lowlands. We might point out a parallel perhaps with North America and assume that the Highlands of Meso-America were occupied by peoples with a basic economy and social organization similar to those of the early phases of the Anasazi and Hohokan cultures in the Southwest and picture the contemporary Lowlands as occupied by a culture and economy similar to, say, the Early and Middle Woodland in the East. With the more stable food supply in the Highlands we can assume that the intensity of the sub-regional symbiosis increased with Highland farmers carrying on trade with Lowland food gatherers for such highly prized products as wild cacao, tropical fruits, copal, rubber, etc.

Stage C. During this stage trade increases, land pressure in the Highlands becomes first evident, and we get the beginnings of colonization of the Tierra Caliente. Some fascinating clues to the early stages of such a movement can be obtained by a study of the Post-Conquest reoccupation of the decimated (by diseases) Lowlands during the Colonial period. McBryde points out a parallel in the exploitation of the middle and lower escarpment in Guatemala by Highland groups. In response to the growing trade Highland groups start seasonal occupation of the nearest forested escarpment for cacao cultivation. As trade increases these plantations increase in size and some families

begin to reside in the frontier lands permanently. The next step is semi-independence of these new communities by initiation of maize cultivation as well as cacao and the communities become more stable. Meanwhile Highland populations are steadily increasing, needs for more land become more urgent, trade volume increases in proportion and colonization moved down into the coast plain itself and a full-scale colonization of the Tropical Lowlands is under way. This same process went on in Vera Cruz and was probably the situation during ancient times as well. The escarpment groups would never lost complete contact with their Highland cousins and the short distances between them would enable them to remain within the trade orbit of the symbiotic region. With the true Lowlanders the situation is different and distance must have operated from the beginning as an isolating mechanism. Morley emphasizes the fact that Maya civilization developed in comparative isolation; Drucker points out evidence for the same situation in the Olmec area (I have pointed out in another section that the Olmec region is not favorably situated to participate in any of our Symbiotic Regions).[44] With this isolation there must have resulted from the very beginning the loss of the intense economic symbiosis of Highland cultures; the culture became stripped of its secular elements and development was more emphasized in the sacred, esoteric direction.

When the tlacolol cultivation early farmers of the Highlands moved down into the Lowlands they must have from the beginning made a number of important and far-reaching discoveries: (1) that the tlacolol system was perfectly adapted for the area; (2) that weed competition was too

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44. Morley, 1946; Drucker, 1943.

severe for complete control with his technological equipment; (3) that newly felled forest lands yield very high for a year or two, then rapidly lose their productivity. The result was a new level of ecological adjustment to the land which we have here called slash and burn cultivation and the initiation of the spirit of "frontierism" which was to give the Lowland Meso-American civilizations a distinctive ethos.

Once the initial adjustment was made the New Lands in spite of their obvious disadvantages must have offered a number of distinct attractions. They were (1) initial abundance of land far beyond that of a Highland valley, and the centrifugal tendency of the system tended to maintain this; (2) much higher yields on sown fields and hence per hour of labor than on tlacolol lands in the Highlands (and in the previous section I indicated the lack of evidence for intensive agriculture for this period); (3) extended growing season which in the better drained hilly sections made late sowing possible in case of a retarded rainy season; (4) double or all-year cropping in a few areas, especially the escarpments which I have suggested as the theatre of the initial stages of colonization; (5) greater variety of crop production and a virtual monopoly on such valued products as cacao; and (6) the lack of need for a heavy outlay of labor for soil and humidity conservation projects.

This stage of colonization is represented in most of the Tierra Caliente today, and the mentioned factors plus the all-year greenness and lushness of the natural vegetation have given the area its title of "La Costa Rica" or as Armillas referred to it at the Jalapa Congress "La Tierra de Abundancia".

The general effect of the above factors is to create a strongly centrifugal economy; even small villages spread their agricultural activity over an enormous quantity of forest and are constantly sending out daughter colonies as soon as the virgin forest starts to thin out. Even before actual land pressure occurs the population begins to expand outward as in modern Valladolid. There is such a high premium placed on the reduced labor and increased yields on new lands that even a density of 8-10 persons per square kilometer produces this strong centrifugality. This is of great interest as we find that by the end of this period (as indicated by the recorded dates; see Morley, page 59 )[45] Maya culture had spread out to occupy the maximum extension it was ever to occupy in succeeding periods. Even without major centers and dense populations we find Coba, Tancah, Copan, Uaxactun, Tikal and Yaxchilan already established as cult centers by the end of this phase. Colonization based on this type of agriculture is exceedingly rapid; Childe has pointed out a similar situation in the forested areas of Europe during the Neolithic period with the same basic system of agriculture.[46]

The archaeological period which seems to correspond with this phase of colonization would be the Formative. Thompson points out that the evidence indicates that the Lowlands were very lightly populated. Actual archaeological evidence of settlement of the Lowlands for the Formative period is scanty. We find it at the bottom of deep deposits in a few major Classic centers such as Copan, Uaxactun, and Tres Zapotes in spite of the great interest and concentration of archaeological

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45. Morley, 1947.

46. Childe, 1950.

activities in the Gulf Coast and Yucatan Peninsula in recent years. We find nothing like the elaborate cult centers of Kaminaljuyu, Cuicuilco, Ameluca and Teotihuacan in the Highlands or Shook's numerous sites on the Pacific coast of Guatemala.

Whereas stratified society and the hieratic complex appear by at least 600-500 B.C. in the Highland areas there is scanty archaeological evidence for it in the Lowlands at this time except for a few individual buildings toward the end of the period as at Uaxactun. Some recent syntheses (Wauchope) date the center of La Venta as Pre-Classic.[47] I cannot here review the arguments, but the only scientific stratigraphy which has been carried out in the Olmec area is that by Drucker and his conclusions are in accord with my postulation.

In my reconstruction we find in the Highlands during this period a steady population growth, climaxed toward the end by the discovery of intensive agriculture; an increasing evolution of rural trade and institutions so that our modern Southwestern Guatemala symbiotic system was probably fully evolved; and finally the development of stratified society and the Hieratic Complex.

For the Lowlands we find a simple folk agricultural society such as Longyear describes and toward the end the introduction of the Hieratic Complex and its technological equipment and social system.

Stage D. This stage would correspond to the Classic in the archaeological record. In the Highlands intensive agriculture becomes the base for the evolution of a full urban, industrial society in which secularization is becoming more and more in evidence (e.g., the growth

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47. Wauchope, 1950.

of industrial wards at Teotihuacan). Population pressure becomes heavy, and international trade greatly expanded, and certain centers begin to exert powerful influences on the rest of Meso-America. With this "internationalization" most of the Tierra Caliente probably fell with trade orbits although even here certain regions such as southern Vera Cruz remained isolated.

In the Lowlands these changes in Highland culture had some repercussions, but in many ways affected Lowland life very little.

In the Peten, following Morley, the relative freedom from outside influences permitted the Maya to evolve a very distinct regional culture in which the sacred and esoteric rather than the secular were seized upon as the focus of a rich Hieratic culture dedicated toward writing, astronomy, the calendar, mathematics, and the refinement of the technological aspects of the complex (architecture, sculpture and painting).

Longyear, Morley and Thompson all emphasize the esoteric quality of this Hieratic Complex in the Maya area and its lack of meaning to the population as a whole; it was ordered and carried on by a small hereditary class who utilized but did not incorporate the rural population into the system.

We find a singular and significant lack of industrialization at the Maya centers. Trade undoubtedly existed, especially international, and the Maya and Olmec were in a favorable position with respect to Meso-American trade as a whole. The items which were exported, however, did not need industrialization: cacao, feathers, skins, rubber and copal. I suspect that considerable areas around Maya centers and along waterways in the more humid areas were occupied by cacao plantations and the type of settlement pattern described by Willey may well have

been related to a near commercial concentration on cacao.[48] Roys describes a similar situation for the Conquest-period Tabascan Plain.[49] If we can visualize the economy of the Barton Ramie Maya as based upon intensive utilization of the alluvial plains for cacao groves and slash and burn cultivation of the nearby slopes, the functional aspects of the settlement pattern there become clear, as well as the wealth in imported goods in the graves.

The important thing about this fluorescence of the cacao trade must be brought out here: it exists as long as there is a Highland market; as soon as the market declines it declines as well. We find a curious parallel in modern times in which prosperity in the Tierra Caliente depends entirely on the value of its products in the international markets. If a Highland center collapses, contacts cease, the Lowland area must revert to isolation and cultural decline follows. In a real sense then Lowland cultures have probably always been dependent on the vicissitudes of Highland ones. The archaeological evidence indicates that the classic centers of Teotihuacan and Monte Alban collapsed first, and Tres Zapotes and Tikal followed suit a few centuries later; in part the collapse must have been due to a reversion to isolation.

We get a picture of a two-caste society in which the integration of the two castes into a single society was only partially achieved. With the lack of urban industrialization to weave rural and urban centers into a tight web of symbiosis, integration must have been exceedingly difficult to achieve. Internal trade between rural communities

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48. Willey, 1955.

49. Roys, 1943.

undoubtedly existed and some minor zoning was probably characteristic but I doubt that it was ever functionally necessary or intensive enough to counteract the centrifugality caused by the slash and burn system. In the Highlands this symbiosis was undoubtedly a powerful factor in welding regions into larger units. Most of the fine aesthetic achievements of Maya culture were probably done by the priests themselves or skilled villagers who were kept on in permanent temple service. This class cannot have been large, and certainly was not large enough to bridge the gap between the two classes.

In such areas as the Peten further expansion of the slash and burn system was probably no longer possible and a neat balance between cultivation and rest cycles was undoubtedly worked out. In the Tierra Caliente today certain areas in Central Yucatan, Los Tuxtlas, Papantla and the Chontalpa seem to be reaching this stage. With the more intensive application of the system we can see a corresponding demographic rise as well and the great labor projects of the Tzakol period correlated with this stage of agricultural colonization. That the system will support this kind of activity on a limited scale is proved clearly by the Colonial building projects carried out in Yucatan in post-Conquest times; there is no need at this point to postulate intensive agriculture.

Toward the end of the Classic period we postulate that overpopulation reached the point, in the main areas of occupation (Peten, Lower Motagua, Puuc, and Usumacinta areas) that the rest cycle was by necessity seriously reduced, to perhaps even a tlacolol level. The extraordinary density of remains in some areas demand a postulation of this type. If I am correct the effects on both the peasant and the

ecology can be imagined. With the reduction in yield, in size of land cultivable, in increase in labor of cultivation, the peasant must have reached a lower-than-subsistence level of living; combine this with forced labor to feed a steadily growing parasitic priesthood and its labor projects and we have the seeds of a peasant revolt. Of even greater interest is the probable effect on the landscape. Kempton, Lundell, Steggarda, and Kelly have all pointed out that as long as the normal cycle of cultivation and rest is maintained grass can be effectively controlled by normal forest regrowth. Under more intensive utilization even the normally unsuitable soils of Northern Yucatan become grass-occupied. Under a normal situation in which the grassy plots are only a fraction of the surrounding forest, the forest returns quickly; but if we imagine a situation in which some half of the land is under cultivation and weeding is intensive, then we reach a point at which the farmer can no longer fight off the grassy weeds and Maya occupation of the Peten by necessity ends. Combine this with an overworked peasantry, and the explanation of the abandonment of the area and subsequent intensification of the colonization of the frontier areas (such as Northern Yucatan) is clear. The sudden appearance of war symbolization in sculpture, and the signs of wanton destruction of stone sculpture in the centers perhaps are indications of a possible proletarian rebellion.

This theory explaining the collapse of the Old Empire Maya Occupation of the Peten along with soil erosion on the slopes (not a factor in normal cyclic cultivation but undoubtedly so with more intense land use) was first postulated by Cooke, has been accepted with some modifications by Lundell, and was utilized by Morley to explain the

archaeological history, but in general has not been enthusiastically accepted by most Maya scholars. Some of them have pointed to northern Yucatan as disproving the savannah invasion theory, as Northern Yucatan has evidently been occupied from Formative times to the present by slash and burn cultivators. This argument is actually a two-edged one. Although it is true that Northern Yucatan was occupied throughout the Formative and Classic periods there is no evidence that the population was very dense, even during the Post-Classic; although we find the huge center of Chichen, no one has shown that the area possessed more than one Chichen or that there were large numbers of contemporary big sites beyond the capacity of normal slash and burn agriculture to support. Finally, these doubters forget the great demographic depression of the Colonial period when most of Yucatan dropped back to a Formative demographic level; the area has had a 400-year rest, and even today is but lightly populated. This 400-year rest period occurred throughout the Tierra Caliente of Meso-America, not only Yucatan. I suspect that the present demographic situation is representative of the more populated periods of the history of the area and that we never had the grotesque overpopulation of the southern peninsula. Furthermore, Northern Yucatan is a sub-humid area and grassy weed invasion under these conditions would be a much slower process and perhaps require an even more intensive system of cultivation than produced savannahs in the Peten. Finally, as Lundell indicates, the shallower, limier soils do not favor grass growth.

Of great interest in this respect is that the only part of Northern Yucatan where we have evidence for a dense population for the Classic period, the Puuc, was to a great extent abandoned during the

Post-Classic. The Conquest period province of Mani, for example, was heavily overbalanced demographically north of the range; the area of Uxmal-Sayil-Labnax-Kabah was not heavily occupied and still isn't.

Aside from erosion of slopes and grass invasion there is going on in modern Yucatan a progressive denudation of the scanty soil cover. I had noted this in the Quintana Roo area where successive burnings have actually burnt off what little soil there is and in many areas there are almost denuded limestone surfaces. Lundell has noted the same thing in other areas in Quintana Roo:

"The role of fire in the destruction of tropical forest is nowhere more evident than in areas of Quintana Roo visited. Beyond the village of Dzitnup, along the trail to Coba, we rode for four hours through utterly desolate country. For at least six years, possibly longer, annual dry-season fires have swept through. In some places few scattered large relic trees...all noted for their fire resistance, still stand, which indicates that high forest covered the area previously, a fact attested to by Indians in Dzitnup. In some sections, not a living plant remained from the former forest, only fallen trees and standing skeletons. Not only has the forest been killed, but the destruction of the humus and roots by fire has resulted in complete erosion of the thin mantle of soil into underground crevices to leave barren stretches of white pitted limestone."[51]

Pelzer in his study of slash and burn economy in Southeastern Asia and Indonesia points out a number of facts with respect to the total effect of intensive application of the system:

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51. Lundell, 1955.

"As has been stated above ladangs decline in fertility after the first crop, and obnoxious grasses and weeds appear among the stooling tree stumps. As long as there is an abundance of forest land at his disposal the cultivator prefers to abandon the clearing. Under favorable conditions the grasses will, in turn, give way to second growth forest. In the course of centuries this second growth forest may develop into a climax forest, that is, a forest having the same composition as the primeval forest. In any case, when tall forest growth again occurs, the land will have had time to recover its original fertility.

"Unfortunately, however, conditions are often not sufficiently favorable for a regeneration of soil fertility and the development of a good second growth forest. As a matter of fact, the practice of shifting cultivation has altered the character of vegetation beyond recognition over wide areas in Southeastern Asia. Instead of a dense primeval rain-forest, we now find extensive open grasslands resulting from the most important tool of the shifting cultivator, fire.

"Generally, the fallow period allows time only for the evolution of mediocre second growth forest, for the shifting cultivator usually returns to an old ladang before even a small percentage of those tree species that made up the original stand have had a chance to come back. Repeated cultivations further impoverish the forest and reduce the number of species. Certain light loving trees that played a minor role in the climax forest will spread rapidly and dominate, together with those species that show a resistance to fire and those that are capable of sending new sprouts out of the old stumps.

"If fire repeatedly invades an abandoned ladang, the tree flora

is reduced until finally only grasses and herbs survive. These persist because their root systems, tubers or bulbs send out new shoots after the fire. The more important grasses and herbs that finally triumph over forest vegetation are....These burn very rapidly and with a hot flame even when still green. After they are well established they catch fire or are set afire every year, almost without exception; this prevents natural reforestation. Furthermore the fire will also invade the neighboring forest and force it gradually back so that the grass area steadily increases. This is especially true in hilly or mountainous country. In the Philippines about 18 percent of the total area is covered with grass vegetation as a result of shifting cultivation and fires.....

"Once the vegetation of an area has been changed from forest to grass, the land is no longer of agricultural use to the shifting cultivator.....

"The spread of grass is especially rapid in regions with a long pronounced dry season, whereas forestation is more likely to take place in areas with a well distributed, high annual rainfall. This may explain why the Phillipines and Indo-China have a larger percentage of open grasslands than do Malaya and the Netherlands Indies.

"A relatively high density of population is an important factor in preventing successful reforestation and encouraging grasses. In a thinly settled forest area there is sufficient land to allow for a long rest period, but an increasing density of population results in the shortening of the fallow period to such a degree that the soil is given insufficient time to recover its fertility.....

"In regions where the density of population exceeds 50 persons

per square kilometer, shifting cultivation becomes wasteful and destructive.....

"As important as reforestation is soil erosion control. Where shifting cultivation is practiced in mountainous regions it often causes such acceleration in the rate of erosion that rivers are choked with sediment and periodically do great flood damage. Flood control could be achieved in most cases by completely closing the headwaters and watershed areas to cultivators. On the more gentle slopes the clearings should be rather narrow, should parallel the contours, and be separated by belts of forests. If at the same time the forest uphill were protected by fireguards, the clear rings would have a chance to close quickly again so that the soil would be protected against abnormal erosion. Terracing would be the most effective method of checking soil erosion, but this requires a great deal of labor, which is scarce in areas of shifting cultivation."[52] (The italics are mine.)

Whatever the answer or answers to the dramatic collapse of the Classic Maya civilization in the areas of its densest population and most brilliant development, the fact remains that as an attempt by urban Highlanders to introduce their culture into the area it was a complete failure. As we have pointed out, in both the Old World and New in the great cultural centers, civilizations are born, grow and die, but new ones replace them; nothing replaces the Classic Peten civilization - it collapses and we have some 1000 years of cultural depression such as has never occurred in the primary areas of cultural growth in the Old World, and there is still no indication of a renaissance.

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52. Pelzer, 1945, pp. 18-19.

Why is this so? I believe the answer lies in the fact that here, unlike in the Meseta Central and Old World centers, there was not only a collapse of the Hieratic or Elite level of the culture, but the peasant society collapsed as well, and without peasants there can be no renaissance. Despite recent assertions to the contrary there is no doubt that, if most of the area of the Old Empire was not totally abandoned by the peasant class, the population at least remained at an exceedingly low demographic level. Cortez's letters do indicate some population, but centers are invariably referred to as "aldeas" and "pueblos" rather than "ciudades", as in his letters referring to the Highland areas, and furthermore if one reads his letters carefully it is quite clear that these small settlements were very widely spread out.[53]

A comparison of the record of the Peten in terms of its ecological exploitation with that of the Mesa Central clearly points out the difference between these two economy types. The Peten was densely settled for some 600 years, produced one brilliant abortive civilization, and collapsed. The Mesa Central has supported a succession of at least four great civilizations and is still the center of Meso-America.

Others have attacked the ecological explanation on the ground that if it were correct one might expect all of the Classic Maya centers to have run equally long courses of history, yet some like Tikal and Uaxactun were occupied for six centuries; others were founded and abandoned all in the ninth or tenth century. This argument is not a very strong one, because as long as there is a demographic frontier

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53. Cortez (see Riverend).

within reasonable distance the overpopulated center will still be able to maintain itself on the production and labor resources of the "new lands". No people are going to abandon a center like Tikal with its heavy inversion of labor and time just because the immediate area is now agriculturally overexploited. Modern Valladolid is a somewhat similar case; the area around it is overexploited and yields very low, the population has been steadily expanding into the colonial regions ever outward, but the location and social dominance of Valladolid has not changed. Later on, of course, when even the immediate frontier lands become over exploited, then distance becomes an important factor and the entire region is abandoned, or in the early stage a new center evolves. The only way to resolve this problem is by extensive settlement pattern studies of rural communities all over the Maya area, both of modern communities and ancient.

Stage D. This is represented not in the Peten but in Northern Yucatan where Maya civilization fled after its collapse in the south. This area was always partially colonized, in the Puuc area densely so, and there is a strong suggestion that the latter area shared in the general collapse of Maya civilization elsewhere. However it may be, the new demographic center lay north and east of the Puuc range in what was probably lightly populated frontier country during the Classic period. Here in the north, Maya civilization was forced to drop down a few levels to maintain itself in a less favorable environment. During the Post-Classic period we find but one major center, Chichen Itza, and this brief glory was almost entirely due to direct Highland influence from Tula. After the collapse of Chichen there are no really major centers comparable to the old Classic centers to take its place.

Roys' study suggests strongly that the interior areas were populated by people with a Circum-Caribbean level of culture.[54] Only on the coast do we get large towns, markets and to some degree a preservation of the old Classic culture. Tozzer even suggests that the old Hieratic Cult collapses altogether and we get private oratories replacing the old dramatic public ritual.[55] The location of the last frontier of Maya culture on the coastal strip is significant, and surely is related to the maintenance of trade with Highland areas via the Xicalango market in Tabasco.

This reconstruction of Maya culture history is of course highly theoretical and undoubtedly will be sharply criticized, but the local archaeological history of the rest of the Gulf Coast Plain suggests a similar overall history as we have previously pointed out. Furthermore the picture I have painted of a densely populated Highland with a developed peasant and elite levels of culture, colonizing the Tierra Caliente, mainly through economic considerations, was exactly reproduced at the time of the Conquest (see McBryde in Guatemala and has been the general picture throughout the Colonial period. I suspect that this has always been true in Meso-American pre-history.

Meggers in her studies on Marajo island gives us an excellent idea of what happens to a high culture without metal tools when it is forced to adapt itself in isolation to tropical forest conditions:

"Even less highly organized groups that attempted to colonize the lowlands were unable to maintain traits that were more advanced than

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54. Roys, 1943.

55. Tozzer, 1941.

the Tropical Forest pattern. One of these, the Marajoara culture at the mouth of the Amazon river, has had sufficient archaeological examination to permit the reconstruction of its course of decline in detail. The sites consist of artificial earth mounds up to 250 meters long and 7 meters high, which were used either for habitation or for burial. The variety of complex decorative styles in the pottery, the details of the burial pattern, and the size and quantity of the mounds imply a social and religious organization of the Circum Caribbean or sub-Andean level, with well developed leadership, social stratification, occupational division of labor, and a religion involving idols and probably priests. The history of this culture on Marajo island begins suddenly with the technological and socio-political development in its most complex form. Mounds were begun, the potters set about their work, craftsmen and specialists of other kinds devoted themselves to their special tasks, while another segment of the population undertook to secure food for all. Initially, it would not be impossible, or perhaps even difficult, for a few people to supply the needs of the group in the new environment as they had in the old one. The forested western half of the Island must have provided considerable game, and the streams and lakes were bountifully stocked with fish. Birds are abundant today and must have been so in aboriginal times.

"This condition could not continue indefinitely however. With intensive exploitation, the game would grow more wary, the fish less abundant, the birds would seek safer spots and an increasing number of man hours would be required to feed the community. The difficulties would mount when the limited area suitable for slash and burn agriculture had been cut over and had to be re-used before fertility was

restored. More and more individuals would have to leave their special occupations and join the quest for food. This change is reflected in the pottery, which shows a consistent decline in quality of decoration, variety of shapes and technical skill. The more elaborate decorative techniques die out approximately in the order of their complexity, those requiring the greatest expenditure of time for their execution going first. The same degeneration must have taken place in other categories of material culture. With the breakdown of the division of labor on occupational lines and the basis for social stratification, came a disintegration of the social system reflected archaeologically in the disappearance of differential treatment of the dead. The decline continued until the culture viewed archaeologically is similar in all respects to the Tropical Forest cultures, in which state it survived until Marajo Island was overrun by an invading tribe of the Tropical Forest pattern."[56]

The similarity in pattern of history to our reconstruction of Maya culture is close except that the Meso-American Lowlands are within "walking distance" of the Meso-American Highlands, and cultural diffusion was a constant fertilizing influence which kept the coastal cultures from completely dropping to a Tropical Forest level.

In slash and burn economy, especially in the more humid portions of the Lowlands, there is nothing in the economy and ecology itself to produce, or foster, if you prefer, a more complex civilization than that of the Carib or Guarani tribes of South America.

In summary, in the intensely settled highland valley, the need

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56. Meggers, 1954.

for trade creates multiple economic institutions and later provides a basis for status and class distinction; it results in vertical and horizontal cleavages of society into social classes and craft specialized groups, which are mutually interdependent, and the whole is a tightly integrated society. The unequal distribution of improved or permanent land further leads to the origin of status groups, creates demographic pressure, results in war and conquest patterns. Intensive agriculture is a circular economy which leads to overpopulation, and more intensive search for solutions to ecological problems, and results in a more permanent role in overall cultural leadership. The need for cooperative labor lends itself to stronger community organization and ultimately state formation; the latter demands a completely new set of specialists in politics. The climate of the Highland area must have very early almost produced the great cycle of agricultural ritual elaborated around the crucial problem of rain; and with this elaboration religious institutions of the hierarchical type were a functional necessity.

In the Lowlands with slash and burn economy none of these ecological conditions are met. We can best consider the colonization of these Lowland areas by the Meso-American civilization as a brilliant failure, the impossible was attempted and one of the great intellectual achievements of human history, the Maya civilization, resulted from this attempt; but it was still a failure. For an understanding of the main current of cultural growth in Meso-America I think we must concentrate attention on the Highland areas where Meso-American civilization was surely born, achieved its most lasting success and is still today the main theatre of cultural development in Mexico and Guatemala.

## The Origin of Urban Society - A Comparative Study

### Introduction

If our ecological arguments as to the character, origin and development of Meso-American civilizations are sound they should apply to cultural development in other areas of the world. In this section I will define a number of ecological theora and test them by a quick survey of the cultural history of the Americas, Negro Africa, the Nuclear Region of the Old World, Tropical India-Southeast Asia, and China.

From our Meso-American data the following ecological laws may be postulated:

1. The earliest agricultural societies began in sub-humid (defined as areas with less than 1000 mms or 40 inches of rain a year) regions which were inhabited by peoples with a seed gathering subsistence pattern as opposed to shell fish collecting, fishing or hunting. In general they are fair to poor areas for hunting and gathering resources and the seed gatherers may have had to practice agriculture by necessity once the population reached the maximum with non-agricultural resources.

2. All true urban civilizations without iron tools are limited to sub-humid regions, of which two subtypes may be defined: (a) exotic river valleys in deserts or nearly rainless areas; (b) light, seasonal rainfall areas in which crops may be raised without irrigation, but the latter technique insures and increases the production.

3. All urban civilizations without iron tools had as their base intensive agriculture; the latter is defined in an earlier section of the text. Dense populations, overpopulation and land scarcity characterize the ecological setting upon which all of these urban societies rest.

4. Fully developed urban civilizations without iron technology

evolve in areas of intense geographic zoning in which an economic symbiosis is absolutely necessary. The more primitive the transport the more microscopic the ecological zones must be; the more efficient the transport the more widely spaced the zones may be and the greater the potentiality of urban development.

5. Slash and burn agriculture without iron tools not only does not support urban societies but is rarely associated with stratified society. In general it goes with a simple unstratified folk agricultural society of which the Amazon forest groups offer a good model. This is especially true in tropical forest areas, less so in temperate forests. By slash and burn agriculture I refer to the classic system in which the soil is not worked and fire is the main agent in clearing.

With the introduction of iron the situation becomes more complex and ecological factors are somewhat weakened. With iron we get metal introduced in peasant technology for the first time; during the Bronze and Copper Ages evidently the average farmer was for all practical purposes a Neolithic cultivator. Aside from its use in technology the inception of iron in the Nuclear Area of the Old World was accompanied by a series of other tools which made possible an increase in the geographical range of urban society, such as efficient sailing ships, new draft animals (camels, horses, mules) and more efficient wheeled vehicles, coined money, and the alphabet (increasing literacy far beyond the complex scripts of the Bronze Age). However iron tools alone, even without the other inventions, evidently were enough to enable urban civilization to spread into some ecological zones. However ecological laws were not completely negated by these factors and the following theora can be presented for critical analysis.

6. Iron Age urban society originated in the same areas where Bronze Age civilizations started and until the industrial revolution those same areas remained Nuclear regions. The spread outward into new ecological zones did not destroy the primacy of the homeland as centers of cultural development.

7. Ecological symbiosis remained of primary importance in terms of the development of urban society, although in many cases the more advanced transport media permitted such societies to flourish in areas of less intense ecological zoning. Here also historical factors may play an important role negating the ecological law. Finally, Iron Age societies, aside from cutting tools, have more complex technology in all spheres of economic life, and specialization may be necessary purely from this point of view.

8. Dense populations and intensive agriculture, even in the Iron Age, do not produce urban society if ecological symbiosis is lacking.

9. True slash and burn agriculture even with iron tools is not associated with urban society but does permit social stratification.

10. Urban societies based on iron tools may exist without intensive agriculture and are often associated with a system of farming similar to our Guatemala tlacolol type.

Our ecological laws are based on four categories of factors: (a) geography; (b) technology; (c) transportation; and (d) subsistence system. Coon in his Principles of Anthropology came to the same theoretical position and this essay is an attempt to point out the application of his principles to culture history.[57]

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57. Chapple and Coon, 1942.

## The Americas

The New World offers a significant proving ground for theora 1. to 5. since no Pre-Contact group with the exception of the Arctic Eskimo and Northwest Coast peoples used iron tools and both of those groups are non-farmers.

At the time of the Conquest the New World was divided up into a number of broad ecological systems.

Over much of the Southwest and North Mexico, Central and Southern California, the Plateau and Basin area of the West, the southern half of South America, and a number of areas in Brazil where savannahs dominated over forest, we find peoples with chipped stone tools, and hunting and gathering economies. Most of the area was unsuited for agriculture with the available technology. All of Canada and the Polar lands were occupied by Neolithic food gatherers. One of the areas, the Northwest Coast, was the scene of a highly specialized sea subsistence pattern in which the incredibly rich resources enabled the growth of a comparatively dense population and a stratified society. Aside from the latter exception food gatherers in the Americas lived in small bands and society was unstratified.

In terms of cultural types the aboriginal farmers fall into seven major groups.

The broad valleys and coast plains of eastern United States were occupied at the time of first European contact by temperate forest-land cultivators whose basic technology was similar to that of Lowland Meso-America, with a few important differences: (a) some groups used stone and shell hoes, thus enabling them to work the soil to a certain extent; (b) in temperate areas forest and weed growth is much slower

and can be more easily checked by simple tools, allowing more prolonged cultivation; (c) soils over most of the area are more fertile and capable of more sustained cropping than in the tropical forested areas of South America; (d) there are large areas of alluvion, softer, more fertile soils which, with the ability of the primitive farmer to combat effectively weed growth, enabled a more permanent system of primitive farming to be carried out.

In spite of the natural advantages of the area which included also ample rainfall (generally in excess of 40 inches or 1000 mms which, combined with a cooler climate, result in a high effectivity) no urban civilization evolved in the East in aboriginal times. In general this was because the aboriginal population never completely accepted agriculture as their basic subsistence pattern and it competed with less arduous and more dramatic methods of subsistence such as hunting.

Agriculture evidently was rejected completely in this area long after it became important in the economy of the Indians of the more arid Southwest. There is no evidence of it at all before Adena times (here I am excepting Adena as post-Hopewell) and the first really certain indications are coeval with the Mississippi period. In other words the probable first introduction post-dated its invention or introduction in the Southwest by some 3000-4000 years if we accept the Carbon 14 dating, and it did not really become an important technique in subsistence until a scant 600 years or so before the Contact.[58]

As a result of this partial acceptance and restricted application

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58. Willey and Phillips 1955.

the population of the east was always on the scanty side and communities were widely space. Intense trade, and especially towns and cities, could not evolve on such a demographic base.

Most Eastern societies with very few exceptions were unstratified. It is of great interest that all or most of the Contact groups which were described as having stratified societies were situated in two ecological sub-zones. One was the immediate coastal plain where the addition of seashore resources plus agriculture gave the culture a richer subsistence base, and the other was the alluvial flood plain of the Mississippi Valley. Interior groups living in rolling hill country such as the Choctaw, Chickasaw and Creek lacked social stratification, the Natchez in the Mississippi Delta and Powhatan on the eastern seaboard both had it.

In connection with the presence of the stratified Natchez society in the alluvial Mississippi Flood Plain it is of undoubtedly great significance that the vast bulk of Prehistoric Temple Mound sites are located within easy reach of these stretches of more fertile soils. Furthermore Mississippi period sites contain shell and flint hoes.

The distribution of sites and presence of these more specialized agricultural tools suggest that a semi-permanent type of agriculture exploiting alluvial flood plains was the base of the development of the elaborate Temple Mound period cultures where we find big building projects and stratified society clearly indicated in the archaeological periods. Stratified society was evidently more widespread in the East during the Prehistoric period and may have been associated with this more intensive system of farming.

In the American Southwest our picture is somewhat different. We

are dealing ecologically with a huge, almost agriculturally useless desert area where the Contact period agricultural groups occupied tiny oases of utilizable land in an area predominantly occupied by wild food collectors (in terms of space rather than demography - actually Kroeber's data suggest that the total population of farmers exceeded that of food gatherers).[59]

Agriculture in this area where practicable was intensive and involved both of the systems we have described for the modern Teotihuacan Valley: flood water and spring irrigation. It is of great importance and significance that here agriculture appeared first in the archaeological record for the New World. If any area in the New World presents an ideal Challenge and Response factor in the invention of agriculture the Southwest is it. Seasonally flooded lands are ideal situations for agriculture discovery especially if the previous subsistence was based on the gathering of wild seeds. If we can imagine a small desert valley inhabited by a small food collecting band moving its campsite regularly in response to the fruition of the seeds. They were undoubtedly food storers as the modern peoples in the area are, and at least part of the year they probably camped on the humid water-saturated sediments left by the seasonal floods. Seeds accidentally scattered on these soils would germinate and from this it is an easy step from observation of this accidental result and planned seeding. Some of the historic groups such as the Colorado Yuma river tribes practiced a system of farming not much more complex. They simply waited for the flood to subside, then scattered the grain on the soft

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59. Kroeber, 1947.

humid soil and let nature take its course. No weeding or working of the soil is necessary, or further irrigation. From this it is a simple step to the conduction of excess water to unflooded lands and irrigation farming is born.

Two of our conditions for the development of urban society are met with in the Southwest: sub-humid climate (with fertile soils capable of sustained cultivation) and intensive agriculture. However over most of the area agricultural land is severely limited and cultivable areas are widely spaced. This means very sparse regional population even in the small favorable sub-regions (maximum density, according to Kroeber, of Anasazi areas of but 5-6 persons per $km^2$)[60] and even wider spacing between population clusters than in the East in spite of the more effective agricultural system and greater dependence upon agriculture as a subsistence base.

The result is the evolution of a tightly integrated and organized folk agricultural society in which each village operates as a separate social and economic world. Trade and economic institutions are feebly developed as distances between communities are excessive (and furthermore are situated in identical ecological settings). Political and religious institutions are elaborated, especially the latter, which is exactly what one finds in all desert agricultural societies. Stratified society is lacking probably because of the small size of the social world. Even the largest villages only had populations of a few thousand or so.

The demographic limitations of the Southwest then aborted the

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60. Kroeber, 1947.

evolution of urban society in that area and we find a folk agricultural, unstratified society from the beginnings of agriculture to the Contact period.

A huge area of tropical forested plain, larger than the United States, occupies most of eastern South America, the bulk of which is part of a single hydrographic system, the Amazon.

Over this huge area all groups seemed to have practiced, during the Contact period, the classic type of slash and burn cultivation we have described for Lowland Meso-America. Trees were girded with stone axes, burned off, and crops planted with digging sticks and fields weeded several times. The typical cycle of a few years of cultivation followed by long rest periods was characteristic.

Although precise demographic data are lacking and no one has analyzed the estimates of early Colonial sources systematically as Kroeber did for North America, there is no doubt that during the Contact period this huge area was very thinly populated by a simple unstratified folk agricultural society. In general, with a few notable exceptions, local groups were small, independent and separated by enormous distances. The hamlet, often made up of a single household, more frequently several related households, with a total population approximately that of our defined hamlet from Yucatan, was the typical settlement unit. Political fragmentation was in general extreme; every small village was autonomous and institutions of any kind, whether religious, political or economic, were very feebly developed. Formal chiefs, stratified society, large aggrupations, intensive trade, were all conspicuously absent. The subsistence base was root crops rather than cereals and limited to tiny patches in the huge sea of

forest. The total effect of human occupation of the Amazon basin on the landscape was probably only slightly greater than that of the rest of the animal world. Lowie mentions an interesting variation of settlement pattern somewhat similar to the Guatemalan "vacant town" among the Macushi.[61]

With the entire area linked by a single river system one might find extensive trade, intensive trade being impossible under the demographic situation, but even this is lacking and trade although present was sporadic and small in volume. The essential ecological unity of this huge area inhibits the need for trade and reduces its necessity to near zero.

We have already shown what happens to a high culture when it is implanted in such an ecological setting and allowed to evolve in isolation. Meggers' study of Marajo clearly demonstrates that tropical forest environments cannot be effectively managed with Neolithic technologies.

Our knowledge of the archaeology of the Tropical Forest area is admittedly meager but it seems dubious, on the base of our present knowledge, that agriculture dates very far back in that area and almost certain that most archaeological groups, with the exception of Marajo, represent cultures similar in content and complexity to those of the Historic period. There is no evidence of a Maya civilization ever having existed in the area and little chance that one will ever be discovered.

Of great interest in terms of our ecological arguments is the fact

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61. Lowie, 1948.

that agriculture was completely absent in the huge stretches of savannah in Eastern Brazil. Some of the groups were hunters and gatherers; most of them seemed to have practiced slash and burn agriculture in the gallery forests and utilized the open grasslands as hunting grounds. We have a clear case of the ecological limitations of slash and burn agriculture. There is a fascinating parallel here also to the aboriginal use of the Plains Area.

In striking contrast to the occupation of the selva we have the intensive settlement and elaborate cultural development of the Andean Area. The origin of agriculture in the Andean region is not yet clear; maize seems to have been diffused from Meso-America but maize was only one of three staples (amaranth and potato) and we have a pre-maize archaeological complex by 2500 B.C. on the North Coast based on beans and squash.[62] There seems little doubt that the first appearance of agriculture in South America was in this region; the lack of archaeological depth or limitation of it elsewhere in the continent strengthens this argument. I suspect that agriculture, based on non-maize crops, was independently invented here as early or possibly slightly later than in the Central Plateau area of North Mexico-American Southwest.

The Andean area, although it has a simpler and easier-to-define geographical pattern, reproduces the Meso-American type of micro-geographical symbiosis almost exactly. There is one important difference: the entire Andean region from top to bottom in terms of ecological zones is an arid or sub-humid region; no part of it has an annual rainfall in excess of 1000 mms.

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62. Bennett and Bird, 1949.

The Andean area consists of a series of long parallel ecological zones running its entire length from north to south. In terms of dense human population we find two major life zones. On the west is a long coastal desert which is almost rainless. It is traversed east and west by some 30 exotic streams which head in the rainier mountain watershed, traverse the narrow coast desert and run off into the sea. These coastal valleys were densely populated in Prehistoric times and were centers of cultural development based on intensive agriculture utilizing irrigation. Although not as warm as the Meso-American Lowlands, most of the aboriginal hot country crops could be grown here such as cotton, manioc, sweet potatoes, coca and even cacao, along with tropical fruits.

Behind the coast are three parallel mountain ranges separated by high inter-montane valleys and plateaus. Practically all important population centers lie above 2000 meters above sea level and extend on up to 4000 meters. Agriculture is practiced well above its upper limit in Meso-America and the major highland valleys are well above the altitude of the Meseta Central in Meso-America, most of them being above 3000 meters. The intervening zone with elevations between 500 and 2000 meters is mainly steep denuded mountain slopes and there is little population concentration, in marked distinction to Meso-America with its densely populated Tierra Templada. Actually in terms of climate it would be more correct to say that the Andean area lacks a Tierra Caliente since the coastal zone has a climate more like that of the Meso-America Tierra Templada, temperature-wise. Important centers of maize cultivation occur from 2400 up to 3500 meters above sea level; some varieties of maize grow as high as 3900 meters but 3400 is about

the upper limit for effective cultivation. In the Maize Belt, however, both potatoes and quinoa are more important as staples and furthermore have a greater upper range, being effectively cultivated up to 4000 meters. Above 4000 meters we find bleak agriculturally non-productive pastures utilized for intensive llama breeding.

In terms then of food production we find a series of ecological zones similar to those of Meso-America although the overall pattern is simpler. Of most importance in terms of regional symbiosis is the clearly cut separation into two parallel zones of specialized production: (a) exotic desert valleys on the coast with hot country products and sea products; and (b) sub-humid mountain valleys with such special cultivates as potatoes and quinoa plus minor seed and root crops along with the stock breeding of llamas and alpaca and production of meat and wool. Above 4000 meters we find a minor sub-zone where stockbreeding is a specialty. The climate of the Peruvian Mountain valleys is a duplicate of that of the Mesa Central; the annual rainfall and distribution of it seasonally in the Cuzco Valley is exactly the same as in the Valley of Mexico. Moving of goods in the Peruvian area was facilitated by the use of llamas as beasts of burden in the Highlands and sailing rafts on Lake Titicaca and along the coast. Aside from zoned food production the limited distribution of other products must have determined economic symbiosis, i.e., metals in the Bolivian Highlands, lake products at Titicaca, building stone, etc.

In other words the two ecological conditions we emphasized in our Meso-American studies are found here in the Andean area as well - ecological zoning and sub-humid climates. Of interest with respect to the former is the fact that Bennett divides the Nuclear Andean area

into a series of three sub-regions running from north to south, each including a segment of the Highlands and an adjacent part of the Coast Desert; in other words our regions of symbiosis were regions of historical unity![63]

Rowe's study of Inca culture at the Contact period indicates that, although the bureaucratic system evolved by them in which the government acted as the main agent of organization of production and its distribution, we still find beneath this formal artificial pattern a basic folk economy based on regional markets and specialized village and ayllu production almost exactly the same as in modern Highland Meso-America.[64] It seems very probable that an economic system similar to that of Contact period Meso-America was in vogue throughout the Andean area in pre-Inca times. The evidence of urbanization in the settlement pattern surveys in the North Coast indicate clearly that we once had a more capitalistic, competitive economy than that of the Historic Incas.

Rowe's ethnographic studies further establish conclusively that at the base of Highland culture was a system of intensive agriculture involving irrigation, terrace construction, crop rotation and use of fertilizers, even more intensive in terms of its overall application to the Andean area than the system was in Meso-America, and that furthermore dense populations were found in each Highland Valley although the overall density was rather low. We have already pointed out a close parallel here with the Oaxaca Highlands, with small mountain valleys

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63. Bennett and Bird, 1949.

64. Rowe, 1946.

separated by large areas of denuded rocky mountains and slopes. The Viru Valley project showed conclusively that this was even more true of the Coastal Area; Willey estimates a probable population of some 25,000 in the 98 km$^2$ of cultivable valley floor during Gallinazo times.[65]

The archaeological records, in the case of the Viru Valley, a steady and gradual accumulation of ecological techniques and accompanying demographic rise which made possible a more extensive application of such knowledge until the hydraulic resources of the small valley were completely controlled by Gallinazo and Mochica times. With this population rise and application of intensive agriculture we find nucleated villages often of large size and during the Gallinazo Period the inception of huge urban clusters which reproduce on a smaller scale the pattern of settlement at Tlamimilolpa.[66]

Here as in the Valley of Mexico urban growth and increasing intensity of agriculture go hand in hand. Almost from the beginning the Peruvian technology included metal which later was even used for peasant technology, and trade in metal ore from the Highlands must have from the beginning been one of the factors in urban development. Towards the final phases of the archaeological record of the North Coast as a whole, full industrial urbanism was as evolved or perhaps even more evolved than on the Mesa Central and the largest center of all, Chan-Chan, is at least as extensive and probably more so than Tenochtitlan or Teotihuacan.

Of interest is the fact that unlike Meso-America the tropical

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65. Willey, 1953.

66. Willey, 1953.

forest-covered slopes of the eastern Andes and immediate forested Lowland Plain were never colonized and brought into the Andean Cultural World. They remained occupied by typical folk slash and burn farmers up until Contact times. Although we undoubtedly did have some trade for forest products (hardwood, feathers, animal skins) the population was never dense enough to be an integral part in the Andean trade systems as in Meso-America. I believe the major reason for this was the fact that the Lowland Coast was of sufficient demographic potential to fill out the commercial needs of the nearby highlands, and its more suitable ecology led to its selection for intensive settlement, whereas the forested eastern slopes were neglected. It is interesting to note that the Inca with their Pan-Peruvian state attempted a small-scale colonization of the area especially for the purpose of establishing state coca plantations. There is a curious parallel here to Guatemala and cacao; and it supports my previous argument that with large states in the Highlands increasing the geographic range of trade orbits, the nearby tropical lowlands may be brought into the economic system.

One of the most interesting regions in the Americas, ecologically and historically, is that which lies intermediate between Meso-America and the Andes. Steward, in The Handbook of South American Indians, grouped this region along with the West Indies into a great culture area called the Circum-Caribbean Area.[67]

Geographically it divides into three sub-regions: the Colombian-Venezuelan, the Central American, and the Antillean.

Colombia, ecologically, shows fascinating parallels to Guatemala

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67. Handbook of South American Indians, Vol. 6, p. 340.

within Meso-America. Sauer analyzes the overall pattern very neatly in the following passage:

"Here three zones were especially important to early habitation: (1) At high levels, around 10,000 feet (3000 m.), the paramos provide excellent pasture and suitable conditions for potato culture. The paramos of the Cordillera of Bogota have been of most importance to settlement, but other paramos of the eastern cordillera, extending into Venezuela, were similarly preferred sites of habitation. (2) The high level savannah basin (around 8,000 feet 2,500 m.) in particular of the eastern cordillera are important agricultural sites, being largely planted to maize. (3) The low steppe and desert basins of Magdalena and Cauca yield tropical products, in part by irrigation.

"The tectonic structure of Colombia gives rise to the greatest diversity of climate; indeed, one finds here almost every climate of South America, excepting those of Cs type. In short distances one may pass from tropical rain forest, through tropical savannah, to desert and steppe or to humid temperate uplands. The spreading design of the Andes gives added diversity of exposure and increases the variety of local climates still further, in contrast to the simplicity of Andean structure to the south. In all respects Colombia has the most minutely detailed and contrasted pattern of physical conditions in South America. Considering also the diversity of useful minerals and its superior position with regard to continental communications, it is obvious that nature has marked out here the most advantageous land for cultural development."[68]

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68. Sauer, 1950.

Bennett, on the other hand, points out some obvious disadvantages with respect to the region as a scene of great cultural development:

"The geography of the Colombian Highlands has been reviewed in terms of human habitation in the general introduction to this volume. In brief, the Colombian Andes are composed of four major mountain ranges running roughly north to south. The westernmost Coastal range, the Serrania de Baudo, is covered with a tropical rain forest, and little is known about its archeology. The next two ranges, the Cordilleras Occidental and Central, are separated by a rift valley drained by the Cauca River. These mountains have high peaks and form reasonably effective barriers. Although large intermont basins are lacking, many small pockets of habitable land are found in each of the altitude zones. East of the Magdalena River, the Cordillera Oriental runs from south to north, then curves eastward, skirts the Maracaibo Basin, and extends well across Venezuela. Although similar in many ways to the other mountain ranges, it contains a series of extensive, high, intermont basins in the Departments of Cundinamarca and Boyaca. These large basins provide the optimum conditions in Colombia for the development of the Andean culture pattern and were the center of the Chibcha civilization. Finally, the isolated Sierra Nevada de Santa Marta is of considerable archeological interest because of the ancient village sites found there, in spite of the fact that the environment seems in no way superior to the other sections.

"In Colombia, the mountain section has a double rainy season during the year, so that the uplands between 10,000 feet (about 3,050 m.) and the snow line are classified as paramo, or cold wet rain forests. This type of environment is not particularly conducive to the llama and

alpaca herding so important in the Central Andes. The Colombian topography likewise effectively isolated many of the cultural units. Not only are the mountain ranges high but the contrasting altitude zones act as barriers against too much shifting from one section to another. Distance is still another factor of isolation.

"Except for the large intermont basins of the Cordillera Oriental, agricultural land was largely limited to the mountain slopes. Since the slopes are forest-covered, the slash-and-burn type of clearing must have been as common in the past as it is today. Throughout the Colombian Andes many pockets of fertile soil are available for this type of cultivation, but there are but few areas in which a large population could be concentrated. The extensive flats of the Cauca River valley might seem to be an exception, but in the past these were apparently so swampy and so covered with coarse grass that they could not be utilized by digging-stick agriculturists.

"The nature of the archeological sites confirms, in part, this environmental analysis. For most of the country, there is no evidence for large, concentrated settlements. The extensive stone villages of Santa Marta are notable exceptions, and there is still a possibility that further exploration in the Chibcha area will reveal more extensive habitation sites. Elsewhere, however, the standard pattern is that of isolated house sites or of a few houses grouped reasonably near to each other. Graves may be located near the house platforms, or may be grouped into irregular cemeteries. This absence of large villages and cemeteries has been an obstacle to comprehensive archeological investigation. Another handicap to archeological exploration is the fact that the pre-Columbians rarely used nonperishable materials,

such as stone or adobe, in their construction work, although exceptions are found at San Agustin and Santa Marta. Furthermore, sites with several periods of occupation superimposed are seldom found, so that most of the materials available for study have come from graves."[69]

The situation seems favorable in terms of our concept of ecological symbiosis but on the other hand, if Bennett is correct then it is not favorable for intensive agriculture (except for the Chibcha Area ) and overall dense populations. We seem to have an area which theoretically reproduces the opportunities offered by certain areas within Meso-America,but which may not have been utilized or utilizable to its full potential by simple technologies. I would like to point out in this connection the repeated statements to the effect that the upland valleys of the Chibcha area have savannah or grassland vegetations (see Sauer, Kroeber).[70] We might well have here a reproduction of the ecological problems offered by Highland Michoacan, Queretaro and Jalisco in Meso-America. Today the Chibcha area is Colombia's granary as is the Bajio in Mexico - do we have a similar ecological situation here? At any rate we find in the Bogota area at the time of the Conquest stratified societies, markets, fairly dense populations (Kroeber suggests 40 per $km^2$); and interestingly enough the largest states in ancient Colombia were centralized in this region. There is, however, no evidence archaeologically of large settlements, towns or villages, much less cities, and the elaborate development of arts and sciences found in the Andean and Meso-American areas is lacking.

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69. Handbook of South American Indians, 1946, Vol. 2, pp. 824-826.

70. Sauer, 1950; Kroeber, 1945.

The greatest difficulty in assessing the role of these intermediate areas of American high cultures is the paucity of data, both archaeological and ethnographic, and even here some of what has been published is in direct contradiction. Steward in his discussion of Western Colombia points out the documentary evidence for large villages and towns; Bennett in his treatment of the archaeology points out that according to this source of data the reverse was true. We don't know what agricultural systems were in vogue at the time of the Conquest or what the real potentiality of Colombia's zones are in terms of primitive technology.

Taking the data as a whole, archaeological and ethnographic, it seems certain that we find throughout the Colombian area with a few exceptions a culture which was characterized by larger political groups than in the tropical forests of eastern South America, with formal chiefs, social classes or stratification, a more intensive utilization of the land with maize as the staple rather than manioc, much denser populations, and well developed arts and crafts as compared again to the eastern region; and without much doubt intensive trade with regularly meeting markets. As Willey and Phillips point out, the culture was in many respects equivalent to the Formative period cultures of Peru and Meso-America.[71]

The archaeological evidence, such as it is, suggests a much shorter utilization of the area by farming societies than in Meso-America and Peru, and this comparative lack of depth may in part explain the lack of a more elaborate culture. In other words we may have had at the

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71. Willey and Phillips, 1955.

Contact period a cultural development which was just getting under way when the Spaniards arrived. If we combine Bennett's and Sauer's statements with respect to the ecology we might well explain the intermediate position culturally (between the simpler folk farmers of the Amazon and the urban peoples of the Andes) as being in part due to its intermediate ecological resources. At any rate it is significant that here in Colombia we find a more varied ecology and denser population with more elaborate cultures than in the sea of flat tropical forest and savannahs that characterize the Amazon basin.

Central America offers a more simple geographical patterning than Colombia. We find three major ecological zones running parallel from west to east. The southernmost or Pacific Coast plain shows very close resemblances to the Pacific coast of Meso-America with reduced width, alluvial origin, scrubbier vegetation, and drier climate than on the Caribbean side. Sauer states that rainfall varies from 800 to 1600 mms which is about the range of rainfall of most of the Meso-American Pacific Coast.[72]

Separating this from the Caribbean or Atlantic Coast are a series of interior volcanic ranges and small valleys. Some of the ranges have altitudes up to 2779-3409 meters above sea level. The interior valleys which are important population centers (the heaviest population and capitals of most modern states in the area are in them) lie at elevations which in Meso-America correspond to the Tierra Templada. In Costa Rica, for example, the Meseta Central has an elevation varying from 650 to 1300 meters above sea level). Climate

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72. Sauer, 1950.

fluctuates tremendously in the hilly hinterland varying with the exact position of the mountain barriers and we get valleys in the mountains with both humid and sub-humid Tierra Templada climates.

The Atlantic Coast Plain on the other hand is wider, flatter, better watered, heavier vegetated and with much higher rainfall than the Pacific coast, running generally over 2500 mms a year and with only a slight seasonal variation.

There are resemblances between the ecology of Central America and Colombia, and some differences. Central America is a much smaller area, lacks Tierra Fria population centers, and has less significant ecological zoning between population centers. Both are intermediate types of ecological regions as compared to Meso-America; both have ecological zoning and rugged topography with mountain and lowland population centers.

Culturally in the sense of basic cultural types the resemblances are even closer, and our summary of Colombia Pre-Hispanic culture could be duplicated for Central America. It is of interest that the important archaeological centers are all located on the drier Pacific Coast or cooler mountain valleys. Furthermore Central America poses an interesting question to proponents of the theory of Meso-American cultural origins as occurring in the tropical lowlands: Why did not Maya civilization penetrate into the Atlantic Coast Plain of Central America any further than the Comayagua Valley? Sauer's maps show that the Caribbean Plains in Honduras and Nicaragua are simply extensions of the phytogeographical regions of the Peten and British Honduras. Central America in general reproduces the ecological conditions of the Meso-American Lowlands as a whole; why do not we have

a more elaborate cultural development in that area in Pre-Hispanic times? My answer is an obvious one in terms of my ecological principles: there are no Meso-American Highlands in the area to provide the needed cultural stimulus and demographic reservoir.

I find it very significant that Meso-American civilization stopped in its diffusion southward exactly at the point where the Guatemala Highlands drop down to the low ranges of Central America. I see here strong ecological factors limiting its growth southward just as other but equally potent ecological factors limited its growth northward.

## The Nuclear Region of the Old World

The Mediterranean shorelands, along with the mountains and plains of the Near East and the Indus Valley of India, form a distinct province of cultural history, and we may call this extensive region the Nuclear Region of the Old World. Important barriers define it sharply from all outlying regions. To the south the Sahara desert has effectively sealed off Negro Africa from important contacts up until the invention of iron tools and the domestication of the camel which permitted caravans to cross over it and bring back gold and slaves from the Western Sudan. To the east the tropical forests of central and northeastern India formed an effective barrier to non-iron-using agriculturalists, and to the north great mountain ranges seal off the Mediterranean-Near Eastern world from the humid lands of Western and Central Europe and the dry steppes of central Asia. These barriers, especially those northward, are of course pierced here and there by natural gateways, and these played an important role in the evolution of trade and urban

society.

The area offers a significant and fascinating series of geographical parallels to the Andean Area and Meso-American Highlands, and some important differences. First of all, and in direct conformance with our Ecological Law Number 2, no part of this huge region has an annual rainfall exceeding 40 inches or 1000 mms except high mountain peaks where humans don't live. The settlement areas all conform to our sub-humid climatic pattern. Within this overall classification we find a great range in precipitation from almost 0 up to the maximum of 1000 mms. Two important ecological sub-types stand out in terms of population concentration. One is the Mediterranean type with a short rainy season falling in the winter and with rainfall running from 15 to 40 inches as a whole. This type corresponds exactly to our Highland Andean and Meseta Central climate except for the reversal in rainy and dry season. The amount of rain and seasonal patterning are very close, especially with the Highlands of Oaxaca, and in both the Mediterranean and the latter area rainfall is more erratic than in the Meseta Central.

The second sub-type is the rainless desert with its oases and exotic river valleys. This type is a minor one in Meso-America, whereas in the Near East exotic river valleys were the scenes of highest cultural development during the pre-Iron Age period. In the New World we find a somewhat analogous situation in the Peruvian Coast.

In both the Meso-American Highlands and the Nuclear Old World Region vegetation is easily controlled and presents no real problem even with primitive tools; soils in valley floors or coastal plains are generally fertile and can be kept under continuous cultivation with simple fertility restoration techniques. The major ecological

problem in both areas is humidity control and the problem was solved the same way in both areas. Irrigation in the Old World area has been of even greater urgency than in Meso-America because the rainfall, aside from being scanty, is very erratic, but dry farming techniques on areas of deep soil are as effective as in the Mesa Central. (See Semple, Chapter 3, for a long description of Mediterranean agricultural methods and problems.[73]) Another important problem is the limited area of good agricultural land. The Old World Area like much of Highland Meso-America and Peru is one of small, highly productive valleys and coastal plains separated by agriculturally marginal mountain slopes. In both areas these small areas are units of characteristic overpopulation and the Mediterranean world, like the Meso-American Highlands, has always been a demographic pressure area. Agricultural systems in the Mediterranean area are always intensive and like Highland Meso-America are closer to gardening than field agriculture. It, like Highland Meso-America, is a land-hungry ecology.

Both Meso-America and the Mediterranean region are dominated by mountain masses which chop them up into separate demographic units, provide water and soil, and create ecological zoning even in small spatial units. Mediterranean agriculture like Meso-American agriculture is characterized by intensive micro-geographical zoning. Semple makes the following statement with respect to the latter point:

"A temporary check to commercial expansion was probably found in the high mountain relief which permitted a variety of exchanges between coast and summit, beginning with fisheries and salt concretions along

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73. Semple, 1931.

the seaboard, followed by grain in the coast plains, figs and olives on the piedmont slope up to 2,000 feet, vineyard products from 100 to 3,500 feet, wheat and barley up to 5,000 feet, and various trees for lumber and mast from 2,000 to 6,000 feet, according to latitude and exposure. Here each zone of altitude yielded products complementary to those above and below; hence neighborhood barter prevailed warranted to satisfy the chief necessary wants."[74]

Russell and Kniffen speaking of Greece point out a similar situation:

"There is a general absence of wide agricultural plains in the Mediterranean Realm. Small valley flats are used for growing grain, the best lands going to wheat, artichokes, onions, garlic, cabbages and flax. Legumes appear on poor soils. Wet flats are used for summer pastures, hay, asparagus and willows. The latter are extremely useful in lands short of timber for fuel, baskets and wagon bodies. The best hill lands are used for fruit orchards, figs and grapes, while the poorer support olives. Mountains are sources of timber, or they serve as summer pastures.

"There is considerable commerce between varying altitudes. Grain lands are low, figs, fruits and olives reach up to about 2,000 feet, vineyards to 3,500, barley up to 5,000 and hogs and timber to 6,000. Sheep and goats cross all zones."[75]

A further result of this local diversity is to ameliorate to a

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74. Semple, 1931, p. 662.

75. Russell and Kniffen, 1951, pp. 207-208.

great degree the limitations placed by topography in overall zonal production and we find here as in the Meseta Central a high efficiency in utilization of limited resources.

Aside from the microgeographic zoning in local areas the region as a whole is characterized by major differences in resources from area to area. Good extended stretches of alluvial deep soil zones, ideal for grains, especially wheat, are rare, and such areas as the great river valleys of Mesopotamia, the Nile and the Po tended to serve as granaries for the entire region. They were also centers of flax cultivation. The Caucasus and Armenian Highlands with their wetter climates were rich sources of lumber, honey, wax and other forest products. Anatolia with its vast upland plateau and its salt pastures was an area of specialized sheep raising and the finest wool came from there and was exported to the Aegean cities for processing. The Black Sea Plains were sources of pastoral products such as hides, wool and cattle. Rocky mountainous areas like the Aegean coastlands were centers of olive raising and vineyards, and processing of wine and olive oil; the forested slopes of Lebanon were important sources of timber; salt was an important item of trade between coast and far hinterlands; incense came from southern Arabia; Spain and the Anatolian Highlands were sources of metals; and the nomadic desert groups in Arabia were specialists in animal products.

We find the basis of this regional specialization is as ecological as in Meso-America; Mesopotamia lacks everything but grain lands; some Greek states like Athens had to specialize or starve as the immediate hinterland was almost useless for grain. We find whole groups of people specializing as middlemen, of which the Phoenicians

and Greeks are classic examples. In part, this was due to the lack of resources at home, in part due to the geographical position; Phoenicia lies between a number of specialized regions: Mesopotamia, Arabia, Egypt and Anatolia. Symbiosis might be categorized as a series of necessary interdependent relationships between paired economic types as Semple has indicated.[76] These would be (a) between grain producers and non-grain producers or limited grain producers; (b) between the ancient centers of urbanization and barbarian hinterland in which manufactured goods were exchanged for raw materials; (c) between sedentary rural groups of grain cultivators and nomadic herdsmen; and (d) between areas of highly specialized resources such as lumber, metals, salt, etc., and the have-nots.

With these significant similarities we find a number of major differences in the ecologies of the two areas. First, internal zoning is more complex in Meso-America and zones of ecological specialization closer together. Second, there are no great alluvial plains with single unified irrigation systems in Meso-America, and these were scenes of primary cultural development in the Old World. The closest parallel to these grain regions of the Mediterranean world in Meso-America is the Mesa Central and the latter area is broken up into smaller units, lacks total unification and centralized hydrography. Its demographic potential wasn't too far behind the Nile Valley, however, if my estimates of its sixteenth century population are correct. (I.e., I estimate about three million for the Meseta Central; common estimates of Dynastic Egypt are four million.) Irrigation was

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76. Semple, 1931.

more crucial to the economy of the population centers of the Old World than in the Mesa Central but probably not more so than in the Oaxaca Highlands. Another difference lies in the role played by the sea in the two areas. The Mediterranean, with efficient sailing ships, served as a highway linking together the wider spaced ecological zones; in Meso-America the sea played a very minor role, even among coastal groups. Transportation in the Mediterranean area was more highly developed in both media, land or water, which meant that intense trade and symbiosis could be spread over a much larger area and urban society therefore was capable of greater expansion. In Meso-America we have already pointed out the limitations placed by transport in this connection.

With this broad geographical comparison as a background we can now make a brief survey of the cultural history of the Nuclear Region of the Old World and assess its role in cultural development of the hemisphere.

The earliest attested folk agricultural society in the history of the world is recorded for this area. Coon reports a date of 5840 B.C. for a Neolithic complex with domestic sheep and goats but no pottery or agriculture and later on, 5330 B.C., we find agriculture, pottery, cattle and pigs are added, from the Belt Cave site in Northern Iran. Braidwood obtained a C14 date of 4758 B.C. from Jarmo in northern Iraq with a pre-ceramic level but containing evidence for agriculture and stock raising.[77] Throughout the Near East in Pre-Agricultural

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77. Coon, 1954.

times, after the Pleistocene we find a population of seed gatherers similar to the Natufians of Palestine, and agriculture was evidently invented by seed gatherers in the more humid, less desert areas of the regions just off to the north and west of the Mesopotamian Plain. Frankfort postulates that agriculture in the beginning may have been based on simply sowing of grain with the digging stick on humid alluvial flood deposits in mountain valleys. He describes a contemporary system practiced by the Hadendoa on the Blue Nile in Nubia which is almost identical to that practiced by the historic Yuman tribes in the Colorado Valley.[78]

The earliest urban society in the Near East evidently began in the Mesopotamian Valley. Here we find a parallel situation to the Mesa Central - an enticing natural environment but which can only be effectively utilized by a heavy outlay in labor and time. The result was the same well integrated city-state organization we have described for the Meso-American area, the need for organization, the production of a substantial surplus and its utilization for trade. Sumer, like the Valley of Mexico, lacks practically everything but good agricultural land so trade from the beginning was a necessity (see Childe[79]) rather than a luxury. In Sumer even stone for tools was lacking, and wood, metal and other basic material also had to come from outside. Markets were further away for most of the traded items than in the Meso-America as ecological zoning is less intense, but the rivers provided a natural highway, and furthermore we find in Mesopotamia that

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78. Frankfort, 1951.

79. Childe, 1946.

urbanism developed hand in hand with more advanced techniques of transport such as sailing boats and pack animals, so the same volume of trade could be carried over longer distances than in Meso-America.

From this primary source Bronze Age urban society diffused rapidly into Egypt, Anatolia, the Aegean Coast, Crete, Iran and the Indus Valley of India before 2500 B.C. It did not penetrate outside of this area in its full form; certain traits such as bronze tools, stratified society, and the temple complex did diffuse into Western and Central Europe, North China and the Western Mediterranean but true cities and true urban society during the Bronze Age did not. It was a highly specialized cultural phenomenon limited to a highly specialized ecology. The reasons for this seem clear. The technology of the peasant class was still based on stone tools; bronze was never plentiful enough to filter down to the poorer classes so we have most of the population, the most important element, still in the Neolithic Age. Effective utilization of the land with such tools, and resultant high demography and production of substantial surplus for the support of cities can only be carried out on fertile, arid land soils where permanent agriculture can be achieved and vegetation regrowth is easily controlled. We have seen in Meso-America that true cities were limited to a Mediterranean-like ecology. In Meso-America as in the Old World certain aspects of Bronze Age society diffused but the full urban pattern did not (e.g., in the Meso-American area, the Hieratic Complex diffused into the Maya area).

One of our ecological principles emphasizes the fact that micro-geographic zoning and intense trade (which depends on the first) must be combined with dense populations and intensive agriculture to produce

an urban society with Neolithic tools. This is nowhere more clearly demonstrated than by the early Bronze Age culture of Egypt. All sources emphasize the isolation of the Nile Valley during this period from the rest of the Near Eastern World. Without the full development of transport characteristic of later phases of the Bronze Age, Egypt remained isolated from the major trade routes. Egypt by herself lacks ecological zoning other than that between cultivated valley and nearby desert, and the latter is a real desert and evidently was rather sparsely populated by nomadic pastoralists.

Egypt's ecology was ideal for the growth of a dense population based on intensive agriculture but lacked the ecological zoning for the development of urbanization. The results are interesting and have been pointed out by Frankfort in a brilliant comparative essay with Mesopotamia.[80] We find that the need for organization in agriculture, the restriction of agriculture to a single narrow ecological band linked by river transport, fostered the development of a unified state very early in Egypt's history; the substantial surplus supported a class-structured society which organized the population into huge workgangs for the construction of monuments; but cities and towns were rare, and urbanism of the type we described for the Meseta Central lacking. What raw products were lacking were gathered by huge governmentally organized trading expeditions (to the Sinai Peninsula for metals, for example) and were restricted to use by the ruling class. There seem not to have been private craftsmen competing in the open market at all, only small groups attached to the royal household.

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80. Frankfort, 1951.

Frankfort points out that the "capital" was simply the place where each pharaoh planned to build his tomb and changed from ruler to ruler! The great architectural clusters seem not to have been centers of population but giant graveyards and ceremonial centers! We have a curious analogy here with our reconstruction of the Maya area with isolation as the major geographical fact - in both cases the civilization was off the major regional trade system and allowed to develop in each case a regional specific type of culture which had remarkable stability. It is of interest that most specialists today feel that Mesopotamia rather than Egypt was the source of Bronze Age civilization.

In Mesopotamia, as in the Mesa Central, events were fast moving, contacts outside intensive and extensive, trade a major activity, cultures rapidly changing and the nomadic groups of the frontier like the Marginals of Meso-America were constantly tipping the scales when cultures became stagnant.

In sharp contrast to the Nile Valley, the Tigris-Euphrates was only unified by periodic conquests, states were of the empire type, the population was concentrated in towns, villages and cities, and we have a typical Mesa Central type of economic organization and symbiosis. Here again I believe ecological factors played a strong role in the basic similarity of Mesopotamian and Mesa Central civilizations. Mesopotamia is closer to the regions of special production we have outlined; the zones are more widely spaced than in Highland Meso-America but Bronze Age society from the beginning had the technology for more effective transport. The desert fringes, unlike Egypt, were densely populated by pastoralists providing a basis for symbiosis between herdsman and village; much of the surrounding area lacked good

grain lands but was densely populated so Mesopotamia had a ready outlet for her surplus.

From the river valleys of Mesopotamia Bronze Age urban society diffused into the shorelands of the eastern Mediterranean and it was this area which was to be the scene of most distinctly commercial types or urban society with its more complex topography and more marked zoning of production. Some groups became special middlemen and industrial processers and Egypt was incorporated into the Symbiotic Region.

With the Iron Age, which was initiated in this same area of high culture, urban society spread into newer and more varied ecological types as we will point out in the following sections. However in spite of this spread outward one can say without fear of contradiction that our defined total Nuclear Area maintained cultural leadership over the rest of the Old World up until the Industrial Revolution. After the Bronze Age fluorescence in Egypt and the Near East, cultural leadership passed to Greece and then Rome, following Rome the brilliant Islamic civilization developed, centered in Mesopotamia, and the European Renaissance was born in the Mediterranean shorelands.

Russell and Kniffen sum up the significance of the eastern part of our Nuclear Region in the following passage.

"The origin of Europe's Neolithic (New Stone Age) culture was in the Dry World. The use of copper began prior to 5500 B.C. in the Dry World, but did not reach Europe for well over 2,000 years. Dry World peoples began using bronze prior to 3000 B.C., but Europeans were slow to accept technological achievements. The Bronze Age was well established by 2500 B.C., but it did not reach central Europe until after 2000 B.C., or northwestern Europe until after 1500 B.C. The Dry World

Iron Age started well prior to 1000 B.C., but did not reach northwestern Europe until after 500 B.C.

"The origins of western civilization spring mainly from the great potamic centers of Nineveh, Babylon, Assyria, and Egypt. Governmental organization was so fully developed that royal dynasties arose in Egypt by 3200 B.C. and the erection of pyramids was begun in 3000 B.C. These structures are imposing enough in themselves, but possibly more significant is the social organization that they imply. Cheops, the largest, which originally attained a height of 481 feet, was constructed out of 2.5 million large blocks of stone which was quarried in the desert some sixty miles from the banks of the Nile. Astronomical observations were being taken in Babylon at least as early as 2234 B.C. Most of our basic mathematics comes from Dry World peoples. We follow a Babylonian custom in dividing a circle into 360 degrees. The names we use for the combinations of stars in the sky originated among ancient Levantine peoples. The Ancient Greeks conceived the idea of the earth's sphericity, and measured the length of the equator by taking observations in Egypt, but the Arabs later devised a better way of computing its size and did so.

"During Europe's Dark Ages the Arabs and other Dry World peoples were caretakers of much of the civilization of the Ancients. They escaped the ravages of the Germanic tribes and the smothering effect of European theological disputes on learning. While practically all of Europe reverted to the throes of barbarism, Arabs were seeking new outposts in the Indies and along the coast of China, creating a trade in luxury items that was to have an important effect on Europeans, bringing from the Far East many of the fruits that now are staples

of the Mediterranean, and developing a necessity for the Voyages of Discovery. They were also advancing as the greatest explorers and scientists of the western world.

"To Dry World peoples we owe the domestication of most animals that have proved to be amenable to the will of man: horse, camel, sheep, goat, pig, yak, ox, and possibly the dog. To them we owe also most of our cereal plants (other than maize and rice), the date palm, and various other domesticated plants. Only the American Indian vies with the Dry World inhabitant in the matter of adapting and improving wild plants to the uses of man."[81]

## India and Further India

India today is a museum of cultures. We find urban civilizations in the major river valleys and coastal plains; folk agricultural groups in the Deccan with a basically Neolithic culture like the Munda; and simple hunters and gatherers in the isolated forested ranges. With this complexity and range of cultures we find a corresponding complexity of ecological zones. In a real sense India is an oversized Meso-America in that it lies principally within the tropics, is dominated by great mountain masses, and has an enormous range in climate. There are some important differences however. In the first place the cultural heartland of ancient and medieval India (and modern India as well) has been riverine lands of two major river systems, the Ganges and the Indus. The high cultures of India, as those of the Nuclear Old World Area, have been riverine cultures. Second, although mountain masses

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81. Russell and Kniffen, 1951, pp. 266-267.

dominate India's landscape they are either not an internal part of the ecological structure of India (such as the Himalayas which form a barrier and border India rather than lie within it) or they are low ranges which do not present much ecological zoning (as the Ghats in Peninsular India). The overall pattern of ecological zones is also simpler in India and we do not get the complex internal regions and sub-regions that we find in Meso-America. The following analysis is based on Russell and Kniffen.[82]

Indian ecological patterning may be summarized in the following terms. To the north we find the Himalaya ranges, the highest mountains in the world and with typical escarpment zoning from snow fields to tropical climates with all intermediate stages. Below this is Nuclear India which consists of a broad lowland belt drained from the center southeastward and southwestward by the mentioned major river systems. Peninsular India to the south is occupied mainly by a low plateau similar to those of Africa. The coastal plain east and west of this interior plateau is similar to Africa also in its extreme reduction of width.

The plateau rises very sharply on the west from the low coastal plain to the peaks of the Western Ghats which run from 4000 to 9000 feet above sea level; it then gradually slopes down eastward to the Bay of Bengal. Just before it levels off to the east coast it rises again to form the Eastern Ghats and then drops off to a wider coastal plain than that to the west. More large streams drain eastward and the Eastern Ghats are broken by wide interior valleys and sloping plains.

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82. Russell and Kniffen, 1951.

The only part of India which presents true ecological zoning, where there is a marked variation in local production, and in which the various ecological zones are densely populated, is the north. Baluchistan and Afghanistan from outside India, along with Kashmir, Nepal, Buhtan and Assam, are all escarpment and mountain districts in the Himalaya system which include a number of distinct ecological zones. Below 2000 meters we find tropical climates, with monsoon forests to the east in Assam, lighter, scrubbier vegetation to the west. Between 2000 and 3400 meters is a zone almost duplicating the Meso-American Tierra Templada, and above this we get the typical sub-zoning of the Meso-American Tierra Fria from temperate forests to conifers, to alpine meadows to arctic snow fields. In the upper alpine meadows we find specialized pastoral groups, further down centers of wool weaving and wood working, and in the sub-tropical zone tea, Mediterranean and northern European fruits along with northern vegetables and grains. Rainfall over most of the Himalayan scarp is generally heavy running heaviest as you go eastward.

South of the escarpment are the two great river valleys, the Indus and the Ganges. The Indus runs in general through sub-humid regions and the aridity increases downstream. In the Punjab or Upper Indus - the "Land of the Five Rivers" - we find a climatic pattern identical to that of the Meseta Central with summer rains and an annual rainfall of from 15-30 inches or 375-750 mms. The Lower and Middle Indus runs through a desert area and agriculture, settlement and overall ecological adjustment is identical to that of the great riverine areas of Mesopotamia and Egypt. In the Ganges Basin the rainfall gradually increases from west to east. Delhi in the upper

valley receives 650 mms of rain, and Lucknow and Benares in the Middle Ganges valley receive about 1000 mms. Further east the rainfall increases to 1500 mms and more in the state of Bengal. Approximately half of India's wheat crop comes from the Punjab (upper Indus) of which half is raised on irrigated lands. Millet, sugar and cotton are cash crops. The Lower Indus is a center of rice, cotton and wheat irrigation agriculture. Most of the Upper and Middle Ganges is a two-crop area with both rice and wheat as staples and again an area of intensive agriculture with irrigation. Further down in Bengal we find over 85 percent of the land in rice. The two major river valleys then are the grain lands of modern India; irrigation and intensive agriculture is the system in vogue and we get enormously dense populations in these fertile alluvial riverine plains. The Middle and Upper Ganges is also the center of urban development in modern India and 30 percent of the total population is urban. This is very high for India; in the humid tropical rice areas such as Bengal we find a very dense rural population but very little urbanization; 98 percent of the population is rural. In the drier Upper and Middle Ganges Valley are six major cities with over 200,000 inhabitants including the capital (Benares, Allahabad, Cawnpore, Lucknow, Agra and Delhi).

The heaviest rainfall in India falls on the Malabar (western peninsular) coast and neighboring escarpment of the Western Ghats on the west side of the peninsula, where it reaches 2500 mms on the coast plain and climbs to 7500 mms in some spots up on the slope. The situation is closely similar to the Tabasco Plain. Just east of the Ghats on the plateau we have a belt of rain shadow where rainfall drops below 1000 mms but in general the plateau has in excess of this figure

and increases to 1500 mms in the north. The east coast and neighboring scarp also receive 1500 mms or more of rain a year so Peninsular India along with Bengal in the Lower Ganges Valley is a humid tropical region, similar to our Mexican Gulf Coast-Peninsula of Yucatan and with the same temperature and precipitation ranges that we saw in the latter region.

In general the coastal plain is occupied by wet rice cultivators and has an enormously dense population although urbanism is little developed. The plateau and hill country is in general occupied by slash and burn cultivators, much less densely settled, and with primitive, really Neolithic tribal cultures. Peninsular India lacks true ecological zoning since none of the population concentrations are above the tropical zone. In the plateau with slash and burn cultivation we find some ecological specialization in the form of forest products which are traded down to the coast.

Urbanism then in modern India occurs in areas of dense population but not in the densely populated tropical regions with rice as the staple. Curiously enough the highest development of urbanism occurs in those regions of India with sub-humid climate, local intensive ecological zoning and a dependence on wheat and barley rather than rice as a staple. We may have historical forces as well as ecological ones here at work; the wheat-barley complex came from the Near East where urbanization is highly developed, the rice complex possibly from southeast Asia where again we find very dense populations but little urban development. In other words dense populations are pre-requisites for full urban society but do not necessarily result in its development. In some parts of southeast Asia such as Luzon in the Philippines we

find intensive wet rice agriculture with a simple unstratified folk society (Ifugao). Here I think the complete lack of zoning is probably the major factor and wet rice cultivation evidently evolved in some area of Southeast Asia where the environment was simple. It probably occurred in some area like the Mekong Valley in Indo-China where we have an alluvial valley with heavy rainfall and original tropical forest cover bordered by low hilly ranges also with humid climates and forest cover. The similarity here with the Malabar Coast-Deccan Plateau is very close.

In speaking of the role played by this heartland of Indian cultural development Russell and Kniffen state:

"Middle India is the nursery of Indian culture, one of the earliest cradles of civilization, the site of India's oldest and most famous cities, as well as an excellent granary. It was the particular goal of conquerors and its possession was the fundamental strength of India's middle-ages Mohammedan and Mongol empires. In modern times it supports many of India's largest cities. It maintained political leadership over Bengal and other parts of British India."[84]

I might add that this was the area of origin of Buddhism, India's greatest philosophical gift to the world.

Tropical India on the other hand has played a minor role in the development of India culture up until the Christian era, presumably until iron tools and wet rice agriculture were fully established. To judge from the archaeological evidence (to be reviewed shortly) and modern distribution of ecological systems, Peninsular India up until

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84. Russell and Kniffen, 1951, p. 406.

that point was occupied by food gatherers and simple folk societies with slash and burn agriculture.

Russell and Kniffen speaking of Bengal, the lower Ganges tropical zone, state:

"Bengal, the downstream province of the Ganges and Brahmaputra valleys, has an area of 86,850 square miles and population of over 62,000,000 or an average density of about 730 per square mile, more than Belgium, and nearly that of England. The density might not be so astounding were it not for the fact that in the seventeenth century the region was sparsely inhabited. Bengal has been created by the British, just as Hong Kong was in China. It is hardly appropriate to speak of 'returning' either, because neither really existed until the British decided to build them."[85] (The italics are mine.)

In terms of India's cultural history we find a striking confirmation of our ecological arguments.

The Indus Valley in many respects belongs to our Old World Nuclear Area, and has throughout much of its cultural history. This is reflected even today in its separation into the independent republic of Pakistan.

Following Piggott's reconstruction of the history of this area we find the first folk agricultural groups moving in, evidently from Iran to Baluchistan about 3500 B.C.[86] Slightly later the Indus Valley was occupied. By about 2800 B.C. we find the rise of the two urban centers of Harappa and Mohenjo Daro and the initiation of a typical

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85. Russell and Kniffen, 1931, p. 405.

86. Piggott, 1950.

Near Eastern style desert valley urban civilization which flourished for some 1000 years. It was a Bronze Age city civilization similar to that of contemporary Mesopotamia and was finally destroyed by migrating Indo-Europeans with iron tools who came into India from the dry lands of west central Asia where so many destroyers of civilization originated.

The Indus or Harappa civilization as it is variously called was evidently entirely limited to our two ecological types, the exotic river valley and subhumid monsoon types, and here again we find striking confirmation of our second ecological law. It may have extended eastward into the Upper Ganges but there is no evidence for it. The Bronze Age urban society in India was short-lived and limited to the typical Near Eastern ecological setting.

As always happens in the cultural history of prize areas the invaders were absorbed and a new urban society based on Iron Age technology followed. In this case it was introduced into the Upper and Middle Ganges Valley as well as the Indus and this region was the great cultural center of Medieval India.

Until fairly recently Peninsular India was an archaeological blank when Wheeler excavated a number of South Indian sites and set up a tentative chronology. Piggott summarizes the conclusions as follows:

"The South Indian stone-axe cultures have been put on a new footing by Wheeler's recent work in Mysore State. His earlier work on the Coromandel coast in 1945 had provided the first fixed date in the sequence of indigenous cultures in that region, by establishing their relationship to imported coins and pottery of the first century A.D.

in a Roman trading-post at Arikamedu near Pondicherry. With dated types of native pottery now identified it was possible to use this evidence in Mysore in conjunction with finds of Roman coins of the same period, and in the Chitaldrug region a sequence was established as follows:

"I. Stone Axe Culture. This was characterized by polished, pointed-butt axes of local rock and a crude microlithic industry in jasper, flint, agate, and crystal. Two small copper objects show that metal was known but extremely scarce. Pottery was hand-made, rarely painted or incised. The beginnings of this phase may go back to early in the first millennium B.C., and it was followed about 200 B.C. by a

"II. Megalithic Culture. This was an intrusive iron-using culture, making wheel-turned pottery and building elaborate megalithic tombs. It continued into the first century A.D., overlapping with

"III. The historical Andhra Culture dated in its earlier phases by Roman coins of the early first century A.D. and pottery of Arikamedu types, and continuing to the third century A.D.

"This evidence, then, shows that in certain areas of South India at least the 'Neolithic' cultures are of relatively late date, surviving almost to the dawn of recorded history. Wheeler has published a map showing the known distribution of stone axes and microliths in India; they appear to occur almost exclusively to the south and east of a line from the Gulf of Cambay to Lucknow, with a few microlithic sites between Cambay and Karachi."[87]

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87. Piggott, 1950, pp. 37-38.

Admittedly inadequate as our archaeological evidence for India is, it checks perfectly with the arguments advanced in this thesis.

Although even less known archaeologically than India, Southeast Asia appears to present a similar overall picture of cultural history to that of Peninsular India, and the ecological situation is very similar over this huge tropical area. Agriculture almost surely developed several thousand years later than in the Near East although there is at least a possibility that it was a separate development based on root crops. Coon seems to lean to this theory in his recent study of culture history.[88] I personally doubt this and would look to Peninsular India for the origins of slash and burn root crop cultivation, later application of the system to dry rice, and final invention of intensive wet rice cultivation in the suitable coastal plain, all presumably due to stimulus diffusion from North India, and made possible largely by the introduction of iron tools.

Throughout Southeast Asia today we find two basic ecological patterns. First is that of the river valleys and coastal plains where we find intensive wet rice cultivation, dense populations, and cultural leadership. Most of the cultural development seems to be directly derivative from India, and the incoming groups selected the areas suitable for wet rice cultivation (or areas occupied by wet rice cultivators) for establishing the major centers of culture. The hilly ranged separating the valleys are invariably populated by simple folk agriculturalists practicing the slash and burn system and with typical scattered, sparse populations. Nowhere in this huge area as

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88. Coon, 1954.

far as I know do we have a case of a brilliant aboriginal civilization evolving with the latter economic base, with or without stone tools, and certainly no urban society.

Most of the area is occupied by Iron Age peoples. It is only in Oceania where we find Neolithic farmers with which we can test out theora 2. to 5. Law 2 states that no urban society without iron tools can exist in humid regions. The law remains unchallenged in this area and we find no culture anywhere in Oceania which even remotely can be classed as urban. Local specialization and trade may be highly developed in some parts of Oceania and populations relatively dense; in many cases equal to that of the African areas where iron tools are used. The main reason for this is the insular character of Oceanic ecology. Islands are like mountain valleys in demographic trends and may become "overpopulated" even with slash and burn cultivation, although even here the initial pressures are probably responded to by "island hopping" first. In this connection it is interesting that the most densely populated islands are the smallest. The huge continental island of New Guinea is much less densely settled than the tiny coral atolls of Micronesia. Sea food in many of the smaller islands equals or in some cases far surpasses agricultural foods in the diet. Islands also tend to have meager resources and we may get island-to-island zoning as in the Trobriands. However even in the latter area as Malinowski makes clear trade is not intensive although quite extensive; the total volume of goods moved and frequency of meeting of trading groups is far below Highland Guatemala and we get no development of such institutions as markets and middlemen.[89]

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89. Malinowski, 1922.

There is a fascinating correlation within Oceania with respect to rainfall-agricultural system-island size-population density-social stratification. We find that Melanesia is far more humid than Polynesia and Micronesia, has a far greater surface area with much larger islands, and correspondingly is an area of major dependence on slash and burn cultivation, has sparser populations and lacks social stratification.

Polynesia and Micronesia on the other hand are huge ocean areas with tiny dot-like islands, small surface areas, relatively dense populations, and with drier climates - some islands are even sub-humid; and we get, correspondingly, irrigation-taro cultivation and stratified societies! Urbanization of course could not occur in the latter areas because of the limitation in overall population size per social world.

## Negro Africa

Of all the great continental land masses Africa presents the simplest ecological patterning, and ecological divisions are characteristically expansive and broad. In general this is due to its overall lack of topography.

True mountain systems are rare; only three small systems occur: the Atlas on the Mediterranean Litorral, the Abyssinian Highland - which is more a high rugged plateau than a true range, and the small Drakenberg range in South Africa. Running from the Nile sources southward for some 1500 miles is a long narrow canyon-like valley, the Great Rift Valley, occupied by a chain of lakes. In certain areas, as in Kenya and Tanganyika we find isolated snow-capped volcanoes as

elevated as Popocatepetl and Orizaba in Meso-America, but these areas of varied relief occupy a small fraction of the continent.

Drainage patterns are likewise simple and the entire huge continent with a few exceptions is drained by three river systems, the Nile, the Congo and the Niger.

Most of Africa is low rolling plateau which begins behind the Atlas Range in the north at an altitude of about 1000 feet and gradually increases southward to reach a maximum of 3000 feet in South Africa. The true coastal plain is very narrow and restricted in area.

The climatic pattern is characteristically simple. We find a maximal rain belt and tropical rain forest occupying a continuous, centralized belt including the northern part of Belgian Congo, the Cameroons and the Guinea Coast. Rainfall generally exceeds 1500 mms over this area and may rise to over 2500 on the Guinea Coast. The rest of the area, south of the Sahara Desert may be described, in general, as a series of concentric belts around this rain center of steadily decreasing rainfall and consequent reduction of the vigor of vegetation from tropical forest to scrub forest, to high savannah, to low grass-desert-scrub savannah to hot steppe. Contrary to popular opinion only a fraction of the continent is covered by forests; approximately 18 percent; the rest is either savannah or desert.

Most of Negro Africa is covered by savannahs. This is the most important fact about the ecological setting of Negro cultures and to a great degree conditioned the cultural history of the area, as much as it is known.[90]

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90. Marbut and Shantz

The border between hot dry steppe and desert roughly marks the boundary between Caucasian Africa on the one hand and Mulatto-Negro Africa on the other. If one were to draw a straight line from the mouth of the Senegal river on the west to the south border of the Anglo-Egyptian Sudan on the other, he would fairly well define the two Cultural Worlds.[91] This discussion relates to that area south of this line. The region to the north is a segment of the Nuclear Old World Area and has been previously discussed.

Herskovitz, Hambly and others have defined culture areas in Africa as they appear today and we will take their definition as a point of departure for the following discussion.[92]

All groups in Africa at present and back to the Contact Period (fifteenth, sixteenth, and seventeenth centuries) with the exception of the Hunting and Gathering Bushmen in the Kalahari area have possessed iron tools, and all farming groups use iron axes, machetes and hoes in cultivation. Most of South Africa, and Africa east of the Great Lakes, is occupied by a folk type of culture based upon cattle herding and hoe agriculture under savannah conditions. Most of the agricultural labor is done by women; men tend to cattle and other livestock. Urbanism is completely lacking in this area, populations in general scattered in individual homesteads or in small hamlets; a few groups live in big villages but the basic pattern is the "kraal" type (see Shapera[93]); trade is minor, markets lacking and specialization

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91. Russell and Kniffen, 1951.

92. Herskovitz, 1949.

93. Shapera, 1951.

other than by sex or age only incipiently developed. Settlements are exceedingly temporary and the basic system of farming is a savannah version of the slash and burn system in which iron hoes are used to turn over the grasses, and fields are cultivated for a few years and then abandoned. No techniques of soil restoration other than resting are practiced and irrigation is unknown in spite of the aridity of much of the area.

Religious institutions are weakly developed and the religious administrative set not separated from the political hierarchy (chiefs are also priests, law-givers, war leaders and administrators).[94]

In sharp contrast to religious and economic institutions, political institutions are highly developed with hierarchies of administrative chiefs, sub-chiefs and headmen; political units often run into the scores of thousands.

In ecological terms East and South Bantu culture represents an adjustment of a people to a savannah vegetation by the use of metal hoes and primitive slash and burn techniques. Population is much denser than in the Amazon as cultivation cycles are shorter (with more effective tools for weed control). Lands may be cultivated until the soil fertility is played out. Population, however, is still sparse, generally running less than 10 persons per $km^2$, often much less. The denser population than that we indicated for Brazil permits the formation of compound political groupings but does not permit intensive trade and the development of economic institutions. Further, there is almost no ecological zoning and intense trade of the Guatemala

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94. Shapera, 1950.

type is unnecessary. Social stratification occurs but it is very simple; only two well defined classes stand out, the chiefly class and the commoners.

The Congo basin, mostly covered by forests, although it presents a somewhat different ecology, is occupied by peoples with a similar type of culture.

We find a simple folk culture again, with no urban centers. The basis of economy is slash and burn cultivation combined with hoes and is the province of women. With the use of metal hoes, however, vegetation regrowth can be more effectively controlled and again land cultivation may be extended until the soil plays out. The Neolithic cultivator on the other hand must stop utilizing a field when the natural vegetation begins to give him too much competition. Modern Maya cultivators, although they use machetes of steel, really have a Neolithic technology in terms of actual working of the soil.

Settlements in general, although of the village rather than kraal type, are small and correspond in size to our Valladolid hamlets, and are exceedingly unstable. Among the Lunda for example they average 14-16 houses and polygamous households are rare. One source suggests that settlements move every four to six years! The lesser stability of these slash and burn communities in the Congo as compared to Meso-American ones is undoubtedly due to the overall lack of fertility of the soil as compared to Lowland Meso-America; most of the area is rather flat, badly leached unalluviated lateritic plain. Only a small fraction of good land may be found in each new locale. The situation is so poor among the Lunda that they often build temporary grass huts when they first enter an area and if there turns out to be a fairly

high percentage of good land they then build larger, more solid mud-walled houses! The original grass huts are then used as young men's clubs or other secondary structures. Where small areas of good soil occur populations may concentrate up to 30-50 per $km^2$, whereas large zones ordinarily have less than 5 as an overall average.[95]

We find a higher development of economic institutions than in the savannah country. Where the Congo river system provides transport we may even find regularly meeting markets and some local specialization (especially in woodworking which was the principal media of Congo aesthetic expression). In spite of this the area lags far behind similarly served regions such as the Nile or Niger, and political and religious institutions resemble those of the savannah peoples. At the residence of powerful chiefs we may find big villages often running into several thousand inhabitants, but these are few in number. The overall resemblance to the culture of the Circum-Caribbean area is close.

In West Africa we find an entirely different situation. Negro cultures reach their most complex manifestation in the Western Sudan and adjacent Guinea Coast. We find complex social class systems, powerful kingdoms - much more stable than the rather nebulous states of South Africa, fully developed urban centers and a development of regional trade similar to that of modern Highland Guatemala.

Agriculture in West Africa is a masculine activity in distinction to most of Negro Africa and we get a correspondingly more efficient utilization of the land. In the more arid north around such centers

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95. McCulloch, 1951.

as Timbuctu we find irrigation and plow agriculture of the Mediterranean type based on small grained cereals. In the forested south on the Guinea coast agriculture is less intensive but corresponds more closely to our Highland Meso-American tlacolol system than it does to the Yucatecan slash and burn. Heavy, short-handled mattock-like hoes are used and the soil is as deeply worked and thoroughly pulverized as in Guatemala.[96] A careful crop rotation is followed involving yams, maize, sorghum and such secondary crops as cotton, sweet potatoes and cassava. These are planted in a regular order and the list includes several staples. Aside from this each house has a farm plot around it[97] which is fertilized by household refuse. The system then is our typical calmil-tlacolol. The tlacolol fields are cultivated four to seven years as an average, then rested about the same number of years and brought into cultivation again. Where large towns occur and the land is losing its fertility some groups contract Fulani pastoralists to graze their animals on farm lands to fertilize them. In the days when Dahomey was a powerful independent state, crop rotation was regulated by a regular Ministry of Agriculture and we find a carefully organized agriculture based on centralized control. In marshy lands rice is an important staple. Aside from this, in the riverside lands cacao is an important cultivate along with the palm nut, and bananas are important non-annual staples.

The greater agricultural productivity of West Africa then is due to a more intensive utilization of the land with either the true

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96. Herskovitz, 1938.

97. Nadel, 1951.

intensive agriculture system of the arid north or the tlacolol-calmil system of the wetter southern area. Aside from this the area is rich in staples so that efficient crop rotation may be carried out. This is obviously more true today for West Africa than at the Contact Period since many of the cultivates are foreign. The system must have been much less efficient in earlier times. The use of metal hoes to work the land has already been mentioned for other parts of Africa but here we find a more effective use of these simple hand tools. Here agricultural labor is the work of the man rather than the woman, as elsewhere in Africa.

The result demographically is a much denser population than anywhere else in Africa. Forde, speaking of the Yoruba in the forested south, gives the following regional densities per $km^2$: Oyo 37, Abeokuta 40, Ondo 22, Tjebu 50, and Colony 94. For the Nupe area further up the Niger in a scrub forest-savannah area densities drop to 14, 8, 12, 9, 20, 21 and 24 per $km^2$. For the Gold Coast Manoukian gives the following summary:

"In the Coastal Area the density is less than 60 per square mile (24 per $km^2$). There is a concentration of population in the rain forest area (the southern plateau of Ashanti) with its ample rainfall and water supply, favorable natural irrigation and considerable agricultural and mineral possibilities; here density is about 100-150 per square mile (40-60 per $km^2$.

"In the savannah area further north, which is more isolated, less productive, flooded for 1-2 months and parched during the rest of the year, population is more scattered; the density is about 60 per square

mile (24 per km$^2$)."[98]

Urbanization and intense local trade seem to correlate with those areas of densest population. Forde for example speaking of the Yoruba area states:

"The Yoruba are the most urban of African peoples. Almost one third live in the fifteen Yoruba towns with populations of over 20,000 inhabitants, while there are some 250 Yoruba towns and villages with populations greater than 1000. Ibadan with 387,133 inhabitants according to the 1931 census, is the largest city in tropical Africa. Ten of the eleven largest towns in Nigeria (over 37,000) are Yoruba, including Lagos which is two thirds Yoruba. But the Yoruba in the west (Dahomey and French Togoland) have a more dispersed type of settlement."[99]

In the more sparsely settled scrub forest savannah country of Nupe on the other hand Nadel states:

"By far the largest proportion of the Nupe population work on the land. In the purely agricultural districts in Trans-Kaduna 9000 out of a male population of 11,000 are farmers. Even in Bida town, the center of crafts, industry and trade, more than a quarter of the population earn their livelihood on the land."[100]

The economy of West Africa, although an Iron Age one, is based to a great part on hand tools and human transport and for this reason should be of great interest to Meso-American scholars.

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98. Manoukian, 1950, p. 11.

99. Forde, 1951, p. 15.

100. Nadel, 1951.

Ecologically the area presents some fascinating parallels to Meso-America and interestingly enough is characterized by a more complex ecological patterning than over most of Africa.

First we have the Coast Plain, approximately 18 kilometers wide. This is the wettest part of the area, a region of delta swamps and tropical forests. It has a complete inland lagoon system ideal for moving goods coastwise with simple boats, which connects with the Niger mouth. This is one of the poorer settled areas as the climate is hot, humid and enervating, even for natives. The chief economic value today lies in its sea resources and of course the presence of the international ports each serving a parallel strip of territory running inland.

Forested Plain. Moving inland one encounters a slightly elevated plateau covered by tropical forests which is about 60 kms wide. This is one of the densest populated regions and is the demographic heartland of such groups as the Ashanti, Dahomey and Yoruba. It is an area of intensive cultivation of palm nut and cacao, and the population density varies in proportion to the number of cacao plantations. There is a fascinating parallel here to the Chontalpa, especially downstream from Huimanguillo near Comalcalco. Land is under such heavy utilization for cacao that there is a shortage of basic foodstuffs and most of the yams, millet, etc., must be imported from the north. Plantations are small, running less than 4 hectareas on the average with a few running up as high as 20. This set-up, small commercial cacao plantations, more than anything else explains the relatively high population density and need for regional trade. Rainfall, drainage, alluviation all correspond exactly to our ecological

situation in the Chontalpa.

Interior Plateau. This is a hilly plain running from 500 to 1200 feet above sea level, covered by scrub forests in the south and gradually decreasing in density of vegetation northward until near desert conditions are met at Timbuctu. From the arid northern region to the coast is a total distance of about 1000 kms. The distance from the savannah area to the coast is approximately 200 kms. The savannah area of northern Nigeria plays an important symbiotic role to the rich cacao lands of the south. It provides the town-dwelling craftsmen and cacao owners of the south with basic foodstuffs such as yams, maize, beans, dried meat, and also cotton cloth and calabashes. From the forested south are imported cacao, kola nuts, palm oil, bananas and citrus fruits. Basic foodstuffs are handled by middlemen who collect them from the farmers in local markets and carry them to regional centers where trucks carry them to their final destinations. Communities along the Niger are served by a highly developed water route based mainly on dugout canoes and there are wealthy middlemen who own fleets of such canoes and live on this interregional trade.

One of the most important facts about this regional symbiosis, especially for the Pre-Contact period, is the fact that the Niger offers an excellent water transport route running the entire length of these sub-regional areas, and in the north provides water for irrigation systems. Today roads and railroads have reduced somewhat its importance, but not entirely.

Although we undoubtedly had a well developed regional trade and urbanism in Pre-Contact times in the south, the extreme urban development is obviously correlated with the rise of commercial cacao

cultivation, which in this case produces the same results as intensive agriculture in terms of the need for regional trade. It is a cash economy rather than a barter one between regions. Cacao grove owners sell their produce to middlemen (who sell it overseas) and with their cash return buy foodstuffs which are brought from the north. The basis is not really one of local regional exchange and specialization, although the latter does occur. The economic base of the system is probably more like that of the Chontalpa than like Highland Guatemala.

On the other hand, aside from this exaggerated development of urbanism in Yorubaland, we find an ancient and widespread trade throughout West Africa and it ties in closely to the zoning of production. It is a parallel banding as in Peru but the zones are much wider although significantly reduced when compared to the rest of Africa.

Following Nadel and Herskovitz the mechanism by which this trade and consequent rise of urban centers seems to be as follows:

1. West Africa is divided up into a series of small kingdoms, each has a capital and often this is its only urban center and often has populations running into scores of thousands.

2. Within each kingdom the bulk of the population are peasant farmers living in big villages and towns. These villages produce a surplus in foodstuffs which are moved by specialized middlemen and women, usually on their backs to the town markets. From there they are moved to the cities.

3. Most towns have enough specialists to fulfill local industrial needs and form a small class within a larger community of farmers. Local trade from village to village in the Guatemala manner is not characteristic and local village specialization not typical. There

is not enough ecological zoning within a kingdom to foster the Guatemalan type of economy.

4. The cities form part of a network of international trade connecting the ecological broad regions. Commercial activities here are more formal and we get typical Near Eastern caravan organization involving draft animals and canoes wherever the latter is possible. In pre-Contact times the entire West African trade system was linked by Arab traders with the North African coast and brought to the Islamic caravan world.[101]

In spite of basic similarities to the Highland Meso-American urban-peasant system there are major differences. The lack of intense local zoning is one of the major geographical differences. On the other hand the agricultural systems parallel closely those in Meso-America. The West African urban system is part of Iron Age urban culture and involves a different set of circumstances than that of urban society in Meso-America. These are a more advanced technology in all crafts (mining, weaving, metalworking, glass making, tailoring) which require specialization, and more advanced transport for international trade. Theoretically cacao specialization could have led to some urbanization in Pre-Conquest Meso-America but the volume of trade, and consequent rise of cities and complex economic institutions to handle it, must have been far below that of West Africa.

The higher density of housesites around major Maya centers than slash and burn agriculture permits might well be due to a commercial development of small cacao plantations around the center and a local

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101. Nadel, 1951; Herskovitz, 1938.

symbiosis between cacao grove owners and peripheral maize cultivators; some of the imported maize may even have come from further afield, such as the escarpments and upper valleys of Guatemala. Here again we run into the distance factor and human transport; it would seem more likely to me that this would be the case for immediate escarpment areas (Palenque, Copan for example) or Pacific Coast areas where markets are closer to the Highland consumer.

In attempting to reconstruct the culture history in Africa we are severely hampered by the lack of good archaeological field work in such key areas as the Anglo-Egyptian Sudan and the Niger river basin. Many of the more complex groups are illiterate which means a dearth of documentary data. Most of our documentary data are second-hand, coming from literate Arab merchants from North Africa.

One of the few areas in Africa where we have a moderately clear archaeological sequence worked out is East Africa. Most of the work was done by Leaky and there still exists considerable controversy over his chronology, especially since one of his upper Pleistocene complexes includes pottery! Cole in 1954 wrote an excellent summary of the prehistory of East Africa and the following data are based on his summary.[102]

The best local sequence yet worked out is from the Rift Valley in Kenya. Here in a small sub-region Leaky and later workers have reconstructed a fairly complete record of human occupation beginning with Middle Pleistocene times. We will here only review the latter phases since our main concern is with agricultural societies. At the

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102. Cole, 1954.

close of the Pleistocene we find in the Rift Valley an archaeological complex Capsian D, which is a good Mesolithic assemblage tied in with those from North Africa.

Following the Pleistocene the post-Pleistocene period is characterized by a series of minor climatic fluctuations to which the archaeology has been tied.

Furthermore some Carbon 14 dates are available for these climatic periods. The correlation between climatic and cultural phases is summarized in the below chart.

| | Climatic Phases | Rift-Valley Sequence | Absolute Dating | Remarks |
|---|---|---|---|---|
| Recent | Recent | Njoro Cave | Post 850 B.C. | Complete Neolithic complex minus agriculture |
| | Nakuran | Gumban B | – Nak. Maximum 850 B.C. | Gumban A + burial mounds |
| Epi-Pleistocene | Dry | Gumban A | | Domestic animals, pottery no agriculture, no polished tools |
| | 2 Makalian | Hyrax Hill | –335' terrace 3000 B.C. | Elmenteitan + Dom. animals |
| | 1 | Elmenteitan | Before 3000 B.C. | Mesolithic culture + pottery |
| Upper Pleistocene | Dry | Capsian D | | Mesolithic Culture |
| | Gambian 3 | Capsian C | | |

The Elmentietan Culture is one which includes a typical Capsian stone industry but in which pottery is present. It definitely is earlier than the Hyrax Hill material which is correlated with a climatic maximum dated at 3000 B.C.

Hyrax Hill. This is called a Neolithic Culture by Cole but he does not define what it contains. The stone industry is still Mesolithic evidently but along with pottery we find bones of domestic goats and sheep but no evidence of agriculture.

Gumban A-B. This is stated to have been derived from Hyrax Hill and again is a pottery-bearing complex with domestic animals but no evidence for agriculture. Typical and diagnostic traits are stone platters and burial mounds. Again the stone industry is characteristically Capsian.

Njoro Cave is the most recent outgrowth of this "Neolithic Culture" and we find a shift to cremated burials, and the appearance of such ground stone tools as bowls, mortars, pestles and grindstone along with pottery. The mortars and pestles are stained with red pigment and there is no evidence that they were used for grain processing. The culture is post-850 B.C.

We seem to have here a long period running perhaps up to the Christian era in which the basic economy remained the same, a hunting and gathering one plus a secondary use of domestic animals. The pastoral economy was evidently based entirely on small animals and weakly developed. Agriculture is completely absent from the record although a number of Neolithic traits occur such as pottery, ground stone tools and domestic animals. This in spite of the fact that we have a major river valley to the north, the Nile, where agriculture began at least by 4000 B.C.

As Cole points out there is no certain evidence for agriculture before the introduction of iron tools which seems not to have occurred before 1000 A.D. in neighboring inland Uganda.

Aside from this the evidence of Leaky's general survey of East and South Africa (our Cattle Savannah Area) indicates that even the aspects of Neolithic culture which did diffuse south are rare over the area and Mesolithic industries in many cases occur down to Iron Age times. It is tempting to visualize most of East and South Africa as being occupied up until fairly recent times by a basic Bushman stock with a Mesolithic Culture represented by Leaky's industries and that agriculture along with iron tools came in together with a full-fledged invasion by Negro peoples, probably from the Congo.

At any rate what the record does show is a singular ecologic block to the introduction of agriculture into the African savannahs; and here we see a fascinating parallel with the Amazon basin of South America. Savannahs would seem to be extremely difficult environments for non-hoe-using farmers to deal with.

Leaky points out that Neolithic celts and axes are rare in the savannah country but common in the forested Congo. Rattray also dug a site in forested Ashanti which evidently is pre-Iron and associated with Neolithic tools.[103] Conceivably then we did get a Neolithic, possibly with agriculture in the forested West Africa-Congo areas in pre-Iron times.

Our major problem, however, involves the origin of the complex urban society of the West African area and here we have a little documentary data to base our arguments on.

During the first millenium B.C. a series of coastal expeditions from Carthage, Egypt and Greece were equipped and they attempted to

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103. Rattray, 1954.

and successfully did circumnavigate Africa. These were fairly large naval expeditions involving several ships and a crew of some size. DeGraft-Johnson points out that the trips delayed several years because the sailors had to disembark regularly and plant crops to support themselves and wait for them to mature before continuing their voyage.[104] I contrast this sharply with, for example, such Spanish expeditions as that of Cortez and Pizarro who found agricultural groups and were able to live off the land. Evidently the West Africa Coast as late as these expeditions was occupied by non-agricultural groups.

The earliest of the famous Sudanic kingdoms was evidently that of Ghana which begins about 300 A.D. Most of the powerful West African states had their heyday between 1000 and 1600 A.D. and were based on a fully developed Iron Age technology. Of great interest is the fact that all of the famous medieval states of West Africa were centralized in the semi-arid-to-desert region of the Middle Niger and Senegal Rivers. The Guinea Coast does not seem to have played an important role in this cultural development. Many of our modern powerful coastal kingdoms such as Ashanti for example seem to be due to the fact that subject groups in the Sudan, following the breakdown in centralized government in the north fled southward and reestablished themselves on the Guinea Coast in comparatively recent times. Seligman states that the Ashanti were once plow cultivators in the Senegal area who shifted to the hoe-tlacolol system on arrival on the Gold Coast (the climate does not favor draft animals for plow cultivation).[105]

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104. DeGraft-Johnson, 1954.

105. Seligman, 1939.

The documents also make clear that much of the evolution and development of states in the Sudan itself is correlated with the rise of urban society on the North African coast and inclusion of the area into the Mediterranean trade world.

We have here then a number of possible conclusions on the basis of present knowledge, which is admittedly skimpy, with respect to Negro Africa:

1. A delay in the acceptance of agriculture into Savannah East and South Africa until the introduction of iron tools which undoubtedly post-dated the Christian era.

2. A possible early folk agricultural society based on Neolithic tools in tropical West Africa and the Congo in which the slash and burn system was probably in vogue; some of the modern Congo and Bush tribes of West Africa might well preserve this original folk society. The basis was probably yam and banana cultivation in the forested areas, millet in the Niger bend. The date of its introduction is not certain but cannot date back to more than a few centuries B.C.

3. The introduction of iron tools revolutionized life on the savannahs permitting agriculture and a more expansive pastoral economy with larger animals such as cattle.

4. In West Africa with iron tools and trade from North Africa we find the introduction also of the North African agricultural complex of irrigation and plows and corresponding demographic rise and formation of large states in the arid and sub-humid north. This development of states and widespread trade with the Mediterranean world reaches a climax from 1000-1500 A.D.

5. With the rise of urban society in the North the forested

South probably becomes included in the trading system. Later with the breakdown of states to the north and final conquest by Moroccans, we get a full-scale movement southward and introduction of the urban society into the Guinea Coast.

This summary is obviously a highly tentative one but is supported by the evidence at hand. What seems to be certain is that Negro Africa in general, with its savannahs and tropical forests, was in terms of the origins of basic cultural types marginal to the Nuclear Old World Area; its position geographically and cultural relationship to that area is somewhat parallel to the position of Northern, Central and Eastern Europe. I do not mean by this that the specific form and content of Negro culture was derived from the Mediterranean area but rather than such general culture forms as "folk agricultural society" and "urban society" along with specific important technological items such as agriculture, and iron tools, were first developed in the Mediterranean north and later diffused southward. I believe strongly that ecological factors were at work in this cultural lag.

## China

China is a nation of great diversity in climate and topography, and undoubtedly this fact is the central one in the evolution and development of the economy of Medieval and Modern China. In Meso-American terms, however, the ecological patterning is simple and ecological zoning broad. This difference can be appreciated when we realize the enormous area of Modern China as compared to Meso-America.

China is traditionally two nations or cultures in one. To the north lies the Hwang-Ho Plain or North China, a sub-humid region with

such crops as millet, barley and wheat as staples. To the South is the Yangtze Basin and hilly South China which together form the South China Province, a humid region where rice is the major crop. The definition between them is rather sharp with the Tsingling Range, with elevations ranging from 6,000 to 10,000 feet separating the two regions. Actually the Yangtze Basin should be defined as a transitional Middle China region with its barely humid climate and wheat-rice agricultural system. These traditional broad divisions have functioned throughout later Chinese history as mutually dependent trade worlds, especially after the development of the Grand Canal and secondary transport canal systems which link the Hwang-Ho and Yangtze Basins.

North China is mostly lowland plain with rugged broken country in the west in the headwater region of the Hwang-Ho Valley. Central or Middle China has a similar but smaller plain in the Middle Yangtze Valley and Delta. The Upper Yangtze to the west, or Szechuan Basin, on the other hand offers more varied topography. South of the Yangtze Valley, South China is a mountainous and hilly plain increasing in elevation and ecological zoning from east to west.

Rainfall increases in quantity steadily from north to south in China. Within such regions as North, South and Middle China it also decreases from coast to inland. In general the climatic pattern of North China is closely similar to that of the Mesa Central with similar rainfall distribution and quantity. South China has a climatic cycle similar to that of the Meso-American Gulf Coast. The Lower and Middle Yangtze Basin has about as much rainfall as the Southern Valley of Mexico and Highland Guatemala; the Upper Yangtze is again a sub-humid region.

Cressey gives a very detailed description of China's ecological regions which is summarized briefly below.[106]

Yellow Plain. This is the largest area of level plain in China and is the drainage basin of the Middle and Lower Hwang-Ho river. Annual rainfall runs from 20 to 30 inches or 500-750 mms a year, most of which falls in the summer. Winters are more extreme than in the Mesa Central, with snowfalls. The area leads China in crop variety but staples center around millet, wheat and barley. Most of the land is dry farmed using techniques described for the Teotihuacan Valley; irrigation is of minor importance. Agriculture is intensive, however, with heavy use of fertilizers and continuous production; and towns and cities are numerous.

Loessland. This is a hilly, mountainous region drained by the headwaters of the Hwang-Ho and is divided up into a number of separate valleys such as the Fen and Wei. It is covered by a rich wind-deposited loess which is one of China's most fertile soils. Small valleys are characteristically overpopulated and although the overall population density is but one-half of the Yellow River Plain, actual land occupation is more intensive.

Rainfall is lower than in the Yellow Plain with but 15 inches a year (375 mms) and irrigation is more important. Terraced slopes are cultivated by dry farming techniques, valleys by irrigation. Millet and wheat are staple crops. Population pressure is more acute in this area than anywhere else in China.

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106. Cressey, 1951.

Yangtze Plain. This is the Middle and Lower Yangtze Valley. The area is criss-crossed by irrigation and transport canals and is one of the most densely populated of all regions in China. Rainfall runs between 40 and 50 inches a year (1000-1250 mms) and is distributed throughout the year. With the more southerly location we find double cropping, with summer rice and winter wheat. Rice is the staple, based in irrigation, the division of the landscape into minute holdings is characteristic, and agriculture is extremely intensive. Finally, like the Hwang-Ho Plain, towns and cities are numerous.

Szechwan Basin. This is the upper Yangtze Valley, a fan-like rolling plain watered by a number of tributaries which cut narrow valleys. Level land is extremely limited and the entire region elaborately terraced for cultivation. It is the most densely populated part of China outside of the major Plains. It is sharply separated from the rest of the Yangtze Valley by the fact that the Tsingling mountains restrict the exit of the Yangtze on its east border to a narrow canyon-like gorge. Rainfall is between 30 and 40 inches, 750-1000 mms, a year, or slightly higher than most of the Meseta Central. Crop variety is, along with the Yellow Plain, highest in China and includes both north and south China crops. Production is very high, agriculture intensive, irrigation basic and population very dense.

Central Mountain Belt. This is the Tsingling and associated ranges which define the major divisions of China. These ranges are highest to the west where they sharply separate the Loesslands from the Szechuan Basin and the latter from the Yangtze Plain. Further east they break down into hills. The north slopes are arid and unvegetated, the southern humid and covered by forests.

South Yangtze Hills. This is a large belt of hilly mountainous hinterland south of the Yangtze Plain, and drained by the Yangtze River. Commercially and culturally it is a dependent region to the Yangtze Plain and its rivers tie in with the riverine traffic of the Plain. It is the warmest and wettest portion of the valley, mainly a rice area with terraced slopes and small irrigated river valleys. Rainfall runs from 50 to 70 inches as in most of the Yucatan Peninsula and Vera Cruz Coast Plain. Soils are very poor and agriculture is carried on only with an enormous price in time and labor. Along with rice it is a major center of tea c ultivation which is practiced on the slopes.

Southeast Coast. This is a deeply indented mountainous coast covered by tropical rain forests. Only five percent of the land is coastal plain. Rainfall varies from 60 to 80 inches (1500-2000 mms) a year, or about that of the wettest parts of the Meso-American Gulf Coast Plain. The land resources are poor, agriculture groups isolated into incommunicable units practicing intensive wet rice cultivation of limited resources and the sea offers as much of an economic resource as the land. This is "maritime China".

Canton Hinterland. This is the wettest and most tropical as well as southernmost of China's natural regions. It is a hilly forested plain with infertile lateritic soils. Agriculture is very intensive based on double rice crops although yields are among the lowest in China.

Southwestern Hinterland. The final region includes the provinces of Yunnan and Kweichow and is a unique region as contrasted to the rest of China. In the first place it is the stronghold of aboriginal

non-Chinese peoples, many with tribal organization and simple folk societies. It is also the only part of China where population concentrations occur at high altitudes and is ecologically complex with the typical terracing of populations as in Highland Meso-America. Settlements range from 2000 to 6000 feet above sea level. It is a mountain and valley area. Rainfall generally exceeds 40 inches although the local patterning is apt to be complex. Chinese occupation does not pre-date the Christian Era. The Chinese settlers are typical wet rice cultivators of the densely populated valley floors, the aboriginal groups hillside slash and burn farmers.

Looking at China and its regions as a whole we find rather striking overall similarity with Meso-America with a broad dual division into dry and humid patterns, in each case similar to their Meso-American counterparts. The Yellow River Plain in climate and topography might be contrasted to the Mesa Central; the Loesslands and Szechuan Basins contrast well with the Southern Meso-American Highlands, and these three regions together are comparable to the Meso-American Highlands. Rivers in North China, however, play a more important role although dry farming as a whole seems to be more important than true irrigation. The Yellow Plain is much larger than the Mesa Central and overbalances, in an areal sense, sub-humid China much more than the Mesa Central does Meso-America; and it is not broken into sub-units as is the latter.

There is no counterpart to the Yangtze Valley in Meso-America in terms of its dominating economic strength and ecological features. South China in general is more mountainous than the Mexican Gulf Coast and of course much more intensely cultivated. Soils and climates are

similar and present the same problems which were solved in different ways.

Of great interest are the two areas of the Loesslands and the Szechuan Basin which together have an areal extension equal to Meso-America. Climate, topography, soils and ecological complexity of the two regions together presents a strongly similar situation to that of Highland Meso-America. Agricultural techniques and land utilization are also closely parallel, and this fact would be more evident if we compared the Aztec Period situation in Meso-America (when land use was more intensive) with our Chinese region.

With the latter point in mind we can now turn to the archaeological record and see how China's ecological divisions have tended to affect and limit her cultural history.

Neolithic Period. Unfortunately China is not one of those areas where the archaeological picture is as yet well formulated. Most of the work has been done in North and West China and to a certain extent this fact weakens our arguments. On the other hand the basic historical picture as based on documents seems clear and the following summary, based on Bishop,[107] seems to agree with the facts. All of the well documented Neolithic sites seem to be in North China, especially in the area Cressy calls the Loesslands. Kansu was evidently the center of diffusion from whence Neolithic culture spread into neighboring Shensi and later into the Yellow Plain. The first appearance probably falls around 3000 B.C. The crops and domestic animals are Near Eastern and all writers seem to feel that the culture was derived from the

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107. Bishop, 1940, 1943.

latter area. It seems to have been a simple folk agricultural society. The selection of the Upper Hwang-Ho Valley for primary settlement was due to two factors: first, the area is at the terminus of the Central Asiatic migration route; and second, and possibly of greater importance, it is an area similar to the Near East ecologically and suited for the introduction of Near Eastern cereals and animals.

Bronze Age. The exact date of entry is guessed by Bishop as around 2000 B.C., and again the complex of associated trates indicate a Near Eastern origin (bronze tools, wheeled vehicles, writing). Again the port of entry was the Loesslands and it was here that Chinese society was cradled and evolved. Both Bronze Age dynasties, Shang and Chou, were centered in this area, and we find our first cities and first states in this same area. Even after the introduction of iron tools, about 500 B.C., the capital of the Han empire was still in the Loesslands.

There is a similarity here on a much larger scale to the demographic expansion of the Peruvian Coast Valleys. In the Hwang-Ho basin early demographic expansion begins in the smaller headwater streams; later on when hydraulic engineering reaches a certain stage of development and labor resources are large enough, the potentially more productive lower valley is occupied and becomes the new demographic center.

Of importance in terms of our previous arguments is the possible role of the Szechuan basin to the south in the origin of trade and cities. The latter is just adjacent to the Loesslands, more tropical in climate, and with important differences in crop production - in other words an ideal partner in a symbiotic regional unit. The archaeological

record is scanty but the documentary data suggest just this situation. The Szechuan Basin was evidently the first of Tropical China's region to be Sinicized. I quote Russell and Kniffen in this respect.

"By the second century B.C. the Chinese were thoroughly established as far east as the Yellow Sea, southward to the Yangtze, and westward to the Kialing River of Szechwan. Population was concentrated in the Wei Valley (Loessland) and Szechwan. The occupation of other parts of China proper, however, was accomplished slowly. Vast areas subject to flooding discouraged settlement along the Lower Hwang Ho. Difficult gorges, rough country, and hostile aborigines blocked routes to the basins of the Yangtze east of Szechuan. Country too high and too cold for agriculture lay to the west and dry territory to the north restricted farming to oasis sites. Southern hills were inhabited by hostile tribes of primitive Caucasoids...."[108]

The data suggest strongly that Szechuan was closely knit to the Loesslands in the development of early Chinese culture.

The data further suggest that practically all of China's cultural development before the time of Christ took place in an area with uniformly sub-humid climate nowhere exceeding 1000 mms or 40 inches a year. Furthermore Chinese agriculture from the beginning seems to have been similar to that practiced today in the same areas.

Even after the conquest of Middle and South China the center of Chinese culture seems to have remained in the more arid north. As Cressey states:

"No other region has played such a large role in Chinese history,

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108. Russell and Kniffen, 1955, pp. 418-419.

nor has any other given birth to so many people as the Yellow Plain. During the 30 centuries of recorded history billions of people have lived on this good earth. The very dust is alive with their heritage. Here is the heart of Classical China."[109]

The documentary history indicates that most of Tropical China was incorporated into the Chinese cultural world only since the Christian era and the full use of Iron Age technology. The same ecological factors we have pointed out for the Near East, India and the Nuclear Regions of the Americas have operated in the development of early Chinese civilization.

Curiously enough we find striking confirmation in China of the situation in India whereby the most developed urbanism occurs in the sub-humid to barely humid regions of North and Middle China, whereas the rice lands of the south have many fewer towns and cities. This in spite of the fact that the south is extremely densely populated. The lack of zoning in the south in part explains this as it does for India and Southeast Asia, but Cressey's data on population per unit of cultivated land suggest another possibility. When wet rice cultivators colonized the south with its poor soils and limited land surfaces, they had to evolve an even more intensive agriculture than in the Yangtze Valley (in terms of time and labor expended). The result is smaller land surface cultivable, which results in a higher population per unit of cultivated land even though total population density is less than in the Yangtze Valley. With poor soils production is comparatively low and the result is little surplus above family needs.

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109. Cressey, 1951, p. 101.

I suspect that wet rice cultivation in general requires too great a price, is too intensive to maintain effectively an urban-peasant symbiosis.

## Summary

In final summary I believe that the ecological postulates advanced by this thesis are sound. No independently invented complex of food crops can at present be archaeologically established for any tropical region of the world. In the Old World the evidence suggests clearly a single center of primary origins of agriculture: the Near East. In the New World the earliest dates for agricultural society are in the arid Southwest for North America and the equally arid Peruvian Coast for South America.

All primary centers of great urban society evolved in sub-humid regions and no Bronze or Neolithic Age urban civilization has existed except in one of two highly specialized ecological types - the arid exotic river valley and the sub-humid monsoon. The 40-inch annual rainfall isobar includes within it all pre-Iron Age urban societies except parts of Meso-America. The reasons for this have been fully explained in the text. Not only have the world's great urban societies evolved in this ecological setting, but even in the Iron Age and on until the Industrial Revolution cultural leadership has remained in those same centers in spite of the spread of Iron Age civilization to other ecological regions.

Wholly aside from our strong functional arguments against the possibility of an urban society developing on a slash and burn agricultural base, we have no historic case of such a combination anywhere in the world, even with iron tools for clearing the bush, unless it is combined with motor transport as in modern Yucatan and Tabasco. Even

here it is the intensive plantation agriculture and international trade which really supports the urban centers rather than local slash and burn cultivation.

The importance of micro-geographical patterning is of course much greater in urban civilizations with simpler technologies and simpler systems of transport; the more primitive, the more important. The more efficient the transport the wider spaced may ecological regions be, and the more complex the technology the more obvious need of specialization. During most of the Bronze Age, technology remained simple, and we find the early centers of civilization in geographically diverse regions. With the Iron Age, symbiotic patterns seem to be much broader and cultural centers in many cases expand to include potentially richer nearby regions (in India from Indus to Ganges Valley; China from Upper Hwang-Ho-Upper Yangtze to the broad plains further down the streams; in Meso-America from the Valleys of Mexico-Puebla to the Bajio) which could not be effectively handled with Bronze Age technology. With the Iron Age, furthermore, we get more advanced transport and ecological symbiosis is on a grander scale (Egypt becomes the granary of the Roman Empire; the Yangtze and Hwang-Ho Valleys are tied into a single interdependent region by canals), and consequently urban society is much more expanded.

# APPENDIX

## ECOLOGICAL AREAS OF MESO-AMERICA

### Area 1. Central Vera Cruz Tierra Caliente

Topography. This is an area of long gentle west to east slopes running down from the Sierra Madre Oriental to the sea in parallel ridges separated by rivers. No true coast plain occurs in this section of the coast but neither is the area "broken" topography. The Tierra Caliente band of this foothill slope country runs from sea level up to 800 meters.

Hydrography. This area comprises the lower and middle courses of the following rivers: Colipa, Juchique, Actopan, Jalcomulco, Jamapa and Atoyac. These, in general, are fast moving, gorge cutting streams with restricted drainage basins and great seasonal variation in volume of water. In general they are not manageable for irrigation and of minor value as transport arteries. Aside from these permanent systems there are numerous rainy season arroyos or barrancas.

Climate. This is one of the most arid sections of the east coast plain and its climate bears great similarity to the Pacific coasts of Guerrero and Oaxaca. The following annual rainfall data was collected from government records: Vera Cruz, 1623 mm; Rinconada, 674 mms; Soledad de Doblado, 844 mms; Tlacotalpan, 1081 mms; Jose Cardel (near Cempoalla), 1000 mms; Cotaxtla, 1200 mms; and Nautla, 1000 mms. The rainfall in general is similar in volume to stations in Morelos and the average is only slightly above that of stations in the Valleys of Mexico and Puebla. The stations on the coast,

however, possess a drier climate than those in the Valley of Mexico due to the greater rapidity of evaporation (annual mean temperature here running around 24.8° Centigrade as compared to 15°-16° in the highland area). Drought conditions in Area 1 are further aggravated by two other factors: (a) rapid runoff due to sloping terrain; and (b) undependability of the rainfall. The latter feature is important and may be illustrated by the following data. Rinconada one year received but 286 mms of rain, another year but 381 mms, and received as much as 734 mms in its best year; Cotaxtla during the five years of observations received 1878, 1333, 875, 1173 and 768 mms; Soledad de Doblado in nine years recorded 921, 1285, 414, 1120, 1104, 695, 939, 730 and 427 mms. This is the one part of the east coast Tierra Caliente where irrigation is a necessity for a stable economy. At the time of the conquest Cempoalla was an important center in an irrigated zone but irrigation was probably a new technique in the area.

Soils. No good soil studies have been made of the area. In general sources tend to classify them as yellow laterites but I feel dubious about this classification. Soil classifications in Mexico in general seem to have been based on broad climatic patterns rather than actual soil studies and the area in question is incorrectly classified climatically. Soils over this area seem to fall closely into the "pradera" division or tropical type of prairie.

Vegetation. This is the only large continuous zone of grassy savannah vegetation on the east coast plain. Tropical forests are in general limited to riversides; in other words they are of the gallery type. Much of the savannah could be called rather scrub forest-savannah transition or park type but the important factor is

the strength of grassy vegetation in the area which must have placed a severe limitation on primitive farming.

Cultural Data. This today is an area of cattle raising and plow agriculture. It includes Vera Cruz, the largest port in Mexico, with about 75,000 inhabitants in 1940. Its economic role in modern Mexican economy aside from the port is a minor one. The following municipios fall within it: Actopan, Ursulo Galvan, Puente Nacional, Paso de Ovejas, La Antigua, Vera Cruz, Boca del Rio, Soledad Doblado, Manlio Fabio Altamirano, Jamapa, Medellin, Yanga, Cuitlahuac, Carrillo Puerto, Cotaxtla, Tenejapa Mata and Apazapan, below 400 meters; and Jalcomulco, Zentla, Temaxcal Camaron, Paso del Macho, Tepetlaxco, Atoyac, Amatlan Reyes and Cuichapa lying from 400-800 meters. This smaller strip between 400-800 meters has a denser population than the larger one below it if we subtract the port of Vera Cruz and only consider rural density. The density (rural) over the lower strip is 22 per $km^2$, the upper 36. The total area of Area 1 is 6235 $km^2$ and in 1940 it possessed a rural population of 152,201 (density 24) and a total population of 228,157 (density 37).

Area 2. Central Vera Cruz Tierra Templada

Topography. This is simply a band of slope country occupying the next tier of municipios up from Area 1. It includes those municipios lying between 800-1600 meters above sea level. The general topography is similar to above; the only change is in altitude.

Hydrography. The middle courses of the same streams as above; in this area however the gorges are steeper and deeper cut than further down and the currents even faster and less manageable for

irrigation or transport.

Climate. The Tierra Templada occupies a medial position in temperature between the Tierra Caliente and the Mexican plateau further up, and many hot country plants may be sown at least in the lower municipios. The average mean temperature of Jalapa for example, just about half way up within the Tierra Templada band, is 17.6° Centigrade. The important fact about temperature, however, is that frosts are very rare as compared to the climatic bands further up. This is probably the most favorable zone for human occupation in Central Vera Cruz. The rainfall pattern is very different from the Tierra Caliente, being much heavier and more dependable. The following data illustrates the climate of the area: Coatepec, 1921 mms; Cordoba, 2270 mms; Jalapa, 1588 mms; Orizaba, 2110 mms; Teocelo, 1930 mms; Huatusco, 2150 mms. In general the rainfall runs around 2 meters and is among the highest readings for Mexico. Aside from the abundance of rainfall it is also highly dependable. From 1941 to 1949 for example it never fell below 1500 mms at Orizaba, Cordoba, Teocelo, and never fell below 1000 mms at Jalapa. The only erratic station was Huatusco; one year it dropped to 517 mms. In spite of the heavy rainfall leaching of soils is probably slight due to the rapid runoff. In parts of the area irrigation is used for winter crops as at Orizaba.

Soils. Here again we are on shaky ground. Both Vivo and Tamayo classify soils in this area as chernozem! I find this even more difficult to accept than their analysis of soil of Area 1; chernozems in general are prairie-grassland soils with climates having annual rainfall between 500-750 mms. It is possible that with the rapid

runoff leaching is so reduced that chernozems are formed but my own general impression of soil in the area certainly does not conform to that of typical chernozems. My notes indicate that the most widespread soil type in the area has very little topsoil and is mainly yellow in color. It is probably yellow laterite. Around Orizaba itself there may be true chernozems. A final factor complicating the situation is the fact that some soil is produced by volcanic eruption followed by fluvial sedimentation; this soil is probably very fertile. In general the combination of heavy rainfall, rapid runoff and moderately leached soils has made this strip into one of the key economic regions of the state.

Vegetation. The Tierra Templada divides sharply into two subzones: a lower one of 800-1200 meters once occupied by tropical forest, and an upper zone of mixed forest between 1200-1600 meters.

Cultural Data. This strip today is the coffee-citrus fruit belt and is probably the richest part of the state of Vera Cruz with respect to value of its production. Politically most of the municipios lie in the state but we have included a nearby detached zone in Puebla-Hidalgo of similar ecology as part of a larger area. The municipios included are given below:

Vera Cruz Section, 800-1200 meters:

Alto Lucero, Landero y Cos, Miahuatlan, Acatlan, Tepetlan, Chiconquiaco, Emiliano Zapata, Tlacotepec, Totutla, Comapa, Cordoba, Fortin, Iztaczoquitlan, Naranjal, Coetzala, Tlilapan, Rafael Delgado, Zongolica, Yecuatla, Juchique Ferrer

Vera Cruz Section, 1200-1600 meters:

Tonayan, Jalapa, Coatepec, Teocelo, Cosautlan, Axocuapan, Tenampa,

Sochiapa, Huatusco, Coscomatepec, La Perla, Mariano Escobedo, Ixhuatlancillo, Nogales, Orizaba, Tenango Rio Blanco, Huiloapan, Cameron Mendoza, Atzacan, Chocaman, Tomatlan, Ixhuatlan Cordoba, Reyes, Magdalena

Puebla-Hidalgo Section, 800-1200 meters:

Tlachichilco, Huehuetla, Tlaxco, Villa Juarez, Pahuatlan, Jonotla, Zongozotla, Huitzilan, Xochitlan, Zoquiapan, Cuetzalan de Progreso, Coatepec, Hueytlalpa

Puebla-Hidalgo Section, 1200-1600 meters

Tututopec, Tlacuiltopec, Huachinango, Juan Galindo, Chiconcuautla Tepetzintla, Tlapacoyan, S. Felipe Tepatlan, Ahuacatlan, Tepango Rodriguez, Cuautempan, Amixtla.

Our statistical data may be summarized:

| Section | Area (km2) | Population (1940) | Density |
|---|---|---|---|
| Vera Cruz Section, 800-1200 mts | 3264 | 145,159 | 44 |
| Puebla-Hidalgo Section, 800-1200 mts | 1339 | 92,855 | 69 |
| Total, 800-1200-mt band | 4603 | 238,014 | 52 |
| Vera Cruz Section, 1200-1600 mts | 2100 | 226,927 | 108 |
| Puebla-Hidalgo Section, 1200-1600 mts | 1306 | 76,975 | 59 |
| Total, 1200-1600-mt band | 3406 | 303,902 | 89 |
| Grand Total, Area 2 | 8009 | 541,916 | 67.5 |

One important distinction should be made between the Vera Cruz section, with its great development of commercial coffee and citrus production and urbanization, and the Puebla-Hidalgo section, where we find a more intact native Totonac culture still functioning with a combination of commercial-subsistence agriculture.

The role played by this area in ancient Meso-American history cannot yet be mapped out; it remains largely an archaeologically

unknown region in spite of its modern development. I suspect we have here a region which probably supported a dense population in ancient times but the terrain, which made the formation of large states and urban transport difficult, along with its small overall size, inhibited its playing a really significant role in overall Meso-American culture history. Living also may have been too easy to stimulate greater development. It may well, however, have played a significant role during the earliest periods.

Area 3. Central Vera Cruz Tierra Fria

Topography. This is rugged headwater country with steep slopes, broken terrain dissected and chopped up by numerous deeply cut ravines. The lower limit is 1600 meters and the upper limit is about 2900 meters if we take the highest altitude of permanent human settlement as its upper limit.

Hydrography. Hundreds of small headwater tributaries of the coastal rivers below, very fast running permanent streams cutting through hilly terrain with rapids, waterfalls and gorges.

Climate. A key factor in terms of human habitation in this band is the occurrence of frequent frosts. At Las Vigas at 2481 meters the annual mean temperature is but 11° Centigrade. These frosts are less frequent below 2000 meters but still are a key factor in agriculture.

Rainfall is uniformly high as all of this zone is on the windward side of the Sierra Madre Oriental. Readings are lower than in the Tierra Templada belt but the lower temperature results in increasing the effectivity so that the situation for agriculture is equally

favorable. Mean rainfall figures run as follows: Las Vigas, 1349 mms; Jalacingo, 1664 mms.

Soils. Due to the small size of this belt it does not appear for separate soil classification from the Tierra Templada in soil maps. It probably is covered by brown forest soils in the lower belts and podzols in the upper zone considering the climate and vegetation. In general soils are poor in this area.

Vegetation. From 1600-2200 meters our mixed forest mentioned for the upper zone of the Tierra Templada continues. Above 2200-2300 meters we find conifer forests. No municipio lies above 2900 meters and we can consider the zone 2900-3000 meters as the limit for occupation by farmers.

Cultural Data. Today this is a zone of maize subsistence farming carried on by villagers with small holdings and with considerable preservation of Indian culture once you leave the main highways. Although densely populated, and probably always so, it without much doubt played a marginal role in Meso-American history due to its small size and the intense fragmentation of population units caused by the topography. We have included in this area four separate, isolated zones lying in Vera Cruz, Puebla and Hidalgo. I summarize the statistical data in the below chart.

Vera Cruz-Hidalgo Section:

Agua Blanca Iturbide, Tenango de Doria, Chila Honey, Naupan, Tlaola, Texcatepec, Huayacocotla and Zacualpa

Vera Cruz-Puebla Section:

Atzalan, Jalacingo, Altotonga, Las Minas, Tutotila, Tlacolulan, Coacoatzintla, Naolinco, Xochiapulco, Zacapoaxtla, Zaragoza,

Tlatlauquitepec, Teteles, Atempan, Yaonahuac Hueyapan, Chignautla, Xiuhtetelco, Teziuhtlan, Jilotepec, Banderilla, Rafael Lucio, Acajete, Tlalnelhuayocan, Jico, Villa Aldama, Las Vigas, Ayahualulco, and Ixhuacan

Maltrata Section:

Maltrata, Aquila, Acultzingo, Soledad Atzompa, Atlahuilco, Roa Barcena, Xoxocotla, Tlaquilpa, Texhuacan, Astacinga, Mixtla Altamirano, Tehuipango, Calcahualco, and Alpatlahua.

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Vera Cruz-Hidalgo | 1372 | 54,155 | 40 |
| Vera Cruz-Puebla | 3320 | 184,396 | 55 |
| Maltrata | 1103 | 43,069 | 39 |
| Total | 5795 | 281,620 | 49 |

Area 4. Northern Vera Cruz-Tierra Caliente

Topography. This is the Tierra Caliente or hot country, situated in that part of the state of Vera Cruz lying north of the Sierra de Chiconquiaco. It also includes parts of neighboring Puebla and Hidalgo. Our area includes all municipios lying between 0 and 800 meters above sea level. This is an area of hilly broken coast plain. Drainage is rapid and streams are numerous.

Hydrography. The lower and middle courses of the following streams are included in this area: Panuco, Tuxpan, Cazones, Tecolutla and Nautla. In general it is an area of abundant streams; the major rivers could easily have served as transport arteries and their currents most of the year are sluggish. There is little barranca

cutting and drainage systems are not extensive. Some flooding of rivers occurs in early autumn following the heavy rains but the flood plains are small.

Climate. In general rainfall is heaviest in the south of the area and gradually decreases to the north. Misantla situated in the windward slopes of the Sierra de Chiconquiaco receives 2263 mms of rain. Further north Papantla receives an average of 1400 mms; at Tuxpan further north it is about 1380 mms; Ozuluama receives an average of 1260 mms and finally Panuco in the far north receives but 900 mms. The belt of Tierra Caliente lying further inland between 400-800 meters receives more rain, as for example Chicontepec just upstream from Tuxpan with about 1530 mms. One might tentatively suggest that this area be broken down into three sub-zones: (a) the area between 0-400 meters and south of Tuxpan; (b) a drier 0-400-meter sub-zone lying between Tuxpan and Panuco. This northern sub-zone presents only slightly more favorable conditions than in Central Vera Cruz.

(c) A third subdivision would be the 400-800-meter strip with higher rainfall. The exact climatic situation of this area cannot be precisely determined without much more data than available at the present time. Aside from the municipios lying within or on the flanks of the Sierra de Chiconquiaco the general climate in terms of annual rainfall suggests a savannah- or transitional savannah-forest vegetation. This is true to the north but the area between Papantla and Tuxpan is clothed by a vigorous tropical forest. The explanation lies in the distribution of this relatively low rainfall through the seasons. At Papantla for example we find that the six wettest months

of the year possess only three times the amount of rain of the six driest. There is therefore a less marked dry season and this more even distribution of humidity permits a tropical forest cover.

Soils. General soil maps indicate that yellow laterites make up most of the soil cover of this state, shifting to praderas further north. With the hilly terrain soil cover is thin and most of the area is unsuited for plow cultivation. A second soil type is the azonal alluvial river flood plains which are small in area and more suitable for modern techniques of cultivation.

Cultural Data. In general this is an area of subsistence slash and burn maize cultivation. Commercial crop production occurs but is minor in importance. Tajin, one of the great cultural centers in ancient Meso-America is within the area. The southern half of it is probably one of the most favorable stretches of Tierra Caliente for slash and burn agriculture. Furthermore it is an area of effective double cropping and today is a petroleum center.

The following municipios are located within it:

Vera Cruz, 0-400 meters:

Panuco, Pueblo Viejo, Tampico Alto, Ozuluama, Tempoal, Platon Sanchez, Chiconamel, Chontla, Tantoyuca, Ixcaltepec, Citlaltepec, Tantima, Tamalin, Chinampa de G., Amatlan-Tuxpan, Tancoco, Tamiahua, Tepetzintla, Temapache, Ixhuatlan Madera, Teayo, Tuxpan, Cazones, Tihuatlan, Coatzintla, Papantla, Gutierrez Zamora, Tecolutla, Martinez Torre, Coyutla, Espinal, Coahuitlan, Chumatlan, Coxquihui, Misantla, Vega de Alatorre, Colipa

Hidalgo-Puebla, 0-400 meters:

Pisaflores, Chapulhuacan, Orizatlan, Jaltocan, Hueyjutla, Ayotoxco,

Hueytamalco, Acatemo

Vera Cruz-Puebla, 400-800 meters:

Pantepec, Jalpan, Francisco Madero, Zihuateutla, Jopala, Hernandez G., Olintla, Huehuetla, Tuzamapa, Tenampulco, Chicontepec, Benito Juarez, Ilamatlan, Camocuauhtla, Zontecomatlan, Filomeno Mata, Mecatlan, Zozocalco, Yuahualica

Statistical Data

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| 0-400-meter zone | 22,850 | 472,000 | 20 |
| 400-800-meter zone | 3,792 | 113,071 | 30 |
| Total | 26,642 | 585,071 | 22 |

Area 5. Central Hidalgo

Topography. This ecological area lies in Tierra Fria or between 1600-3000 meters. Most of the municipios lie between 1600-2200 meters above sea level and frosts are a frequent menace to farming. It is part of the great Mexican plateau but is not a flat level area by any means. It is broken up into separate valleys and drainage basins by ranges of low hills.

Hydrography. True streams are rare; there are a great number of barrancas and arroyos which have a seasonal flow of water. The only permanent water supply is by springs, of which there are few in the area.

Climate. This is one of the most arid areas of Meso-America. Annual rainfall is summarized below: Actopan, 440 mms; Huichapan, 353 mms; Ixmiquilpan, 287 mms; Mixquiahuala, 554 mms; and Zimapan,

373 mms. Almost all of this rainfall is concentrated during the summer months so we combine high evaporation with scanty rainfall, and with a final combination of scanty soil and rapid drainage we have one of the most unfavorable ecological zones in Meso-America for agriculture. Finally rainfall often delays until June or even July and the quantity varies considerably year by year, thus making the sowings prey to droughts and early frosts. For efficient dry farming at this altitude a minimum of at least 600 mms of rain is necessary. The situation is further aggravated by the lack of permanent water sources for irrigation.

Soils. This area is covered by chestnut soils in general, and under irrigation, valley bottoms are very productive. Soil however is scanty over the area, being found in depth only in the flat valley floors; the hills are denuded or nearly so.

Vegetation. Desert vegetation, mainly cacti, characterize the area. Nopal and maguey are the key agricultural crops and both grow wild in the area.

Cultural Data. This is one of the poorest regions of the republic and is occupied by Otomi Indians. Pulque and tuna are the chief sources of income with minor cultivation of maize, beans, wheat and barley for local consumption and sale in the valley villages. This area played a significant historical role as the barbarian frontier to the more favorable regions just south of it, and was the probable center from which barbaric tribes such as the Chichimeca invaded the Valley of Mexico. The aboriginal and modern population of the area is surprisingly dense but the level of living is low; this may be significant in understanding the role of this area in general plateau

history. The Chichimeca, who evidently combined hunting and gathering with agriculture, were numerous enough to destroy urban societies to the south on at least two occasions (fall of Teotihuacan and Tula).

The following municipios lie in this area: Tecozautla, Huichapan, Nopala, Chapantongo, Zimapa, Santa Maria Tepeji, Cardonal, Huasca, Omitlan de Juarez, Atotonilco del Grande, Actopan, El Arenal, Mixquiahuala, Francisco Madero, San Salvador, Santiago, Chilcuautla, Alfajayucan and Tasquillo.

The total area is 6385 $km^2$ and in 1940 it possessed 165,873 inhabitants or 26 per $km^2$.

Area 6. The Valley of Mexico

Topography. This is a great plateau plain ringed on three sides by high mountain sides and to the north by lower discontinuous ranges of hills. The surrounding mountain ranges are of volcanic origin and run from 3000 to nearly 6000 meters above sea level. The Valley floor is remarkably flat and with little relief. The zone of habitation runs from 2200-2800 meters above sea level with no agricultural villages above 2800 meters.

Hydrography. Before the construction of the Gran Canal the Valley was a hydrographic unit, all drainage collecting and forming a chain of lakes in the lowest part. There are a restricted number of small spring-fed or snow-melt-fed streams and a large number of dry season arroyos. Springs are common along the south shores of Lake Chalco-Xochimilco, east of Texcoco, south of Mexico City, in the Teotihuacan Valley, around Tula and Cuauhtitlan. Permanent

streams and springs are important in perennial irrigation, the arroyos for flood water irrigation, the lakes for chinampa cultivation and the latter in pre-conquest times knit the valley into an economic unit due to their transport advantage.

Climate. In the 2200-2800-meter zone of human habitation we must classify the climate of the valley as sub-humid to semi-arid. Above that level it duplicates conditions of the Tierra Fria of Central Vera Cruz. Rainfall increases from north to south. In the northern valley we find that Pachuca records but 419 mms of rain, the driest station; Tula, 674 mms; Tizayuca, 600 mms; Teotihuacan, 557 mms; Teoloyucan, 664 mms; Tepotzotlan, 564 mms. In the central valley Texcoco records 775 mms; Chapingo, 656 mms; Tlalnepantla, 655 mms; Tacubaya, 767 mms; and in the southern valley in the district of Chalco this increases to 1142 at San Rafael and 1015 mms at San Juan de Guadelupe. For good dependable corn crops in the Valley at least 600 mms of rain are necessary, and a good soil cover. In general, however, dry farming if combined with humidity preservation techniques of the type described in our Teotihuacan Valley study produce excellent crops. The most important problem in maize cultivation is in the combination of early frosts with a delayed rainy season. Irrigation provides an answer to both the rainfall and frost problem and irrigation sources of the two types mentioned are abundant.

Soils. Most soil studies classify the soils of the central and southern valley as chernozem and the northern valley as chestnut, both fertile soils. Volcanic activity is important in this area as a soil-forming process. Soil cover over the middle and southern

sections is deep, in the north much scantier, and this combined with scantier rainfall makes maize cultivation without irrigation precarious there.

Vegetation. Most of the Valley floor in the southern and middle valley was probably occupied by mixed forest or forest-steppe transition before its removal by cultivators; forests were probably more typical in the south. In the north the predominant vegetation was probably of the steppe type with cacti as an important element. Above 2800 meters the southern and middle valley mountain wall is clothed by a dense conifer forest.

Cultural Data. This is one of the most densely populated rural areas of the republic and contains the modern capital.

It is an area of dairy and truck farming along with the production of such grains as maize, wheat and barley, and of pulque. Irrigation is today much less important than in ancient times due to the actual loss of water sources as a consequence of erosion, forest denudation of the slopes, and absorption of water sources to supply the huge urban center of Mexico. Dry farming has supplanted it to a great extent. Throughout modern, colonial and ancient history this area has played a major role. Three of the major archaeological sites of Meso-America - Tula, Tenochtitlan and Teotihuacan - are within it and Texcoco may rank as a fourth.

The following political divisions lie within it: all of the Distrito Federal and the following distritos of the state of Mexico: Cuauhtitlan, Chalco, Otumba, Texcoco, Tlalnepantla, and Zumpango; plus the following municipios from the state of Hidalgo: Pachuca, Zempoala, Real Monte, Tolcayuca, Mineral Chico, Epazoyucan, Tezontepec,

Tizayuca, Tula, Tepexi, Tetepango, Tezontepec, Tlacoapan, Tepetitlan, Atotonilco, Ajacuba, and Atitlaguia. The total area is approximately 9523 $km^2$, of which 7209 $km^2$ lie within the state of Mexico and Distrito Federal and the remainder in Hidalgo. Excluding the City of Mexico the total population of the area in 1940 was 828,121, or 87 per $km^2$ (73 in the Hidalgo section and 91 in the D. F.-Mexico zone).

Area 7. Puebla-Tlaxcala Plain

Topography. This is in general a flat plain lying between 1600-2400 meters above sea level. The terrain slopes down from north to south.

Hydrography. Two drainage systems flow through this area: the Atoyac and the Nexapa. The part of the drainage which flows through our area is the upper or northern and the flow of water is southward. Both the Atoyac and the Nexapa are permanent streams fed in part by the melt waters of the snow fields of Popocatepetl and Iztacihuatl along with rainy season drainage off Malinche. Aside from the permanent sources numerous arroyos flow into these two major rivers and increase their volume during the rainy season. The feature which sets off this area from surrounding ones is the abundance of water for irrigation.

Climate. The climate is similar to that of the central Valley of Mexico. Puebla itself receives 799 mms of rain; Huejotzingo, 838; Tlaxcala, 717 mms; and Apizaco, 959 mms. Those municipios lying over 2000 meters above sea level receive frequent autumn and winter frosts

and here as in the Mexican Valley frosts are the major problem for the cultivator.

Soils. Soil cover over most of this area is abundant; only on slopes and surrounding foothills is the soil cap thin. In general they fall into the chernozem classification and are very fertile for grains.

Vegetation. The original vegetal cover was destroyed probably several thousand years ago by cultivators but undoubtedly was of the type mentioned for the Valley of Mexico.

Cultural Data. Two state capitals, Puebla and Tlaxcala, the former the fourth largest city in Mexico, along with the city of Atlixco, are situated within this rich agricultural area. The main production is grain: maize, wheat and barley. There is a specialized development of fruit orchards - apples, plums, peaches and pears - around Huejotzingo and Cholula. Much of the area is under irrigation and yields are high. During the colonial period Puebla and Cholula were two of the most important Creole-Mestizo centers in Mexico. The archaeology of the area is little studied but it contains Cholula, one of the major sites in Meso-America and which possesses the largest single building erected by ancient Meso-Americans anywhere. Aside from Cholula, Tlaxcala was a major center at the time of the conquest and previous to Tlaxcala, Huejotzingo was an important post-classic military power.

The area includes the following distritos:

Tlaxcala: the three districts of Hidalgo, Zaragoza and Cuauhtemoc. Total area 1286 $km^2$; population 141,034; density 110.

Puebla: the distritos of Puebla, Atlixco, Cholula and Huejotzingo.

Total area 2885 km$^2$; population 349,427 if we include the city of Puebla, if not 201,810. The corresponding densities are 121 and 77 per km$^2$.

The total land area of Area 7 is 4,171 km$^2$; the total population (1940) including Puebla is 490,461, excluding it 342,844, the corresponding densities being 117 and 85.

Area 8. Tierra Templada of Morelos-Puebla

Topography. This area includes all of the state of Morelos plus the Nejapa Valley in Puebla. We might classify it as a sloping dissected plain in which the angle of slope is down from north to south. It is not level but is broken up by low parallel ranges of denuded hills with intervening flat areas which are called collectively "Los Valles de Morelos". The bulk of the area lies between 800-1600 meters, with a few municipios located above 1600 meters included to maintain geographical symmetry.

Hydrography. Most of our area is drained by the upper tributaries of the Rio Balsas: the Amacusac which has several main branches and drains most of Morelos, and the Nejapa with two main branches, one draining eastern Morelos and the other western Puebla. The Nejapa is a permanent stream being fed mainly from melt waters of Popocatepetl. Part of the Amacusac drainage is also permanent with springs in the Ajusco range as feeders. Springs in general are abundant in northern Morelos.

Climate. Rainfall may be classed as sub-humid and the stations record about the same as the southern Valley of Mexico. The situation

is somewhat less favorable than the Valley, however, as evaporation is more intensive (due to lower altitude) and drainage more rapid. Irrigation although not an absolute necessity enables double cropping and increases the production of rainy season crops. Cuauhtla recorded 639 mms; Jonacatepec 853 mms; Tlayacapa 924 mms; and Puente de Ixtla 938 mms. These stations are all situated down in the valley floors. Up in the Ajusco escarpment rainfall is somewhat higher, Cuernavaca receiving 1039 mms, Atlatlahuacan 1179 mms and Apipasco 1428 mms.

Soils. Much of the area is occupied by hilly slopes, some of them denuded or with a scanty soil cover. The valley bottoms are covered by a deep mantle of fertile alluvium classified as chernozem by Vivo. The situation is probably more complex but in general bottom lands are very productive, especially when combined with irrigation.

Vegetation. A curious combination of tropical scrub forest with cacti is characteristic of this area, but most of the former has been removed for intensive agriculture.

Cultural Data. This area today is a center of wet rice and sugar cane production with irrigation in the valleys and temporal maize cultivation on the slopes. Most of the land is in small holdings and ejidos. There are a large number of small urban centers in the area such as Cuernavaca, Yautepec, Cuauhtla, Jojutla and Izucar de Matamoros.

Throughout the colonial and pre-Spanish period this area with its Tierra Caliente products was closely linked to Areas 6 and 7 in a tight symbiotic trading network and these three areas together represent the area of greatest development of urbanism in Meso-America.

The archaeology is but superficially reported but there are numerous medium sized sites, and Xochicalco is one of the largest of all Meso-American centers. The following political units lie within it:

Morelos Section, Tierra Fria:

Tlalnepantla, Huitzilac, Tepoxtlan, Atlatlhuacan, Ocuituco, Tetela del Volcan, Tlayacapa, Totolapan

Morelos Section, 1200-1600 meters:

Cuernavaca, Jiutepec, Zacualpan, Ayala, Cuauhtla, Yecapixtla, Yautepec

Morelos Section, 800-1200 meters:

Temixco, Emiliano Zapata, Xochiltepec, Axochiapan, Jantetelco, Jonacatepec, Tepalcingo, Jojutla, Tlaltizapan, Tlaquiltenango, Zacatepec, Amacuzac, Coatlan, Mazatepec, Miacatlan, Puente de Ixtla

Puebla Section, 1200-1600 meters:

Izucar, Teopantlan, Tilapa, Tlapanala, Tepeojuma, Xochiltepec, Epatlan, Coatzingo, Ahuatlan, Totoltepec, Tepemaxalco, Tepexco Mariano Escobedo

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Morelos over 1600 mts | 1012 | 26,223 | 26 |
| Morelos 1200-1600 mts | 1223 | 75,279 | 62 |
| Morelos 800-1200 mts | 2708 | 81,409 | 30 |
| Puebla 1200-1600 mts | 1621 | 39,862 | 25 |
| Total | 6564 | 222,773 | 34 |

Area 9. East Puebla Plain

Topography. In general this is a vast flat plateau plain with most of the elevations running between 2000-2400 meters above sea

level. It has little or no relief.

Hydrography. This is an area of few streams even of the barranca type. What few there are either drain into the Atoyac or the Papaloapan. Between Perote and the eastern border of Tlaxcala are a series of saline marshes.

Climate. Just behind the Sierra Madre Oriental we find a narrow belt of very arid land lying along the eastern margin of the area. Perote in the state of Vera Cruz is within this rain shadow and receives but 470 mms of rain, and Tehuacan but 476 mms. Most of the area receives approximately the same rainfall as the Puebla-Tlaxcala Plain; Amozoc records 925 mms, Chalchicomula 863 mms. The majority of the area is excellent for cereal crops and has long been an important wheat and maize producing region.

Soils. In general chernozems dominate with siernozems to the east. Soils are fertile and over most of the area deep, especially around Tepeaca and Tecamachalco.

Vegetation. Desert type to the east and probably steppe to mixed forest to the west, but no vegetal cover remains today.

Cultural Data. This is an area of villages and subsistence grain cultivation. During the colonial period it was an important grain producing center but in the pre-conquest period it evidently played a secondary role, probably always being a frontier zone to more densely populated regions just west of it.

The following political divisions fall within our area:

Arid Eastern Zone:

Tehuacan, Zoquitlan, Coyomeapan, Santiago Miahuatlan, Nocolas Bravo, Tepanco de Lopez, Caltepec, Chapulco, San Antonio Canada, Vincente

Guerrero, all of San Juan de los Llanos distrito minus Zautla, and Perote in Vera Cruz.

Semi-Arid Western Zone:

The following municipios in Tepexi distrito: Tepexi, Ixcaquixtla, Coyotepec, Atexcal, Juan Mendez, Ahuatempan, Molcaxac, Cuayuca, Tlatlauquitepec, Atzompa; the entire distritos of Tecali, Tepeaca, Tecamachalco; the distrito of Juarez in Tlaxcala, and Chalchicomula in Puebla

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Semi-Arid region (west) | 7375 | 262,135 | 36 |
| Tepexi Region or Middle Atoyac | 2070 | 33,588 | 16 |
| Arid Eastern Region | 4817 | 104,732 | 22 |
| Total, Area 9 | 14262 | 400,455 | 28 |

Area 10. Tlaxcala-Hidalgo Plain

Topographically this area is a vast plateau plain broken up into several units by low ranges of denuded hills. No extensive permanent drainage systems occur but there are numerous arroyos and barrancas of local significance which flow during the rainy season. Some parts of the area as the Tlaxcalan portion are perhaps more long lomas than plain but in general it is a level area. Most of the municipios lie above 2000 meters.

Climate. Few stations exist for the area but what data we have suggests a rather unfavorable situation for agriculture. Tlaxco in in Tlaxcala records an average of but 583 mms of rain, Calpulalpan

in the same state 608 mms (in a foothill strip), and Tulancingo in Hidalgo 594 mms. Droughts are frequent and the rainy season often delays. This, aggravated by the fact that the area is subject to early frosts, makes dry farming precarious. Furthermore permanent water sources are almost non-existent so irrigation must be of the storage type, or possibly in areas of deep soil flood water irrigation combined with humidity conservation techniques.

Soil. Combined with the above unfavorable climatic conditions soil cover is scanty over much of the area with good concentrations only around Calpulalpan, Tulancingo and Apan. Most of the area is gentle slope with a thin soil cover. Humidity preservation techniques therefore are limited to only these few deep soil bottoms. Vegetation is non-existent, the slopes and hills being often denuded and the valley bottoms being intensively cultivated. What little natural vegetation exists is of the desert type.

Cultural Data. The economy of this area today revolves around a single plant, the maguey, and a single product, pulque; the highest quality of pulque in the Meseta Central comes from this area, especially from northern Tlaxcala and Tulancingo. In the valley bottoms with deeper soils grains such as corn, barley and wheat are cultivated but the amount of land suitable for such cultivation is very limited. In pre-Hispanic times the area was marginal to the higher centers further south and dependent culturally and possibly economically on them. I do not mean that the thorough-going commercialization of maguey products we find today was typical of ancient times but certainly something similar on a simpler level was probably true. The area includes the following political divisions:

Tlaxcala: the districts of Morelos and Ocampo

Puebla: the following municipios: Ahuazotepec, Chignahuapan, Aquixtla, Iztacamaxtitlan, Tetela del Ocampo, Zautla, Zacatlan

Hidalgo: the following municipios: Apan, Tlanalapan, Tepeapulco, Almaloya, Singuilucan, Cuautepec, Acaxochitlan, Metepec, Acatlan and Tulancingo

Total Statistical Data

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Tlaxcala | 1502 | 38,982 | |
| Puebla | 2521 | 97,742 | |
| Hidalgo | 3050 | 86,573 | |
| Total, Area 10 | 7073 | 223,297 | 31 |

The fairly heavy density of population is a good measure of the value of maguey cultivation in a commercial economy.

Area 11. Tierra Templada of Northern Hidalgo

This is a rather composite region really made up of three smaller ones but the published information does not enable us to define these internal borders with any certainty. We have assigned the municipios in the three sub-areas mainly on map observation and our analysis is subject to a margin of error. Topographically we have a northern sub-zone which is escarpment country similar to the Tierra Templada of central Vera Cruz and covered by tropical and temperate forests. Just east and south of this zone is a belt of Tierra Fria municipios which occupy the high valleys of the Sierra Madre Oriental. Finally south of them we are in the third sub-area, a rain shadow semi-arid region broken up into mountain valleys and

secondary ranges. This latter area is characterized by large stretches of broken country unsuited for farming interspersed with very small fertile valleys of the type of the Valley of Mextitlan. Hydrographically all of it is headwater country of one drainage system, the Panuco. Many of the arid valleys possess permanent springs for irrigation and in the northern sub-zone drainage is abundant and permanent.

Climate and Soil. Our data is very scanty in both of these factors. Most of the municipios lie between 800-1600 meters in the area as a whole and annual temperatures must fall in the typical tierra templada pattern. For the wetter northern area we have the following data on annual rainfall: Calnali 2216 mms; Huejutla, just below 800 meters, records 1954 mms. For the small Tierra Fria zone Molango receives 1142 mms. In the arid southern sector I have data only from Meztitlan Valley from three stations which recorded averages of 419, 425 and 484 mms. Aside from this low annual precipitation rainfall is not dependable with some years dropping as low as 324 mms. All stations lie between 1264-1329 meters above sea level. With the fairly high annual temperature of about 20° Centigrade evaporation is intense, and agriculture only practicable on deep soil valley bottoms and really only efficient when combined with irrigation. Populations are concentrated in this area in the fertile valley bottoms and sparsely scattered over the intervening hills. Soils in the humid north are generally classified as rendzina and in the arid south chernozems or siernozems. The arid zone soils are very fertile when combined with irrigation. Vegetation in the south consists mainly of cacti.

Cultural Data. The humid area is a region of slash and burn subsistence farmers who speak mainly Huasteca; the southern arid sub-zone is one of limited but productive grain cultivation in the valley bottoms and maguey-nopal cultivation on the slopes, with mainly an Otomi-speaking population.

The pre-conquest history of the area is unknown. During the final period or just before the conquest it evidently was considered as the political center of the Chichimeca and played the role of a barbarian frontier to the more populous regions to the south. Interestingly enough the arid sub-region was welded into a single powerful state whereas the humid slash and burn sub-area was broken up into scores of petty city states. Meztitlan was an important source of cotton to the peoples of the Valley of Mexico at the time of the conquest.

Northern Humid Sub-Area:

Pacula, Jacala, Tlahuiltepa, La Mision, Lolotla, Tlachinol, Tepehuacan de Guerrero, Calnali, Huazalingo

Tierra Fria:

Molango, Xochicoatlan, Tianguistengo, Zacualtipan Atlapexco, Huautla

Arid Southern Sub-Area:

Xochiatipan, Juarez Hidalgo, Eloxocchitlan Metztitlan, Metzquititlan

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Northern | 2504 | 73,563 | 29 |
| Tierra Fria | 1259 | 63,406 | 50 |
| Southern | 1557 | 34,907 | 22 |
| Total, Area 11 | 5320 | 171,876 | 32 |

Area 12. Papaloapan Basin

Topography. This is a vast flat tropical coast plain with almost no relief. All municipios lie below 100 meters above sea level. It lies almost entirely within one extensive hydrographic basin, the Papaloapan. This river system is of the Amazonic type with an extensive system of tributaries flowing all year and with high water table, and flowing in general through a flat unbroken plain. The bulk of the water comes from the escarpment just behind the coast plain which is one of the wettest regions in Meso-America. Although in the escarpment zone rain does fall all year there is a pronounced wet season which causes the Papaloapan to flood annually, causing great destruction to life and property. Flood plains are extensive and today are tropical fruit producing zones. There are, however, large areas of swamps and swamp savannahs around the lower course and delta. The topography and hydrography are a miniature reproduction of the situation in the Amazon Basin.

Climate. The coast plain itself has lower rainfall than the escarpment but still boasts a heavy precipitation. The following stations give an idea of the annual precipitation: Tierra Blanca 1527 mms; Alvarado 2315 mms; Tlacotlalpa 1080 mms; San Cristobal (Ingenio) 1412 mms. In general there is a considerable range in rainfall and furthermore rainfall is erratic over the flat plain. This seems to be related to the topography; there is no relief to regulate it. The combination of erratic rainfall, often very heavy, sometimes as low as drought proportions, plus the problem of flooding has retarded this area in economic development throughout the colonial and modern period. A final factor here is malaria.

Soils. A fairly high percentage of the area is made up of alluvial flood plain which is generally fertile, if flooding could be controlled might well be converted into productive plantation farming.

The bulk of the riverside lands near the delta and Laguna de Alvarado are undoubtedly water-logged gleys, and the areas not reached by the flood plains in the middle course of the main stream and tributaries are covered by yellow laterites, the latter type probably being the most important of the three soil types in acreage.

Vegetation. Most of the area is covered by monsoon jungle except for the flood plain savannahs, lagoons and swamps around the Laguna de Alvarado. I suspect but do not have first-hand data, that there are numerous stretches of elevated savannah in the interior as in Tabasco.

Cultural Data. This area played a very minor role in the colonial and modern history of the republic, and the population has always been sparse and malaria-ridden. What archaeological data we have suggest that it played a marginal role in pre-Hispanic times also. In recent years the federal government has attempted to colonize this area with huge dam projects to control flooding but to date the problems have not been solved. It includes the following municipios from Vera Cruz:

Tlalixcoyan, Alvarado, Ignacio de la Llave, Tierra Blanca, Cosamaloapan, Otatitlan, Tlacojalpan, Tuxtilla, Chacaltianguis, Tesechoacan, Ixmatlahuacan, Acula, Amatlan C., Tlacotalpan, Saltabarranca, Angel Cabada Playa Vicente, Santana Rodriguez

Total area 9620 $km^2$, population 136,419, density 14 per $km^2$.

From Oaxaca I also include Acatlan, San Felipe Usila, San Jose Chiltepec, San Juan B., Valle Nacional and Valerio Trujano.

Area 13. San Martin Coastal Mountain Area

Topography. This is a range of hills on the Vera Cruz Coast Plain which separates the Papaloapan from the Coatzacoalcos drainage and is isolated from the Sierra Madre Oriental. The highest peaks range up to 1500 meters. The area is a roughly circular one consisting of all municipios over 100 meters in height which are arranged around this central massif. Almost all of the municipios are between 100-400 meters, with few above the latter elevation. Land above this elevation is usually too steep or possesses too little soil for cultivation. Municipios below 200 meters include mainly long gentle lomas or slopes; those above are covered by rough broken terrain with canyons, valleys and hills.

Hydrography. Streams are abundant and drainage is headwater and dendritic, flowing in all directions from the central massif and later joining either the Papaloapan or Coatzacoalcos drainage systems; as has been stated it is a watershed. Drainage is fast and streams swiftly flowing.

Climate. Rainfall is both heavier and more dependable than in the flat coastal plain and although strongly seasonal still permits both summer and winter crops on the same field. The following stations give an idea of annual precipitation: San Andres Tuxtla 2114 mms, Catemaco 1900 mms.

Soils. Soils are universally lateritic in type, generally reddish in color. Leaching is probably not heavy above 200 meters due to the broken terrain but the 100-200-meter band evidently suffers more from this process.

Vegetation. The area is entirely covered by tropical forest with a minimum of savannah. Peaks are often forested all the way up although the soil cover is exceedingly scanty.

Cultural Data. This is the most densely populated part of Vera Cruz south of the port. The area is inhabited almost entirely by mestizo slash and burn cultivators with a combination subsistence-commercial economy. It is an area of double cropping and probably represents one of the most favorable areas in Meso-America for slash and burn cultivation. In pre-conquest times it was evidently the nuclear area for the vigorous Olmec regional style and played an important role in Meso-American cultural history. The population, area and political divisions are summarized below:

Santiago Tuxtla, Los Tuxtlas, Catemaco, Mecayapan, Soteapan, Hueyapan, Acayucan, Sayula, Texistepec, Oluta, Jilotepec

In population density there is a sharp division between municipios lying above 200 meters and those between 100-200:

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Above 200 meters | 3594 | 70,754 | 20 |
| 100-200 meters | 2437 | 21,465 | 9 |
| Total, Area 13 | 6031 | 92,219 | 15 |

Area 14. Tabasco Coast Plain

This region is a duplication in some respects of our Area 12. It is a vast flat coastal plain, all municipios within it lying below 50 meters, and has almost no relief. Within it are the lower courses of five major river systems, three of which are among the most extensive systems in Meso-America. These, from west to east, are the Coatzacoalcos, Tonala, Grijalva, Usumucinta and Candelaria. All in common with the Papaloapan receive most of their volume from the escarpment behind the coast plain, are permanent, have numerous tributaries and extensive drainage basins, flow through flat coastal plain, have high water tables, move sluggishly during most of the year, flood annually depositing silt and sand and forming extensive flood plains, and possess extended swampy deltas.

Rainfall. Rainfall is more abundant and dependable in this area than in the Papaloapan basin and double cropping is possible at least in the humid flood plains. Data on annual precipitation was collected from the following stations: Coatzacoalcos 2884 mms, Minatitlan 2876 mms, Huimanguillo 1879 mms, Comalcalco 1905 mms, Villa Hermosa 1829 mms, Nacajuca 1523 mms, Alvaro Obregon 1463 mms, and Ciudad del Carmen 1683 mms. There is a general decrease in rainfall from west to east and increase from the coast plain to the escarpment as comparison with Area 15 will clearly indicate.

Soils. Vivo and Tamayo in their overall soil classification give this area a gley classification. The situation is much more complex. First of all a sizeable percentage of the area is alluvial river flood plain and the soils in general are good for plantation cultivation. The deltas of the rivers are a vast network of swamps and

periodically flooded lands which undoubtedly have mainly gley soils. Further inland in between the streams are large stretches of elevated forest and savannah which have mainly lateritic soils. I estimate that probably at least 60 percent of the coast plain is of the latter soil type.

Vegetation. Most of the area is in tropical forest but there are large stretches of upland savannah in western Tabasco and in the Coatzacoalcos basin, and considerable areas of swamp vegetation at and below the confluence of the Usumacinta with the Grijalva, around the Laguna de los Terminos and also around the lower courses of the Tonala and Coatzacoalcos.

Cultural Data. The bulk of this vast coast plain is only with difficulty made fit for human habitation. Today the most productive zone is the Middle Grijalva flood plain, along with the municipio of Comalcalco which is occupied almost entirely by the old flood plain of the Grijalva, now called the Rio Seco. This is the most important agricultural zone of the state of Tabasco and is the center of banana and cacao plantation agriculture. Most of eastern Tabasco and southwestern Campeche is either unoccupied or used for cattle ranching, and the Coatzacoalcos Basin is used for cattle ranching and petroleum drilling with very little agricultural development. The Tonala basin is for all practical purposes a wasteland.

The same general situation today applies to a minor degree for the colonial period. The role played by this coast plain in ancient Meso-America is not clearly defined but undoubtedly was marginal. The eastern part was occupied by the Maya and only one major center, Comalcalco, is found in the area, and this simply a cultural outpost

or frontier center. It is significant that the largest center is in the most productive modern area. The only other important archaeological zone known in the area is La Venta and here again it seems to have been a provincial outlyer to the Olmec homeland in the Tuxtla region.

Most sites in the area are small and a high percentage of them consist of single plaza earth mounds.

The following municipios lie within the area:

Tabasco: Paraiso, Comalcalco, Cardenas, Huimanguillo, Jalpa, Cunduacan, Nacajuca, Centla, Centro, Jalapa, Macuspana, Jonuta

Campeche: Ciudad del Carmen, Palizada

Chiapas: Catajaja

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Tabasco | 17,340 | 195,929 | 11.0 |
| Campeche | 22,869 | 18,566 | .8 |
| Chiapas | 634 | 4,285 | 6.8 |
| Total, Area 14 | 40,851 | 218,780 | 5.3 |

Area 15. North Chiapas Tierra Caliente

Topography. This is a narrow band of municipios mainly within Chiapas which are found just behind the Tabasco Coast Plain area and adjoin it. They are all between 50-400 meters above sea level. The area is hilly, broken country, the lower foothills of the Sierra de Chiapas.

Climate. This is one of the most humid regions in Meso-America. Palenque with 3186 mms of rain is the only precise measurement of

annual rainfall I've seen, but Landaverde estimates from 3000-5000 mms for this zone as a whole from scattered data. There is a late-summer-early-fall maximum but rainfall occurs almost every month of the year and double cropping is characteristic.

Hydrography. This is headwater country with a humid climate. The result is that there are thousands of small fast-running permanent brooks and streams which later join either the Grijalva or the Usumucinta. It is this heavy rainfall in the hinterland which is largely responsible for the annual floods in the coast plain. With the broken terrain runoff is very fast.

Soils are mainly yellow laterites; leaching here is minimal as the water runs off rapidly into the coast plain below. Over most of the area soil cover is scant, especially on the lomas and hills.

Vegetation. This belt is covered by very dense tropical rain forest.

Cultural Data. This is the great cacao-producing belt of modern Mexico, especially around Teapa and Pichucalco. To the east around Palenque cattle raising is the principal activity. Aside from these two commercial activities all small cultivators sow maize by the slash and burn technique.

In pre-Hispanic times it evidently was one of the major centers of the Maya civilization and the site of Palenque ranks with the greatest of all Maya ceremonial centers.

The following municipios fall within Area 15:

Chiapas:

Reforma, Pichucalco, Juarez, Sunuapa, Ostuacan, Nicapa Tecpatan, Ixtacomitan, Ixtapangajoya, Solusuchiapa, Amatan Huitiupan, Sabanilla,

Tila, Tumbala, Palenque, La Libertad, Salto de Agua

Tabasco:

Macuspana, Tacotalpa and Teapa

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Chiapas | 14,281 | 116,766 | 8 |
| Tabasco | 3,352 | 45,443 | 14 |
| Total, Area 15 | 17,633 | 162,409 | 9 |

Area 16. Tierra Templada of North Chiapas

Topography and Hydrography. This is a belt of municipios between 400-1600 meters above sea level situated parallel to and just behind Area 15. The area is exceedingly broken mountain foothill and slope similar to our Tierra Templada of central Vera Cruz. Hydrography is headwater in type and with abundant small streams. The area is not continuous, being broken up into two separate sections.

Climate. We have very few climatic data from this area. Simojovel recorded 1572 mms of rain annually, Copainala 1047 mms. The picture is undoubtedly complex depending on the exact relation of the municipio to prevailing winds. Both of our stations are in the 400-800-meter zone. What we can probably be sure of is that none of the municipios can be classed as semi-arid; the figure of 1000 mms is probably a minimum for the area and 1000 mms at the general altitude of the area produces a humid climate. I doubt if any station records over 2000 mms. Evidently in this general region the rainfall maximum occurs at the 50-400-meter zone and drops off

further up the slope. In the Central Vera Cruz region we noted a maximum further up between 800-1600 meters.

Soils and Vegetation. No data is available for this zone but most of the soils probably fall into the lateritic group. Vegetation is tropical forest in the lower bands running to mixed forest further up.

Cultural Data. This is a zone of aboriginal villages with subsistence economies based on maize cultivation, in the lower strip of the slash and burn type, further up more intensive in character, but specific data is lacking for this area.

The following municipios lie within the area:

400-800 meters: Copainala F. Leon, Chapultenango, Ishuatan, Tapilula, Simojovel, E. Bosque

800-1600 meters: Yajalon, Chilon, Chalchihuitan, Pantelho, Berriozabal, Villa Allende, Osumucinta, Ixtapa, Soyalho, Larrainzar, Bochil, Jitotol, Ocotepec, Tapalapa, Coapilla, Pantepec

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| 400-800 meters | 1582 | 30,177 | 20 |
| 800-1600 meters | 3196 | 61,200 | 19 |
| Total, Area 16 | 4778 | 91,377 | 19 |

Area 17. Tierra Fria of Chiapas

Topography. Most of Chiapas above 1600 meters is mountain peak and mountain slope and in general unfavorable to human occupation. There are, however, a number of high valleys with soil and climatic

conditions similar to those of the southern Valley of Mexico. Population in these valleys is apt to be extremely dense but overall density of a municipio only moderately so, as the valley to mountain ratio is a very low one. The main drawback in the Chiapas mountain area is the low percentage of valley to mountain and small total area within the 1600-meter contour. If the Tierra Fria were more extensive one might expect the area to have played a key part in the origin of urban society in Meso-America. Aside from the small total size, the valleys individually are miniature and separated by mountains into isolated units. Altitudes vary from 1600-2300 meters in the municipio centers.

Climate. We have data only from San Cristobal de Las Casas. The annual rainfall at the latter is about 1171 mms or about that of Chalco in the Valley of Mexico. The area gives one the impression of being more humid than the Mexican Plateau in general and the data from this station confirm this point of view. It was probably a forested area before the cover was removed for intensive cultivation, with mainly conifers as the type. Soils are generally classed as chernozem, but these are undoubtedly limited to valley bottoms with podzols further up on the slopes.

Cultural Data. This is an area of Indian culture and intensive subsistence agriculture. In spite of its small size one of the key Spanish colonial centers, San Cristobal, was founded in this region, and is still one of the three urban centers of Chiapas (Tuxtla and Tapachula the others). The area is fertile and productive in the valleys but arable land is very limited.

Municipios included within the area are Teopisca, Chanal,

Huistan, Tenejapa, Oxchuc, Mitontic, Chenalho, Ciudad de las Casas, Zinacantan, and Chamula in the center; and the detached municipios of Teran and Salistahuacan. The total area is but 2135 $km^2$ and the population 75,022, with a density of 37 per $km^2$.

Area 18. The Central Valley of Chiapas

Topography and Hydrography. This is a huge elevated hilly plain in general between 400-800 meters above sea level. It is also a hydrographic unit being the upper Grijalva Valley. Mountain ranges delimit it to the north, south and east; the Sierra de Soconusco to the south; and Sierra de San Cristobal to the north.

Climate and Soils. The Valley of Chiapas although a lowland valley is semi-arid. It is in a rain shadow between the two mentioned mountain ranges and the precipitation cycle is similar to the Mexican Plateau. The station of Tuxtla Gutierrez with an annual mean rainfall of 941 mms and Cintalapa with 844 mms give an idea of precipitation in this area. Combined with this low rainfall we have high evaporation as it lies entirely within the Tierra Caliente. The situation for rainy season cultivation is less favorable than in the Mexican Plateau especially when we consider that it is rolling hilly country. Finally this climatic pattern of rainfall and temperature produces a savannah vegetation so that the overall picture for agriculture is not bright. Today it is mainly cattle country. Aerophotos of the area show a narrow ribbon of humid riverside plain running through a vast rolling grass-covered plain. Primitive farming was probably limited to these river bottom strips. Vivo classifies

the soils as chernozem but I suspect that they are more tropical, probably of the pradera type.

Cultural Data. The modern capital of the state of Chiapas lies within this area. Most of it today is used for cattle raising and the population is rather sparse. In pre-Spanish times it probably played a secondary role in the development of urban society but may have been important during the formative period; certainly its role was minor in succeeding periods.

The following municipios fall within our area: Ocozocuautla, Cintalapa, Jiquipilas, Villa Flores, Villa Corzo, Suchiapa, Chiapa de Corzo, Tuxtla, Acala, Chiapula, Totolapa, Nicolas Ruiz, Venustiano Carranza, La Concordia, Angel Albino Corzo, and Chicomucelo. The total area is 18,540 $km^2$, population 130,975, and density 7 persons per $km^2$.

Area 19. Tierra Templada of Comitan

Topography. This is a series of slopes and mountain valleys lying between 800-1600 meters above sea level in eastern Chiapas. The area is very complex topographically, hydrographically and climatically; the only unity is in the sense that it is composed of a series of contiguous municipios between the above altitude limits. This is our poorest defined area and should be broken down into sub-units.

Climate. There is evidently some climatic uniformity although this statement is based on rainfall data from two stations. Comitan itself at 1530 meters above sea level receives 1004 mms of rain a

year and is situated in a large dry flat highland basin. Motozintla at 1455 meters is situated in another basin and records 741 mms. One is tempted to group these basins with those of the same altitude (Atitlan) in southwestern Guatemala into a single area, but the Chiapas area is evidently much drier than the corresponding Guatemalan one. The climate is roughly similar to that of Morelos in central Mexico in both temperature and rainfall.

Soils. Vivo places them as chernozem, probably generally correct as it fits into the climatic picture.

Vegetation. Probably steppe (hot) and transitional scrub forest. The distinction between a semi-arid Tierra Caliente and a semi-arid Tierra Templada region in Meso-America is an important one, as the former produces grassy savannahs difficult for primitive cultivators to handle, whereas the vegetation in the latter case is easily controlled (contrast the Central Vera Cruz Tierra Caliente with Morelos in Central Mexico and the Tuxtla Savannah with the Comitan Tierra Templada here in Chiapas.)

Cultural Data. The area is less densely populated today than the corresponding Morelos-South Puebla Tierra Templada in Central Mexico, and offers the same climatic picture. I do not know, however, what the complete environmental picture is, especially with respect to irrigation sources, intensive agriculture, valley-to-mountain ratio, etc., and therefore cannot estimate the role in pre-Spanish history of Meso-America, but I suspect it was one of the key areas of Chiapas. Today it is an Indian area.

Modern municipios include Altamirano, Comitan, Amatenango del Valle, Pinola, Socoltenango, Tzimol, La Trinitaria, Frontera Comalapa,

La Independencia, Las Margaritas, Siltepec, Motozintla, Mazapa, Amatenango, and Bella Vista. In the middle of the area are a cluster of three municipios, El Porvenir, La Grandeza, and Bejucal del Ocampo, which are situated above 1600 meters and are included within our area.

In terms of population density our area divides sharply into two sub-regions. One to the west includes the first ten municipios in our list and the second includes the last five plus the three Tierra Fria municipios. The statistical data are summarized below:

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Western Area | 11,432 | 67,977 | 6 |
| Eastern Area | 1,952 | 51,928 | 26 |
| Total, Area 19 | 13,384 | 119,905 | 9 |

Area 20. The Chiapas Coast - Humid Eastern Sub-Zone

Topography. This is the belt of coast plain on the Pacific side of Chiapas. Our area is Tierra Caliente lying between sea level and 800 meters. Most of the municipio cabaceras are on the coast plain proper and are below 200 meters. The exact land form is not well described in any source I have seen but the contour maps indicate a basically similar pattern to the Guerrero coast, one of lomas and hills rather than flat coastal plain. Drainage is short, fast and abundant with a large number of small streams heading in the north in the Sierra de Xoconusco and running south to the Pacific. It is an area of numerous separate parallel local drainage basins.

Soil and Climate. Soils are alluvial in origin and come from the volcanic range of Xoconusco. Vivo classifies them as yellow lateritic but they are undoubtedly more fertile than most laterites. The general rainfall pattern for the Pacific coast has been described in an earlier section. Our eastern zone of the Chiapas coast is the most humid stretch of Pacific coastland in Mexico and is evidently wetter than adjoining Guatemala as well. At Tapachula 2490 mms of rain occur annually.

Vegetation. This part of the coast is occupied by dense tropical forest.

Cultural Data. Today this is Mexico's number 2 coffee producing area and is simply the western extension of the Guatemala Coffee Belt. It is an area of a combination commercial-slash and burn subsistence economy very similar to that of Huimanguillo in Tabasco. In immediate pre-Spanish times it was a rich cacao producing area from which came the prize Aztec cacaos.

The following municipios lie within our area: Acapetagua, Escuintla, P. N. Comaltitlan, Huixtla, Tuzantan, Huehuetan Mazatan, Tapachula, Cacahoatan, Union Juarez, Tuxtla Chico, Metapa Frontera Hidalgo, and Suchiate.

The total area is 5181 $km^2$, population 124,066, density 24 per $km^2$.

Area 21. Chiapas Coast Plain - Western Area

Topography and Hydrography. This is a western continuation of Area 20 and possesses the same type of topography and hydrography.

Soils and Climate. The soils are classed as yellow laterites.

The area is noticeably drier than Area 20 but no really clear border defines the two areas. We simply get increasingly arid conditions as we move westward. The only station for which we have data is Tonala which records 1628 mms of rain a year. The vegetation is of the tropical jungle type gradually shifting to scrub forest and savannah to the west.

Cultural Data. Today this is mainly a cattle zone and is sparsely populated. In pre-Hispanic times it was evidently well populated and some of the sites such as Tonala are of good size.

The area includes the municipios of Arriaga, Tonala, Pijijiapan and Mapastepec. The total area is 6014 $km^2$, population 36,251, and density 6.

Area 22. Lower Balsas Area

Topography and Hydrography. This is the Lower Balsas basin and its flood plains. The Balsas is one of the most important river systems in Meso-America and collects most of the drainage of the Meseta Central and carries it west and south to the Pacific. As its tributaries head in sub-humid or semi-arid areas the flow of water varies enormously from one season to the next. Many of the tributaries are seasonal streams, a few as the Amacusac and Nejapa are permanent, but so heavily tapped for irrigation that only rainy season flood water runs from them to the Balsas.

Topographically the Lower Balsas valley is a deep trough-like depression, the floor of which in general is below 800 meters or Tierra Caliente. The upper tributaries such as the Mixteco, Atoyac,

Nejapa and Amacusac run mainly through Tierra Templada, or above 800 meters. The Valley floor is very narrow, actually just a ribbon of land running between rugged high mountain ranges. Effective agriculture is limited to these fertile strips although hillside cultivation of a special tropical type can be carried out to a limited extent especially further up the slopes in the ranier Tierra Templada band. Our municipios cover both climatic zones as they are in general of large size. Municipio centers are usually in the flood plain.

Climate. The Lower Balsas valley is in general a semi-arid region. Rainfall is about that of the Meseta Central but due to the higher temperatures is less effective and the rough terrain makes for rapid run-off. Stony hillsides offer better opportunities for primitive farming than deep soil flatlands as water retention is better. This generalization would exclude of course flood plains which are the best of all. Zirandiro records but 877 mms of rain, Churumuco 696 mms, Huacana 842 mms. Aside from the low precipitation rainfall is very irregular at some stations, varying from 300-1200 mms. For efficient agriculture either irrigation or flood-water farming is a must in this area. Soils are classified by Vivo as praderas but the area has too much topography for zonal soil classifications to have much meaning.

Vegetation is scrub forest on the slopes and cacti; deeper soil areas tend to have a denser covering of the same type. Grasses are not dominant.

Cultural Data. Population in this region today is low in overall density but mainly concentrated in the valley floor where it is probably fairly dense. It today is a minor source of Hot Country

products for Mexico City. The part played by this area in pre-conquest times is unknown. It is likely that the population features of today roughly represent those of ancient times.

The following municipios lie within this area: Coahuayutla, Zirandaro, Coyuca Catalan, Ajuchitlan, Cutzamala Pungarabato, Tlalchapa, Arcelia, Zacazonapan, Tiquicheo, Tuzantla, Huetamo, San Lucas, Churumuco, Caracuaro, Nocupetaro, Tacambaro, Turicato, Tejupilco, Otzoloapan, Amatepec and Santo Tomas

The area measures 22,086 $km^2$ and in 1940 possessed 247,844 inhabitants, or approximately 11 persons per $km^2$.

Area 23. Costa Chica of Guerrero

Topography and Hydrography. This is a segment of the Pacific coast and with typical Pacific coast type of drainage, with a large number of small parallel north-south-running streams flowing down from the Sierra Madre del Sur to the Pacific Ocean. Most of these streams are sharply seasonal with fast-moving flood-like quality during the rainy season, and a sluggish reduced volume during the dry season, some being completely dry. The coast plain compared to most of the Pacific coast is fairly wide and elevations below 800 meters are found much further inland. Much of it is hilly broken country.

Climate, Vegetation and Soil. Rainfall data from the area indicate generally sub-humid conditions or even semi-arid. Highest readings come from the coast escarpment up near the upper limit of the Tierra Caliente; the coast plain itself receives much less.

Furthermore variation from year to year is great and rainfall therefore not dependable. Ometepec further up receives an average of 1346 mms of rain, San Marcos on the coast but 1078 mms. Soils are classed by Vivo as pradera. Vegetation varies from coastal savannah-scrub forest to jungle.

Cultural Data. The area is today a center of cattle raising and is sparsely populated. The pre-Spanish role is unknown except for the conquest period, when it evidently was an important cacao producing zone in which irrigation was known and utilized for cacao cultivation. The following municipios lie within it: San Marcos, Tecoanapa, Ayutla Libres, Acatlan, Florencio Villareal, Cuautepec, Copala, Azoyu, Zapotitlan, Tlacoapac, Copanatoyac, Xalpetlahuac, Malinaltepec, Atlamaljacinga, Zoyatlan Juarez, Metlatonac, Igualapa, Tlacoachixtlahuaca Ometepec and Cuajinicuilapa. The total area is 12,738 $km^2$, population 144,982 and density 11.4 per $km^2$.

Area 24. Costa Grande de Guerrero

Topography and Hydrography. This is a western extension of Area 23. Drainage and general topography are similar. It differs mainly in the narrower coast plain and more precipitous mountain wall behind it; the Tierra Caliente belt or land below 800 meters is much narrower, plain and escarpment together.

Climate, Vegetation and Soil. Here again conditions are closely similar to those of the Costa Chica. Soil and vegetation are similar. Acapulco with an average of 1504 mms of rain presents a lusher appearance but the other stations record lower rainfall - Atoyac

1250 mms, and La Union 1122 mms.

Cultural Data. Here again this is but a continuation of the situation in Area 23. Acapulco is exceptional as a port and tourist resort. The following municipios lie within our area: La Union, Petatlan Tecpan Galeana, Atoyac de Alvarez, Benito Juarez, Coyuca de Benitez, and Acapulco de Juarez. The total area is 12,666 $km^2$ and population 98,485 or 7.8 per $km^2$.

Area 25. Middle Balsas Basin

Topography and Hydrography. This is a huge tract of low mountain area lying mainly in Tierra Templada (800-1600 meters) and includes few central municipios lying at higher altitudes and a few occurring below this level. In general, however, altitudes of municipios are at the intermediate level and for the sake of symmetry those few exceptions are included. The area is more of a unit hydrographically since most of the drainage flows into the Balsas. Most of the habitation centers are situated on long gentle escarpment slopes or valley bottoms.

Soil, Climate and Vegetation. This area in general in the three categories above conforms closely to our Morelos-South Puebla area. Soils run from chernozems to praderas and are fertile. Vegetation ranges from scrub forest to desert type with grasses minor. The following data give an idea of annual rainfall in the area: Chilpancingo 887 mms, Iguala 1113 mms, and Alcozauca 836 mms, or about that in Morelos.

Cultural Data. This is the most important region in modern

Guerrero. The capital of the state and largest communities are situated within. It is a key area for tropical products for the Meseta Central along with our Area 8. The same situation seems to apply for the Aztec period; it was densely populated and a producer of Hot Country crops and products for the Meseta and one of the early Hot Country conquests in Aztec expansion. Its role in pre-Aztec times is not known.

Municipios from Guerrero, 800-1200 meters:

Xochihuehuetlan, Huamuxtitlan, Alpoyeca, Alcozauca, Tlapa, Atenango del Rio, Copalillo, Tenango Tepexi, Tepecoacuilco, Apaxtla, Cuetzala, Teloloapan, Ixcateopan Cualac, Atlixcac, Quechultenango, Mochitlan, Zumpango del Rio

Municipios from Guerrero, 1200-1600 meters:

Olinala, Chilapa, Chilpancingo, Tixtla, Ahuacatzingo Totolapan, Pedro Ascencio Alquiseras, Tlataya

Municipios from Guerrero, over 1600 meters:

Tlacotepec, Martin Cuilapan, Zitlala

Municipios from Guerrero, 400-800 meters:

Iguala, Huitzuco, Cocula, Leonardo Bravo

Municipios from Oaxaca, 800-1600 meters:

Guadelupe Ramirez, San Andres Tepetlapa, San Miguel Ahuehuetlan, San Miguel Tlacotepec, Santiago Coicoyan

Population and Area, Guerrero Municipios

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| 800-1200 meters | 9874 | 162,337 | 16 |
| 1200-1600 meters | 8976 | 116,400 | 13 |
| Over 1600 meters | 2012 | 26,552 | 13 |
| 400-800 meters | 3204 | 48,509 | 15 |
| Total, Area 25 | 24066 | 353,798 | 15 |

Area 26. Valley of Oaxaca

Topography. This is a series of interconnected highland valleys forming for Highland Meso-America an extensive area of flat bottom land. The general appearance is similar to that of the Meseta Central but is situated at a lower level. The mean altitude of the Valley floor is about 1600 meters as contrasted to the 2200-2300 meters of the Valley of Mexico. The municipios within the Oaxacan Valley range in altitude from 1500-1800 meters. Above 2000 meters we find mountain tops or denuded upper slopes. Frosts play a limiting role in agriculture in the case of the upper municipios but are negligible factors in those municipios at the 1500-meter contour. The approximate area is 8400 $km^2$ but this figure includes slopes as well as Valley floor. The Valley is a hydrographic unit, being the Upper Atoyac River basin, the Atoyac not being of course the same Atoyac of the South Puebla area. Most of the drainage is sharply seasonal although springs do occur.

Climate, Soils and Vegetation. Total annual rainfall closely resembles that of the northern and Middle Valley of Mexico with stations ranging from 500-750 mms annually; in general the climate is perhaps equivalent to the Valley of Teotihuacan. The lower altitude reduces somewhat the effectivity, however, as compared to the Mexican Valley but at the same time the lower level increases the growing season and reduces the frost threat. Ejutla receives 602 mms of rain, Etla 662 mms, Oaxaca 650 mms, Ocotlan 742 mms, Tlacolula 493 mms, and Zimatlan 721 mms. Soils are classed by Vivo as chernozems. Vegetation is of the steppe type with cacti predominant.

Cultural Data. This is the most important area in the state of

Oaxaca today and was throughout the colonial period. The state capital is situated here and the rural population is denser than anywhere else in the state. Agriculture is intensive but mainly of the dry season type and Indian cultural tradition strong. It is a key producer of grains. In pre-Spanish times the Valley of Oaxaca along with the neighboring Mixteca Alta was one of the most important areas of Meso-America and one of the largest of all ancient cities; Monte Alban lies within it. The Valley has been intensively cultivated and an important cultural center for at least two thousand years, a record only equalled by the Meseta Central.

The following municipios lie within it: Ejutla, the entire district of 13 municipios; Ocotlan district, all municipios; Distrito El Centro, all municipios; Etla distrito, all municipios; Zimatlan, all municipios; Zaachila, all municipios except San Miguel Peras and San Miguel Cuatro Venados; and all of the district of Tlacolula.

The total area is 8400 $km^2$, the population 250,000, and density 30 per $km^2$.

Area 27. Isthmian Area

Topography and Hydrography. This is a belt of Pacific coast lying below 400 meters. This is the widest extension of land lying below 400 meters on the Pacific coast of Meso-America and is due to an important and ancient break between the mountain ranges of Mexico-North America and the Guatemala-West Indies at the Isthmus of Tehuantepec. The coastal plain in general is hilly and becomes progressively so as you go inland. The drainage is seasonal and

southward. A range of low hills separate the drainage of this area from that of the Coatzacoalcos basin to the north.

Climate. The area is one of the most arid as well as most extensive of the Tierra Caliente zones of the Pacific coast. Salina Cruz receives 1040 mms of rain a year and is the only station for which we have data. My feeling is that this is somewhat higher than the average for our area as a whole. Vegetation is a combination of scrub forest and cacti. Most of it today is savannah, and grasses may be an important native vegetation. Soils are classed by Vivo as praderas. I feel that without irrigation cropping in this area must have been rather precarious although possible.

Cultural Data. Today this is a cattle raising area and Salina Cruz is an important port and bathing resort for Oaxaquenos. Its pre-Spanish role is unknown. Most of the area falls within the two districts of Juchitan and Tehuantepec and all municipios of those two districts lie within it except the following municipios: Guevea de Humboldt, Santa Maria Totolapilla, San Miguel Tenango, Santa Maria Guiengati. The total population in 1940 was approximately 100,000 and area 12,000 $km^2$ with a density of 8 per $km^2$.

Area 28. Mixe Highlands

Topography and Hydrography. This is an extensive, internally complex high mountain area in northeastern Oaxaca. The only unity it possesses is in altitude; all municipios lie above 1600 meters. Most of the municipios lie in the districts of Villa Alta, Mixe and Ixtlan. Hydrography is also complex, some drainage being Pacific,

some joining the Papaloapan system.

Climate, Soils and Vegetation. No climatic data are available from this area and there is likely to be great variation in rainfall from station to station due to the topographical complexity. Soils are not known; Vivo includes it with the rest of Highland Oaxaca under a blanket designation of "chernozem", an unlikely classification.

Cultural Data. This is a rugged refuge area for modern Indian groups and is occupied by several native subsistence farming ethnic groups. The following political units lie within the Mixe Highland Area:

Distrito of Villa Alta: All municipios except Hidalgo Yalalag, San Juan Juquila Vijanos, San Idelfonso Villa Alta, Santiago Camotlan, Santiago Lalapa;

Distrito of Ixtlan: All municipios except the following: San Juan Quiotepec, San Pedro Yaneri and Santa Maria Zoogochi;

Distrito of Mixe: All municipios except the following: San Juan Cotzocon, San Juan Mazatlan, San Pedro San Pablo Ayutla, Santiago Atitlan.

The exceptions in the three districts are added to Areas 33 and 34.

The area also includes the following municipios from other distritos: Santo Domingo Albarados, Santa Ana del Valle, San Pedro Quatoni, San Dionisio Ocotepec, San Juan Lalana, San Juan Petlapa, Santiago Jocotepec and San Juan B. Jayacatlan.

Area 29. Tierra Templada of Eastern Oaxaca

This is a zone of municipios lying between 400-1600 meters which breaks down roughly into two sub-areas. Area 1 is the low mountain region between our Isthmian and Mixe highland areas and occupies the intermediate altitude zone. Area 2 is the escarpment of the Oaxaca coast. In both cases the hydrography is complex and mainly headwater to the Pacific drainage.

Climate and Soils. For sub-area 1 there is data from only one station, Yautepec, which records 790 mms of rain a year. The area in general has an arid appearance and this figure may be taken as a good typical station. For area 2 or the Pacific coast escarpment rainfall is undoubtedly much higher. De La Pena estimates that the Zona Cafetera receives from 1500-3000 mms of rain; this is the coffee zone which occupies the 800-1500-meter band. Further down the rainfall drops to the 1200-2000-mms range. In general rainfall along this southern escarpment is similar to that of the Tierra Templada of Central Vera Cruz and Tapachula areas, and vegetation tropical forest to tropical scrub forest. Soils are classified as pradera.

Cultural Data:

Area 1 includes the municipios of Guevea de Humboldt, Santa Maria Totolapilla, San Miguel Tenango, Santa Maria Guienagati, Nejapa de Madero, San Bartolo Yautepec, San Carlos Yautepec, San Juan Lajorcia, Asuncion Tlacolita, San Juan del Rio, San Pedro Totolapan, Santa Maria Zoquitlan, San Juan Lachigalla.

Area 2 includes the municipios of San Mateo Pinas, Pluma Hidalgo, San Jacinto Tlacotepec, Santiago Minas, San Lorenzo Texmelucan,

Santo Domingo Teojomulco, San Mateo Yucutindoo, San Miguel Sola de Vega, Santiago Textitlan, San Gabriel Mixtepec, San Miguel Panixtlahuaca, San Pedro Juchatengo, Santa Catarina Juquila, Constancia del Rosario, Putla de Guerrero, Asuncion Tlacolula, Nejapa de Madero, Quioquitani, San Bartolo Yautepec, San Carlos Yautepec, San Juan Lajorcia.

Area 30. Oaxaca Coast

Topography and Hydrography. This is the narrow Pacific coast plain of Oaxaca and adjacent lower slopes, the upper limit being 400 meters. Drainage runs south from the Oaxaca ranges and there are numerous permanent streams, as the Coffee zone just above the plain is an area of heavy rainfall.

Soils, Climate and Vegetation. Rainfall is much less than in the Coffee zone of Area 29 just above it. De La Pena estimates a general average precipitation over the area of between 1000-1700 mms and stresses the irregularity of rainfall necessitating irrigation for effective agriculture. Published data indicate his figures may be too high. Pochutla records but 848 mms of rain or even less than Salina Cruz, and is probably the most arid station on the Pacific coast of Meso-America east of Michoacan. Puerto Angel in the same district records some 1016 mms. There is evidently a rainfall climax in the district of Juquila in the center of this area and the rainfall falls off from this maximum both to the east and west. Rainfall in this central zone runs from 2-3 meters but drops off to but 1300 mms to the west at Pinotepa Nacional. In some years 2-4 times as much

rain may fall as on other years. The general situation resembles closely that of the Tierra Caliente of Central Vera Cruz. Vegetation varies from forest to savannah, locally varying, and Vivo classifies soils as pradera.

Cultural Data. This area today is sparsely populated and mainly a cattle raising district. It is a blank archaeologically.

The following municipios lie within it: San Pedro Amusgos, Santa Maria Ipalapa, Santa Maria Zacatepec, Benito Juarez, San Pedro Pochutla, Santa Maria Calotepec, Santa Maria Huatulco, Santa Maria Tonameca, San Pedro Mixtepec, San Pedro Tututepec, Santa Lucia Teotepec, Santa Maria Temaxcaltepec, Santos Reyes Nopala, Santiago Amoltepec Totoltepec de Valdes and all the municipios of the district of Jamiltepec except San Antonio Tepetlapa

Area 31. Tierra Fria of Southern Oaxaca

Topography and Hydrography. These are the high mountain slope and valley communities of the Sierra Madre del Sur. All municipios lie over 1600 meters, and most of them are between 1600-2000 meters above sea level. One should subdivide the area separating those lying north of the Sierra from those south, as there is likely to be sharp climatic differences with more arid conditions to the north. Published data do not allow a more refined definition, however, and we have grouped all of them together. The more arid northern subzone is mainly the sub-valley of Miahuatlan which perhaps more properly could be considered an appendage of the Valley of Oaxaca. The area in general is watershed country with numerous, mainly

seasonal, streams which ultimately enter the Atoyac or flow into one of the coast plain streams. The Sola de Vega section is one of deep canyon valleys and steep slopes.

Climate, Soils and Vegetation. The climate, soil and vegetation of the arid Miahuatlan Valley closely approximates conditions in the Oaxaca Valley and Miahuatlan is our only source of rainfall data for the region. It receives but 525 mms of rain. I found no data on the remainder of the region but rainfall probably approximates that for the stations in the canyons and valleys of the southern part of the Mixteca Alta (see Area 36) and is higher than the Miahuatlan Valley.

Cultural Data. Today this is an Indian stronghold with subsistence farming. The archaeology is unreported with a few exceptions. The following political divisions lie within it:
The entire Distrito de Miahuatlan plus the following municipios from other districts: San Pedro Martir Quiechapa, Santa Catarina Quieri, Santa Maria Ecatepec, Santa Maria Quiegolan, San Juan Lachao, San Juan Quiahije, Santiago Yaitepec, San Francisco Sola, San Francisco Cahuacua, San Idelfonso Sola, Santa Cruz Zenzontepec, Santa Maria Lochixio, Santa Maria Sola, Santa Maria Zaniza, San Vicente Lochixio, Candelaria Loxicha, San Agustin Loxicha, San Baltasar Loxicha, San Bartolome Loxicha, San Miguel del Puerto, San Pedro el Alto, San Miguel Peras, San Pablo Cuatro Venados

Area 32. Mixteco-Atoyac Tierra Templada

Topography and Hydrography. This is a large area in southern

Puebla and northern Oaxaca which includes those municipios situated between 800-1600 meters above sea level in the Mixteco and Atoyac tributaries of the upper Balsas. In general it is a hilly broken plain with small narrow valleys and limited bottom lands. Drainage is in general seasonal.

Climate, Soil and Vegetation. Rainfall and climate in general are similar to that of the Morelos-Nejapa area. Chiautla receives 847 mms, Ixcaquistla 782, Piaxtla 719 mms. In general rainfall is adequate for rainy season crops but droughts are a frequent occurrence and the only certain cultivation is by irrigation of the small alluvial flood plains. Soils are classified by Vivo as chernozems, probably true in the valleys. Most of the area is, however, denuded slope and hill and the valley communities seem almost like oases. Vegetation is markedly xerophytic.

Cultural Data. This area is similar in general to Area 8 in climate, soil, topography, and economy. It is, however, much less productive due to the lower ratio of valley to hill and far less water for irrigation. The pre-conquest importance of this area may have been high assuming the aboriginal population thoroughly manipulated it within the limits of primitive technology.

The following political units lie within it:

**Puebla:**

Distritos of Acatlan, Chiautla, and the following outside municipios: Chigmecatitlan, Zacapala, Tlaltempan, Huautlatlauca, Santo Domingo Huehuetlan

**Oaxaca:**

Calihuala, Santiago del Rio, San Sebastian Tecomaxtlahuaca, Cosaltepec,

Fresnillo Trujano, Mariscala Iturbide, San Jorge Nuchita, San Jose Ayuquila, San Martin Zacatepec, San Miguel Amatitlan, Santa Cruz Tecachi Mina, Santa Maria Camotlan, Santiago Chazumba, Santiago Huajolotitlan, Santiago Miltepec, Santo Domingo Tonala, Santo Domingo Yocchino, Santos Reyes Yucuna, Tezoatlan Segura y Luna. Most of the Oaxaca municipios lie in the distrito of Huajuapan.

The total area of the Puebla zone is 6645 $km^2$, the total population (1940) is 112,558, and the density 17 per $km^2$.

Area 33. Upper Papaloapan Tierra Templada

Topography and Hydrography. This is a trough-like valley set deep into the Sierra Madre on the Oaxaca-Puebla-Vera Cruz border. It is formed by the two streams, the Salado coming down from the north and heading in the Meseta Central and the Rio Grande coming from the south heading in the Oaxaca highlands. Both drain into a single straight valley in which they join about half-way and then turn at right angles to flow down into the east coast lowlands, later to join the Papaloapan. Municipios lying in this valley or nearby slopes all fall between 800-1600 meters above sea level.

Rainfall, Soil and Vegetation. This is one of the truly arid areas of Meso-America and agriculture is impossible here without irrigation. Tehuacan on the northern margin of the area records but 476 mms of rain; this drops to only 299 mms at Cuicatlan in the valley proper. General conditions of climate, topography, and soil are very similar to the Meztitlan Valley in eastern Hidalgo. Soils are classed by Vivo as siernozem and the vegetation is markedly

xerophytic.

Cultural Data. This is an Indian stronghold and an area of Indian culture. The archaeology is unknown. The following political units lie within it:

Puebla:

Distrito of Tehuacan; the following municipios: Ajalpan, Chilac, Coxcatlan, San Jose Miahuatlan, Zinacatepec, Eloxochitlan, Altepexi, San Sebastian Tlacotepec.

Oaxaca:

From three distritos of Cuicatlan, Teotitlan del Camino and Ixtlan. Santa Maria Tecomavaca, San Martin Toxpalam, San Juan de los Cues, Santiago Nanahuatipan, Cuyamecalco, San Andres Teotilalpan, San Francisco Chapulapa, San Juan B. Cuicatlan, San Juan B. Toacoatzintepec, San Juan Tepeuxila, San Pedro Sochiapan, San Pedro Teutila, Santa Ana Chiquihuitlan, Benito Juarez, Concepcion Papalo, Santa Maria Texcaltitlan, Santa Maria Tlalixtac, Santiago Necaltepec, Valerio Trujano, Santa Maria Papalo, Santos Reyes Papalo, San Marcos S. Flor, San Juan Quiotepec, San Pedro Yaneri, Santa Maria Zoogochi.

The total area of the Puebla zone is 1269 $km^2$, the population (1940) is 34,838, and the density 26 per $km^2$.

Area 34. Tierra Templada of Oaxaca-Vera Cruz

Topography. This is a belt of foothill and escarpment lying between 400-1200 meters just behind coastal Areas 12 and 13. It is broken hilly foothill country or slope with abundant, fast-flowing

drainage. It includes municipios from the districts of Choapa, Tochtepec, Villa Alta and Mije in Oaxaca.

Climate, Soils and Vegetation. No meteorological data are available but most of it is covered by dense tropical rain forest, and to judge by the nearby coast proper it cannot be lower than 2000 mms and is probably much higher. Soils are not described.

Cultural Data. Today this is a stronghold of Indian groups practicing slash and burn subsistence agriculture. It was an important area for Aztec trade and Tochtepec itself was a major link in the Aztec coastal trade.

The following municipios lie within this area:
Santiago Choapan, San Juan Comaltepec, Santiago Yaveo, San Felipe Jalapa de Diaz, San Juan B. Tuxtepec, San Lucas Ojitlan, San Pedro Ixcatlan, San Miguel Soyaltepec, San Pedro Ozumin, Santa Maria Jocotepec, Hidalgo Yalalag, San Juan Juquila Vijanos, San Idelfonso Villa Alta, Santiago Camotlan, Santiago Lalapa, San Juan Cotzocon, San Juan Mazatlan, San Pedro San Pablo Ayutla, Santiago Atitlan

## Area 35. Mixteca Alta Huajuapan Area

Topography and Hydrography. This is the northern and eastern part of the Mixteca Alta in Oaxaca lying mainly in the distritos of Huajuapan, Nochixtlan, Coixtlahuaca, Teotitlan del Camino, and Cuicatlan with a few municipios from other distritos. It is a high mountain area with the population concentrated in small valleys and mesetas, and a considerable amount of rugged topography separating these population units. Hydrography is headwater and mainly -

seasonal. It is a Tierra Fria with all municipios running above 1600 meters and mainly falling between 1700-2200 meters above sea level.

Climate. This is one of the more arid regions in Meso-America. Huajuapan receives an average of 740 mms, Nochixtlan receives but 360 mms, Teposcolula 751 mms. The important feature here, however, is not total rain but dependability. Only Nochixtlan receives less rain than is needed for agriculture in terms of average quantity but all three stations are highly erratic and rainfall uncertain. Irrigation is the prime factor in converting these mountain valleys into productive farming areas. Most of it is of the flash flood type as springs are rare. With the high altitude, however, evaporation is slight and simple humidity conservation techniques such as the cajete, terraces, bancales combined with irrigation produce excellent results as De La Pena's study clearly indicates.

Soil and Vegetation. The soils of the valley bottoms are chernozems and very productive when the problem of drought is resolved. Most of the slopes and hills are denuded and badly eroded and terraces are a must for erosion control in this area. Much of the erosion is probably post-Spanish and related to population decline and abandoning of marginal lands during the sixteenth century, as there is evidence that slopes were under careful terrace cultivation during pre-conquest times. The unfavorable economic situation of this area today is mainly due to the sixteenth century depression and lack of application today of well-known techniques of land management.

The vegetal cover has been long since removed in this area and

probably ranged from mixed forest to xerophytic.

Cultural Data. Today this is one of the centers of Mextecan culture and is populated by Indian subsistence grain cultivators. The people are among the poorest in Mexico due to the mentioned factors. During at least the Post-Classic period this was one of the most important areas of Meso-America, possibly the source of the secular-militaristic revolution following the Classic. The role played by this area in the history of the Meseta Central in Post-Classic times was considerable.

The following municipios lie within the area:

Huajuapan Distrito:

Asuncion Cuyotepeji, Huajuapan de Leon, San Jeronimo Silacayopilla, San Juan B. Suchitepec, San Pedro San Pablo Tequixtepec, San Simon Zahuatlan, Santa Catarina Zapoquila, Santiago Ayuquililla, Zapotitlan Palmas

Nochixtlan: All 31 municipios

Coixtlahuaca: All 13 municipios

Teotitlan del Camino:

Huautla de Juarez, San Antonio Eloxochitlan, San Bartolo Ayautla, San Francisco Huehuetlan, San Jeronimo Tecoatl, San Jose Tenango, San Juan Coatzospan, San Lorenzo Cuaunecuiltilla, San Mateo Huautla, San Miguel Huautla, San Pedro Ocopetatillo, Santa Ana Ateixtlauaca, Santa Cruz Acatepec, Santa Maria Chilchotla, Santa Maria Ixcatlan, Santa Maria Jiotes, Santa Maria Teopoxco, Teotitlan del Camino, Santiago Texcalcingo.

Distrito of Cuicatlan: San Pedro Jocotipac

District of Teposcolula: All 21 municipios

Area 36. Mixteca Alta - Tlaxiaco Area

Topography and Hydrography. This is the western and southern part of the Mixteca Alta. Like Area 35 it is an area of headwater drainage, mainly seasonal in type, and is an area of small valleys and rugged mountains. Most of the drainage is Pacific and is part of the Rio Grande-Atoyac system. Valleys here, however, tend to be somewhat lower in level, deeper and more canyon in type. Water sources in the form of springs are also more abundant. Most valleys lie between 1500-1800 meters above sea level and suffer less from frosts than the Huajuapan area.

Climate. The main basis for my separation of this part of the Mixteca from the Huajuapan area lies in climate. Rainfall in the canyon-like valleys of the Tlaxiaco area is both heavier and more dependable although irrigation is still a necessity for thoroughly successful agriculture. Tlaxiaco itself receives between 945-1003 mms of rain and Juxtlahuaca 1094 mms.

Soils and Vegetation. Vivo characterizes this area as having chernozem soils. The original cover was undoubtedly mixed forest but most of it has been cleared for cultivation.

Cultural Data. The exact role of this area in Post-Classic history has not yet been defined but it probably should be considered along with Area 35 as a historical unit. Today it is occupied by Mixteca Indians who practice a subsistence grain agriculture.

The area includes the following municipios:

Tlaxiaco District: All 34 municipios

Silacayoapan District:

Nieves Ixpantepec, San Agustin Atenango, Santa Cruz, San Nicolas y

Hidalgo, San Francisco Tlapacingo, San Juan B. Tlachichilco, San Juan Cieneguilla, San Juan Igualtepec, San Lorenzo Victoria, Santiago Tamazala, Santiago Yucuyachi Silacayoapan, Zapotitlan Lagunas

Juxtlahuaca District:

San Juan Copala, San Juan Mixtepec, San Martin Itunyoso, San Martin Peras, San Mateo Tunuchi, Santiago Juxtlahuaca, Santos Reyes Tepejillo

Putla District:

La Reforma, San Andres Cabacera Nueva, San Andres Chicahuaxtla, Santa Cruz Itundujia, Santa Lucia Monte Verde

Jamiltepec District: San Antonio Tepetlapa

Area 37. Toluca Valley

Topography and Hydrography. This is a large highland basin just west of the Valley of Mexico. The Valley floor itself covers about 5000 $km^2$ and the total area is about 6500 $km^2$, making it only slightly smaller than the Mexican Valley and one of the most extended areas of flat land in the Meso-American highlands. It is a single drainage system, the Lerma, which later joins the Santiago and forms one of the most extensive river systems in Meso-America. Its flow is permanent, being fed by abundant springs from the Sierra de Las Cruces, and provides one of the largest irrigation systems in Meso-America. The Valley is almost entirely closed by mountain walls except to the north. The mean elevation is considerably higher than the Valley of Mexico, running on the average between 2500-2700 meters above sea level.

Climate and Soils. The mean average temperature of the Tolucan

Valley stations is distinctly lower than in the Valley of Mexico. For example Toluca itself has a mean annual temperature of but 12.8° while Texcoco has 15.7°. The climate of the Toluca Valley in general is similar to that of the higher municipios in Chalco. Frosts are more frequent and irrigation almost a necessity for pre-rainy season sowing to avoid this menace. Rainfall runs as follows: Toluca 793 mms, San Antonio Buenavista 662 mms, Ocoyoacac 1043 mms, Huixquilucan 1161 mms, El Oro 756 mms, Jocotitlan 915 mms, or about that of the central and southern part of the Valley of Mexico. In general soils are chernozems and very fertile.

Vegetation. Today the natural plant cover has been removed in intensive agriculture but it probably consisted of mixed forest with conifer forests on the slopes.

Cultural Data. This valley is part of the region called by Mexican agronomists "El Bajio", a huge flat valley-plain of fertile chernozem soil and abundant water for irrigation which during colonial and modern times has served as the true granary of Mexico, producing abundant crops of wheat, maize, barley, potatoes and truck vegetables. There is probably no other area of equal agricultural potential in Meso-America for grains. It includes the Lerma-Santiago drainage and adjacent valley floor in the states of Mexico, Michoacan, Jalisco and Guanajuato, and is one of the most urbanized areas in Mexico. Agriculture is in part mechanized but a substantial part of it is colonial European in type with draft animals and plows, abundant use of fertilizers and pre-sowing irrigation.

For some reason not yet clear this Valley and the Bajio in general played a very minor role in Meso-American cultural development

and may correctly be considered a barbarian frontier. West in his Cultural Geography of the Tarascan area points out significantly that at the time of the conquest the fertile valley floors of the Michoacan Bajio were almost unutilized and agriculture was of a special Tierra Fria short-cycle roza type limited to slopes. He further suggests that the compactness of the soils in the valley bottom discouraged primitive farming. If this idea be applied to the Toluca Valley as well it might well explain the lack of development of large centers such as Teotihuacan in the neighboring Valley of Mexico. Frosts and the absolute need for an extensive well-organized irrigation system may have been a further limiting factor. Significantly enough in the latter respect the Valley of Tenancingo just to the south is evidently much richer archaeologically and is lower in altitude, more or less lying about the altitude of tha Valley of Mexico.

The Toluca Valley includes the following municipios:

Valley Floor:

Tenango del Valle, Rayon, San Antonio de la Isla, Chapultepec, Calimaya, Almoloya del Rio, Tianguistengo, Mexicalcingo, Atizapan, Chapulhuac, Ocoyoacac, Atenco, Metepec, Lerma, Toluca, Zinacantepec, Almoloya de Juarez, Xonacatlan, Otzolotepec, Temoaya, Jiquipilco, Ixtlahuaca, San Felipe del Progreso, and Temascalcingo

Slope Areas:

Acambay, Atlacomulco, Jocotitlan, El Oro de Hidalgo Xalatlaco, Villa Victoria

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Valley Floor | 4167 | 361,312 (including Toluca)<br>317,883 (excluding Toluca) | 87<br>76 |
| Slope Municipios | 1278 | 71,683 | 56 |
| Total, Area 37 | 5445 | 432,995 (including Toluca)<br>389,566 (excluding Toluca) | 80<br>71 |

Area 38. Southwestern Mexico

Topography and Hydrography. This is a complex mountain area south and west of the Toluca Valley of small valleys dominated by extensive mountain masses. It is a hydrographic unit as all drainage flows south into the Balsas river. Most of the municipios lie at a lower level than in the Toluca Valley, running from 1600 to 2400 meters above sea level but concentrated in the 1800-2200-meter belt. The climatic conditions in terms of temperature are then more favorable than in the Toluca Valley. The area is made up of three valleys in the state of Mexico - Bravos, Sultepec and Tenancingo - plus several odd municipios in Guerrero.

Soils and Climates. The temperature approximates closely to that of the Valley of Mexico but it is a more humid area. A more apt comparison perhaps would be with the Chiapas Tierra Fria or the Tierra Fria belt of Central Vera Cruz. Springs are abundant in the area. Tenancingo receives 1408 mms of rain a year and Valle de Bravo 1871 mms. Taxco in Guerrero receives 1455 mms. Rainfall in general is about double that of the Valleys of Mexico and Toluca. Soils are not classified by any source but Sanchez Colin states that in general they are poor in nitrogen, phosphorous, potassium and

calcium. On the other hand they are very rich in humus. The Valley of Tenancingo is more fertile than any other part of the area. The general picutre suggests heavy leaching and the possibility seems strong that forest soils somewhat podzolized are characteristic of the area. Vegetation is lush mixed forest running to conifers on the slopes.

Cultural Data. Most of the area is mountain and exceedingly rich in minerals. Agricultural land is at a premium and intensively cultivated and populations are dense on the valley floors. The situation is comparable in every way to the Tierra Fria of the Vera Cruz-Puebla border. Grains are the main produce and most of the land is small holdings. The pre-Hispanic history of the area is largely unknown but what data we have suggest a dense population.

The following municipios lie within the area:

Guerrero: Tetitpac, Pilcaya, Taxco

Tenancingo Valley:

Joquicingo, Ocuilan, Malinalco, Tenancingo, Zumpahuacan, Tonatico, Ixtapan de la Sal, Villa Guerrero, Coatepec Harinas, Almaloya Alquuisiras, Zacualpan

Sultepec-Bravos Area:

Sultepec, Texcaltitlan, San Simon de Guerrero, Temascaltepec, Valle de Bravo, Ixtapan del Oro, Amanalco deBecerra, Donato Guerra, Villa Allende

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Guerrero | 1307 | 40,670 | 31 |
| Tenancingo Valley | 2015 | 91,954 | 43 |
| Sultepec-Bravos Valley | 2772 | 86,329 | 31 |
| Total, Area 38 | 6094 | 218,953 | 36 |

Area 39. Jilotepec Area

This is a small band of high mountain valleys lying just north of the Toluca Valley. Drainage is complex, some streams draining northwest into the Santiago and others northeast to the Tula-Panuco system. Municipios are all situated above 2500 meters and many lie 2700-2800 meters above sea level. As a whole this area in terms of population location is higher up than any other Meso-American region.

Climate. Rainfall is roughly similar to the Valley of Mexico and Valley of Toluca. Taximay receives 828 mms of rain a year, Polotitlan 608 mms. Frosts are probably not as severe as in the slightly lower Toluca Valley as the more complex topography offers more shelter. Soils are chernozems.

Cultural Data. This area was another of the barbarian frontiers of the Central Mexican area mainly populated by Otomi-speaking groups. Today it is an Otomi stronghold and center of grain cultivation.

Municipios: Polotitlan, Aculco, Timilpan, Soyanaquilpan, Jilotepec, Chapa de Mota, Morelos, Villa de Carbon

The total area is 2250 $km^2$, population 76,986, and density 34.

Area 40. Michoacan Coast

Topography and Hydrography. This area divides sharply into two sub-regions. The Rio de Tepalcatepec, a tributary of the Balsas, runs almost due east-west parallel to the coast. Just south of it and parallel to it is a low coastal mountain range, and south of it a hilly coast plain with local drainage. The Tepalcatepec Basin forms one of the sub-regions and the hilly coastal plain the second.

The river flood plain of the Tepalcatepec is approximately 400 meters above sea level. From this point the land slopes sharply upward to the north to the Meseta Central or Tierra Fria, over 2000 meters above sea level. All municipios (such as Uruapan, Paracuaro, etc.) above 1600 meters on this escarpment slope are included in our Michoacan Plateau area. All those below 1600 meters we are including in the Tepalcatepec sub-area of the Michoacan Coast area. To the south the land slopes up also to the Sierra de la Costa but even the highest peaks are below 1800 meters and all municipios lie well below the Tierra Fria contour. The Coastal drainage is the second of our sub-areas, and most municipios here lie well up on the escarpment and not on the plain itself.

Climate and Soils. The flat Tepalcatepec river plain is one of the most arid lowland areas in Meso-America. Nestled deep between two parallel ranges it is effectively cut off from most of the rain-laden Pacific winds. Piedras Negras receives but 406 mms, Buenavista 575 mms, Apatzingan 677 mms, Nueva Italia 604 mms, Churumuco 696 mms. This low precipitation combined with a concentration of rain during the hot summer months when evaporation is at a maximum makes agriculture almost impossible here without irrigation. Further up on the northern escarpment rainfall is heavier; at such centers as Paracuaro and Acahuato it increases several hundred millimeters and further up at Uruapan this increases to a meter and a half (see data from Area 41).

The coast plain is probably about as arid as the valley floor of the Tepalcatepec. What data we have from the area indicate somewhat higher rainfall but the data is from municipio centers and

these are all situated well up on the Coastal range escarpment. Coalcoman for example receives 1114 mms of rain, Aguililla 939 mms. It seems probable that there is no more arid stretch of Pacific coast plain anywhere between here and the southern limit of Meso-America. The only rival would be the stretch from Pochutla to Juchitan in Oaxaca.

Soils are classified by Vivo as praderas. Vegetation varies from scrub tropical bush to xerophytic. On the upper slopes soils shift to lateritic and vegetation to jungle.

Cultural Data. The area today is very sparsely populated. The coast plain is mainly used for cattle grazing, the Tepalcatepec basin for agriculture. Two types of farming are practiced. One is intensive cultivation with plows and irrigation on the flat valley floor. These lands are in general very productive. On the slopes a special short-cycle roza type of cultivation is practiced. The Valley of Tepalcatepec evidently has a high potential agriculturally if the irrigation sources are thoroughly used (springs) but there is no archaeological or documentary evidence to indicate that this was done in pre-Spanish times. The following municipios are included in the area:

Tepalcatepec Basin: Tepalcatepec, Apatzingan, La Huacana, Buena Vista Tomatlan

Coastal Drainage: Aguililla, Coalcoman, Villa Victoria, Coahuayana, Aquila, Arteaga

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| Tepalcatepec Drainage | 8,151 | 29,502 | 3.6 |
| Coastal Drainage | 13,438 | 51,028 | 3.8 |
| Total, Area 40 | 21,589 | 80,530 | 3.7 |

Area 41. Michoacan Plateau

Topography and Hydrography. This is a vast highland plateau with a general elevation in excess of 1800 meters and with most municipios lying between 1800-2300 meters or about that of the Valley of Mexico. It is broken up by volcanic ranges and isolated cones into sub-areas. Some of the municipios on the slopes may be up as high as 2800 meters but evidently here as further east this is the upper limit for effective maize cultivation. Drainage is radial in all directions. Some streams flow north into the Lerma-Santiago system, some south into the Tepalcatepec-Balsas. It is an area of lakes, some of large size such as Cuitzeo and Chapala, others much smaller as Zirahuen and Patzcuaro. Springs and permanent streams are abundant especially in specific sub-zones.

Climate. In general precipitation is similar to that of the Valleys of Mexico and Toluca just to the east. There is a marked increase in the western fringe of our area as some municipios are situated on the upper escarpment of the Pacific coast and receive the full effect of the rain-laden winds. La Piedad for example receives 1034 mms, Ario de Rosales 1226 mms, and Uruapan 1683 mms of rain. Most of the municipios receive between 652-1000 mms of rain.

Stations are as follows: Zacapu 837 mms; Patzcuaro 1110 mms, Quitzeo 652 mms, Morelia 781 mms, Hidalgo 892 mms, Zinapecuaro 755 mms, Zitacuaro 963 mms, Tlalpujahua 907 mms and Maravatio 777 mms. In general droughts are an infrequent menace in the Tarascan Meseta but on open plains frosts may be a serious problem, and here irrigation or other humidity preservation techniques may solve the problem. Evidently the pre-conquest peoples did not sow open areas very much, and restricted their agricultural operations to sheltered slopes.

Soils. Vivo gives the area a blanket designation of chernozem and here we have West's excellent study to illustrate the difficulty of using general climatic-soil principles to assess soil types for complex mountain areas in Meso-America. West defines three soil types:[1]

Yellow-Brown, found on the upper slopes occupied by a pine-fir vegetation. This is a leached, infertile soil formed under more humid climate and is sandy in texture and therefore moisture-retentive and may be sown as early as March. Above 3000 feet are podzols. Lime content of yellow-brown soils is very low.

T'upuri, a soil type occurring between 6500-8000 feet on the lower slopes and valley floors. It is porous, soaks up moisture rapidly and the surface dries rapidly sealing off the humidity below, again allowing early sowing, and may be classed as Tierra de Humedad. It is a fine sandy loam in texture and is more fertile than the Yellow-Brown. It has more organic material and more soil minerals

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1. West, 1947.

but is still calcium deficient.

Caranda, a reddish brown clay soil found below 6500 feet and of volcanic origin. It is a temporal soil and cracks under drought and suffers heavily from erosion. It occurs chiefly in the Tierra Templada and around Patzcuaro, and in the Tierra Fria below 2000 meters.

Alluvion, a special azonal type around the lake shores.

Vegetation. Most of the Meseta was covered by a pine-oak forest shifting to fir on the upper slopes. Most of it today in the valley floors has been removed. To the north this shifts to scrub forest and grass.

Cultural Data. Today the Meseta is a stronghold of Tarascan and Tarascan-Mestizo culture and has one of the densest rural populations in Mexico. Most of the population live in villages, often of large size, and are subsistence maize farmers. To the north in the area known as the Bajio we find more advanced agriculture and specialization in grains.

At the time of the conquest this area was the center of a powerful state centered at Tzintzuntzan which was challenging Aztec power. There is no evidence that the area was of significance in Classic or even pre-Aztec times and this Tarascan state might be properly considered as one of a series of barbarian frontier kingdoms which rose periodically and destroyed the civilizations in the nuclear area. It is significant that these barbarian militaristic states always seem to center in semi-arid or sub-humid highland regions. Limitations in land utilization evidently stunted a more elaborate cultural development in an otherwise favorable area. Evidently the richest

soils, the T'upuri, were too difficult to work with primitive tools and further were situated in open frost-plagued plains. Today these problems are solved by plowing and humidity conservation techniques, including extensive irrigation. It is of significance that the Patzcuaro area is not within this T'upuri soil zone and further has extensive patches of fertile alluvium to ameliorate an otherwise unfavorable soil situation. A further limiting factor may have been the tendency of sods to form on the plains.

The following municipios lie in the Tarascan Plateau: Tancitaro, Paracuaro, Uruapan, Nuevo Uracho, Ario, Taretan, Ziracuaretaro, Santa Clara, Tingambato, Patzcuaro, Cheran, Nahuatzin, Erongaricuaro, Zacapu, Coeneo, Quiroga, Villa Jimenez, Huaniqueo, Panindicuaro, Puruandiro, Angamacutiro, Penjamillo, Churintzio, Zinaparo, Numaran, La Piedad, Tzintzuntzan, Morelos, Huaniqueo, Chucandiro, Cuitzeo, Tarambaro, Morelia, Acuitzio, Santa Ana Maya, Alvaro Obregon, Charo, Cruz de Caminos, Tzitzio, Hidalgo, Indaparapeo, Quereotaro, Zinapecuaro, Susupuato, Juarez, Juangapeo, Zitacuaro, Ocampo, Tuxpan, Aporo, Angangueo, Irimbo, Senguio, Tlalpujahua, Maravatio, Tepuxtepec

The total area is 21,485 $km^2$, the total population 714,875 with a density of 33 inhabitants per $km^2$.

## Area 42. The Tierra Templada of Western Michoacan

Topography and Hydrography. This is simply a western extension of Area 41, a level plateau region interrupted by volcanic cones and low hills. All of the municipio centers lie between 1500-1600 meters above sea level and fall in the upper limit of Tierra Templada,

which is the basis for separating this area from the rest of the Michoacan Plateau. It is largely a frost-free area.

Climate. The rainfall cycle is similar to Area 42; Zamora receives 825 mms of rain a year, Cotija 694 mms. The main distinction in climate between this area and Area 41 has already been noted (frost-free).

Soils and Vegetation. Similar to Area 41.

Cultural Data. The area includes the following municipios: Regules, Venustiano Carranza, Vista Hermosa de Negrete, Pajacuaran, Tanhuato, Yurecuaro, Ixtlan, Ecuandureo, Jiquilpan, Sahuayo, Villamar, Chavinda, Zamora, Tlazazalca, Cotija, Tinguindin, Tangamandapio, Jacona, Tangancicuaro, Chilcota, Pureparo, Tocumbo, Los Reyes, Charapan, Paracho, Periban, Parangaricutiro.

The total area is 8092 $km^2$, the total population 277,266, and population density 34 per $km^2$.

Area 43. Northern Yucatan

Topography. This is a vast lowland plain with very little elevation. Practically all municipios are located below 50 meters above sea level. The only topographical break is in the south of the area where we find a range of low hills known as the Puuc with a general elevation of 130-160 meters, a few isolated peaks reaching nearly 300 meters in altitude south of Tekax. Although the area has little topography the surface is not really flat but pitted and scarred by depressions and broken by ridges into one of the most difficult terrains for walking in all of Meso-America. The basic construction

is limestone.

Hydrography. This area is distinctive in that it lacks surface drainage completely except for a small stream near Champoton. Rainfall seeps down through the limestone and collects underground to form subterranean lakes and streams. Often at weak spots the limestone roof has caved in over this underground drainage to form what are in effect natural wells called cenotes and provide the rural population with most of its water supply. Swamps or bajos are rare in Northern Yucatan being more characteristic of areas further south and east.

Climate. On the basis of climate one could subdivide this area. All of it is of course Tierra Caliente but there are important variations in precipitation. The driest point is Progreso on the northwest coast which receives but 448 mms of rain a year and cannot support maize cultivation. One might view the climate of the area in terms of parallel circular bands of increasing rainfall starting with Progreso and working southward and eastward. The next band inward from that around Progreso would include such stations as Halacho 973 mms, Hunucma 830 mms, Merida 875 mms, Sotuta 965 mms, Maxcanu 985 mms, Izamal 995 mms. The next climatic belt inward would include stations receiving over 1000 mms of rain such as Tekax 1080 mms, Chichen Itza 1167 mms, Espita 1025 mms, Valladolid 1187 mms, and Tizimin 1125 mms. For the final band we have no data except from right on the coast where Campeche receives 935 mms and Champoton 1275 mms.

Below 900 mms a year of rain in this area generally produces a drought situation with maize cultivation and the bulk of this area

is in nequen. The 900-1000 mms stations agronomically are in an area of mixed nequen-maize cultivation and the milpa frequently suffers from drought. Stations which receive over 1000 mms of rain lie in what is called "La Zona Maicera" of modern Yucatan and offer the best possibilities for maize cultivation.

Soils. Soil cover over most of northern Yucatan is exceedingly scanty, in the central and northern part of the area along with the Valladolid region to the east soil is limited to pockets in the limestone. Around Tizimin, Los Chenes region of northern Campeche, and in the small valleys of the hilly Puuc soil cover is deeper but even in those areas is limited to a few feet. Soils are generally classed as rendzinas by Mexican agronomists. Lundell offers the following data on Yucatecan soils. They are calcareous in general type, reddish in color, with a high calcium oxide and organic matter content with a pH value ranging from 6.68 to 7.45. Yucatecan soils are in general fertile, their characteristic improductivity is due more to soil quantity than quality.

Vegetation. Most of the area today is covered by a low scrub thorny bush as a consequence of milpa activities. Of especial importance is the lack of prominence of grasses although the rainfall cycle seems to call for the formation of true savannahs. Lundell feels that the soils inhibit grass growth and are more favorable for thorny, woody scrub forest. Very little virgin forest is left but it evidently was always of a dry jungle type rather than true tropical forest. Around Progreso cacti predominate as the basic vegetation form.

Cultural Data. This area is one of the most densely populated

areas of Tierra Caliente in modern Meso-America. One of Mexico's largest cities, Merida, lies within it and around this center, with the center of gravity northward, lies the Nequen zone, an area of intensive plantation cultivation of this product for the international market. To the east, south and west of this Nequen zone in the wetter part of our area we find villages of Maya-speaking slash and burn cultivators.

In pre-conquest times Northern Yucatan was one of the most important archaeological areas of Meso-America with two major centers, Uxmal and Chichen Itza plus numerous secondary centers, some of considerable size. It evidently was well populated and a cultural center during both the Classic and Post-Classic periods.

The area includes the following modern political units:

| Section | Area ($km^2$) | Population (1940) | Density |
|---|---|---|---|
| State of Yucatan | 38,508 | 516,899 | 13.4 |
| Municipios in Campeche | | | |
| Calkini | 786 | 16,898 | |
| Hecelchakan | 1,237 | 7,725 | |
| Tenabo | 836 | 3,154 | |
| Campeche | 2,922 | 28,894 | |
| Hopelchen (one-half) | 2,575 | ? | |
| Champoton (a small fraction) | 500 | ? | |
| | 47,391 | 573,570 | |
| Maximal probable population for portions of Hopelchen and Champoton | ____ | 10,000 | ____ |
| Total, Area 43 | 47,391 | 583,570 | 12.3 |

Area 44. Quintana Roo

Hydrography and Topography. This in reality is an extension eastward and southward of Area 43. We find the same lack of elevation combined with complex micro-relief noted for the previous area. Surface drainage, however, is more abundant, especially in the form of aguadas or bajos, shallow extensive swamps which convert to lakes during the rainy season. Cenotes occur but are rare compared to Northern Yucatan. Of local significance is the chain of permanent miniature lakes around Coba. Coba is situated in a vast depression and has a deeper soil cover than most of the Peninsula. Around Ascencion Bay are extensive tidal swamps; much of the huge peninsula which juts south from the Bay consists of tidal swamps and salt flats; from the air it has an unhealthy, desolate appearance.

Soils and Climate. No soil studies comparable to those in Area 43 have been made but there is little doubt that soil types in general are similar. Soil is equally scanty in this area with deep soil areas being confined to the area around Coba, adjacent to Tizimin in the north and around the Bahia de Chetumal.

Climate conforms closely to that of Area 43, stations receiving a similar quantity of rain. Chetumal for example receives 1050 mms of rain, Vigia Chica 912 mms, and Cozumel a little higher with 1507 mms. Vegetation is of the Yucatecan type but is here more developed but I believe only because of its lesser degree of utilization by slash and burn cultivators.

Cultural Data. The area includes the modern territory of Quintana Roo, the most sparsely populated of all of the major political unities of the Mexican Republic. The area covers 50,843 $km^2$ and

the population in 1940 was but 26,967 people.

Even in prehistoric times it evidently played a marginal role and most of the archaeological sites are small and unimpressive, the only exception being Coba.

Area 45. Southern Campeche

Topography and Hydrography. This is a low elevated plateau occupying the south interior zone of the Peninsula of Yucatan and situated slightly higher than surrounding regions to the north, west and east. Actually the elevation is slight; it doesn't even appear on large-scale contour maps. Its definition by Lundell was a phytogeographic rather than topographic.

Soil and Climate. Soil is scanty as in Northern Yucatan, and probably similar in type. Lundell separates this area from surrounding ones on the basis of vegetation; it is a drier, scrubbier forest as compared to the Peten, consisting almost entirely of zapote. He believes that the area probably receives less rainfall than nearby regions.[2]

Cultural Data. The area falls mainly in Campeche only slightly spilling over into Quintana Roo. It includes most of the municipio of Champoton and about half of Hopelchen, approximately 19,000 km$^2$ of wild, almost unpopulated zapote jungle. It is not possible to determine precisely the modern population but it cannot exceed 5000-6000 in all and this is probably an overestimate. In spite of its

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2. Lundell, 1937.

modern situation the area was probably one of the most densely populated of all Lowland Meso-America during the Classic Period.

Area 46. Northern Peten

Topography and Hydrography. Lundell gives an excellent summary of this aspect of Northern Peten geography which I quote below:

"As already noted, Northern Peten is the southernmost part of the dissected Yucatan table land, a low plateau with a maximum elevation not exceeding 400 meters.

"Limestones covering the Peten area are all believed to be Tertiary. The strata were laid down after the mountains of Chiapas, Alta Vera Paz and southern British Honduras were formed, and therefore do not share in the disturbances of the latter. However slight folds are evident in Northern Peten as a series of east-west flexures as shown in the cross section given by Sapper (1899).

"The uplands comprise the east-west hills and broad areas of underdrained, slightly undulating country along the low ridges. The hills are broadly rounded or somewhat flat topped, gentle slopes predominate, yet cliffs and steep slopes are encountered near the summits of some.

"In the uplands numerous sinkholes (dolines) called aguadas, exist which apparently have been formed through subterranean erosion. Most of them are small rain water ponds with clayey impervious bottoms; some have connections with the under-drainage system and hold water for only a few hours. Many are seasonal, drying out during the rainless months. There are other, mostly larger, aguadas,

depressions dipping below the water table, that hold water permanently.

"Lying between the east-west hills are wide trough-like depressions at the bottoms of which we find lakes, swampy lowlands and streams. Scores of lakes exist; some, such as Lake Peten and Yaxha, are of considerable size.

"The lowlands are flat 'subsidence basins' according to Sapper (1899). Cooke (1931) believes that these basins once formed shallow lakes which have been silted by erosion of the uplands until they lie above ground water level during the rainless period. Their heavy impervious clay soils largely prevent under-drainage. The result of lack of drainage has been the formation of extended swampy areas, known as bajos or akalches, synonymous terms. Overflows from the basins occur during the rainiest months. Water stands in the bajos the greater part of the wet season and may only partially evaporate during the dry season in some years."[3]

Climate and Soil. Lundell, basing his conclusions on one station, makes the following estimate of rainfall in this area:

"The average rainfall of Northern Peten, as is shown by the El Paso records, is approximately 1762 mms. In an analysis of the record some interesting points stand out. Rainfall varies greatly from year to year. In 1928 a total of 990 mms fell, while in 1929 there were 2369 mms, a difference of 1379 mms between the two years. As Page (1933) points out in discussing the climate of Northern Yucatan, there are cycles of wet and dry years. In 1924, 1925, 1929 and

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3. Lundell, 1937.

1933 the precipitation was above average. In 1930, 1931 and 1932 it was normal, yet on the average more than 600 mms below 1929 and 1933, whereas in 1926, 1927, 1928 the rainfall was considerably below the mean. From the standpoint of the vegetation the three successive dry years culminating in the drought of 1928 were critical years.

"The years are divided into seasons, the dry extending from November into May and the wet from May through October. The extremely dry months are January, February, March and April. In March and April 1927, 1929 and 1933 the rainfall was almost nil. For the five months from December 1926 through April 1927 the rainfall was only 71 mms. Although 1928 was the driest year, its evenly distributed precipitation alleviated conditions and lessened the fire hazard.

"The records reveal two maxima of rainfall, occurring in June and September."[4]

Soils. "The soils of Northern Peten have not been surveyed or studied in any detail. In my travels across the region, I have noted some of their major features.

"The well drained soils of the uplands are all immature, being shallow calcareous clays. They belong to a local type designated technically as rendzina. On the hills and steeper slopes the soil mantle is generally so thin that it scarcely covers the outcropping limestone. In valleys and on slightly undulating terrain, the depth may be several hundred feet in which case there is a very thin top covering of litter below which lies a gray-black layer of clay. Under this lies a grayish almost black layer in which fragments of limestone

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4. Lundell, 1937.

become more numerous toward the substratum. Soils of a similar nature on the hills near La Libertad in the savannah country were found by Stuart to be slightly alkaline, the pH value ranging from 7-8.

"This rendzina soil on the well drained uplands is the most extensive type, covering possibly 60 percent of Northern Peten. Although in many places it is reduced to accumulations in pockets of the outcropping limestone, nevertheless it supports vigorous calciphile forest growth. The large roots of the trees sprawl out over the limestone penetrating the substrata through cracks. In view of the fact that dry seasons may extend over periods of five months it is remarkable that forest growth can exist on the hills; yet sapodilla forest, admittedly somewhat xerophytic, is everywhere present in undisturbed sectors. Forest exists where we would expect sparse growth. As already noted, the fact that the limy rendzina soils support such a vigorous growth of non-grasses possibly explains why such long disturbed sectors as Northern Yucatan have not been reduced to savannahs.

"The shallow reddish brown soils found in Northern Yucatan and in the small denuded areas of Northern Peten, such as Sabana Kantetul, are chiefly rendzina soils which have become reddish through oxidation following loss of organic matter. The fact that the grayish-black forest soils become reddish when the land is cleared and burned over periodically is evidence enough to show unquestionably that milpa agriculture, continued over centuries, tends to reduce organic matter in the soil and thereby lessen fertility.

"The soils of the poorly drained and undrained lowlands vary

considerably. As a whole they may be classified as deep acid clays.

"The most extensive lowland soils are those of the bajos. Drainage is very poor and for long periods the bajos are flooded. The soils are deep, very heavy, compact, sticky acid clays which crack when dry. The upper layers range from grayish to black to reddish brown in color. The lower layers are generally light gray to whitish, a typical characteristic of glei soils. Their depth has not been determined. The vegetation cover is low, gnarled, xerophytic swamp forest.

"Along streams, on lake banks, in mucky bogs, and in the intermediate poorly drained zone lying between the swamps and the well drained uplands, minor soil types are present, but nothing is known of them."[5]

Vegetation. Three basic tree types dominate the high forest of the Peten: the zapote which is the most common, the caoba or mahogany, and the ramon. All three occur together but one of the three tends to dominate locally. The mahogany is dominant in deep soil areas, gentle slopes or well drained valleys; the ramon is limited to archaeological sites and probably are escaped cultivates. Most of the forest is of the zapotal or zapote-dominating type which is the only one which thrives on shallow soil slopes. Lundell estimates 75 percent of the upland forest is zapotal.

Akalche areas have a separate floral assemblage and in one local area of deep clay soils savannahs dominate. In general the Peten is forested rolling country with the zapote as the dominant tree type.

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5. Lundell, 1937.

Cultural Data. The area includes approximately the northern half of the modern department of El Peten in Guatemala and covers some 20,000 $km^2$. Today it is almost unpopulated virgin forest except around Lake Peten. The approximate population is about 10,000.

In contrast to its modern situation the Northern Peten area is one of the richest of all Meso-American archaeological areas and during the classic period was the theatre of one of the major regional civilizations of Meso-America. The largest of all Maya centers, Tikal, lies within it.

Area 47. The Usumacinta Basin

Topography and Hydrography. This is a rolling broken lowland plain with a single drainage system, all streams flowing into the Usumacinta. No part of the area lies above 400 meters but many of the archaeological centers are situated between 100-200 meters above sea level. Drainage is fast and rapid with the streams mainly being of the gorge cutting, rapids type and with a marked variation in seasonal flow of water. In general topography it corresponds in type to Area 46.

Soils, Climates and Vegetation. Soils probably conform to the Northern Peten type. Rainfall data are available only from the edge of the area where it joins the Tabascan Plain. Tenosique records 2214 mms. Rainfall is liable to vary greatly. From Tenosique and running along the strip bordering the main stream proper, rainfall probably runs between the 1762 mms of the Northern Peten station and the Tenosique 2214 mms. South of this, however, especially in the

rugged foothill headwater country of the lower slopes of the Guatemala and Chiapas ranges, it undoubtedly runs much higher. The area is covered by tropical forest of the Northern Peten type.

Cultural Data. Today this area is almost unpopulated forest. Twenty thousand $km^2$ of it lie in the department of Peten in Guatemala which has a maximum of 10,000 inhabitants. The rest of it lies in Tabasco including the three municipios of Emiliano Zapata, Balancan and Tenosique, and in Chiapas, the municipio of Ocosingo. These four municipios together in 1940 totalled 17,242 $km^2$ and had a combined population of 25,829. The total for the area then is approximately 37,242 $km^2$ in area and 35,829 in population, with an overall density of just short of 1 person per $km^2$.

This area along with the Northern Peten witnessed the highest development of Maya Classic civilization with two major centers situated within it: Yaxchilan and Piedras Negras.

Area 48. British Honduras

Topography and Hydrography. Lundell groups this area along with Quintana Roo into a single East Coast phytogeographical area.[6] I prefer to separate it on climatic grounds; rainfall is much heavier than in Quintana Roo. To the north and south the area is characterized by alluvial fans and flood plains of local streams, of which the Hondo is the most important stream. The center along with most of the area is occupied by the Maya Mountains, an extensive upland

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6. Lundell, 1936.

plateau region broken up into sub-units by ridges and hills of little altitude. The maximum elevation is less than 800 meters and most of the area falls between 400-700 meters. Drainage on the plateau is subterranean but the lowland plains to the north and south are well watered with numerous surface streams.

Climate, Soils and Vegetation. Rainfall is much heavier in British Honduras than in the neighboring Quintana Roo and Northern Peten areas. At El Cayo on the north edge of the Plateau or Upland zone 2050 mms of rain falls annually; Middlesex just northeast of the uplands receives 3600 mms. Lundell states that "No stations are available for the plateau but the precipitation must exceed 2500 mms over the greater part of the area."

Soils in the uplands are classified by Lundell as follows: "The soil is a black clay containing a high percentage of humus. It is thin on the hills but reaches an observed depth of as much as 3 meters in the valleys."

To the east of the Maya Mountains and Plateau is a granitic formation known as the Pine Ridge where the soils are classed by Lundell as acid, coarse sands. This area is covered by pine forest and is unusable for milpa cultivation. Rainfall here is generally higher than the plateau to the west.

The rest of the area is covered by the typical Yucatecan floral assemblage with scrubbier forest on the slopes and lush rain forest in the valleys.

Cultural Data. The population today is relatively dense compared to most of the Yucatan Peninsula with some 73,000 people living in an area of 20,000 $km^2$, or approximately 4.0 inhabitants per $km^2$.

However one-third of that population lives in the city of Belize so that the rural population as a whole is rather scanty and concentrated mainly in the northern third of the area.

In Classic Maya times the area played a secondary role and there are few large sites. Of great interest, however, is the extraordinary development of terracing in the plateau region; evidently in this one area the Maya attempted intensive agriculture. Of importance in this connection is the fact that this is the most elevated of the Lowland Maya sub-areas.

## Area 49. Guatemala Highlands

Topography and Hydrography. This area is much too complex to be assessed as a single unit, and indeed is characterized by greater micro-geographic division than any area of similar size in Meso-America. To catch and be able to discuss this microgeography one needs a breakdown of the Highlands by municipios, and such data is lacking. The area, as here defined, is all of Guatemala above 400 meters of altitude. Some of the volcanic peaks reach nearly 4000 meters so we get an enormous range of ecological zones. Typically Highland Guatemala may be roughly subdivided into Tierra Caliente, below 800 meters; Tierra Templada, 800-1600 meters; and Tierra Fria, over 1600 meters. Some of the higher valleys are over 2000 meters above sea level.

Topographically one can distinguish a series of parallel zones. First we have the Pacific Coast Plain dealt with in Area 50. Behind this a rain-drenched escarpment of volcanic slopes, the Pacific

Lower Tierra Templada. Above 1200 meters we are in the Young Volcanic Range proper, an area of small valleys and ravines with a reduced but still abundant rainfall. Behind this Young Volcanic Range are a series of ash plateau basins generally lying above 1600 meters, such as the Valleys of Guatemala, Chimaltenango, Chichicastenango, Quetzaltenango and Totonicapan. These valleys hold most of Guatemala's population today and are extremely densely populated. They are bordered to the north by a string of older volcanoes known as the Continental Divide. North of the divide are a series of lower interior valleys, the Cuilco, Negro and Motagua, which flow through deep valleys and generally flow northeastward toward the Caribbean Sea. This is the most arid region of Highland Guatemala as the deep valleys are cut off both to the north and south by high mountain ranges; there is a strong similarity here to the Rio Balsas. North of this zone is a great massif of limestone, the Cuchumutanes Mountains, which rises 1000 meters above the interior valleys to the south.

Beyond this to the north is our Usumacinta drainage, and the Highlands end with this belt.

Hydrography over this great area is exceedingly complex, and is mainly seasonal as are most of the rains. Barranca cutting is characteristic and the Highlands as a whole is an area of deep canyon valleys and slopes; plateaus are rare and small in area. As the Continental Divide runs through the center of the area drainage runs off both north and south to finally enter the Caribbean Sea-Gulf of Mexico and Pacific Ocean.

Soils, Climate and Vegetation. No good overall soil study of

Guatemala has been published as far as I know. Soils are of volcanic origin in the southern part of the area and are notably fertile.

There is enormous climatic variation within the area and this variation calls for a more complex breakdown into sub-areas. On the Pacific escarpment Tierra Templada band we get some of the highest readings for Meso-America in annual rainfall. McBryde gives the following data from the Coffee Belt, 400-1200 meters above sea level: La Reforma 4485 mms, Helvetia 4333 mms, Santa Cecilia 4635 mms, Las Mercedes 3870 mms, Panajabal 3777 mms.

At Atitlan, at 1560 meters nestled on the shores of a lake situated within the Younger Volcanic Range rainfall decreases to 1443 mms; at Guatemala City we find an annual rainfall of 1257 mms at roughly the same altitude. Other stations at this altitude band are Antigua 1003 mms, and Patzicia 1305 mms.

Further up in the high valleys of Quetzaltenango in Tierra Fria it decreases to 671 mms and we get a precipitation and temperature cycle similar to that of the Valley of Mexico.

All rainfall data are from McBryde.[7] In general the Highlands with the exception of some high valleys and the low canyon-like valleys like the Motagua, is an area of abundant precipitation, much higher than the Meseta Central and the Oaxaca Highlands and similar in many respects to the Tierra Templada-Fria zones of the escarpment of the Mexican Gulf Coast; especially the similarity is close to the Orizaba-Jalapa area.

Vegetation is correspondingly more exuberant. Most of the slopes

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7. McBryde, 1945.

and volcanoes are forested on up to the tops by mixed pine and oak. Where the rainfall drops below 1000 mms we get more steppe vegetation; in the Motagua valley cacti predominate.

Cultural Data. In order to give population data by ecological zones one would have to break it down by municipio, and municipio data are not available to me. In 1940 Guatemala possessed 2,780,000 inhabitants, almost all of which (excepting the huge department of El Peten and Izabal in the northern Lowlands) lived in the two areas, Guatemala Highlands and Guatemala Pacific Coast. The total population in the Northern Lowlands did not exceed 30,000, so that for all practical purposes the national population total was also the total for the densely populated southern half of the nation. The two areas then, the Guatemala Highlands and Guatemala Coast, together comprising some 65,000 $km^2$, possessed some 2,750,000 inhabitants in 1940 with a density of 42 per $km^2$ - one of the densest populations in modern Meso-America. We cannot break this down into a Highland or Pacific Coast section as our data are by Distritos which are large units that sprawl over all ecological zones. However some departments are mainly coastal, some mainly highland, and a glance at the population density map shows clearly that the center of gravity of the modern population lies mainly above 400 meters. The most densely populated departmentos are over 1000 meters above sea level.

Today Guatemala is an Indian stronghold, especially above 1000 meters.

Area 50. Lower Motagua Valley

General. I have no precise data on this area, but what can be gleaned from archaeological reports indicates that it can be set apart as a definite Ecological Area. It is the lower part of the Motagua Basin plus the area around the Izabal Lagoon. It is an area of Tierra Caliente, all being below 400 meters. The Motagua evidently floods annually and the area in climate, hydrography, vegetation and crop production resembles the Tabasco Plain. Rainfall is perhaps even heavier than the Coast Plain proper of Tabasco, perhaps approaching the Palenque-Teapa belt on the Tabascan-Chiapanecan border.

Area 51. Guatemala Coast

General. This is the Pacific coast below 400 meters above sea level. It is an area of abundant drainage with numerous small permanent streams. The vegetation cover, according to McBryde, is savannah except along the streams where we have gallery forests.[8] Rainfall runs generally between 1685-1885 mms a year, surprisingly high for a savannah vegetation. Today it is mainly a cattle grazing area. Shook emphasizes the great number of large pre-Classic sites in this area with architecture and suggests it as one of the primary centers of origin of the high civilization of Meso-America. During the Classic and Post-Classic periods it evidently played a minor role.

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8. McBryde, 1945.

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