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"There Is No Intra-Specific Struggle in Nature"

Can we inherit the lessons of Lysenko's time, in our own time?

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The remarkable quote in my title is not from the middle ages, but actually was made, and repeated many times during the 20th century, by an evolutionary geneticist, Trofim Denisovich Lysenko[7] (1898–1976; Fig. 1). How he could make such a statement is a story with lessons for our own time. Lysenko was the predominant geneticist of the Soviet era, even though he was not a geneticist and vehemently opposed genetics. Feeding on the government's desperate attempt to improve agriculture, he became the archetype of the destructive duping of politicians by pseudoscience. He also shares, with Jean Baptiste de Lamarck (1744–1829), the dubious reputation of having believed that traits acquired in life can be inherited and are the basis of adaptive evolution.

The Lysenko saga has been described by outraged authors, including combatants within Russia who helped extirpate his influence and rescue Soviet science.[1–4] But everything arises from somewhere, and other authors have tried to understand the degree to which the Lysenko fiasco began with legitimate science and science policy.[5,6]

In 1927, Lysenko, a young agronomist of Ukrainian peasant origin and a provincial education, appeared in the media, credited with major discoveries that could bring productivity to barren fields. Agricultural breeding, or "agrobiology," as he called his version of it, was an important science in the Soviet Union, which, because its northern location, was vulnerable to major crop failures. In 1928, Lysenko published a monograph on the role of temperature in plant development. His work, which was presented and discussed at major science meetings,[8] brought him to the attention of the government.

Starting in 1929, Stalin implemented grandly ambitious national programs of central planning in science. These programs were intended to create the perfect socialist world, superior to the cruel capitalism that had collapsed into the Great Depression. Stalin's central planning included a brutal collectivization of agriculture that purged its most knowledgeable (and well-off) landholding farmers, with the side benefit of greatly worsening the problem of chronic food shortages.

Along came Lysenko, with revolutionary ideas that promised quick, cheap, and dramatic improvements in crop yield. Lysenko's work was controversial and widely criticized because it was at odds with well-established genetics. But Lysenko already had a chip on his shoulder against the bourgeois "Ivy League" elite of Soviet scientific society. This, along with his haste, sloppy experiments, prickliness in response to criticism, and fervid enthusiasm, led to a "conflation of theory with observation and speculation with experience."[5:63] He was a master of creative reporting and, despite the fact that he had few if any actual results, his wild promises were too tempting for the authorities to resist.

HOW TO PUT STEPPES INTO YOUR SPRING

Plant development involves both the stocks being grown and the conditions of their cultivation. Plant improvement was achieved by selective breeding. Recent advances made possible by the Mendelian theory of inheritance had helped make genetics a vigorous science in the USSR. Nonetheless, many of the world's leading biologists could not accept Mendelian genetics as the basis of the evolution or control of complex biological traits, including important traits in domestic crops that geneticists traditionally improved by selective breeding.

The molecular nature of genes was unknown. But it was known that genes were nearly invariant causal units that were faithfully transmitted from generation to generation; only rarely were they altered by mutation. To Lysenko, it was absurd to suggest that such rare change, which was random in nature, could provide the variation that Darwinists proposed was always ready to be molded by adaptive natural selection. Most known mutations were harmful. Moreover, gradual change, even as practiced intensely by agricultural breeders, led to new strains but never to new species. The genetic explanation for adaptive evolution seemed even less plausible given the theory of August Weismann (1834–1914), according to which somatic (body) and germ (sperm or egg) cells were isolated from each other, pre-

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Figure 1. T. D. Lysenko. From Lysenko[7] (not copyright).

venting changes that arose during an organism's life from being transmitted to its offspring.

Lysenko accused Western science of abandoning Darwinian materialist evolution for metaphysical, unchanging, but unknown "genes" that conveniently satisfied the capitalist's need to view the world in terms of competition among individuals, a view with consequences that included the widespread advocacy of eugenics. To the contrary, Lysenko said that he was the true Darwinist. The inheritance of acquired characteristics reflected change that, far from being rare and random, was actually a direct material, not metaphysical, response to the environment, a direct product of the environment. As in my title quote, Lysenko repeatedly denied that evolution worked through Malthusian overpopulation and competitive struggle for resources. Instead, he argued, individuals within a species contend with challenging environments; their competition is from other species, not their own. After all, it is carnivores, not rabbits, that eat rabbits, and wheat competes with weeds, not wheat.

Unlike Darwinian competition, Lamarckian inheritance is positive and benign. It has been called "soft inheritance" because it does not involve the competitive "hard inheritance" and excess mortality of natural selection. Lysenko called Lamarck's insight "one of the greatest acquisitions in the history of biological science."[7:526]

The Mendelians' mistake, Lysenko said, was to separate organisms from their environment. Rather, "The organism and the conditions required for its life constitute a unity."[7:583] At each stage in an organism's embryological development and life history, appropriate cells are "educated" by their environment to form specific types of cells. Moreover, those changes are inherited: for example, leaf cells divide into leaf cells. Organisms respond to their environment by becoming different: for example, plants grow taller with sun and water. "The organism has no concretely given characters, nor does it undergo arbitrary changes of form."[7:12] The way natural selection really works is that plants that are successfully modified by experience reproduce, not that they must outreproduce their neighbors. Since each individual has the ability to respond, adaptations can accumulate in only a few generations. Natural selection is a true creative force that brings new traits into existence, unlike the geneticists' theory by which selection can only sort through existing variation, unable to produce anything new.

Lysenko did not claim personal credit for these ideas. They were due to the Russian fruit-grower, I.V. Michurin (1855–1935; Fig. 2), whose byword for agronomists was that: "We cannot wait for favors from Nature; we must wrest them from her."[7:476] Lysenko conveniently greased his own Lamarckian-Michurinist skids by defining heredity as "the property of a living body to require definite conditions for its life and development and to respond in a definite way to various conditions."[7:390]

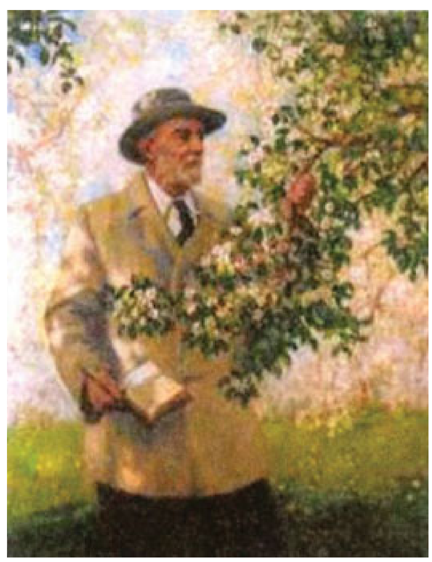

Figure 2. Ivan Vladimirovich Michurin, Lamarckian fruiterer. www.russia-ic.com/people/general/m/86/.

Figure 3. Vernalized wheat plants reported by Lysenko. Plants sown on the same day but with different numbers of presowing chill-days. Plants chilled for more than 36 days formed proper mature ears. From Lysenko[7] (not copyright).

The USSR is a cold place. As a shivering character in Chekov's play *The Cherry Orchard* quips on a frosty day in May, "Our climate is not adapted to contribute."[9:2] Much of the country has a short growing season. Some plants, like winter wheat, need to sprout in the fall and undergo winter cold before growing to maturity in the spring. Unfortunately, many seedlings are lost in severe winters, reducing crop yield. But if seeds were chilled and wetted for a number of days, then stored, a process Lysenko called "vernalization" (Fig. 3), they could sprout in the early spring and mature before the growing season ended. Lysenko thought that by regionally adjusting this treatment one could "educate" plants to particular growing conditions and that the result would be inherited. Vernalization could be achieved much faster than by selective breeding. What's more, it could be done by local farmers themselves, the proletariat taking control from the bourgeois scientists and their laboratories. The frozen steppes would bloom into a paradise, with bunches of berries and ears of grain.

In 1929, vernalization was tested on Lysenko's own father's farm. A great story for the media, its success was hyped as a sensational discovery and became a legitimate topic for research both at home and abroad.[5] The evidence was scant. Negative results went selectively unreported, while even hints of findings were lauded. But Lysenko gained the ear of policy-makers. And it wasn't just vernalization. Almost incredibly, Lysenko was able to foist off a stream of ideas that were problematic or even laughable. One was that breeding normally self-fertilizing inbred (genetically identical) strains with other individuals from the same strain would increase yield, Later, this idea was sneeringly characterized as tantamount to asserting that if you shake a closed bottle of water you will get more water.[3]

Lysenko's influence was highly destructive to science and scientists, which makes it difficult even to consider which of his ideas might have any merit. But legitimate science must always be open-minded. The phenomenon of vernalization is real; we now know some of its genetic basis. At least in some experimental plants, the preflowering meristems (stem tips) require cold exposure before being activated by warmer springtime temperatures and sunlight. One gene, called Flowering Locus C (*FLC*), is responsible for the prevention of premature wintertime flowering. Numerous other genes have been found that regulate the *use* of *FLC* to control the process (see www.jic.ac.uk/profile/caroline-dean.asp).

The mechanism appears to be epigenetic, meaning that the organism's DNA sequence is not changed, so the change is not a mutation in the usual sense. Instead, it involves chemical modifications of the way DNA is packaged in the cell. These modifications make the *FLC* gene accessible to proteins that activate the gene's expression. Some reports even suggest that the altered timing is affected by experience and can be inherited in the seeds that form from flowers that have been so induced.[10,11] Unlike the usual sequence-changing mutations, epigenetic changes can easily be reversed. Numerous examples are being discovered.[12,13] For example, exposure of maize roots to chill has been reported to cause major epigenetic changes in the genomes of root cells that alter the phenotype of the plant and its offspring.[10,11] We mammals have a more rigidly separated germ line than plants do, but if environmental exposures induce epigenetic changes in all our cells, they could be inherited. Effects acquired or learned in utero can yield parent-offspring correlations that seem to be genetic. Human blood pressure levels may be an example. How often such changes persist for additional generations without being reset in the offspring is a critical unanswered question.

We do know that environmental circumstances can make big enough differences in the traits of organisms that members of a species can seem so different in different environments as to be mistakenly called different species. Such variation is known as polyphenism.[14] If, in a given environment, a polyphenic trait is useful and mutations arise that increase the chance that an individual will manifest that trait, what started out as an environmental effect can evolve by natural selection to become genetic. Such evolution is known as the Baldwin effect, or genetic assimilation.[15]

This is interesting for evolutionary anthropology because much of our experience really is inherited—but culturally, not genetically. In fact, Baldwin's ideas were largely based on learned social behavior.[16,17] Hominin evolution has always been integrated with culture. As we strive to adapt to our environments by making houses, clothing, and weapons, working together in groups, and growing food, we pass those skills to the next generation. If learning to be equitable to each other were beneficial, the evolution of societies of the kind Marxism predicted could eventually become more genetically hardwired. That does not seem to be in our behavioral deck of cards at the moment, and anyway would take countless generations. If it were to happen, it would be "Lamarckian" in some sense, but not in any genetic sense that would threaten current evolutionary theory.

In any case, Lysenko's ideas were not supportable by his actual research, which included misrepresentation of (non)results based on shoddy experiments. So even if mechanisms for Lamarckian adaptation are someday discovered, Lysenko's ghost will not be able to claim vindication. Instead, he was influential only because, in the complex arenas of science and politics, oversimplified truth can play into wishful thinking about difficult issues. Complexity is annoying.

SPRING FORWARD. . .AND FALL BACKWARD

When the USSR needed drastic improvement in its food supply, Lysenko answered the call. Stalin was taken in by a man a Pravda journalist dubbed the "barefoot professor," who promised fast results that also fit the Marxist egalitarian wishlist.[4,5] Although Lysenko was "not conspicuous for his erudition,"[4] his influence grew in 1936 when Stalin repressed dissent to unify the USSR against the encircling Nazi regime that rationalized its vicious racism on natural selection and genetics.[18]

In 1948, modern geneticists were purged from the Soviet science populations, some hauled before trumped-up tribunals for various alleged crimes. Thousands of careers were ruined; some opponents even died in prison.[4] If that was the hardest form of hard selection, an episode of soft selection followed, as the miscreants were replaced in their jobs by scientists who had learned the Lamarckian lesson from their environment and toed the Lysenko line. We'll never know whether Lysenko had painted himself into such a corner that he feared being purged if he did not purge his opponents first. But the stress was enough for him to check into a sanatorium for a bit of recuperation.[5]

In the end, what had initially appeared as a great spring forward for agriculture was not subject to sufficient independent scrutiny. Soviet science fell steeply backward in what has been described as "submission of the plant world to the orders of the party."[19:277] Some Western geneticists have tried to absolve the Lysenko history to a degree, in part because of its claimed social goals. They have questioned whether Lysenkoism actually had a negative effect on Soviet crop yield.[6] But when careers are ruined and scientists are sent to prison, such sympathy is not very persuasive.

After Stalin's death, Khrushchev became even more enamored with Lysenko. But an undercurrent of legitimate genetics had somehow survived in the USSR and, in 1965, after Khrushchev also died, Lysenko was finally pushed out of his directorship of the national Institute of Genetics. Nonetheless, he was able to retire peacefully at home, not in the Gulag.

In 1918, R.A. Fisher (1890–1962) had reconciled Darwinian gradual evolution with discrete Mendelian inheritance into a single theory of genetic inheritance.[20] Then, in 1930, he extended that synthesis into a genetic theory of evolution.[21] In debates about genetics, Fisher was not exactly a disinterested party, but his take on Lysenko is instructive. In the dreadful year 1948, Fisher quoted from a Lysenko speech and asked whether Lysenko was a scientific maverick seeking recognition, an ignorant peasant sincerely driven to improve Russian agriculture, or a power-seeking ideologue. Fisher concluded that "The reward he is so eagerly grasping is Power, power for himself, power to threaten, power to torture, power to kill."[22:875]

The Lysenko saga has faded into history, with little to teach us about science. But some of the cultural lessons may still be with us.

HARD AND SOFT SELECTION

On a recent BBC radio program about Lysenko, the British biologist Steve Jones asserted that science is again being "sovietized," only this time it's happening in the West. It might seem poor taste to liken anything today to the Stalinist era, but he was referring to the ways science increasingly depends on considerations other than the disinterested pursuit of knowledge. We don't face the hard selection of the Gulag, but there is a growing amount of soft selection.

If you doubt this, talk to someone whose tenure or even salary depends on grants in a system in which only a small percent of applications are funded. Careers depend on the judgment of confidential review tribunals who defend the interests of the field as they see it. A widely recognized result is that pressure to obtain funds and publications has made science increasingly conservative and incremental. People can be driven out "softly" just by being discouraged.

Creative interpretation of research results is not unknown today and journalists sensationalize any new finding, flimsy evidence notwithstanding. Investigators, being humanly vain and needing to build careers, have learned to orchestrate the media to mutual benefit. Glowing promises are made that are privately acknowledged to be unrealistic, at best, but that are fundable. Perhaps more serious is that large set-asides for pet topics and mega-projects are increasingly frequent. This arguably threatens science by making applicants tailor applications to the available trough, encouraging incremental change and conformism and sequestering funds from other ideas or approaches. There is pressure for research to be "translated" into direct public or commercial impact. This laudable ultimate goal impatiently colors the proximate course of science, changing basic research into engineering and infusing curiosity with a profit motive even in universities.

These are problems of thought constraint within science. But another manifestation in our country today is against science itself. Teachers are experiencing many forms of intimidation to prevent them teaching evolution in American high schools. There has been soft selection by religious ideologues to silence them, and they have not, so for, been suffering the hard selection of losing their jobs.

Science, like any aspect of society, has its polarized orthodoxies and ideologies,[23] and the party line changes. Today there is a growing preference for nature over nurture, a genetic determinism that is even penetrating the social sciences. But if nature rules today, it's an emergence from past excesses on the nurture side, not least being the various fervently anti-science subjectivism that deeply affected many fields, including anthropology.

There will always be disputes and false theories in science. If there were not, it would mean we already knew everything. Screwy ideas are usually screwy, but occasionally turn out to be true and transforming. More importantly, solid negative results that challenge current wisdom have a hard time getting into print: They aren't sexy enough, but they can be the most informative results to publish because they can force new thinking.

It's natural to grouse about how one's own times are going to pot; that's not new even to science.[24] A lot of good work is being done, even if not everyone who wants to do it gets an equal chance. Those of us who have been well-treated by the system naturally tend to be happier. But we needn't face something as pernicious as Lysenkoism to be wary of the risks presented by too much centralization or conservatism in research, publication, or funding. If there is any lesson for us from the Lysenko history, it's that "The more closely science is involved with politics and practical affairs, the more pervasive becomes its dependence on social goals, values, and wishes."[5]

Regardless of any legitimate science with which it started, the Lysenko history shows there can be chill winds that blow no good to anyone except those who fall in line. Nowhere should science have to undergo a chill of orthodoxy in order to flourish with springtime vigor. If there are lessons to learn, they may be, first, to live in a pluralistic democracy, but second, not to let vested interests take control of science. And, if things aren't going well, take a cold shower. It will put spring in your steps!

NOTES

I welcome comments on this column: kenweiss@psu.edu. I have a feedback and supplemental material page at http://www.anthro.psu.edu/weiss_lab/index.shtml. I thank Anne Buchanan, Brian Lambert, Jeff Kurland, and John Fleagle for critically reading this manuscript. This column is written with financial assistance from funds provided to Penn State Evan Pugh professors. Thanks to George Milner for the gift of a copy of Lysenko's book.

REFERENCES

1 Graham L. 1972. Science and philosophy in the Soviet Union. New York: Alfred A. Knopf.

2 Joravsky D. 1970. The Lysenko affair. Cambridge, MA: Harvard University Press.

3 Medvedev ZA. 1969. The rise and fall of T. D. Lysenko. New York: Columbia University Press.

4 Soyfer VN. 1989. New light on the Lysenko era. Nature 339:415–420.

5 Roll-Hansen N. 2005. The Lysenko effect: the politics of science. New York: Humanity Books.

6 Lewontin RC, Levins R. 1976. The problem of Lysenkoism. In: Rose H, Rose S, editors. The radicalization of science. Ideology of/in the Natural Sciences. London: Macmillan. p32–64.

7 Lysenko TD. 1954. Agrobiology. Moscow: Foreign Languages Publishing House.

8 Lysenko TD. 1928. Effects of the thermal factor on the duration of phases in the development of plants. Baku: Ghandzha.

9 Chekov A. 1904. The cherry orchard. Mineola, NY: Dover.

10 Sano H. 2002. DNA methylation and Lamarckian inheritance. Proc Japan Acad. Series B 78:293–298.

11 Steward N, Ito M, Yamaguchi Y, Koizumi N, Sano H. 2002. Periodic DNA methylation in maize nucleosomes and demethylation by environmental stress. J Biol Chem 277:37741–37746.

12 Jablonka E, Lamb MJ. 2002. The changing concept of epigenetics. Ann NY Acad Sci 981:82–96.

13 Chong S, Whitelaw E. 2004. Epigenetic germline inheritance. Curr Opinion Genet Dev 14:692–696.

14 Suzuki Y, Nijhout HF. 2006. Evolution of a polyphenism by genetic accommodation. Science 311:650–652.

15 Weiss KM. 2004. Doin' what comes natur'lly. Evol Anthropol 13:47–52.

16 Baldwin JM. 1896. Heredity and instinct. Science n.s. III:438–442.

17 Baldwin JM. 1897. Organic selection. Nature 55:558.

18 Baur E, Fischer E, Lenz F. 1931. Human heredity. New York: Macmillan.

19 Conquest R. 1991. Stalin: breaker of nations. New York: Viking Press.

20 Fisher RA. 1918. The correlation between relatives on the supposition of Mendelian inheritance. Trans R Soc Edinborough 52:399–433.

21 Fisher RA. 1930. The genetical theory of natural selection. Oxford: Clarendon.

22 Fisher RA. 1948. What sort of man is Lysenko? Listener 40:874–875.

23 Weiss KM. 2008. The good, the bad, and the Ugli. Evol Anthropol 17:129–134.

24 Shapin S. 2008. The scientific life: a moral history of a late modern vocation. Chicago: University of Chicago Press.