A main point in the argument of our paper was that Lysenko would not have been able to achieve domination of Russian genetics, and to suppress Mendelian genetics, if he had not had the full support of the Soviet government. It is therefore important to try to analyze the arguments which led the government to endorse Lysenko's ideas officially for 20 years, and recently to withdraw its support. To anyone who has read the disputations of Lysenkoists and Mendelians in the 1940's, it is apparent that the validity and design of the experiments involved were only a minor point compared to political and ideological considerations.

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Caspari and Marshak compare the activities of Lysenko with the Scopes trial in Tennessee in 1925. Surely such a comparison serves only to soften the lethal implications of Lysenkoism. Lysenko was the guiding genius behind the purges of science from 1936 to 1948, in which some geneticists were known to have been put to death (see Garrett Hardin, *Nature and Man's Fate*). Vavilov, who was President of the Academy of Sciences, was arrested and sent to Siberia, where he died; others simply disappeared. The Scopes trial was an amusing sideshow comparable to the flagpole-sitting and related antics of the 1920's in the U.S.A. The defendant was fined $100; his conviction was reversed by the Tennessee Supreme Court; Clarence Darrow, who defended him, gained enormously in fame and reputation; and the uninterrupted study of genetics and evolution in the U.S.A. continued to move forward to new achievements in the laboratories of investigators such as Morgan, Muller, Bridges, Wright, and Dobzhansky. . . .

We learn from Caspari and Marshak that Lysenkoists are now willing to accept the existence of DNA as hereditary material, this being "a tribute to the remarkable developments which have taken place in Western genetics. . . ." By the same token, an acknowledgment of the existence of the moon might be interpreted as a tribute to the remarkable photographs taken by Ranger VII.

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. . . In their concluding paragraph Caspari and Marshak say, "The tragedy of Lysenkoism is that so much precious time has been lost for the biological sciences in the U.S.S.R." I cannot but disagree with this conclusion. The "tragedy of Lysenkoism" and of the conditions which permitted the rise of this "extraordinarily ambitious and ruthless scientific adventurer" is represented by the fate of Academician N. I. Vavilov who died in a Siberian labor camp for having the desire and determination to pursue the truth. I was a subject of a Communist-dominated state for several years and can attest that Vavilov's fate was shared by countless others, scientists and nonscientists, for the very same offense. Science cannot be evaluated without considering the man who participates in it, benefits from it, or suffers from it. For us the tragedy is a human tragedy first and a scientific one second; only to Soviet officials may it appear to be an economic one. . . .

It would have been desirable to include in the article a list of references. During my comparatively short stay in the U.S. I have noted the existence of several useful publications on this subject without specifically searching for them. These include Theodosius Dobzhansky's translation of one of Lysenko's pamphlets, *Heredity and Its Variability* (King's Crown Press–Columbia University Press, 1946); Julian Huxley's *Heredity East and West: Lysenko and World Science* (Schuman, New York, 1949); A. G. Morton's *Soviet Genetics* (Lawrence and Wishart, London, 1951); and C. Zirkle's *Death of a Science in Russia* (University of Pennsylvania Press, 1949); and *Evolution, Marxian Biology, and the Social Scene* (University of Pennsylvania Press, 1959). . . .

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Financing Key Ideas

I note with great interest the editorial by Wolfle ("The productive environment for innovation," 30 July, p. 501) in which he reports on a Defense Department study of the conditions that have led to the most successful research achievements. It seems to me significant that in most cases funding for the development of the "key idea" was not readily available, and that "the company or university paid the expenses from its own funds, or borrowed money intended for related work or other activities. . . ." It seems to me that in such a situation a very careful evaluation of the need and the idea would first have been made so as to provide the retrospective justification for the diversion of these funds, and I suspect that the results were much less costly than they would have been if obtained with funds specifically allocated to them under a contract. I wonder how this factor could be built into our funding systems? . . .

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Fertility Experiment Recalled

Popular interest in multiple human births, and especially in the recent instances of quadruplets, quintuplets, and even one set of stillborn sextuplets born to women treated with gonadotrophic hormones FSH (follicle-stimulating) and HCG, (human chorionic), prompts me to report on our experience nearly 25 years ago with cats. Our problem was not dissimilar to the present human one, though we were only trying to increase the number of cat fetuses for our experiments and harbored no thought of abetting a human population explosion.

Many cats fail to come into estrum in the laboratory at the expected season, and their infertility is related to their failure to develop ripe follicles and release ova. We reasoned that a little of the new Fevold-Hisaw follicle-stimulating hormone, followed by luteinizing hormone (LH), might correct this condition. We had had partial success with pregnancy urine and serum extracts, especially when administered during the season of expected estrum (*1*).

A graduate student, R. F. Becker (now at Duke University) was dispatched to Boston to learn how to prepare the hormones from sheep pituitary glands, after which we went into the business of cat-fetus production on a scale limited only, we hoped, by the availability of mature female cats from Chicago alleys and a few virile males. We opened Pandora's box!

Multiple births are the rule in cats, the normal range being two to six, rarely seven, kittens per litter. No fewer than eight fetuses were found *in utero* or were born of 12 hormonally treated cats. The maximum number was 20 embryos. The largest litter of living kittens at term was nine (plus four stillborn). Exploratory laparotomy performed early in gestation in several instances revealed uteri packed with uncountable numbers of embryos; ovaries consisted of solid masses of corpora lutea. Total resorption or early abortion of the uterine contents occurred in three instances. Eight other cats that were given the hormones and were mated either failed to become pregnant or lost the embryos at early stages.

The hormones prepared by Becker were administered as follows: FSH subcutaneously for 3 to 8 days, followed by a single dose of LH intravenously on days 4–8. Matings took place on days 4–9. The main estrous season of cats is March to May. Estrum followed administration of FSH during November, December, and January in 20 of 22 cats; in one of the two failures FSH had been implanted beneath the skin in a pellet.

These experiments were discontinued during 1939 when our research needs changed. The method offered little hope of increasing the availability of full-term cat fetuses which we required for experiments on asphyxia neonatorum (*2*).

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References and Note

1. W. F. Windle, *Endocrinology* **25**, 365 (1939).
2. The only report on the experiments on asphyxia neonatorum in the cat appears as a footnote in W. F. Windle, *Neurological Deficits of Asphyxia Neonatorum* (Thomas, Springfield, Ill., 1958), pp. 31-32.

Lissajous Figures by Analog Computer

I. L. Finkle's letter (18 June, p 1541) concerning Lissajous figures generated by a digital computer warrants the reply that an analog computer is much better suited to this task. My Fig. 1 shows a Lissajous figure generated by a PACE TR-20 analog computer and drawn by a Moseley model 7000A *x-y* plotter.

The computer is wired to solve the differential equations for damped free oscillations:

$$x + 2\psi x + \omega^2 x = 0,$$

where $\psi = \eta/2m$, $\omega^2 = g/L$, η is the coefficient of viscosity, m is the mass of the pendulum bob, and L is the length of the pendulum. The solution to this equation is

$$x = a\, e^{-\psi t} \cos \{[(\omega^2 - \psi^2)]^{\frac{1}{2}}\, t + \alpha\},$$

where a is amplitude, t is time, and α is the phase angle. Two such differential equations with different values of ω and ψ and different initial conditions, are solved simultaneously, with the solutions plotted along perpendicular axes. The frequencies can easily be made small enough so that the maximum speed of the plotter pen is not exceeded.

The advantages of the use of an analog computer are obvious: no approximation is needed, and the lines are properly curved; large size pictures may be drawn, limited only by the size of the plotter (usually at least 8½ by 11 inches, or 22 by 28 cm); no photographic process is involved, as with the CRT plotter. Even though the analog computer may take as much as 100 times longer than a digital computer, computer time is usually much cheaper for an analog machine than for a digital one. Thus the Lissajous figures are of superior quality and the cost is at least comparable.

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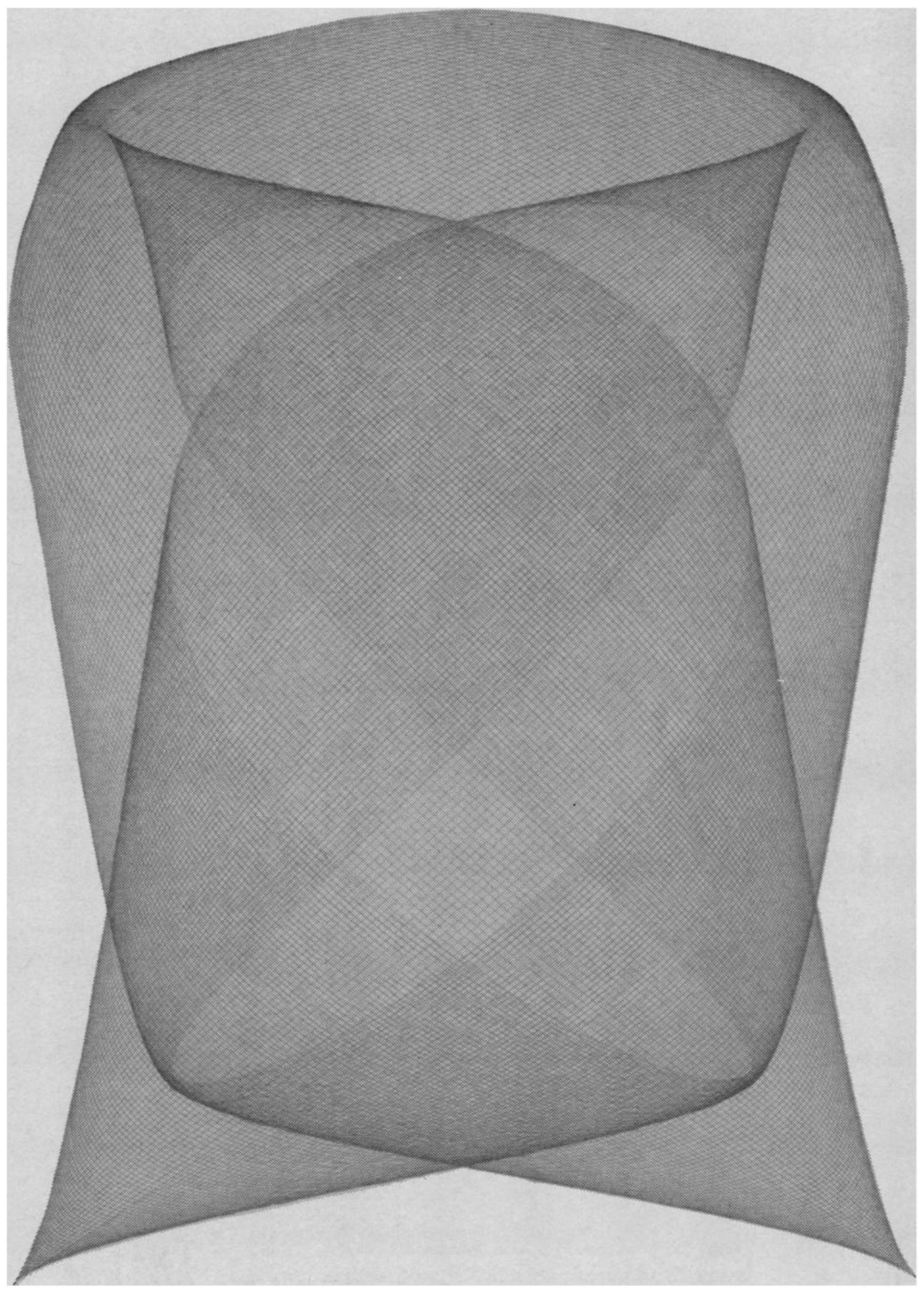

Fig. 1. A Lissajous figure produced by an analog computer and drawn by a 11- by 17-inch (28- by 43-cm) *x-y* plotter. Here $\omega_1/\omega_2 = 2.998/2.000$, $2\psi = 0.001$, $\alpha = 0$.