ergy transactions that determine climatic regimes (*37*). As a first step, a comprehensive radiation climatology of the globe is needed.

Better information on extraterrestrial fluctuations of radiation and deeper understanding of the atmosphere-ocean relations will throw new light on the problem of climatic trends. The tedious analysis of geological evidence is likely to leave the problem of ice ages in the state of working hypotheses.

The greatest advances of climatology are destined to lie in the border field of biology, provided an adequate cooperative research program is started. The interactions between the physical changes in the atmosphere and living organisms are too great a challenge to scientific curiosity to remain in a relatively unexplored state. We have already pointed to the special problems of agroclimatology, a solution to which population increase will demand. Similarly, the role of climate in gerontology and various pathological states begs for quantitative studies.

It is further certain that some experimentation with artificial alteration will take place. One can only hope that the long-range view will prevail and that the experiments will be carefully designed with a view toward physical and statistical validation. This is a large program which probably will take years and permit of few short cuts. Man may not become master of his climatic environment, but the next decades at least promise that he will be able to understand it much better than in the past.

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Pavlov and Lamarck

The great Russian scientist once reported experiments in support of Lamarck. Were his final views Lamarckian?

Gregory Razran

Recently Nathaniel Kleitman wrote me: "For quite some time I have been trying to ascertain if Pavlov ever retracted the statement made in 1923, at the International Physiological Congress at Edinburgh, and elsewhere, that successive generations of rats acquired conditioned reflexes with progressively less training. In his review of *I. P. Pavlov: Selected Works,* that appeared in *Contemporary Psychology,* Vol. II, p. 274, Gantt stated that Pavlov 'rescinded this statement about heredity when he had more critically surveyed the original experiments . . .' However, when queried by me on this subject, Gantt said: 'I have no reference to a retraction in print, although there may be one.'"

Analogous questions have been directed at me, from time to time, at meetings and in letters, by a number of American scientists, and once by a member of the State Department. Consideration of the evidence on this matter in its entirety and, for convenience, in chronological sequence, may thus be worth while, particularly since Soviet theorists have for some years been proclaiming Pavlov the true and renowned backer of scientific Lamarckianism or,

The author is professor of psychology at Queens College, Flushing, New York.

in their own words, "creative Soviet Darwinism, the true and progressive doctrine of creative evolution of life and mind." Let us look at the evidence.

First Mention

Pavlov posited for the first time the possibility of the inheritance of acquired conditioning in 1913, in an address before the Ninth International Congress of Physiologists at Gröningen, and then again in 1914, in an address prepared for an International Congress of Psychiatrists, Neurologists, and Psychologists in Switzerland, which was canceled on account of the war. The exact statement in 1913 was: "It may be assumed that some of the conditioned newly formed reflexes eventually become transformed into unconditioned ones through heredity" (*1*). The 1914 statement, more positive and specific, read: "It is highly probable (and there are to this effect some factual indications) that, when the same conditions of life are maintained in series of successive generations, newly formed [conditioned] reflexes uninterruptedly [in Russian, *neprerivno*] become constant [unconditioned] reflexes" (*2*, vol. 3, p. 222; *3*). No mention whatsoever was made of the problem in any of Pavlov's subsequent writings before 1923.

Edinburgh Inheritance Report

In 1923 came to light what since has often been called "The Edinburgh Inheritance Report." Pavlov came to the United States in the summer of 1923 and delivered one address on 5 July at the University of Chicago and another on 7 July at the Battle Creek Sanitarium. Then he proceeded to Edinburgh (after his wallet containing $2000, was stolen from him at Grand Central Station in New York) to address the 11th International Congress of Physiologists (*4*). The Edinburgh address, identical with the one given at Chicago, was published in the transactions of the congress in the *1923 Supplement Volume of the Quarterly Journal of Experimental Physiology* (pp. 39–43); the Chicago address had appeared earlier in *The Scientific Monthly* [**17**, 603–608 (1923)]. The Battle Creek address, somewhat shorter than the Chicago–Edinburgh one, was published in the *Bulletin of the Battle Creek Sanitarium* (*5*) and in *Science* (*6*). Both addresses contain the inheritance report, though the version in the Battle Creek address is the longer of the two. It reads (note that in neither is the inheritance section the main theme and that in both it is really only a small, but striking, aside):

"The latest experiments (which are not yet finished) show that the conditioned reflexes, i.e. the highest nervous activity, are inherited. At present some experiments on white mice have been completed. Conditioned reflexes to electric bells are formed, so that the animals are trained to run to their feeding place on the ringing of the bell. The following results have been obtained:

"The first generation of white mice required 300 lessons. Three hundred times was it necessary to combine the feeding of the mice with the ringing of the bell in order to accustom them to run to the feeding place on hearing the bell ring. The second generation required, for the same result, only 100 lessons. The third generation learned to do it after 30 lessons. The fourth generation required only 10 lessons. The last generation which I saw before leaving Petrograd learned the lesson after 5 repetitions. The sixth generation will be tested after my return. I think it very probable that after some time a new generation of mice will run to the feeding place on hearing the bell with no previous lesson.

"It is well known that a chicken when it just comes from the egg immediately begins to pick up any black spot on the floor, trying to find some grain, thus showing that it has an inborn reflex from the eye to food reaction. Why should we not build up the same reaction, not from the eye but from the ear as indicated in the case of the white mice?" (*5*, p. 4; *6*, p. 361).

T. H. Morgan quoted the first two of the aforementioned paragraphs in his *Evolution and Genetics* (1925) with the following comment: "There was some consternation in 1923 when the great Russian physiologist, Pawlow, reported the results of experiments that go far beyond what most Lamarckians have dared hope. Pawlow's conclusions—and as yet we have only his conclusions—are very surprising" (p. 157).

Conditioned Reflexes

In 1927, *Conditioned Reflexes,* consisting of a series of lectures delivered by Pavlov at the Petrograd Military Medical Academy, was published in Russian, and was immediately translated into English by C. V. Anrep, Pavlov writing a special preface to the English edition (*7*). And here on page 385 we find a footnote pertaining to the sentence, "Such criteria [characteristics of types of nervous systems] when perfected should greatly assist the development of a strictly scientific experimental investigation of the hereditary transmission of different aspects of the nervous activities of animals," which reads:

"Experiments which have been communicated briefly at the Edinburgh International Congress of Physiology (1923) upon hereditary facilitation of the development of some conditioned reflexes in mice have been found to be very complicated, uncertain and moreover extremely difficult to control. They are at present being subjected to further investigation under more stringent conditions. At present the question of hereditary transmission of conditioned reflexes and of the hereditary facilitation of their acquirement must be left entirely open" (*7*, p. 385).

Editions of the "Twenty Years"

Neither the Edinburgh–Chicago nor the Battle Creek address was included, during Pavlov's lifetime, in any of the six editions of his *Twenty Years of Objective Study of the Higher Nervous Activity (Behavior) of Animals* (known better in English as *Lectures on Conditioned Reflexes*). The six editions of the *Twenty Years*—so named because the first edition was published in 1923, twenty years after the beginning of conditioning experimentation—are in all respects *complete* collections of Pavlov's formal addresses and articles on conditioning, each edition supplementing the one preceding (dates of editions: 1923, 1924, 1925, 1928, 1932, and 1938), and the last edition containing a preface by Pavlov written about one month before his death. Likewise, there is the striking fact that the topic is nowhere mentioned in any of the five published volumes of *Pavlov's Wednesday Seminars,* supposedly the repositories of everything informal that Pavlov had said about conditioning in the 1930's.

Complete Works

The Battle Creek address first appeared in Russian, with a reference to *Science,* in 1949, in the fifth volume of

the first edition of Pavlov's *Complete Works* (*2*, vol. 5, pp. 309–312) and again in the second part of the third volume of the second edition of the *Works* (1951, pp. 428–432). And it was only then, at the height of Lysenkoism, that Soviet experts on Pavlov—as well as those not so expert—began beating the drum loudly and repeatedly in exultation over the alignment of Pavlov's views and proofs with those of Michurin and Lysenko (the sounds of the drums have weakened considerably in the last two or three years, but, as noted in the aforementioned review by Gantt, they have by no means been wholly silenced). The writings of Y. P. Frolov, a conditioning experimenter and Pavlov popularizer of no mean magnitude, are a particularly appropriate example of this Soviet interplay of *Zeitgeist* and scholarship. In Frolov's 291-page *Pavlov and His Work*, published in 1937 (translated into English), there is not a word about Pavlov and heredity. But in Frolov's 78-page pamphlet *The Great Physiologist, I. P. Pavlov*, published in 1950, a whole section on "Higher nervous activity and creative Darwinism" appears, and Pavlov is quoted to have said:

"For if no one may affect your substance, your gene, Mr. [(*8*)] Morgan, then all that is left for us to do is to merely observe nature, nothing else. What we have then is not a laboratory but a prayer house. But what we wish to do is to actively interpose in [the workings of] nature. And this we will do, Mr. Morgan, your disapproval notwithstanding" (p. 70).

And in the second (1952) edition of the pamphlet there is an additional final phrase ". . . and we will produce the facts to prove our claims."

Oral Comments

The quotation from Gantt given in Kleitman's letter contains also the sentence: "Pavlov remarked to me that one of the biggest scientific errors of his life was his assertion that acquired habits could not be inherited." And to this I would like to add that, while spending a summer afternoon with Pavlov in 1934, I asked him specifically what his present views on the problem were. His answer was a shoulder shrug coupled with the sound of a typical Russian "Ekh" which to me meant "Don't ask," and I preferred not to pursue the question.

Conclusion

Though there is no evidence that I. P. Pavlov ever formally renounced Lamarcks' *doctrine as such* (only a personal statement to Gantt and my own "Ekh" impression), Pavlov certainly retracted specifically the positive results of his experiment—and the fact that he never repeated the experiment, as intended, and shunned any discussion of the topic, may well be construed as evidence that he did not expect positive results to be obtained. Soviet theorists' wholesale alignment of Pavlov with Lamarck, Michurin, and Lysenko is thus a gross misrepresentation of a great and careful experimenter and of a critical and discriminating discoverer and blazer of new truth and evidence. Let us hope that this practice of subserving exact science to social dogma is on the wane. There is some reason to believe that it is.

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3. ———, *Lectures on Conditioned Reflexes* (International Publishers, New York, 1928), p. 242.
4. The statement in *Science* [58, 45 (1923)], reprinted from the *New York Times*, that "Pavlov was refused a British visé to his passport . . . and will not be able to attend the Edinburgh Congress of Physiology," should be emended. The British Consulate in New York did refuse Pavlov a visa. However, the Central Government in London yielded to protests from American and British scientists and finally granted him the visa while he was on the high seas. The Pavlov address was read in English by his son, Vladimir Pavlov, while, according to A. N. Richards and J. T. Wearn (*New Yorker*, January 20, 1951), "Professor Pavlov stood before a huge audience in Edinburgh . . . following every word, now and then nodding his head vigorously and muttering, '*Da, da.*'"
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8. The word *Mr.* occurs in the original Russian, presumably as an extra index of dissension.

News of Science

Traveling Science Library

This year the American Association for the Advancement of Science and the National Science Foundation, cooperatively with book publishers of the United States, will provide about 1400 of the nation's senior high schools with 350 "circulating libraries," each consisting of 200 carefully selected science books. The AAAS Traveling High School Science Library Program is being supported for the fourth year by an NSF grant. The current award, announced today, amounts to $500,000.

During its first year of operation the Traveling Science Library circulated 11 sets of 150 books among 66 senior high schools. Last year demand was so great that the AAAS could honor only a fraction of the applications it received. The new NSF grant makes possible the current expansion of the program. The library will go to schools in all 48 states, Alaska, the Canal Zone, Hawaii, and Puerto Rico. Fifty books will be sent at a time, with an exchange approximately every 2 months, so that each school will have use of a complete set during the year.

Evaluation studies made by the AAAS disclose that on the average only 5 percent of books in most high-school libraries concern science and mathematics. The studies also indicate that the traveling libraries provide an effective incentive for participating schools to take action to satisfy, in varying degree, the appetite for science reading stimulated by the AAAS books. Publishers, almost without exception, have provided the books at cost.

Objectives of the Traveling High School Science Library Program are as follows:

1) To develop in high school students