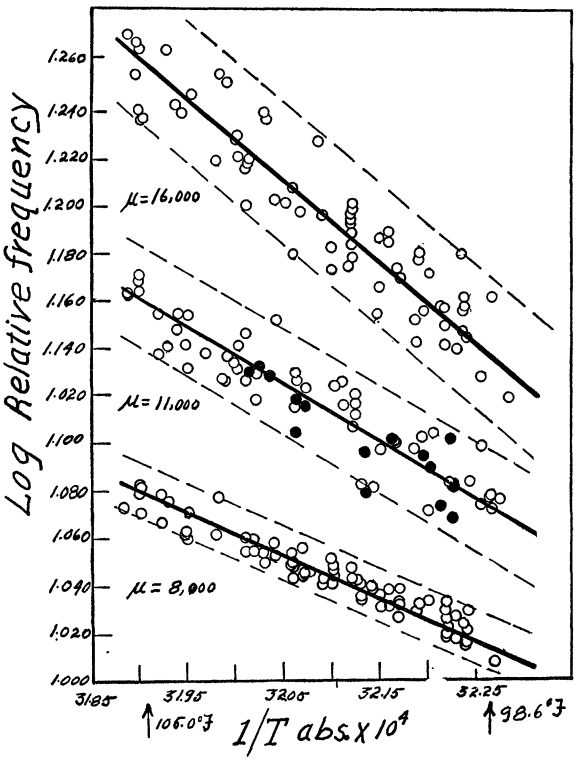

FIG. 1.

experiments (each a week apart) on a multiple sclerosis out-patient. Each experiment involves from 5 to 9 points; approximately 500 alpha waves are averaged for each point in Fig. 1.

The relative *variability* is shown by the vertical height of the band between the two parallel broken lines on either side of the heavy mean line. The $\mu = 11{,}000$ band corresponds likewise to 11 experiments on 2 general paretics who have had the disease longer than those of the 8,000 group. The $\mu = 16{,}000$ band corresponds to 14 experiments on the 2 other general paretics. One of these was decidedly the most advanced case of the group. The clinical record of the other, while showing an advanced stage, was incomplete and did not permit one to say that the paresis was more advanced than in the 11,000 group. The clinical records were independently analyzed by Dr. F. H. Sleeper. Of course, many more cases are necessary before clinical generalizations can be made. Some 115,000 alpha rhythms have gone into the determinations. Individual experiments are brought together in the band of appropriate slope by multiplying ordinates by a suitable constant. The ordinate intercept of each group is, therefore, arbitrary. The slopes alone are here significant. The 15 solid black points of the $\mu = 11{,}000$ curve show frequencies as a function of *descending* temperatures in 4 experiments. No hysteresis effect is seen, thus indicating the quantitative *specificity* of the temperature effect and showing that any small downward drift in frequency which may occur in time at normal body temperature is quantitatively overcome when the underlying mechanisms are driven by elevated temperatures. The slight decline in frequency after 1 to 2 hours recorded by Loomis, Harvey and Hobart[3] may possibly be due to a corresponding fall in temperature as basal metabolic conditions are approached.

There is no question of the independence of the three μ values as evidenced by the three distinct slopes of the lines. It is interesting that the variability represented by the width of the parallel bands apparently increases with the advancement of general paresis. The banded form of the variability means that the relative (per cent.) variability is constant over the temperature range for each graph. The variability is, of course, organic and far exceeds errors of measurements and is of the type commonly found in studies of physiological rates as a function of temperature. The specific factors making for excessive variability listed by Jasper were avoided to a great extent in the series. The *reversible* fit of the Arrhenius equation, the specific μ's which correspond to numerous determinations for O_2 consumption and CO_2 production in cells and the measured variability thus obviate the criticisms. In addition, Jasper's findings do in fact support our own. His values of 7,000–8,000 calories for normals and petit mals agree well with ours for the normals, the multiple sclerosis patient and the two least affected general paretics. The higher values of 11,000 and 16,000 appear to be products of the advancement of the infection which might quite reasonably be expected to shift the pacemaker, *i.e.*, the slowest process in the sequence of cortical cell respiratory events determining the relaxation oscillation frequencies. Work with poikilothermous organisms has repeatedly shown similar shifts due to chemical manipulation from one of these three values to another (Crozier and Stier).[4] Jasper agrees with me in favoring the idea of a relaxation oscillator mechanism for the brain waves, but for different reasons. It would indeed be surprising, granting such a mechanism, if the Arrhenius equation did not fit the data.

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PYRUVIC ACID IN URINE AFTER HARD EXERCISE

DURING nine experiments in which athletic young men ran quickly to exhaustion on a treadmill, we col-

[3] A. L. Loomis, E. N. Harvey, G. Hobart, SCIENCE, 83: 239–241, 1936.

[4] W. J. Crozier and T. J. B. Stier, *Jour. Gen. Physiol.*, 9: 547–559, 1926.

lected urine from the subjects before and after the run. The nitroprusside test for pyruvic acid[1] was negative for the urine passed before exercise, but was positive for that passed after exercise. We collected urine also from eight boys after they had run the ¼ mile or the ½ mile race in a track meet. In seven cases the test was positive.

Pyruvic acid 2:4-dinitrophenylhydrazone was prepared from the boys' urine by the method used for pigeons' blood by Johnson.[2] The melting point was 214° (uncorr.) and the mixed melting point with synthetic pyruvic acid 2:4-dinitrophenylhydrazone was 213° (uncorr.). Therefore the substance giving the positive nitroprusside test in the fresh urine was probably pyruvic acid.

In one experiment a subject ran on a treadmill to complete exhaustion in 1.70 minutes at 11.2 m.p.h. Urine was collected before and 50 minutes after the run and blood was drawn from the antecubital vein before and 5 minutes after the run. Analyses for pyruvic acid were made by Peters and Thompson's[3] modification of the Neuberg-Case method. The results are shown in Table I.

TABLE I

PYRUVIC ACID (MG. PER 100 CC)

	Before run	After run
Blood	<1	3.37
Urine	0	5.80

Methylglyoxal also can be detected by the use of 2:4-dinitrophenylhydrazine, but we have not seen methylglyoxal 2:4-dinitrophenylosazone in any of our experiments. Therefore, pyruvic acid but not methylglyoxal seems to be one of the variable constituents of blood and urine during hard exercise. These results are interesting because of the contention by the schools of Embden and Meyerhof that pyruvic acid is of considerably greater significance than methylglyoxal in muscular metabolism.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PRACTICAL METHOD FOR INDUCING OVIPOSITION IN DIURNAL LEPIDOPTERA

IT has long been the general impression that living butterfly eggs were difficult to obtain. During the summer of 1932, while attempting to obtain numbers of larvae for experimental purposes, the writer succeeded in finding a satisfactory method for inducing oviposition in all the species tried.

Gravid females ready to deposit eggs were obtained in the field. These could be detected by their tendency to hover about the food plant, or by their leisurely flight and inclination to pause near leaves rather than on flowers. The wings of these insects were clipped to within a fraction of an inch of the body in order to prevent fluttering, which usually resulted in rapid exhaustion. A small amount of food plant was next placed in a curved-neck bottle filled with water, and the tips of the stems were cut off under water. The leaves of the plant were placed so that they were in contact with the bottom of an ordinary Mason jar lying on its side (Fig. 1). The jar was then oriented so that the bottom or closed end was nearest to the source of light, which was a large window. After the butterfly was released in the jar, the open end was closed with netting.

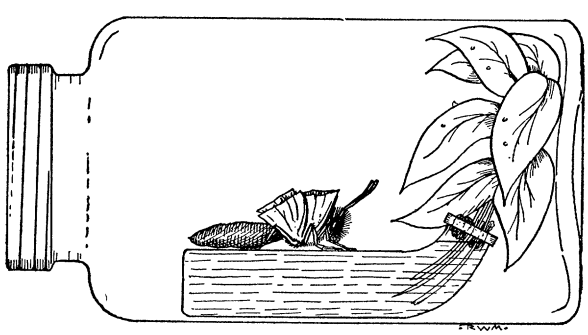

FIG. 1. Butterfly ovipositing jar. Light enters from the right.

In such close confinement with the food plant the butterfly invariably would become active, walking first in the direction of the light, up over the food plant and back again. Many individuals would deposit an egg on the plant at each trip until all the eggs were laid. Once a day the insects were removed and fed on sugar water, the fore tarsi being immersed in the solution to insure prompt feeding.

The following species were tried and all oviposited readily: *Papilio ajax* L. (=*asterias* Cram.); *Pieris protodice* Bdv. and Lec., *Pieris rapae* L.; *Colias eurytheme* Bdv.; *Vanessa atalanta* L.; *Vanessa cardui* L.; *Basilarchia arthemis* (Drury), and *Basilarchia archippus* (Cramer). When confined without food plant, a specimen of Harris' Checker-spot, *Melitaea harrisi* (Scudder), laid a single mass of more than two

[1] L. J. Simon and L. Piaux, *Bull. Soc. Chim. Biol.*, 6: 477, 1924.
[2] R. E. Johnson, *Biochem. Jour.*, 30: 31, 1926.
[3] R. A. Peters and R. H. S. Thompson, *Biochem. Jour.*, 28: 916, 1934.