was to ensure the maximum of output with the minimum of fatigue. Overtime was an elastic term, and not only imposed a severe strain on the worker, but it curtailed unduly the periods for rest and repose; it was uneconomical, physiologically extravagant, and frequently resulted in lost time and diminished output.

UNIVERSITY AND EDUCATIONAL NEWS

The University of Chicago has received from Mr. Frederick H. Rawson a gift of $300,000 for the construction of a laboratory building in connection with the plans for the medical school.

A provisional gift of $100,000 to the University of Vermont has been given by General Rush C. Hawkins, of New York. The money is given on condition that the university raise an additional $200,000.

Tulane University has received a bequest of $60,000 for the School of Tropical Medicine, available after the decease of the wife of the late Colonel W. G. Vincent.

The new gymnasium of the Stevens Institute of Technology was dedicated with appropriate ceremonies on November 18. The building, which was erected at a cost of over $125,000, is the gift of Mr. William Hall Walker, of New York.

Dr. L. V. Heilbrun has been appointed instructor in microscopic anatomy at the College of Medicine at the University of Illinois.

The School of Medicine of the University of Alabama announces that two new all-time professors have been appointed to the faculty. Dr. Joseph M. Thüringer, of the Harvard Medical School, becomes head of the department of anatomy, and Dr. Claude W. Mitchell, Ph.D. (Nebraska, '13), M.D. (Chicago, '15), head of the department of physiology and pharmacology.

Mr. William George Palmer, B.A., formerly scholar, has been elected to a fellowship at St. John's College, Cambridge. Mr. Palmer, who came up from Guildford Grammar School, took a first in each part of the Natural Science Tripos, 1913–14, with distinction in chemistry, and was awarded the Hutchinson studentship.

DISCUSSION AND CORRESPONDENCE

SYNCHRONISM IN THE RHYTHMIC ACTIVITIES OF ANIMALS

Two men walking together keep step so easily that the keeping step seems automatic. With a similar feeling of its naturalness we keep time in various ways, as in marching or dancing to music. Although these actions seem so automatic, they all or nearly all were learned by conceptual awareness of the relations between one's own actions and the actions of others, and purposive imitation of the latter. Such awareness of relations and purposeful imitation have not been found in animals (with the possible exception of the Primates). Certainly in most of the behavior of animals the tendency to keep time with an external rhythm is conspicuously absent. When two horses are driven abreast, each trots in his own rhythm in sublime disregard of his team-mate. Every circus has its so-called dancing animals, but I never saw one that really kept time with the music except as the trainer prompted it. Some birds have wonderful musical powers, but I never knew of a case of two birds singing in unison, nor of a bird singing synchronously with any external rhythm.

Nevertheless, although an animal can not have a concept of the relation between two coinciding rhythms, it is supposable that some animals might have an innate mechanism that would bring them into synchronism with an external rhythm, just as two pendulums or two dynamos, if properly adjusted, maintain a perfect synchronism. Let us review the observations that might substantiate such a supposition.

Many animals are provided with lock and key reflexes which produce an admirable synchronism. Two cocks fighting jump at each other at almost the same moment. Many birds, notably some of the Limicolæ, fly in close flocks and the whole flock turn apparently at the same moment in their rapid evolutions. But it is important to notice that these actions are not rhythmical. To maintain such admirable synchronism and at the

same time maintain a rhythm would be a quite different task.

There are some cases in which animals do act in synchronism with an external rhythm, but so far as I have observed they are always cases in which the time of the animal's actions is regulated by a powerful force from the environment, and fall under one of the two following heads: (1) Slow rhythms, such as those of the seasons, or of day and night, in which there are changes in temperature, light, etc., which have plenty of time to act on the organism; (2) cases in which there is bodily contact between the organism and that with which it keeps in synchronism, as the case of a canary swinging on a swing-perch, or that of certain spiders swinging on their webs. Are there any cases which do not fall under either of these two heads? Some observers have reported them, but let us examine their reports.

Dr. Edward S. Morse[1] cites a case from memory in which he saw "fireflies flashing in unison," but he gives no exact details. He quotes a paper by Mr. Blair[2] mentioning the same phenomenon; but Mr. Blair states that he never observed the synchronism himself, and he does not cite any authority who has observed it. Dr. Morse in another paper[3] quotes R. Shelford as observing a tree full of fireflies pulsating "so that at one moment the tree would be one blaze of light, whilst at another *the light would be dim and uncertain.*"[4] This last clause makes it appear that some fireflies were not in synchronism with the others, and thus brings in the statistical fallacy to be mentioned presently. Dr. Morse quotes Dr. H. C. Bumpus as another observer of the phenomenon; I wrote to Dr. Bumpus, asking certain questions, and he kindly sent me the following statements as to his observation: he saw the synchronism in perhaps 50 fireflies distributed over two acres; he noticed the synchronism only as he was passing the area, so can not say how long it lasted; the interval between flashes was perhaps a half second; he thinks the synchronism was not accidental and not an illusion; but he thinks there were also *some fireflies that were flashing asynchronously.*[4] Now, where a large number of fireflies are flashing at slightly differing rates there must be a great amount of accidental synchronism; to determine whether there is a degree of synchronism not due to mere accident, one would need a statistical examination. Viewing any large assortment of instances without statistical methods, one can see in them whatever one is predisposed to see; and we are always predisposed to perceive a rhythm—this is a well-known psychological fact. I once had an experience which I think was like that with the fireflies: I was looking at a great area of water covered with ripples flashing in the sunlight, and the flashes I saw were all synchronous, at a rate of perhaps three per second; but their synchronism must have been an illusion.

Dr. Morse[5] quotes a different case, from Cox, who says:

> Certain ants . . . when alarmed, knock their heads against the leaves and dead sticks . . . every member of the community makes the necessary movement at the same time.

This case would seem to necessitate that the ants perceive time relations, for each ant must know when the sound is to come and must anticipate it by making the head movement. It is much more probable that the synchronism was an illusion of the observer.

Professor W. B. Barrows[6] reports seeing a bittern sway gently from side to side as the grass around it was swayed by the wind. But it is doubtful if the observer, seeing the bird against a moving background, could tell truly whether it swayed or not. The details which are given make the phenomenon seem very like an illusion.

In 1897, Dolbear[7] stated that all the crickets in a given field chirp simultaneously. But

[1] Morse, E. S., SCIENCE, February 4, 1916, 169–170.

[2] Blair, K. G., *Nature*, December 9, 1915, 414.

[3] Morse, E. S., SCIENCE, September 15, 1916, 387–388.

[4] Italics mine.

[5] Morse, E. S., *loc. cit.*, 387.

[6] Barrows, W. B., *The Auk*, April, 1913, 187–190.

[7] Dolbear, A. E., *American Naturalist*, Vol. 31, 970–971.

Professor Shull[8] observed more carefully, found that this was not the case, and concluded that the synchronism observed by Dolbear was an illusion. However, Shull observed certain cases in which two individuals were in synchronism. His observations are not open to the objections raised in case of the fireflies, because: first, there being only two crickets concerned, the statistical fallacy does not enter; secondly, his observations were repeated and checked with great care, the rate of chirping being accurately timed. There can be no doubt that Shull observed real synchronism between two crickets at a time. But he says (in a letter to me, dated October 8, 1916):

> I am at present inclined to think that these cases of synchronism were usually accidental. . . . However, the insects do, I am sure, influence one another. . . . I regard it as still an open question whether something more than chance was involved.

In the article quoted, he questions whether the synchronism may have been due merely to temperature; for at a given temperature nearly all the crickets chirp at almost exactly the same rate.

In answer to our question whether animals ever do maintain a synchronic rhythm of a sort not included under (1) and (2) of my fourth paragraph, we have found good evidence for an affirmative answer only in the case of crickets chirping. And in that case it is still somewhat in doubt whether their simultaneity is accidental, or due to the influence of environment, or due to a lock and key adaptation by which one cricket stimulates the other. If any naturalist can give complete and accurate observations on such synchronic rhythms, these will be of great interest to the psychologist.

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Is Cucumber Mosaic Carried by Seed?

In 1915 cucumber mosaic caused a rather serious loss on one of the farms where cold frame cucumbers are grown in the tidewater section of Virginia. The same disease again developed on this farm in the spring of 1916 on land which was in cucumbers last year and also on land which had not grown this crop for the past three years. This year as usual the seed was sown in pots in the greenhouse and the plants were transplanted to the cold frames on April 5, 1916.

On May 25, 1916, before the glass covering had been removed from the cold frames, the writer observed typical mosaic plants scattered throughout the frames. A little later "white pickle" fruits were also obtained from the diseased vines. Of a total of 7,785 plants 110 were diseased on the above date.

The cold frame growers in this section all use one strain of forcing-cucumber seed which they obtain from the same seed company. On visiting the other cold frame farms during the same week typical cases of mosaic were found on three of the five farms and plants suspected of the disease were observed on the other two. Plants on one of the latter two farms have since produced typical "white pickle" fruits though the leaves are not strikingly mottled.

These observations indicated that the disease was carried by the seed, but as in some cases the diseased plants were growing on land which had produced mosaic plants the previous season, there remained the possibility of a soil factor.

Data which made the matter of soil transmission appear less likely was obtained from cucumber plants which the writer was growing at the Virginia Truck Experiment Station. These plants were from the same strain of seed as that used by all of the cold frame growers. The seed was planted April 27, 1916, in a cold frame of steam sterilized soil which had not previously grown a crop of cucumbers. Of a total of 155 plants 58 typical mosaic plants were observed on June 5, 1916. No insects were observed on the plants up to that time, probably due to the fact that the bed is surrounded on three sides by a tall hedge and on the fourth side by the station greenhouses. The high percentage of diseased plants and the failure to account for the disease in any other way lead the writer to think that this mosaic came from the seed.

[8] Shull, A. F., The Stridulation of the Snowy Tree-cricket (*Œcanthus niveus*), *Canadian Entomologist*, 1907, Vol. 39, 213–225.