during the summer of 1935. Seasonal movements of some animals, in connection with breeding or hibernation, may result in their greater destruction temporarily, but such killing is no basis for the estimation of a continuous daily rate of killing. Finally, let no sweeping conclusions as to the destructiveness of the automobile in respect to wildlife be drawn from such limited and variable observations as have been described here. The problem is in need of a systematic statistical survey covering several seasons and various localities.

W. A. DREYER

UNIVERSITY OF CINCINNATI

IS A PACEMAKER INVOLVED IN SYNCHRONOUS FLASHING OF FIREFLIES?

ONE hesitates to add another discussion to the long series already published on the fascinating problem of synchronous flashing of fireflies. The existence of this phenomenon in the tropical Orient is well established, and good descriptions of it have appeared in this journal[1, 2] and elsewhere.[3] It is so easily observable in Siam that some of the efforts to explain it away are "more remarkable than the phenomenon itself."[2] However, my own observations suggest that the mechanism which maintains the synchrony involves a pacemaker, with stimulation through the light, a view not altogether in accord with previously published statements, but in agreement with a recent general interpretation of such phenomena.[4]

The phenomenon, during certain seasons,[1] may be readily observed from a boat in the Chao P'ya River between Bangkok and the sea. At some distance from the shore one may observe flashing in mangrove trees extending (at my estimate) for a quarter of a mile or more up and down the river. Although all the insects in these trees are flashing at the same frequency, and seem at first glance to be flashing in perfect unison, it has been my observation that each flash appears as a pulse of light that moves with great rapidity across the field of vision from one side to the other. In other words, in a long stretch of shore one may detect a slight *difference in time* of flashing (though *not in frequency*) between the insects that are some distance apart. My wife and others with me have verified this observation. Perhaps it could not be made satisfactorily in a small area, because, in spite of the high frequency (over ninety flashes per minute), all the trees visible at one time are darkened between consecutive flashes. In other words, if, as seems likely from this observation, a pacemaker stimulates the synchrony, the latent period of response to the stimulus by the individual insects is extremely short.

Morrison[1] pointed out two facts that are in accord with this interpretation, (1) the synchronism of the flashing may be inhibited by "exposing them [the fireflies] to a bright light for about a minute," and (2) "when the light is turned off, the synchronism returns, having its origin, apparently, in some individual or group generally located in the central part of the tree. From this group, then, the synchronism extends over the entire tree in an irregular wave until all of the insects are flashing in unison." However, he did not believe that the synchrony once established involved a pacemaker: "Furthermore, any follow-the-leader action on the part of the insects would result in a wave of light passing over the tree and originating from a definite point, a fact which is not the case once the synchronism has begun." What I have observed is this particular bit of crucial evidence—not a wave of light passing over a single tree, however, but a wave of light passing over a long row of trees.

Of some interest in connection with the suggestion of a permanent pacemaker are the experiments described by Hess.[5] In one of the rare observations of synchronous flashing of American species, in this case in a valley near Ithaca, New York, he found that he could initiate synchronous flashing by means of a pocket flashlight and even cause the insects to adopt a somewhat higher frequency.

It is not difficult to conceive of an internal mechanism which would make possible such a rhythmic behavior in a single individual. It might be some kind of recovery mechanism, as was early suggested.[6] A greater problem lies in the explanation of a synchrony which involves so many thousands of individuals; although, of course, a recovery mechanism may very well have a part in determining the frequency. A mechanism which is responsible for rhythmic behavior does not explain the synchronism of rhythmic behavior in different individuals. That seems to require an integrative factor. My own suggestion is that a pacemaker is a continuous as well as an initiating factor. In the absence of a pacemaker mechanism we should be forced to postulate the existence of an accurate physiological chronometer, a mechanism to most of us quite inconceivable.

GORDON ALEXANDER

UNIVERSITY OF COLORADO

THE FIRST SCHOOL OF CHEMISTRY

I HAVE just been reading Thomas T. Read's short article[1] on the First School of Chemistry, in which he

[1] T. F. Morrison, SCIENCE, 69: 400–401, 1929.
[2] Hugh M. Smith, SCIENCE, 82: 151–152, 1935.
[3] T. F. Morrison, *Journal of the Siam Society, Natural History Supplement*, 7: 71–81, 1927.
[4] W. C. Allee, "Animal Aggregations," pp. 88–96. Chicago, 1931.
[5] W. N. Hess, *Biological Bulletin*, 38: 39–77, 1920.
[6] K. G. Blair, *Nature*, 96:411–415, 1915.
[1] SCIENCE, October 18, 1935, page 371.

mentions the School of Chemistry established at Columbia in 1862.

A somewhat similar case is that of the School of Applied Chemistry at Yale, which was started in 1847 by Professors Benjamin Silliman, Jr., and John P. Norton. The school later became the Scientific School and in recognition of the gifts of Joseph Sheffield became the Sheffield Scientific School in 1861. Up to 1852 the Scientific School was a School of Applied Chemistry; from that date other scientific subjects were introduced.

PHILIP E. BROWNING
YALE UNIVERSITY

SCIENTIFIC BOOKS

THE ALLIGATOR

The Alligator's Life History. By E. A. McILHENNY. 117 pp., 18 illustrations from photographs. The Christopher Publishing House, Boston, 1935.

THIS little book, though written in popular vein by a well-known business man, is a really valuable contribution to the ecology of our largest native reptile. It is doubtful if any other educated man has ever lived so long and intimately with *Alligator mississippiensis* as has Mr. McIhenny, who has spent his entire life at the family estate on Avery Island, Louisiana, and has studied the alligator from early boyhood days. A considerable number of facts brought out in this interesting account, so far as the reviewer is aware, are here made known for the first time.

He has studied the food habits of the alligator, both by seeing the animals caught and by an extensive study of stomach contents. He saw a 3-year-old cow seized and drowned by a 12-foot 'gator and a "large sized" deer by a 9-foot 'gator. He saw a 3½-foot alligator eat an entire brood of eight young duck as they swam less than 200 feet across a lagoon. The stomach of a male alligator, 10 feet, 1 inch long, contained 11 herons, 4 garfish and 4 turtles. Muskrats are the chief food of alligators in land-locked ponds. Water snakes and gars are frequently eaten, so that where alligators are numerous these forms are scarce; and where gars are numerous, game fish are apt to be scarce.

In studying the rate of growth he toe-marked many young animals, which were caught and measured at intervals, thus getting data on growth under absolutely natural conditions.

The largest alligator of which he knew the actual measurement was 19 feet, 2 inches long. The females seldom if ever exceed 9 feet in length. A 15-foot alligator is 30 to 40 years old.

An individual alligator may occupy the same den for 30 years. This den may be 60 feet long and have more than one entrance. The author has watched the animal excavating its den in the bank of a stream. He has also watched, from a blind, a female build her nest and lay the eggs in it, at a rate of about one egg every nine seconds. He says the female crawls over her nest once or twice a day and moistens it by voiding urine over it.

By repeated observations he determined that the normal period of incubation is 63 days, with only 2 or 3 days variation either way. Daily maximum and minimum temperature readings were taken of the interior of the nest and of the outside temperature. The highest maximum recorded for a nest was 102°; the lowest minimum was 88°.

It is commonly said that the mother pays no attention to her young after liberating them from the nest, but the author states that the young remain with their mother until the onset of the breeding season of the spring following their birth; and he has, on several occasions, seen the mother crush an animal in her jaws and hold it at the surface of the water for her young to devour.

The author is evidently skeptical of the reviewer's statement that embryos are found in fresh-laid or even in uterine eggs, but says if such be true it is an abnormal condition. Of the hundreds of alligators and caiman eggs opened by the reviewer, practically all those that were fertile contained embryos in early stages of development. The author is of the opinion that the bellow or roar of the alligator, always by the male, which may be heard on a quiet night for a distance of three miles, is a challenge rather than a call to the other sex.

The alligator has already been exterminated over a large part of its original habitat, but it has been shown that it will increase rapidly if given protection against hunters. For example, it was protected on various southern refuges and in four years increased so rapidly that the muskrat hunters complained, and 100 hunting permits were issued which resulted in the destruction of between 88,000 and 89,000 alligators in the year 1916.

Three years ago Mr. McIlhenny set aside about 5,000 acres of suitable land where no alligators were to be killed; already a large increase in young animals has been noticed.

Mr. McIlhenny has never heard of an authentic case of a human death by an alligator.

ALBERT M. REESE
WEST VIRGINIA UNIVERSITY