large cortical convulsions resembles the sequence of events in the spinal cord after injection of toxin into the cord or motor nerves. The similarities during treatment with the same pharmacological agent, tetanus toxin, suggest that the inhibitory transmitter operating at cortical synapses mediating the late phase of "antidromic" cortical inhibition is very similar to, if not identical with, the inhibitory transmitters active in the spinal cord (*10*).

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13 April 1962

Reappearance of Eulimnadia agassizii with Notes on Its Biology and Life History

Abstract. After being unreported for 83 years, *Eulimnadia agassizii* Packard was collected from a temporary pool in Woods Hole, Massachusetts, in 1956 and again in 1961. This conchostracan attains maturity in 5 days and may reappear several times during the summer months in the same location.

The conchostracan phyllopod *Eulimnadia agassizii* Packard 1874 has not appeared in the nets of collectors since its discovery more than 80 years ago on Penikese Island in Buzzards Bay, Massachusetts. It was first found in a small pool of fresh water by Walter Faxon on 27 August 1873, and immature stages were collected in the same pool in early August of the following year. This species has been rediscovered twice in recent years in a sand trap at the golf club at Woods Hole, Massachusetts. The animal was fittingly named in honor of Louis Agassiz by Alpheus S. Packard, Jr. (*1*). Packard, one of Agassiz's students and an instructor at the famous Anderson School of Natural History, was on Penikese Island and possibly was present at the time of the original collection.

Although several expeditions have sampled the small ponds on the island quite thoroughly (*2*) and various individuals have undoubtedly examined the fauna of these fresh waters, *E. agassizii* has not been reported since its original discovery (*1, 3*). Since its original discovery was not questioned, its absence was explained mainly on the basis of a theory that subsequent collections were not made sufficiently early in the year, when pond-water temperatures were low. However, current evidence indicates that *E. agassizii* is probably not a spring form but one that appears primarily in early fall in years of unusually heavy rainfall during large storms.

On 18 July 1956, 4 days after a very heavy rain, both the northernmost sand trap of the third hole of the Woods Hole Golf Course and a natural depression more than 50 feet away, separated from the sand trap by a low rise, contained 4.5 inches of water and many phyllopods bearing eggs. A representative sample of animals was collected, preserved, and sent to a specialist for verification of identification. The water disappeared the following day. The phyllopods decreased in number as the pools dried out.

From this time until the second rediscovery of these phyllopods, on 29 July 1961 after a heavy rain on 23 and 24 July, there had been insufficient rainfall during the warm months to keep water in the sand trap for much more than 24 hours. On 29 July the population was again large, and brown individuals were distributed throughout the pool. On 30 July they were carrying eggs, were starting to accumulate in small depressions, and had turned grass-green through ingestion of benthic diatoms that had appeared in large numbers. Sampling on both 29 and 30 July revealed no larval stages and no males. The only other macroscopic organisms were small brown diving beetles and waterstriders. The water temperature on 29 July at 11 A.M. was 32.5°C, and on 30 July at the same time, 32°C; both days were cloudless. By 5 P.M. on 31 July the trap was dry and no phyllopods were found.

On 23 August a rainfall of more than 1 inch filled the sand trap again. On 26 August larval forms appeared and doubled in size about every 12 hours until 28 August, when they became adults. On this day, just before the water disappeared from the trap, a small sample of *Eulimnadia* was collected (*4*) and placed in a battery jar with trap water. Here they remained alive for more than a week, eventually attaining maturity without developing eggs.

On 30 September, 5 days after severe rain accompanying hurricane "Esther" had deposited more than 2 inches of water, examination of the trap revealed nothing but a few aquatic beetles. The water disappeared within 24 hours.

The phenomenon of a species of phyllopod hatching more than once in a single location during the same season is probably better explained by the hypothesis that different groups of eggs of the same generation that had overwintered in soil, hatch after subsequent soakings than by the hypotheses that eggs of the second hatching need two soakings before developing, or that the second brood came from eggs of the first brood. The phenomenon resembles the situation in related branchiopods and in copepods, where repeated hatchings have been observed experimentally and in nature in dry depressions that have been occasionally filled by rain water.

Dexter (*5*) collected a series of three separate hatchings of the fairy shrimp *Eubranchipus vernalis* from a single pool in the seasons 1955–56 and 1958–59. The pool lost its water repeatedly by evaporation or by freezing solid. Larvae of the first two hatchings never reached maturity. It is obvious that all the eggs hatched that season were present from the beginning. Undoubtedly many others remained unhatched until a later time. It is not known why some eggs hatch at one soaking and others during a later soaking. Variability in hatching time may be related to racial differences in egg permeability, or to variations in their depth in the soil at the bottom of the pool.

These animals have an unusually short life cycle and pass through larval stages rapidly as compared with most conchostracans whose development is known. Certainly the relatively high temperature of the water acts as a stimulus to both growth and development; a somewhat analogous adaptation has been observed in desert Crustacea, with lapses of many rainless years between hatchings and unusually rapid passage through larval stages during the brief life of temporary pools.

The reappearance of *Eulimnadia agassizii* in this location appears all the more unusual in the light of information received from Herman Wessner, caretaker of the Woods Hole golf course for many years (*6*). He stated that only screened marine beach sand from Nobska had been placed in this particular trap for the past 15 years. This may be evidence that these animals have been there for a long time; they have not been found elsewhere in the Cape Cod area.

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27 March 1962

Nature of the Sound Produced by Drosophila melanogaster during Courtship

Abstract. The wing vibrations of courting male *Drosophila melanogaster* Meigen produced pulsations of sound, with each pulse apparently caused by 1 to 2 cycles of wing movement. The average repetition rate at 25°C was 29.8 pulses per second. The rate was dependent on temperature, increasing at 1.4 pulses per additional degree Celsius.

A variety of overt male courtship behavior patterns is evident among the many species of *Drosophila*. For a given species, some or all of the following elements may be observed: tapping the female with the legs, posturing near the female, vibration or scissoring of the wings, and "licking" of the genitalia. Spieth (*1*) presents a comprehensive account of courtship and mating for 101 *Drosophila* species. These courtship behavior patterns have been intensively studied by researchers interested in the evolution of behavior and the development of sexual isolation between similar species.

The most obvious characteristic of courtship in *D. melanogaster* Meigen is the wing display, in which the male extends one wing to an angle of approximately 90 degrees to the side of the body and vibrates it. The wing extended is usually the one closest to the head of the female. The male ultimately assumes a position to the rear of the female and, in one coordinated series of movements, applies its proboscis to the female genitalia and attempts to copulate. If unsuccessful in this attempt, the male generally persists in its courtship-posturing at various angles to the female, vibrating a wing, and trying to mate.

There is at present no direct evidence that the wing vibrations of male *Drosophila* serve as an auditory stimulus to the female. Indirect evidence supporting (*1, 2*) or casting doubt on (*3*) the existence of such a stimulus is presented by various authors. My research was initiated in an attempt to characterize the wing vibrations of male *D. melanogaster* so that the function of this element of courtship behavior might be more thoroughly studied.

Virgin wild-strain adults which had been caged individually for 4 to 5 days after their emergence from puparia were used. For each trial, a male and female were anesthetized with carbon dioxide and were placed in a cylindrical cage constructed of 32-mesh plastic screen and measuring 12 mm in diameter by 10 mm in height. The bottom of the cage was mounted on the sensitive element of an Altec model 21 D condenser microphone, and the top was covered with a glass cover slip.

The microphone and attached cage were shielded from extraneous noise by an insulated box. The interior of the box, measuring 8 inches in height by 4 by 4 inches, was filled to a depth of 5 inches with rock wool insulation; the microphone was embedded in the insulation with only the cage exposed. Each side and the bottom of the box were constructed of two 2-inch-thick layers of glass wool placed alternately between three ½-inch-thick layers of plaster board. The outer surface of plaster board was faced with ½-inch-thick plywood. The top of the box was covered with five sheets of ½-inch-thick plexiglass which were separated from each other by 1-inch air spaces.

The microphone generated heat which increased the air temperature in the cage by ¼° to ½°C per minute. Temperatures were measured with a Leeds and Northrup single range potentiometer connected to copper and constantan thermocouple leads. The leads were joined inside the cage.

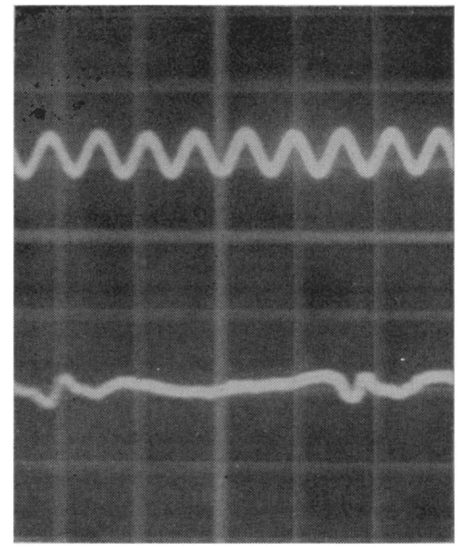

Fig. 1. Sound produced during courtship by a *D. melanogaster* male at 25.3°C. Top trace is a time marker at 200 cy/sec. Bottom trace shows sounds produced during two consecutive pulses of wing movement, with one pulse at each end of the trace.

Sounds produced by the males during wing vibration were transmitted from the microphone through an alternating current preamplifier to an oscilloscope. Photographs of the traces on the oscilloscope screen were obtained so that the nature of the sound could be accurately characterized.

The vibrations consist of series of discontinuous pulses of sound (Fig. 1). The pulses, each of which appears to correspond to between one and two complete cycles of up and down wing motion, occur at fairly regular repetition rates for any given temperature; the average rate at 25°C was 29.8 pulsa-

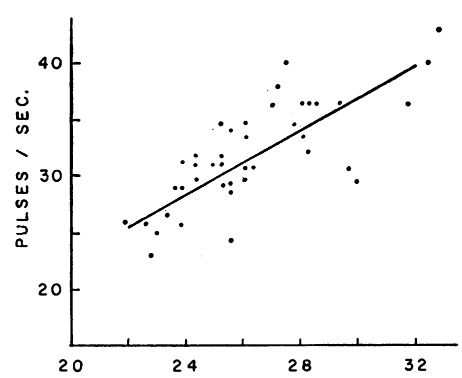

Fig. 2. Relationship between temperature and frequency of pulses of wing movement produced by male *D. melanogaster* during courtship. Correlation coefficient is 0.79, significant at 0.05 probability level.