9974 P

Function of the Giant Fibers of the Central Nervous System of the Crayfish.

C. A. G. WIERSMA.

From the William G. Kerckhoff Laboratories of the Biological Sciences, California Institute of Technology, Pasadena.

Johnson[1] has made studies about the course, the connections and the function of the giant fibers of the central nervous system of a few crustaceans, especially of Cambarus. Without actually isolating these fibers, he came to the conclusion that both sets of giants, described as the median and the lateral giants, have the function of flipping the tail. The median giants seem to connect with the motor fibers of each abdominal segment by a very simple contact mechanism; the connection of the lateral giants with the motor fibers is not as well known.

With the same method as used in the studies on the peripheral nerve-muscle system of crustaceans[2] it was possible to isolate in the oesophageal commissures these 2 sets of giant fibers of *Cambarus clarkii* and to stimulate them separately. The median giant fibers are considerably thicker than the lateral ones, the former have a diameter which varies between 200μ and 250μ, whereas the latter measure 60μ to 90μ in the animals used.

It was found that single induction shocks applied to the unprepared oesophageal commissure or to any of the 4 giants caused a twitch-like contraction of the flexor muscles of the tail, a stretching of the legs and an inward movement of the antenna. The other fibers in the oesophageal commissures do not give a noticeable reaction to single shocks (with faradic stimulation various effects may be obtained from them). The tail contractions were registered either isotonically with load or isometrically and it was found that the effect of single shocks applied to any of the 4 fibers did not vary with the strength of the stimulus within wide limits. The threshold contraction is of a considerable strength and only with very strong shocks is a higher contraction obtained, which is due either to stimulation of the other giant fiber in the same commissure by current escape, or to a repeated discharge in the stimulated fiber. There can thus be no doubt about the validity of the all-or-none relation of this system, which is the more convincing as the series of connections which each giant makes in the row of ganglia would be an ideal

1 Johnson, G. E., *J. Comp. Neurol.*, 1924, **36**, 323; 1926, **42**, 19.

2 Harreveld, A. van, and Wiersma, C. A. G., *J. Physiol.*, 1936, **88**, 78.

opportunity for decremental conduction to show, as the number of ganglia reached would be then proportional to the strength of the stimulus.

The question whether these fibers are really intracentral fibers and thus connected with the peripheral neuron by a synapse must be answered in the affirmative. It is possible to stimulate separately the 3 peripheral nerve bundles which leave each ganglion on both sides. Single shocks of moderate strength never result in a real twitch of the tail. Only on stimulation of the third root is some flexion obtained, but this contraction is localized to the segment innervated by this root. After cutting a third root, stimulation of the peripheral part has an effect similar to that obtained before the cutting, whereas stimulation of the central stump does not result in a visible effect unless the stimulus is made so strong that a stimulation of the giant fibers in the chain is possible by current escape.

Experiments on the summation of 2 single induction shocks given to 2 different giants were carried out in 3 combinations. For the 2 median giant fibers it was found that no summation occurred when they were stimulated simultaneously. When either one was stimulated before the other with intervals up to about 1.3σ there was no summation. With slightly longer intervals there was some summation, which became maximal at an interval of about 1.7σ, and declined slowly with increasingly longer intervals. For the 2 lateral fibers the maximum interval between stimuli during which no summation occurs is about 4.5σ and the first summated contraction is usually also maximal. When a median and a lateral giant are combined, the result is less clear than in the foregoing cases. Often some summation is obtained at all intervals. It should be remarked that the contractions caused by a median and a lateral giant are often not quite equal in height; in a fresh preparation the median usually causes a somewhat stronger contraction than the lateral, but this varies in different animals and in the course of one experiment. There is usually a pronounced summation when these 2 fibers are stimulated simultaneously. When the median giant is stimulated before the lateral one, summation occurs at all intervals at which the 2 contractions fuse. When the lateral giant is stimulated first a range of intervals occurs giving much less or no summation, this range is from about 0.5σ to 3σ; longer intervals again give summation.

These experiments show that a "refractory period" is obtained by stimulation of different fibers, and from this it must be concluded that all 4 giant fibers govern the same peripheral nerve-muscle systems in the tail.