sure showed the average ventral aortic systolic pressure to be 28.2 mm Hg, the average dorsal aortic systolic pressure to be 15.4 mm Hg, and the average ventral aortic pulse pressure to be 13.3 mm Hg. The reflex cardiac inhibition, following the increased ventral aortic pressure which results from a spontaneous ejection reflex, lowered the ventral aortic diastolic pressure to a significant degree. The mechanism may therefore be considered of physiological significance and may be compared with the carotid sinus mechanism of mammals.

When the amphibian *Necturus maculosus* was used, reflex cardiac inhibition resulting from mechanical or electrical stimulation could be obtained only from the gills (Fig. 1). A sudden increase of vascular

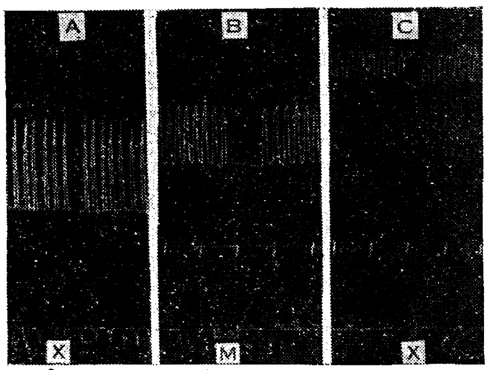

FIG. 1. Reflex cardiac inhibition. Heart beat recorded by lever. Time, five-second intervals. A. *Squalus acanthias*. Cord destroyed. Increase of pressure, at X, to 44 mm. Hg in the first branches of the ventral aorta. B. *Necturus maculosus*. Cord destroyed. Mechanical stimulation of left gills at M. C. *Necturus*. Decerebrated. Increase of pressure, at X, to 49 mm Hg in the ventral aorta.

pressure within the gill vessels also evoked reflex cardiac inhibition, even when the burette pressure was as low as 34 mm Hg.

It is conceivable, therefore, that in the course of evolution the wide-spread sensory areas of the ancestral form, possibly typified by the elasmobranch, with *Necturus* as an intermediate type, were concentrated or restricted until the condition seen in the mammal was reached. Since the carotid arteries of the mammal are derivatives of the primitive branchial system, the reflex cardiac inhibition of branchiovascular origin may exemplify the evolutionary forerunner of the carotid sinus reflex in mammals.

Inasmuch as the threshold for this reflex in *Squalus acanthias* was found to average 10.7 mm Hg above the dorsal aortic systolic pressure, and the average ventral aortic pulse pressure was found to be 13.3 mm Hg it follows that inhibition may occur with each heart beat. For example, in a typical case the ventral aortic systolic pressure was 22 mm Hg, the ventral aortic pulse pressure was 16 mm Hg, and the reflex was elicited when the pressure in the burette was raised to 18.6 mm Hg, a pressure well below the ventral aortic systolic blood pressure. Marked vagal tone of the heart has been found to exist in elasmobranchs.[4] It is suggested, therefore, that this vagal tone is initiated and maintained reflexly through the successive increases in blood pressure in the afferent branchial system due to the heart beats. It may be possible, however, that the vessels of the first two gills, isolated by the experimental procedure from the direct effect of the heart and exposed only to back pressure from the dorsal aorta, have become adapted to a lower pressure and show an abnormally low threshold. We have seen no evidence, however, for this supposition.

In mammals action currents synchronous with the heart beats have been recorded in the afferent vagus and in the cardiac depressor nerve.[5] Bronk[6] found action currents in the cardiac depressor and in the carotid sinus nerve of the rabbit coincident with the rapid rise of pressure in the pulse wave followed by comparative inactivity during diastole. This evidence and that obtained from the dogfish point to a special function of these afferent nerves, stimulated by the systolic pulse, in connection with the reflex origin of vagal tone. The phylogeny of a special physiological process in mammals is thus indicated.

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A LABORATORY EXPERIMENT IN ANIMAL BEHAVIOR

MOST modern courses in elementary biology or zoology include in the laboratory at least one exercise on reactions of living animals to stimuli such as light, gravity, touch, chemicals, etc. The animals which have been most frequently used in our own laboratories are Eisenia, Tenebrio larvae and Drosophila. Light responses of Eisenia and Tenebrio larvae are not easily studied in the laboratory which does not have suitable darkrooms available. This year we tried with considerable success a study of the responses of an animal which reacts readily to light under laboratory conditions.

Many fresh-water mussels are infested with para-

[4] B. R. Lutz, *Biol. Bull.*, 59: 211, 1930.

[5] W. Einthoven, *Quart. Jour. Exp. Physiol.*, 1: 243, 1908; E. D. Adrian, *Jour. Physiol.*, 61: 49, 1926.

[6] D. W. Bronk, *Proc. Soc. Exp. Biol. Med.*, 28: 1014, 1931.

sitic water mites which live between the gills. One of the common species of the eastern United States, *Unionicola ypsilophorus* var. *haldemani* (Piers), is found in *Anodonta cataracta* Say. This mite occurs abundantly, at least in eastern Massachusetts, and can be obtained at any time of year when the host is available. When these animals are removed from the host, washed and placed in water free from host material, they show a positive response to light. If water from the mantle cavity, or water extract of the gills is added to water containing the mites, they usually show a distinct reversal to a negative state as regards the light. This negative response may persist for a half hour or more if the concentration of host material is high. The reversal may be interpreted as a type of conditioned response brought about by some material from the host; the positive response to light being primitive and the negative response acquired since the mites have taken up a parasitic life. It may also be shown in the case of *Unionicola* from *Anodonta* that only material from the host will bring about a reversal, water from the mantle cavity or extract of the gills of such forms as *Elliptio* or *Lampsilis* having no effect on the mites. The influence of host on parasite is seen therefore to be specific for a particular host-parasite combination.

In a typical experiment ten mites are placed in a small rectangular glass jar with sufficient water to cover them. This is placed between two light sources which may be used alternately. In a series of trials, using first one light source and then the other, the number of mites which are positive may be determined and any which are negative may be removed if desired. If one light source is of high intensity (100 watt lamp) and one of low (15–25 watt lamp) they may both be used at the same time and the effect of intensity on the behavior of the mites observed.

Next, using one light source and attracting the animals to the end of the jar toward the light, a small amount (1–3 cc) of filtered extract of gill may be added in the neighborhood of the mites, and usually there is an immediate reversal to a negative state. This is not a chemotropic response, for the mites will often move out of the region of greatest concentration of extract to a region of lower concentration. If results are not conclusive the mites may be washed, returned to fresh water, and the experiment repeated.

Finally, if desired, the mites may be allowed to collect on a small piece of gill and usually, regardless of directional illumination, they will remain on the piece of gill probably as the result of a positive stereotropic response to a familiar surface.

Not all species of mites are satisfactory for such experiments. Some have been parasites for so long that they have lost almost all power of locomotion, others, such as *Unionicola fossulata* (Koen) from *Cyclonais tuberculata*, are positive only to light of low intensity (about 0.1 meter candles) a condition difficult to attain outside the darkroom.

Two papers by the author regarding the behavior of parasitic water mites have appeared elsewhere.[1]

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Experiments on the nature of the structural units of solids: ALEXANDER GOETZ (by invitation). It is necessary for a general understanding of the physical properties of crystalline solids to assume in addition to a regular geometric configuration of atoms or molecules in a crystal lattice also the existence of a mosaic structure, as has been proposed in recent years by Smekal, Ewald, Darwin and Zwicky mostly with regard to heteropolar substances. Because of the special interest of the effects depending on the mosaic structure in metals, *i.e.*, homopolar lattices, a systematic experimental investigation has been started which, up to the present, leads to the following general conclusion: A crystal consists of a more or less regular conglomerate of structural units, the size of which is a quality of the substance in question. Each unit is an ideal crystal in itself, its boundaries which coincide with certain low index planes form potential walls, which as such affect the electric transparency of the crystal. Impurities of structurally different substances are imbedded within the boundaries affecting their separating qualities and being sometimes even able to start new types of boundary-layers along different crystallographic planes. At higher temperatures the perturbing influence of these boundaries affects the structural unit to a larger extent and thus decreases the size of the ideal structural unit without affecting their number. Hence a block of metal in its most stable, *i.e.*, single crystalline configuration is considered as consisting of a crystalline and an amorphous component.

Supra-conductivity and the Hall effect: EDWIN H. HALL. Kamerlingh Onnes described two experimental investigations, each of which he regarded as indicating that there is no Hall effect in the supra-conductive state of a metal. In the first of these, plates of tin and of lead, respectively, in the supra-conductive state were tested directly for a Hall effect in the usual way, between the poles of a magnet. In the second, a spherical

[1] "Reversal of Phototropism in a Parasitic Water Mite," *Biol. Bull.* 59, 165, 1930; "Specific Influence of the Host on the Light Responses of Parasitic Water Mites," *Biol. Bull.*, 61, 497, 1931.