mutual contamination of characters in hybrids justifies the warnings given by breeders as to loss of characters in hybridization, and the care that they exercise to maintain pure races.

15 (107). **"The mechanism of conduction and coördination in the heart, with special reference to the heart of Limulus": A. J. CARLSON.** (Presented by **RUSSELL BURTON-OPITZ.**)

I. *The Rate of Conduction.* — It is advocated, chiefly by Engelmann, that the rate of conduction of an impulse in the heart is too low (20 cm. to 30 cm. per sec. in the frog; 2 m. to 4 m. per sec. in the dog) to take place in the nervous tissue. The slow conduction in the heart is thus construed as an argument in favor of the myogenic theory. This is based on the erroneous assumption that all nervous paths in the same animal conduct with the same, or practically the same, rapidity. The author has shown that this is not the case even for the motor nerves to the striated muscles. On the contrary the rate of conduction in the nerve stands in direct relation to the rapidity of contraction of the muscle supplied by the nerve.[1] On this principle one would expect the *rate of conduction* in the intrinsic nervous plexuses of the alimentary tract and of the heart of a vertebrate to be as much slower than that in the motor nerves to the skeletal muscles, as the *contraction* of heart-muscle and muscle of the digestive tract is slower than that of skeletal muscle. The rate of conduction in the intrinsic nerves of the vertebrate heart has not yet been determined. In the heart of Limulus, this can be done by the ordinary graphic method. The author has shown that in the heart of Limulus the rhythm is neurogenic, not myogenic, and that the conduction and coördination take place in the nervous and not in the muscular tissue.[2] The proofs of these conclusions are demonstrative. The author has lately measured the rate of conduction in the intrinsic heart nerves of this animal and has found it to be 40 cm. per second. The rate in the motor nerves to the limbs as found by the author is 325 cm. to 350 cm. per second. That is to say, *the rate of conduction in the nervous plexus in the heart is from eight to ten times slower than in the peripheral motor nerves.*

[1] Carlson: *American Journal of Physiology*, 1904, x, p. 401.

[2] Carlson: *American Journal of Physiology*, 1904–'05, xii, p. 67; also, p. 471.

II. *Conduction in the Heart in the State of Water-Rigor.* — The experiments of Fredericq, Waller and Reid, Bayliss and Starling, Schlüter, Engelmann, Hofmann, and Bethe have shown that the heart walls may conduct without contracting or being able to contract. This can be interpreted in two ways, viz.: (1) The conduction takes place in the nervous tissue, or (2) the conduction takes place in the muscular tissue, but the processes of conduction and contraction are so independent of one another that the muscle may conduct without contracting. The latter is the explanation usually adopted, based on the experiments of Biedermann and Engelmann on conduction in muscle in the state of water-rigor. Engelmann worked on the frog's heart. In the heart of Limulus the above two possible explanations may be put to experimental test.

The author transected the heart-muscle in the region of the second and the fourth heart-segments and dissected away a portion of the muscle about 0.5 cm. in length, leaving the three portions of the heart connected alone by the nerve-plexus (the median nerve-cord and the lateral nerves). The anterior and the middle portions of the heart continued in rhythm by virtue of the impulses from the ganglion of the posterior portion, these impulses reaching the two anterior portions by means of the intact nerve-plexus. When this nervous plexus is severed in the fourth segment, the region of the heart anterior to the sections ceases to beat. Hence, the anterior portion of the heart thus prepared beats in response to impulses that reach it through the nerve-plexus on the middle portion. Now, when this middle portion of the heart is placed in water, the muscle of this region absorbs water and ceases to beat or respond to artificial stimulation, while the anterior portion still beats in synchrony with the posterior portion of the heart. The nerves will also lose their conductivity if left in the water long enough. On replacing the water by plasma or sea-water the nerves are quickly restored. The muscle is restored very slowly and sometimes not at all. The nerve-plexus in the Limulus heart is composed of nonmedullated nerves, just as is the intramuscular nerve-plexus in the heart of a vertebrate. Now, since the behavior of the Limulus heart and the heart of a vertebrate in the state of water-rigor is the same, and, further, as

the anatomic conditions (nerve-plexus and muscle-cells) are similar in both, it seems probable that the tissue concerned with conduction in water-rigor is also the same in both. In the Limulus heart it has been demonstrated to be the nerve-plexus and not the muscle. In the vertebrate heart it has not been demonstrated to be the muscle. The recent experiments of Humblet, Hering, and Erlanger, of transecting on compressing the auriculoventricular muscle-bundle in the septum of the mammalian heart, decide nothing relative to the myogenic or neurogenic nature of conduction and coördination, because it has been shown by Tawara that this muscle-bundle is surrounded and accompanied by a nerve-plexus similar to that in the auricles and the ventricles themselves.

16 (108). **"Further observations on the effects of alcohol on the secretion of bile": WILLIAM SALANT.**

In a previous communication[1] on the effect of alcohol on the secretion of bile, it was stated that diminution in the rate of secretion of bile was observed after intravenous injection of alcohol. No definite conclusions could be reached at that time, however, as to whether the diminished secretion was due to alcohol, for a steady decline in the flow of bile was very often noticed during the periods before the administration of alcohol. Recent observations in a series of similar experiments on dogs, in which the rate of secretion remained unchanged for several periods or differed slightly, showed some diminution of the flow of bile after intravenous injection of alcohol. There was also a decrease in both the organic and inorganic constituents of the bile after intravenous injection of alcohol, but the relative amounts of solids were only slightly affected. The diminished excretion of solids, however, cannot be attributed to alcohol, for a wide range of variation prevails in the organic and inorganic constituents of the bile of untreated animals.

The effects are entirely different when alcohol is introduced into the gastrointestinal canal. The methods employed in this relation were identical with those of the previous experiments. Anesthesia was induced by ether without the aid of morphin. In every case the neck of the gallbladder was securely ligated to prevent flow of bile from that direction. A cannula was then intro-

[1] *Proceedings* of this Society, 1904, i, p. 43.