with Armour's preparation gained much less than the others. However, there was some variation in this respect between individual animals and the difference in the weight curves cannot account for the lack of compensatory hypertrophy in the group fed with Armour's tablets.

We have no reason for assuming that the cause of this difference is due to the admixture of another substance to the anterior pituitary. Dr. F. Fenger was kind enough to give us a detailed description of their mode of preparing the Armour anterior pituitary tablets. There are some differences in their and our own technique, and it is possible that this accounts for the differences in the effects obtained with the 2 preparations. In experiments which we have already begun, we shall attempt to separate the 2 substances responsible for the 2 opposite effects on the thyroid gland of the guinea pig which we found in certain preparations of anterior pituitary gland.

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Effect of Anoxemia, Carbon Dioxide and Lactic Acid on the Autonomic Fibers of Somatic and Visceral Nerves.

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In a previous paper,[1] the effects of anoxemia, CO_2 and lactic acid on certain fibers of somatic nerves were described. Further investigations by the author[2] and by Heinbecker and Bishop[3] have identified in autonomic nerves 2 other components of potential which possess properties different from those previously described by Gasser and Erlanger.[4] Similar action potentials traced by Erlanger and Gasser[5] from sympathetic rami into somatic nerves and thoroughly studied there by them apparently arise from similar fibers. We have found their potentials to have the same properties there as in autonomic nerves. These fibers have a higher threshold, a slower conduction

[1] Heinbecker, Peter, *Am. J. Physiol.*, 1929, lxxxix, 58.

[2] Heinbecker, Peter, PROC. SOC. EXP. BIOL. AND MED., 1929, xxvi, 349.

[3] Heinbecker, P., and Bishop, George H., PROC. SOC. EXP. BIOL. AND MED., 1929, xxvi, 645.

[4] Gasser, H. S., and Erlanger, Joseph, *Am. J. Physiol.*, 1927, lxxx, 522.

[5] Erlanger, Joseph, and Gasser, H. S., *Am. J. Physiol.*, 1929, in press.

rate, a longer absolutely and relatively refractory period, a longer chronaxie, and a potential at the stimulus of longer duration.

With the use of higher amplification (200 mm. per mv.) than employed in the previous work on CO_2, the compound conducted action potential of sciatic nerves of the frog, turtle, cat, dog and the monkey give rise to the same 4 components of potentials, named A, B_1, B_2 and C as are found in autonomic nerves. Taking the frog's sciatic as a type, the A wave arises from thickly myelinated fibers (somatic motor and sensory) as previously shown by Erlanger.[6] The B_1 wave presumed to correspond to the Delta wave described by Erlanger and Gasser but now with higher amplification no longer recognized by them as a separate entity is considered by the author, both because of its conduction rate and its other properties, to correspond to the B_1 wave described by the author[7] and by Bishop and Heinbecker.[4] In autonomic nerves it has been shown to arise from larger relatively thinly myelinated visceral afferent fibers. The results previously presented consequently cover the A and the B_1 potential waves of the new nomenclature. The materials used have been chiefly the sciatic nerves of bull frogs and autonomic nerves of the turtle.

Under anoxemia and lactic acid (N/1) the threshold of the B_2 and C fibers is finally raised. There is usually a definite preliminary lowering under anoxemia. With pure CO_2 the threshold of the B_2 fibers is little altered or moderately raised or lowered. That of the C fibers is usually quite definitely lowered. The conduction rates always are ultimately diminished. The absolutely refractory periods are increased. These findings apply to all 3 agents. Under anoxemia and lactic acid (N/1) the conducted action potential increases in temporal dispersion and its amplitude is decreased, ultimately to extinction, the B_2 and the C before the A, the C before the B_2 component. Under CO_2 the B_2 potential wave is moderately depressed, the C potential little altered or increased. Recovery with oxygen and washing with Ringer's is rapid but less so than with the A component and accompanied by a definite increase in total area above normal. Conduction rate and absolutely refractory period in good preparations return to normal. Threshold usually is lowered below the normal with recovery. Especially in the early stages of recovery there frequently occurs in these processes as was found previously for the A and B_1 processes, a dissociation of ordinarily correlated properties.

[6] Erlanger, Joseph, *Am. J. Physiol.*, 1927, lxxxii, 644.

[7] Heinbecker, Peter, *Am. J. Physiol.*, 1930, in press.

It has been observed that the B_2 and C potential waves are diphasic even when the nerve is killed between leads in a manner to render the A process apparently monophasic. When the nerve is killed only at the distal lead leaving the B_2 and C record almost completely

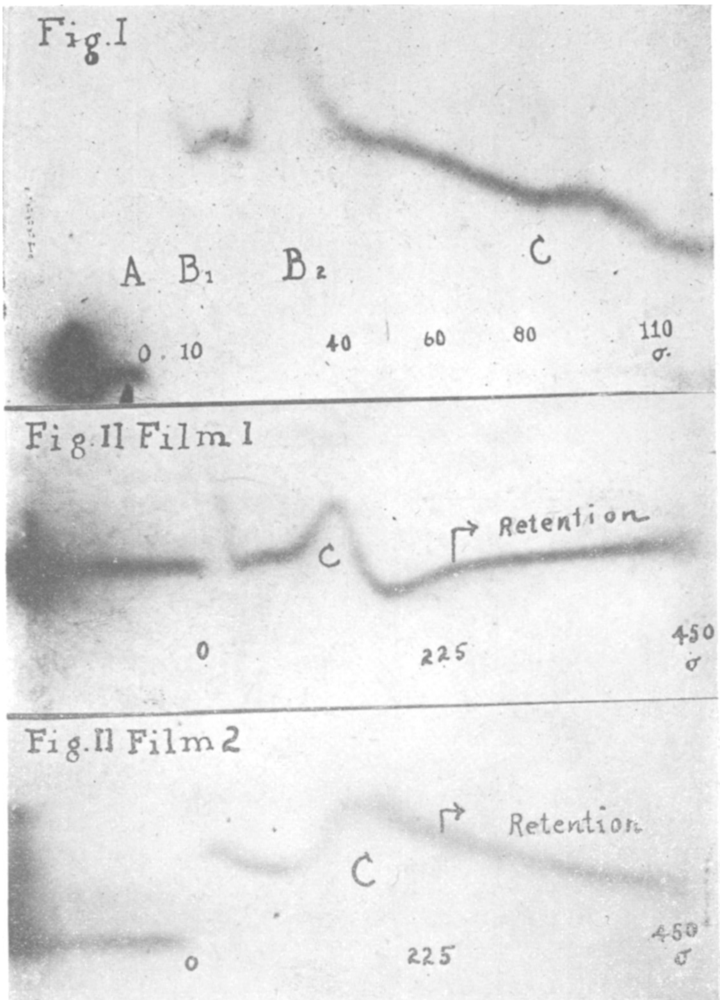

FIG. 1. Conducted action potential bullfrog sciatic after 20 minutes in pure CO_2. Note 4 potential components. Rates are B_1—3.5, B_2—1.9, C—0.5 m.p.s. as contrasted with the normal B_1—9.5, B_2—3.6, C—0.6 m.p.s. A rates not measured.

FIG. 2. Film 1. Conducted action potential normal turtle cervical sympathetic trunk showing particularly the C wave and the retained portion of the action potential. Record is quite diphasic.

FIG. II. Film 2. Conducted action potential same nerve after 3 minutes in oxygen on recovery from CO_2. Record is *apparently* monophasic because recovery at the anode is still slight. Note marked increase in height of retention.

diphasic (2 equal phases), anoxemia, carbon dioxide and lactic acid depress the second phase materially before the first phase is much altered indicating an increased susceptibility to these agents near the injured point. In partly diaphasic records retention of the second phase presumably accounts for the late positive "after-effects" reported by Amberson and Downing[9] and others. In fact, by consideration of the possibilities of differential depression or augmentation at the 2 leads, one suffering depression due to killing near the distal electrode, it is possible to account for the variations of the potential form, reported by recent authors, under anoxemia and CO_2. During depression with anoxemia and carbon dioxide and more especially during recovery, the retention of potential (Levin[10]) is much altered from the normal, being increased in amplitude but probably not in duration. It lasts in altered nerves, as in the normal, for the A wave at least 200 to 300 sigma and for the C wave at least 1000 to 1200 sigma, that of the B wave approximating that of the C rather than the A.

While investigating the effects of anoxemia, etc., on the A wave it was noted (unpublished data) that the recovery curve, that is, the curve of threshold strength of stimulus against time after a first response, showed an increased height but that complete recovery was not noticeably protracted, that is, the end of the relatively refractory period remained about the same. The change in the steepness of the curve of the recovery of thresholds of the A wave above described resembles the change in steepness of the retention curve under CO_2 and anoxemia.

Definite evidence of treppe during depression as regards both the body of the action potential and its retained portion has been observed.

It is a privilege to acknowledge the helpful criticism of Doctor George H. Bishop in this work.

8 Bishop, George H., and Heinbecker, Peter, *Am. J. Physiol.*, 1930, in press.

9 Amberson, W. R., and Downing, A. C., *J. Physiol.*, 1929, lxviii, 19.

10 Levin, A., *J. Physiol.*, 1927, lxiii, 113.