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Metabolism of Peripheral Leg Nerves and the Ganglionated Nerve Cord of the Lobster.

T. H. CHANG.* (Introduced by R. W. Gerard.)

From the Physiology Course of the Marine Biological Laboratory, Woods Hole.

With the exception of the studies of Meyerhof and Schultz[1] on the oxygen consumption of non-medullated nerve, all recent studies of nerve metabolism have been limited to the usual medullated type. The present experiments, paralleling some of those of Gerard[2] on the frog sciatic, have been carried out on the peripheral leg nerves and the ganglionated nerve cord of the lobster, *Homarus Americanus,* typical unmyelinated nerve of the invertebrate type.

The ventral ganglion chain and the nerves from the large crushing and cutting claws and the small walking legs were carefully dissected out under sea water and kept in this medium throughout the experiments. Oxygen consumption was measured with Warburg manometers, using 3 cc. conical vessels with an inset for alkali and a side bulb for fluid to be poured on the nerve in the course of a run. All experiments were performed at 23.8 to 24.2°C., except those involving the temperature coefficient.

In a number of experiments the dry weight was determined as a fraction of the moist. For the claw nerves it was 11.2% (24 experiments); for the ganglion chain 14.3% (16 experiments). The Qo_2, expressed as cubic millimeters of oxygen per gram moist weight per hour, averaged 81.4 (extremes 48 to 122) for all nerves and 123 (range 107 to 139) for the ganglion chain. The nerves to the cutting or crushing claws each averaged 86; those to the walking legs, 71. No sex difference was observed.

The respiration of the nerves did not remain constant with time, but fell about 10.5% per hour, a little more than this at first, a little less later, during 4 or more hours. The ganglion Qo_2 held surprisingly constant, losing only 1.5% per hour over the same time.

The Q_{10} from 15° to 25° was 1.74 ± 0.1 for the claw nerves (average of 5 experiments).

Addition of methylene blue caused an average increase of 17% in the oxygen consumption of the claw nerves, and 23% for the

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[1] Meyerhof, O., and Schultz, W., *Biochem. Z.*, 1929, **206**, 158.

[2] Gerard, R. W., PROC. SOC. EXP. BIOL. AND MED., 1930, **28**, 1052.

ganglia. Azure A and B led to about the same rise as the methylene blue. Cresyl blue had a still greater effect, causing an average increase of 60% for the nerves and 29% for the ganglia. The methylene blue and cresyl blue were used in concentrations of about 0.04% and the azure of 0.07%, the dyes being tipped onto the nerves during a run. M/1000 NaCN produced regularly 70% to over 90% inhibition of the oxygen consumption of both tissues, and occasionally inhibition appeared to be complete. This cyanide decrease was largely or completely reversed by the subsequent addition of either cresyl blue or methylene blue. Thus, with cresyl blue, the immediate effect was an increase of oxygen consumption to about 140% of the original level, followed by a fall during 5 hours to a value over 50% of the original. Methylene blue led to a return of oxygen consumption to approximately 50% of the original, both in the ganglion and nerve.

Acid production, presumably due to glycolysis, was estimated in terms of the liberation of CO_2 from sea water in a nitrogen filled manometer, and is expressed, similarly to oxygen consumption, as $Q_{CO_2}^{N_2}$. In all cases this value was greatest at the start, fell to 1/2 to 1/5 at the fifth hour, and then apparently began to rise again. The averages for the first eight hours were: leg nerves, 29.7 (7 experiments); claw and leg nerves, 36.7 (6 experiments); ganglion chain, 42.7 (9 experiments). The Q_{CO_2} was increased, in 2 experiments, by the addition of glucose and also by cresyl blue, the nerves responding much more than the ganglia. The oxidation quotients for nerve were 0.42, for ganglia, 0.35; but there is no reason to believe these represent maxima.

Three experiments on *Limulus* claw nerves gave an average Q_{O_2} of 82. The dry weight was 16.5% of the moist.

The actual values of oxygen consumption are somewhat lower than those found by Meyerhof and Schultz for crab nerve at a lower temperature, and it is surprising that the ganglia, including many nerve cells, respire but little more than the nerve itself. The stimulating effect of dyes and their ability to largely offset the inhibition due to cyanide is in harmony with the similar findings of Gerard[2] on the frog sciatic. (Chang and Gerard).[3] Attempts to measure the increased oxygen consumption during stimulation were not entirely satisfactory, and we hope to continue this work later.

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[3] Chang, T. H., and Gerard, R. W., *Am. J. Physiol.*, 1931, **97**, 511.