

ABSTRACTS OF MEMOIRS

RECORDING WORK DONE AT PLYMOUTH LABORATORY

BAKER, P. F. & BLAUSTEIN, M. P., 1968. Sodium-dependent uptake of calcium by crab nerve. *Biochim. biophys. Acta*, Vol. 150, pp. 167-70.

Crab nerves gain calcium when immersed in sodium-free sea waters based on lithium, choline or dextrose. This net gain results from a large increase in calcium influx. The rate at which calcium is taken up depends on the sodium content of the cells, being highest in sodium-loaded cells. These experiments suggest that small changes in internal sodium might exert powerful effects on metabolism through changes in calcium influx and the concentration of free calcium within the cell.

P.F.B.

BAKER, P. F., BLAUSTEIN, M. P., MANIL, J. & STEINHARDT, R. A., 1967. A ouabain-insensitive, calcium-sensitive sodium efflux from giant axons of *Loligo*. *Proc. physiol. Soc.*, 20 May 1967, *J. Physiol., Lond.*, Vol. 191, pp. 100-2P.

It has long been known that much of the sodium efflux from squid axons is coupled to the uptake of potassium ions. This process is largely unaffected by the concentration of calcium in the bathing medium; but is inhibited by low concentrations of the cardiac glycoside, ouabain. Evidence is presented for a second component of the sodium efflux the properties of which suggest that it represents a system entirely separate from that which effects sodium-potassium exchange. This new component of the sodium efflux is completely dependent on the presence of external calcium and is unaffected by very high concentrations of ouabain. An interesting feature of this calcium-dependent sodium efflux is that it increases approximately as the square of the internal sodium concentration whereas sodium-potassium exchange increases linearly with internal sodium. Although calcium-dependent sodium efflux is most marked in sodium-free media, especially sea waters based on lithium, some calcium-dependent flux is still detectable in sea water.

P.F.B.

BAKER, P. F., BLAUSTEIN, M. P., HODGKIN, A. L. & STEINHARDT, R. A., 1967. The effect of sodium concentration on calcium movements in giant axons of *Loligo forbesi*. *Proc. physiol. Soc.*, 7-8 July 1967, *J. Physiol., Lond.*, Vol. 192, pp. 43-4P.

In view of the evidence that there is a calcium-dependent component of the sodium efflux, experiments were performed to see whether there is a calcium influx associated with the sodium efflux. The influx of ^{45}Ca was increased in sodium-free media, especially sea waters based on lithium, and for any given external solution was increased by raising the internal sodium concentration in the axon. These experiments show that the properties of the calcium influx parallel those of the calcium-dependent sodium efflux; but it is not clear whether the two fluxes are tightly coupled. In sodium-free media the calcium efflux was reduced.

P.F.B.

BAKER, P. F., FOSTER, R. F., GILBERT, D. S. & SHAW, T. I., 1968. Sodium transport and perfused axons. *Biochim. biophys. Acta*, Vol. 163, pp. 560-2.

The normal operation of the sodium pump is lost in axons which have been subjected to prolonged perfusion with salt solutions of composition similar to that of

axoplasm. Further investigation has shown that this loss is progressive: axons perfused for a short time having an apparently normal pump. It would seem that perfusion either supplies materials which are toxic or, more likely, progressively removes something which is essential for operation of the pump.

P.F.B.

BAKER, P. F. & MANIL, J., 1968. The rates of action of K^+ and ouabain on the sodium pump in squid axons. *Biochim. biophys. Acta*, Vol. 150, pp. 328-30.

Removal of external potassium stops the operation of the sodium pump within a few seconds. This rate does not differ from the rate at which sodium-free sea waters block electrical activity in the same preparation. These results show that during sodium-potassium exchange the sodium pump is absolutely dependent on external potassium.

The rate of inhibition of the sodium pump by the cardiac glycoside ouabain was also investigated. The rate of inhibition was concentration-dependent, but at any given ouabain concentration depended both on the metabolic state of the axon and also on the ionic composition of the external medium. The experiments suggest that, for ouabain to interact with the pump sites, some form of energy must be available within the axon.

P.F.B.

CORNER, E. D. S. & COWEY, C. B., 1968. Biochemical studies on the production of marine zooplankton. *Biol. Rev.*, Vol. 43, pp. 393-426.

A general survey of the literature principally covering (a) studies on zooplankton culture and growth; (b) the chemical compositions of the animals and various algal diets, with especial reference to proteins, amino acids and fatty acids; (c) metabolic activity of zooplankton in terms of oxygen uptake, nitrogen excretion and phosphorus excretion; (d) the efficiencies with which captured algae are assimilated by the animals and converted into new tissue.

E.D.S.C.

EDMUNDS, M., 1968. Acid secretion in some species of Doridacea (Mollusca, Nudibranchia). *Proc. malac. Soc. Lond.*, Vol. 38, pp. 121-33.

Secretion of an acid fluid of pH 1 or 2 is described from five species of dorid mollusc. In *Onchidoris fusca* and *Doris verrucosa* it is likely that the acid is inorganic rather than a mucopolysaccharide although the evidence is inconclusive. Both species have clear cells similar to those that occur in other acid-secreting molluscs and polyclads, but it was not possible to prove that these cells do in fact secrete acid. In *Anisodoris stellifera*, *Discodoris pusae* and *D. tema* it is possible that the epidermis also secretes acid, but by far the most important source of acid in these species are the large subepidermal glands. These glands are highly adapted towards ejecting fluid away from the animal and are provided with a muscular wall, narrow-bore opening and sphincter muscle. The fluid is probably inorganic since there is no trace of mucin in the gland, and the cytoplasm of the secretory cells of *D. tema* have the same clear appearance that occurs in other acid-secreting molluscs. The close similarity between the glands of *Anisodoris stellifera* and *Discodoris pusae* is used as evidence for the taxonomic relationship of these two genera. Acid secretion has evidently evolved independently in the cowries (e.g. *Cypraea*), *Philine*, the pleurobranchids and at least twice in the dorids. In all of these acid is only secreted when the animal is irritated and it is therefore concluded that acid secretion is a defensive adaptation.

M.E.

HUGHES, G. M. & BALLINTJN, C. M., 1968. Electromyography of the respiratory muscles and gill water flow in the dragonet. *J. exp. Biol.*, Vol. 49, pp. 583-602.

An account is given of the main skeletal elements and muscles involved in the respiratory movements of the dragonet.

Using electromyographic techniques, it has been shown that the muscles chiefly involved in rapid ejection of water are the adductor mandibulae, protractor hyoidei and hyohyoideus. During the expansion phase of the cycle the levator hyomandibulae and sternohyoideus are active, though in some cases the latter only comes in at higher levels of pumping.

Changes in volume flow across the gills have been produced by either (a) altering the hydrostatic pressure gradient (Δp) across the system, or (b) altering the oxygen or carbon dioxide content of the inspired water. Electromyography confirmed that the relative increase in flow rate with negative Δp 's is due to active pumping against the adverse pressure gradient.

With changes in level of O_2 and CO_2 in the inspired water a clear relationship was demonstrated between stroke volume and the level of electrical activity as measured by the height of the integrated electromyogram. The time courses of the changes in respiratory frequency and height of integrated EMG during recovery from a decrease in P_{O_2} or an increase in CO_2 suggest that the gas tensions of the inspired water are detected by receptors on the gills and thus influence the electromyogram activity, but the slower change in frequency is due to a change in the blood affecting receptors in the brain.

G.M.H

HUGHES, G. M. & KNIGHTS, B., 1968. On the effect of loading the respiratory pumps on the oxygen consumption of *Callionymus lyra*. *J. exp. Biol.*, Vol. 49, pp. 603-15.

The oxygen consumption of *Callionymus lyra* is about 40 cc/kg/h at 11 °C but it varies according to the size and sex. Males have a significantly higher metabolism than females for specimens above 30 g.

The oxygen consumption is increased in specimens which have rubber horns attached about their opercular openings or their opercular and buccal cavities cannulated with polyethylene tubing. The effects are least in fish above 90 g.

Variations in the resistance to flow out of the opercular cavity were achieved by altering the bore of rubber tubes attached to the horns fixed about the opercular opening. The O_2 consumption was significantly increased if the tubes were less than $\frac{3}{8}$ in. diameter.

It is concluded that the experimental set-up used to measure ventilation volume directly increases the oxygen consumption of the fish, mainly because of an interference with the normal respiratory movements and the general mechanical irritation, but these effects are relatively small for fish about 90 g. With this limitation, however, the method of measuring ventilation volume, utilization and O_2 consumption used with this fish has much to recommend it, especially where the effect of changes in environmental conditions is to be studied.

G.M.H.

HUGHES, G. M. & UMEZAWA, S.-I., 1968. Oxygen consumption and gill water flow in the dogfish *Scyliorhinus canicula* L. *J. exp. Biol.*, Vol. 49, pp. 557-64.

The oxygen consumption of resting dogfish (*Scyliorhinus canicula*), determined by several methods, gave values in the range 20-55 cc/kg/h at 12 °C. The oxygen consumption increases as the rate of water-flow past the fish was increased but there was no marked change in respiratory frequency at the flow rates studied. The respiratory frequency increased, however, when the oxygen content of the inspired water was reduced.

The ventilation volume of the dogfish was measured by collecting water in rubber chambers fixed round the outside of the external gill openings. The resting ventilation was about 120 cc/min/kg at 12 °C.

The relationship between the rate of water flow across the gills and an imposed hydrostatic pressure gradient showed a linear relationship and the fish was unable to pump water across the gills when the pressure in the chamber affixed outside the gill slits exceeded that on the mouth side by more than 0.7 cm water.

When the flow across the gill was relatively low at least 70% of the oxygen was removed from the water, but with increasing flow rates this utilization fell to between 40% and 50%.

G.M.H.

HUGHES, G. M. & UMEZAWA, S. -I., 1968. On respiration in the dragonet *Callionymus lyra* L. *J. exp. Biol.*, Vol. 49, pp. 565-82.

The position and nature of the opercular opening in *Callionymus* made it possible to determine directly the volume of water pumped over the gills and the P_{O_2} of the mixed expired water. The normal ventilation volume for a 100 g fish was about 30 cc/min. The relationship between cardiac and respiratory rhythms showed a variety of ratios; the heart usually having the higher frequency. Individual variations were common but close couplings were sometimes observed in the absence of anaesthetic and at normal P_{O_2} 's.

Changes in minute volume produced by altering the hydrostatic pressure across the respiratory system did not affect the heart rate but utilization fell at higher flow rates. *Callionymus* is able to pump against an adverse hydrostatic gradient of about 2 cm H_2O .

Oxygen consumption is related to the ambient P_{O_2} over a wide range (30-120 mm Hg). Sudden lowering of the P_{O_2} in the inspired water leads to compensatory responses in which the minute volume is maintained or increased as a result of a rise in stroke volume and lowered respiratory frequency; there is also a marked bradycardia.

The results suggest that the receptors mediating bradycardia occur on the gills and respond directly to the change in P_{O_2} rather than to the secondary increase in flow produced by the hypoxia.

G.M.H.

KRESS, A., 1968. Untersuchungen zur Histologie, Autotomie und Regeneration dreier Doto-Arten *Doto coronata*, *D. pinnatifida*, *D. fragilis* (Gastropoda, Opisthobranchiata). *Revue suisse Zool.*, Vol. 75, pp. 225-303.

In the course of studying autotomy and regeneration of the cerata in *Doto* species it was found necessary to examine some of the distinguishing characteristics of *Doto coronata*, *pinnatifida* and *fragilis*. As contribution to the normal histology, the different types of epithelial and subepithelial glands observed in the three species are described. An attempt was made to group the free blood cells in three categories. Problems of autotomy are discussed and the external morphology and the histology of the regenerating cerata described.

Following a loss of cerata the wound is small. There is no leakage of body fluid and the edges of the epithelium are drawn together through muscular contraction. After that the epithelium in the immediate area shows degenerative changes. After the second day a small protuberance is visible and the first signs of mitosis can be observed. The cells are small with large nuclei and distinct nucleoli. In the course of growth mitosis increases and the arrangement of cells becomes more regular. Between the 4th and the 6th day the first mucus glands appear, and between the 7th and the 11th day the granular cells of the epithelium and the ciliated cells are reformed. In 3-4 weeks all

the skin elements are present but appear similar to those of cerata in an early stage of development. The hepato-pancreatic gland is restored by mitosis in continuity with the remnant of the original gland. Between the 15th and 20th day the outgrowing tip forms lobes.

The role of the amoebocytes in removing damaged material and the differentiation of free blood cells into 'defensive cells' are discussed.

A.K.

KRESS, A., 1968. *Trapania pallida* sp.nov. (Opisthobrancia, Gastropoda), a genus new to Britain. *Proc. malac. Soc. Lond.*, Vol. 38, pp. 161-5.

A single specimen of the genus *Trapania* was found in Wembury (near Plymouth) in August 1966. Neither the shape of the body, the colour, or types of radula-teeth agreed with any of the known species. The animal is now described as *Trapania pallida*.

A.K.

McLACHLAN, J., 1968. Cystocarpic plants of *Gigartina teedii*—a new record for the British Isles. *Br. phycol. Bull.*, Vol. 3, pp. 575-7.

Plants of *Gigartina teedii* (Roth) Lamour, bearing mature cystocarps are recorded for the first time in the British Isles (excluding the Channel Islands). These plants were collected in the River Yealm, Devon, during August 1967, and voucher specimens are deposited in the herbarium of the Plymouth Laboratory.

J.M.

NEUWOTH, P. R. & TAYLOR, A. R. A., 1968. The distribution of *Ceratocolax hartzii*. *Br. phycol. Bull.*, Vol. 3, pp. 543-6.

Ceratocolax hartzii Rosenv. (Fam. Phylloporaceae) has been found to occur only on *Phyllophora brodiaei* (Turn.) Endlich. and its various forms. New records reported here confirm that it is truly circumboreal and widespread in the Arctic seas, and show that its range in the Atlantic extends south to Rhode Island, U.S.A., and Ireland.

P.R.N.

POTTS, G. W., 1968. Unwanted oil. *Sea Front.*, Vol. 14, pp. 221-33.

This article refers to the pollution caused by the 'Torrey Canyon' incident and briefly summarizes some of the proposed and used methods of cleaning up the oil. The first step is to see if such pollution can be avoided. Already legislation restricts the discharge of waste oil near the coasts and proposals are being made to confine ships carrying hazardous cargoes to routes where, in the event of an accident, widespread contamination would not occur. However, in the event of an accident, salvage of the ship, the cargo or both should be attempted. Failing this, the difficult job of collecting oil at sea must be faced. Bombing the wreck disposed of and burned some of the cargo, but once the oil was mixed with seawater it proved almost impossible to burn. Booms were used to confine spilled oil, and were effective in harbours and estuaries in calm conditions, but would be little use in rough seas. Agglomerates were used with some success (especially by the French) to consolidate the oil both at sea and on shore prior to being scooped up and disposed of. 'Craie de Champagne', a mixture of chalk and stearate, was used to sink oil at sea and proved most efficient. The French also modified a coaster to suck up oil, but this was slow and depended on wind speed and the thickness of the oil on the sea. Other methods of scooping and mopping up oil have been attempted at sea and on the beaches with varying degrees of success. In England oil was dispersed chiefly with the use of detergents and almost 3 million gallons were used. It was the most efficient and quickest method of removing oil from inaccessible

rocky shores. On sandy beaches the detergents only washed the oil deeper into the sand, where it persisted for many months. These non-ionic detergents are highly toxic and killed countless marine organisms during the oil-cleaning activities. Steamspraying proved much slower and less efficient than detergents at removing oil from the beaches. Untreated oil is gradually removed by natural agencies. Some fractions of the oil evaporate, reducing its volume, while abrasion by sea and sand wears oil from plastered rocks. Bacteria attack and slowly break down the oil and even limpets graze apparently unharmed upon it. With more dangerous cargoes the risk of pollution at sea is becoming more serious and effective ways of dealing with accidents must be found.

G.W.P.

SOUTHWARD, A. J., & SOUTHWARD, E. C., 1968. Uptake and incorporation of labelled glycine by pogonophores. *Nature, Lond.*, Vol. 218, pp. 875-6.

Autoradiographs show that *Siboglinum atlanticum* is capable of removing tritium-labelled glycine from sea-water solutions as dilute as $10^{-7}M$ and binding it in an alcohol-insoluble form.

A.J.S.