

ABSTRACTS OF MEMOIRS

RECORDING WORK AT THE PLYMOUTH LABORATORY

BAKER, P. F. & MCNAUGHTON, P. A., 1978. The influence of extracellular calcium binding on the calcium efflux from squid axons. *Journal of Physiology*, **276**, 127–150.

The Ca efflux from unpoisoned squid axons seems to consist of three components: Ca_o-dependent Ca efflux, Na_o-dependent Ca efflux and a 'residual' flux that persists in the nominal absence of external Ca and Na and is little affected by the further removal of external Mg.

Evidence is presented to show that much of the apparent dependence on Ca_o of the Ca efflux from unpoisoned axons probably does not reflect a membrane process but results instead from the existence of a Ca-binding matrix external to the plasma membrane. Removal of external Ca produces a fall in efflux which is not maintained but returns to its original level over 20–60 min. Readmission of Ca produces only a transient increase in Ca efflux. Addition of EGTA to nominally Ca-free media also produces only a transient rise in Ca efflux.

Direct measurement of Ca binding to the surface of highly cleaned axons reveals appreciable binding over a wide range of Ca concentrations. A high affinity component of superficial binding can be recognized which has a capacity of about 60 p-mole/cm² axon membrane and is half-maximal at about 0.3 μM-Ca in Na-ASW. This component of binding is unaltered in cyanide-poisoned axons and in media in which Na is replaced isosmotically by Tris; but is reduced in the presence of 1 mM-La or after brief exposure of the axon to pronase. There is also a component of large capacity and lower affinity which was not saturated by 100 mM-Ca_o.

After brief pronase treatment the sensitivity of the Ca efflux to external Ca is markedly reduced although the Na-dependent Ca efflux persists apparently unaltered.

Addition of La produces a transient increase in Ca efflux followed by a maintained fall. 300 μM-La largely inhibits the component of the Ca efflux that persists in the nominal absence of external Na and Ca. Higher concentrations of La also inhibit Na_o-dependent Ca efflux.

The Ca_o-dependent Ca efflux and Na_o-dependent Ca efflux seen in poisoned axons persist in the presence of EGTA or after pronase treatment, suggesting that both are genuine membrane processes.

We conclude that in unpoisoned axons 50–90% of the Ca efflux can continue in the absence of external Ca, Na and Mg and may reflect an uncoupled extrusion of Ca. Most of the remaining efflux from these axons is Na_o-dependent although a small Ca_o-dependent component can be distinguished in the absence of Na. Poisoning results in the loss of uncoupled Ca efflux, the appearance of appreciable Ca_o-dependent Ca efflux and alteration in the kinetics of Na_o-dependent Ca efflux.

BAKER, P. F. & SCHLAEFFER, W. W., 1978. Uptake and binding of calcium by axoplasm isolated from axons of *Loligo* and *Myxicola*. *Journal of Physiology*, **276**, 103–125.

Axoplasm isolated from giant axons of the squid *Loligo* and of the polychaete worm *Myxicola* continues to bind Ca and maintain an ionized Ca concentration close to 0.1 μM which is similar to that seen in intact axons.

Injection of Ca into isolated axoplasm only produces a transient rise in ionized Ca showing that axoplasm can buffer a Ca challenge.

In order to characterize the Ca-binding systems isolated axoplasm was placed in small dialysis tubes and exposed to a variety of artificial axoplasm containing ⁴⁵Ca.

In the presence of ATP, orthophosphate and succinate, Ca uptake was appreciable and after 4 h exposure of *Loligo* axoplasm to 0.1 μM-Ca, approximately 100 μmole Ca/kg axoplasm was bound. Binding could be divided operationally into two distinct processes, one that requires ATP or succinate together with orthophosphate and is blocked by cyanide and oligomycin, and one that is unaffected by these reagents.

Energy-dependent binding has a large capacity, but a rather low affinity for Ca, being half-maximal between 20 and 60 μM-Ca. In *Loligo*, its properties closely parallel those of a crude

mitochondrial preparation isolated from axoplasm; but there are some interesting differences in *Myxicola*. Energy-independent binding is half-maximal at ionized Ca concentrations between 80 and 160 nM but is readily saturated and has a capacity of 6–60 $\mu\text{mole/kg}$ axoplasm.

Ca binding by *Loligo* is greatest in media containing roughly physiological concentrations of K and is reduced by isosmotic replacement of K by Na. This effect seems to be confined to the energy-dependent, presumed mitochondrial, component of binding.

Ca binding by *Loligo* axoplasm is reduced by both La and Mn ions.

COURTNEY, W. A. M. & LANGSTON, W. J., 1978. Uptake of polychlorinated biphenyl (Aroclor 1254) from sediment and seawater in two intertidal polychaetes. *Environmental Pollution*, **15**, 303–309.

Aroclor 1254 in sea water ($12 \mu\text{g/l}^{-1}$) was prepared, without the use of an organic solvent, by pumping sea water over the commercial mixture of PCB. Since the intertidal polychaetes *Arenicola marina* and *Nereis diversicolor* accumulate similar body residues whether held in 1 ppm A 1254 on sand or in $1.1 \mu\text{g/l}^{-1}$ A 1254 in sea water, there is no evidence that benthic infauna of polluted areas are more contaminated as a result of these insoluble pollutants adsorbing to their particulate habitat. However, fine sediments sequester all of these pollutants when shaken with sea water in the laboratory. Therefore, where this occurs in less polluted conditions in the field, the benthic polychaetes would become contaminated and short-term experiments indicate that body loads of PCB would persist.

Intertidal polychaetes of the Norfolk coast show similar levels of PCB contamination to other species in the North Sea.

FINDLAY, I., 1978. The role of the cuticular stress detector, CSD₁, in locomotion and limb autotomy in the crab *Carcinus maenas*. *Journal of Comparative Physiology*, **125A**, 79–90.

CSD₁, situated between the insertion of the anterior BI levator muscle (AL) and the breakage plane in the BI, is sensitive to strains imposed upon the BI by isometric contractions of the AL muscle. The posterior levator muscle (PL) is supplied by two axons: one, slow unit elicits small ejp's in PL muscle fibres and has no influence upon PL tendon orientation. The other, fast PL unit elicits fast ejp's and results in PL tendon rotation. Reflex connexions from CSD₁ excite the PL fast unit and inhibit activity in AL units and the PL slow unit. During normal locomotion AL and PL fire synergistically with alternate firing from the BI depressor muscle. PL activity results from central excitation of the slow unit, the PL muscle provides little, if any support to the limb. Accidental autotomy is prevented by CSD₁ inhibiting AL activity should the breakage plane be threatened, but to achieve autotomy when the limb is injured, CSD₁ reflex inhibition of AL units is over-ridden or bypassed while excitation of the PL fast unit by CSD₁ is retained to switch AL force onto the breakage plane.

HARRIS, R. P., BERDUGO, V., CORNER, E. D. S., KILVINGTON, C. C. & O'HARA, S. C. M., 1977. Factors affecting the retention of a petroleum hydrocarbon by marine planktonic copepods. In *Fate and Effects of Petroleum Hydrocarbons in Marine Organisms and Ecosystems. Proceedings of a Symposium, Seattle, Washington, November 10–12, 1976* (ed. D. A. Wolfe), pp. 286–303. Oxford: Pergamon Press.

¹⁴C-1-Naphthalene was used as a model compound to study the retention of an aromatic hydrocarbon by marine planktonic copepods during 24 h exposure experiments. Seven species were investigated, including representative estuarine, neritic and oceanic forms. Naphthalene concentrations varied from 0.2 to 1000 $\mu\text{g/l}$, a range including those that might occur temporarily under an oil spill.

Significant positive correlations were demonstrated between naphthalene retention and copepod size measured as dry weight and total lipid content; but a negative correlation was observed with temperature, and retention was diminished in animals starved for progressively longer periods. Amounts of the hydrocarbon absorbed on the surfaces of the animals appeared to be only a small fraction of the totals accumulated.

Supplementing the quantity of ¹⁴C-1-naphthalene in solution with a relatively small amount as suspended food led to a marked increase in radioactivity in the animals. In addition, studies on

the fate of naphthalene ingested by male and female *Calanus helgolandicus* during feeding for 24 h on a plant diet showed that, compared with bulk constituents of normal foodstuffs, the hydrocarbon was more readily assimilated. About half the assimilated fraction was released in soluble form during feeding, either as unchanged hydrocarbon or metabolites, and the other half retained. There was no evidence that the size of the portion retained varied with the sex of the animal.

Upon transfer of the animals to clean sea water following exposure, exponential depuration was observed, but in the case of *Eurytemora affinis* radioactivity accumulated by nauplius I was still detectable in the resultant adults 34 days later.

LANGSTON, W. J., 1978. Accumulation of polychlorinated biphenyls in the cockle *Cerastoderma edule* and the tellin *Macoma balthica*. *Marine Biology*, **45**, 265-272.

Two species of marine bivalve, *Cerastoderma edule* (Linnaeus) and *Macoma balthica* (Linnaeus), were exposed to particles contaminated with three commercial polychlorinated biphenyl (PCB) mixtures, Aroclors® 1242, 1254 and 1260. The accumulation of PCB in bivalve tissue was monitored for periods of up to 40 days. In addition to measuring total PCB concentrations, which reached 60 ppm of Aroclor 1242 in *M. balthica*, the fate of individual PCB homologues of different chlorine content, ranging from 2 to 8 chlorine atoms per biphenyl molecule, was also determined. Selective accumulation of PCBs with 5 chlorine atoms per biphenyl molecule occurred, whilst isomers of very low and very high molecular weights were accumulated at much slower rates.

LANGSTON, W. J., 1978. Persistence of polychlorinated biphenyls in marine bivalves. *Marine Biology*, **46**, 35-40.

Bivalves (*Cerastoderma edule* and *Macoma balthica*) which had previously been exposed to Aroclors® 1242, 1254 and 1260 were able to reduce their tissue burdens of chlorobiphenyls with 2 to 5 chlorine atoms in short-term static assay systems. Elimination rates decreased with increasing chlorination and removal of isomers with more than 5 chlorine atoms was not recorded. Position, in addition to the number, of chlorine atoms influenced the persistence of chlorobiphenyls. Isomers with most 'ortho'-substituted chlorine atoms were least persistent. Experiments with single isomers indicated variation in the elimination of low chlorinated isomers between bivalve species. These biological and chemical influences on tissue residues, together with environmental parameters such as temperature and suspended solids, are considered in relation to the use of bivalves as bio-indicators of marine pollution.

MADDOCK, L. & PINGREE, R. D., 1978. Numerical simulation of the Portland tidal eddies. *Estuarine and Coastal Marine Science*, **6**, 353-363.

A numerical model in the Portland region simulates the hourly development of the Portland eddies. These eddies are generated by vorticity derived as the tide curves round Portland Bill. The hour by hour development of tidal streams are then summarized in terms of the tidal ellipse properties for this region.

SCHMEKEL, L. & KRESS, A., 1977. Die Gattung *Doto* (Gastropoda: Nudibranchia) im Mittelmeer und Ärmelkanal, mit Beschreibung von *Doto acuta*, n.sp. [The genus *Doto* (Gastropoda: Nudibranchia) in the Mediterranean and the Channel, with description of *Doto acuta*, n.sp.] *Malacologia*, **16**, 467-499.

Eight species of the genus *Doto* from the Mediterranean (Naples) and the Channel (Plymouth) are described, including 1 new species: *Doto acuta*, n.sp.

Four species, *Doto coronata* (Gmelin, 1971), *D. cuspidata* Alder & Hancock, 1862, *D. fragilis* (Forbes, 1838) and *D. pinnatifida* (Montagu, 1804) can be found in the Plymouth area. The following can usually be found in the Naples area: *D. acuta*, n.sp., *D. coronata*, *D. floridicola* Simroth, 1888, *D. paulinae* Trinchese, 1881, and *D. rosea* Trinchese, 1881. Another species which has also been found in Naples, *D. doerga* Marcus, 1963, from the Caribbean Sea, has already been described extensively (Schmekel, 1968a) and is therefore mentioned here only in the synopsis. *D. coronata*, the most common species described, is the only one which can be found in both Plymouth and Naples.

SOUTHWARD, A. J. & SOUTHWARD, E. C., 1978. Recolonization of rocky shores in Cornwall after use of toxic dispersants to clean up the *Torrey Canyon* spill. *Journal of the Fisheries Research Board of Canada*, **35**, 682–705.

Fourteen thousand tons of Kuwait crude oil, reduced from 18 000 tons by weathering at sea, was stranded along 150 km of the coast of West Cornwall, England, in March 1967. The oil was treated with 10 000 tons of toxic dispersants during cleaning operations. By itself the oil was not very toxic, although it killed some limpets and barnacles, and most of the mortalities that followed cleaning were due to the dispersants. There was a graded effect. Most animals and some algae were killed on the shores treated heavily with dispersants, while a few animals and most algae survived in places less heavily treated. However, long stretches of coast were contaminated to some extent by drifting of patches of oil and dispersants along the shore and by indiscriminate dispersant use in remote coves. The general sequence of recolonization was similar to that which has been found after small-scale experiments, where the rocks were scraped clean, or where limpets were removed, but took longer to complete. There was first a rapid 'greening' by the alga *Enteromorpha*; then a heavy settlement and growth of perennial brown algae (*Fucus* species), leading to loss of surviving barnacles. A settlement of limpets and other grazing animals followed, with eventual removal or loss of the brown algae. The final phases were a reduction in the limpet population and a resettlement of barnacles. Lightly oiled, wave-beaten rocks that received light dispersant treatment showed the most complete return to normal, taking about 5–8 years; heavily oiled places that received repeated application of dispersants have taken 9–10 years and may not be completely normal yet. Most common species returned within 10 years, but one rare hermit crab is still missing from places directly treated with dispersants. The early recolonization by algae resulted in a raising of the upper limit of *Laminaria digitata* and *Himantalia elongata* by as much as 2 m in wave-beaten places, demonstrating that grazing pressure by limpets must be one of the factors controlling the zonation of these plants. Later, other species of plants and animals were found higher up the shore than usual, under the shade and shelter provided by the dense canopy of *Fucus*. Fluctuations in the populations of algae and herbivorous animals during the course of the recolonization illustrate the importance of biological interactions in controlling the structure of intertidal communities. Pollution disturbance affects the herbivores more than plants, hence the point of stability of the community is shifted towards the sheltered shore condition of low species richness and greater biomass.