

ABSTRACTS OF MEMOIRS

RECORDING WORK AT THE PLYMOUTH LABORATORY

BONE, Q., KICENIUK, J. & JONES, D. R., 1978. On the role of different fibre types in fish myotomes at intermediate swimming speeds. *Fishery Bulletin. National Oceanic and Atmospheric Administration of the United States*, **76**, 691–699.

Electromyographic studies of herring, carp, and trout swimming in a tunnel respirometer show that the activity of different fibre types in the myotomes during fast sustained swimming differs in different fish, depending upon the pattern of innervation of the fast zone of the myotome. A dual mode of activation of some fast fibres is suggested in higher teleosts.

BUTLER, E. I., 1979. Nutrient balance in the Western English Channel. *Estuarine and Coastal Marine Science*, **8**, 195–197.

Over a 10-year period the waters of the Western English Channel always contained significant quantities of dissolved nitrogen and phosphorus. As one form of nutrient such as nitrate was exhausted there was usually an increase in one of the other nitrogen fractions such as the organic. Some species of phytoplankton directly utilise organic nitrogen compounds and it is suggested that as the nitrate is exhausted the phytoplankton population may change such that species capable of utilizing other forms of nitrogen become dominant. This need not involve a drop in total productivity and thus throws doubt on the classical theory of nutrient limiting growth.

CLARKE, M. R., 1979. The head of the sperm whale. *Scientific American*, **240**, 106–117.

The head of a sperm whale can represent a quarter of the animal's length and a third of its total weight. Much of its volume is occupied by the spermaceti oil – a complex mixture of wax esters and triglycerides. Problems of buoyancy encountered by the whale are outlined and it is shown that these could be overcome if the whale can vary the temperature of the spermaceti oil three or four degrees during its long dives. The whale head has special structural features which can facilitate rapid heat exchange and calculations show that sufficient exchange for the whale to attain neutral buoyancy could take place during a dive cycle. This hypothesis accounts for the unusual structure of the whale's snout, the thermal properties of the spermaceti oil, the volumes and dimensions of the oil and nares, the observed buoyancy and the temperature of the oil when the whale is at the sea surface.

CORNER, E. D. S., 1978. Pollution studies with marine plankton. Part I. Petroleum hydrocarbons and related compounds. *Advances in Marine Biology*, **15**, 289–380.

This review discusses oil pollution in the context of a simplified food-chain model that begins with sea water and proceeds through phytoplankton to zooplankton. The topics include 'dissolved' and particulate hydrocarbons in sea water, levels and types of hydrocarbons in phytoplankton and zooplankton, toxicity studies with planktonic organisms in the laboratory and in controlled eco-system experiments and factors affecting the accumulation of aromatic hydrocarbons in the planktonic food web. The review ends with suggestions for future work, especially studies of a biochemical kind.

DAVIES, A. G., 1978. Pollution studies with marine plankton. Part II. Heavy metals. *Advances in Marine Biology*, **15**, 381–508.

This review examines the outcome of the research, published mainly in the preceding 10 years, on the interaction of heavy metals with marine plankton. The work on phytoplankton and on zooplankton is, as far as possible, dealt with separately though in some sections, e.g. on metal uptake by zooplankton from their food, there is inevitably some overlap. The subjects considered include the rates and mechanisms of heavy metal uptake and loss and the sub-lethal toxicity of

metals towards both laboratory maintained and natural populations of the plankton. The review also contains three Appendices in which most of the currently available data from measurements of the effects of metals on phytoplankton cultures, and the levels of metals in natural populations of phytoplankton and zooplankton have been tabulated.

The review concludes with recommendations on how the gap between the type of information obtained from laboratory experiments and that required for assessing the environmental impact of heavy metals might be closed.

DICKSON, A. G. & RILEY, J. P., 1979. The estimation of acid dissociation constants in sea-water media from potentiometric titrations with strong base. I. The ionic product of water – K_w . *Marine Chemistry*, 7, 89–99.

The various assumptions implicit in the calculation of acid dissociation constants (based on ionic medium standard states) from potentiometric titrations using a cell with liquid junction (i.e. a pH measuring cell) have been examined. It was concluded that results can be obtained having an accuracy commensurate with the experimental precision. It has been shown that although the precise composition of the medium is a function of the hydrogen ion concentration (because of the protolytic nature of some of the ions in the media, e.g. sulphate and fluoride), the effect of such variations in the medium composition can be compensated for when defining the activity of hydrogen ion on an ionic medium standard state by defining the concentration of hydrogen ion as:

$$[H]_{SWS} = h(1 + \beta_{HSO_4} S_T + \beta_{HF} F_T),$$

where β_{HSO_4} and β_{HF} are the relevant association constants and S_T and F_T are the total concentrations of sulphate and fluoride, respectively.

This approach was used to obtain values for the ionic product of water (K_w) in artificial sea-water media at various temperatures and ionic strengths. These were fitted to give the equation (molal concentration units):

$$pK_w = 3441 \cdot 0/T + 2 \cdot 256 - 0 \cdot 709 I^{1/2} \text{ (rms deviation } 0 \cdot 01),$$

where I is the formal ionic strength of the artificial sea-water medium and T is the absolute temperature. The values obtained are in reasonable agreement with those found by previous workers.

DICKSON, A. G. & RILEY, J. P., 1979. The estimation of acid dissociation constants in sea-water media from potentiometric titrations with strong base. II. The dissociation of phosphoric acid. *Marine Chemistry*, 7, 101–109.

The three dissociation constants of phosphoric acid have been determined in sea-water media over the temperature and ionic strength ranges 5–30 °C and 0.3–0.9 *m*. The results obtained fitted the equations (concentrations in mol per kg of solution):

$$pK_{1P} = -75/T + 2 \cdot 16 - 0 \cdot 35 I^{1/2} \text{ (rms deviation } 0 \cdot 034),$$

$$pK_{2P} = 737 \cdot 6/T + 4 \cdot 176 - 0 \cdot 851 I^{1/2} \text{ (rms deviation } 0 \cdot 015),$$

$$pK_{3P} = 2404/T + 1 \cdot 31 - 0 \cdot 87 I^{1/2} \text{ (rms deviation } 0 \cdot 17).$$

The results are only in moderate agreement with those of Kester & Pytkowicz (1967). The reason for this lies partly in differences between the pH scales adopted and partly in the poor precision inherent in their method.

HOLLIGAN, P. M., 1978. Patchiness in subsurface phytoplankton populations on the northwest European continental shelf. In *Spatial Pattern in Plankton Communities: Proceedings of the NATO Conference on Marine Biology* held at Erice, Italy, November 13–21, 1977 (ed. J. H. Steele), pp. 221–238. New York and London: Plenum Press. (NATO Conference Series: IV. Marine Sciences, vol. 3.)

Over much of the Continental Shelf around the British Isles a chlorophyll-rich layer within the seasonal thermocline persists for two to four months and may yield as much particulate organic

carbon as the spring diatom outburst. Dinoflagellates are generally the dominant phytoplankton. Temporal fluctuations in the concentration of chlorophyll *a* and in the abundance of individual species are considerable, and these probably reflect changes in the balance between light-dependent growth of the plant cells and depletion by grazing.

HOLLIGAN, P. M., PINGREE, R. D., PUGH, P. R. & MARDELL, G. T., 1978. The hydrography and plankton of the eastern English Channel in March 1976. *Annales biologiques*, **33**, 69–71.

Data on the hydrography and plankton in the eastern English Channel obtained on a cruise of RV 'Sarsia' in March 1976 are summarized. In the relatively clear waters along the coast of France the spring phytoplankton outburst was well developed and also the concentrations of herbivorous zooplankton were highest.

KIMURA, J. E. & MEVES, H., 1979. The effect of temperature on the asymmetrical charge movement in squid giant axons. *Journal of Physiology*, **289**, 479–500.

Asymmetrical displacement currents ('gating currents') have been recorded in intracellularly perfused squid giant axons by averaging the currents associated with depolarizing and hyperpolarizing voltage pulses. The effect of temperature on 'gating currents' was studied and compared with the effect of temperature on Na currents.

Increasing the temperature in seven steps from 0 to 15 °C increased the area under the on- and off-response (Q_{on} , Q_{off}). The average Q_{10} values for Q_{on} and Q_{off} (measured with depolarizing pulses to 0 or 20 mV) were 1.41 and 1.62, respectively.

The on- and the off-response were described mathematically by the sum of two exponentials. The first component of the on-response, Q_{on1} , represented 80% or more of the total charge movement associated with 2.5 msec pulses; the Q_{10} of Q_{on1} was similar to that of total Q_{on} . The first component of the off-response, Q_{off1} , represented 50–70% of total Q_{off} ; its Q_{10} was smaller than that of total Q_{off} .

The temperature dependence of the rate constants $(\tau_{on1})^{-1}$ and $(\tau_{off1})^{-1}$ was stronger at temperatures below 6–8 °C ($Q_{10} = 3.1$ – 6.4) than at higher temperatures ($Q_{10} = 2.0$ – 3.3). In an Arrhenius plot *two lines* of different slope were required to fit the data.

The effect of increasing the temperature on the Q vs. V curve can be described as an increase of Q_{max} or, alternatively, as a shift of the curve to more *negative* potentials.

Increasing the temperature from 0 to 15 °C increased the peak of the Na current (recorded in sea water with a fifth of the normal Na concentration), increased the rate constants τ_m^{-1} and τ_h^{-1} and shifted the m_∞^3 and h_∞ curves to more *positive* potentials.

The Q_{10} of the rate constant τ_m^{-1} varied between 2.04 and 2.61 and was independent of temperature. In an Arrhenius plot the values for τ_m^{-1} could be fitted by a *single line*.

The results support the view that 'gating current' does not simply reflect changes of the Na activation variable m . The increase of Q_{on} , Q_{off} with increasing temperature may be attributed to an increase in membrane fluidity. The possibility that those charges which become mobile at higher temperatures may not be related to gating is considered.

MEVES, H., 1977. Activation, inactivation, and chemical blockage of the gating current in squid giant axons. *Annals of the New York Academy of Sciences*, **303**, 322–338.

During the last years the main interest of those who study excitable membranes has focused on intramembrane charge transfer, i.e. movement of electrically charged organic molecules inside the membrane. Currents due to orientational changes of molecules inside the membrane are called gating currents because it is generally believed that the intramembrane movement of charged molecules is responsible for the opening and closing of the gates in the Na channel. The article describes what is known about the presumed connexion between intramembrane charge movement and changes in Na permeability. The evidence which supports the view that the two phenomena are in some way related can be summarized in the following four points: (1) the simultaneous blockage of gating current and Na current by Zn, glutaraldehyde and ultraviolet light; (2) the voltage-dependence of the asymmetrical charge movement which turns on steeply at a potential close to the threshold of the action potential; (3) the time course of the asymmetrical charge movement

(characterized by the time constants τ_{on} and τ_{off}) which is similar (but not identical) to the time course of the Na activation variable m or Na conductance g_{Na} ; and (4) the total or partial inactivation of the charge movement during a long or short depolarization which qualitatively (but not quantitatively) resembles the inactivation of the Na conductance.

PINGREE, R. D., HOLLIGAN, P. M. & MARDELL, G. T., 1979. Phytoplankton growth and cyclonic eddies. *Nature, London*, **278**, 245–247.

Cyclonic eddies are clearly visible on infra-red satellite images of tidal fronts around the British Isles. Direct observations made in July 1978 on the physical and biological properties of an eddy on the Ushant front are described. It is suggested that eddies influence the transfer and growth of phytoplankton in this region and also may initiate, through vertical mixing processes, blooms of the dinoflagellate, *Gyrodinium aureolum* Hulburt, that have occurred in 1975, 1976 and again in 1978.

SOUTHWARD, A. J. & NEWMAN, W. A., 1977. Aspects of the ecology and biogeography of the intertidal and shallow-water balanomorph Cirripedia of the Caribbean and adjacent sea-areas. *F.A.O. Fisheries Report*, no. 200, 407–425.

Intertidal barnacles are poorly represented on open coast shores of the Caribbean, and the species diversity in the intertidal and shallow water habitats is lower than in the tropical eastern Pacific. The reduced cirripede fauna of the Caribbean can be explained by the different ecosystem and geological history of the region. Compared with the tropical eastern Pacific and nearby parts of the western Atlantic, the Caribbean has a smaller tidal range, a lower biomass of plankton, a greater development of coral reefs and more shores formed from porous reef limestones: these are all unfavourable to development of a barnacle zone. Intertidal grazing by reef fish and sea-urchins also reduces barnacle populations. The importance of the ecosystem, especially the reef biotype, is shown by better growths of barnacles in Caribbean harbours and bays where coral reefs are absent and the water richer in plankton and other particles, and by the reduced barnacle populations found on the offshore islands of the eastern Pacific where some coral reefs are present. A small number of species common to the Caribbean and the tropical eastern Pacific are apparently relicts of a once continuous shallow water fauna of Tertiary times, a fauna slowly modified by the tectonic movements and climatic changes during the formation of the present-day Caribbean and its complete separation from the eastern Pacific.

WHITFIELD, M. & TURNER, D. R., 1979. Water-rock partition coefficients and the composition of sea water and river water. *Nature, London*, **278**, 132–136.

Using a simple chemical reactor model a strong correlation is established between the mean oceanic residence time of an element and the partitioning of that element between sea water and crustal rock. The ocean-rock partition coefficient ($K_{Y(sw)}$) is shown to be related to the electrostatic contribution to the element-oxygen bond energy (Q_{YO}) and a second correlation is established between these parameters. In this way the concentrations of all the elements so far identified in sea water fall in a coherent pattern. The global mean composition of river water, which represents an intermediate step in the formation of sea water from rock weathering, is shown to conform to a similar pattern.