MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

Report of the Council for 1962–63

The Council have to report with regret the deaths of Vice-Admiral Sir John A. Edgell, K.B.E., C.B., F.R.S., who had been a Vice-President of the Association since 1948, Mr A. T. A. Dobson, C.B., C.V.O., C.B.E., who had been a Vice-President of the Association since 1950; and Dr R. Dohrn, one of the original Honorary Members of the Association elected in 1945.

During the year the following have been elected Vice-Presidents of the Association, Prof. Sir Alister C. Hardy, Kt., D.Sc., F.R.S., and Prof. C. M. Yonge, C.B.E., D.Sc., F.R.S.

Honorary Treasurer

It is with very deep regret that the Council have to report the sudden death on 14 December 1962 of our Honorary Treasurer, Mr Harrison S. Edwards, who had served the Association with great devotion since 1956 and had been since 1950 a representative Governor of the Fishmongers' Company.

Sir Edward Chadwyck-Healey, Bt., M.C., has been nominated by the Court of the Fishmonger's Company as representative Governor in Mr Edwards's place, and the Council are pleased to report that he has consented to be Honorary Treasurer.

The Council and Officers

Four ordinary meetings of the Council were held during the year, two in the rooms of the Royal Society, one in the rooms of the Linnean Society, and one at Plymouth. At these the average attendance was seventeen.

The Plymouth Laboratory

The fabric of the laboratory buildings has been kept in good order throughout the year and a number of rooms in the south and north buildings have been redecorated.

A new steel door has been fitted to the pump house situated on the foreshore.

Ancillary to the work on the laboratory extension, suspended ceilings have been fitted to all rooms and passages on the first floor of the original north building. These have glass wool felting laid over aluminium-backed sheets and should do much to insulate the building, as well as reducing the volume to be heated.

Aquarium

There have been no structural alterations to the aquarium and the system has continued to work to full satisfaction.

In September, after adding new sea water to the reservoirs there was a sudden and rapid outburst of a colourless flagellate in the tanks. Visibility was reduced to 2 or 3 ft after which the water rapidly became exceptionally clear. The animals appeared in very good condition throughout the outburst.

A new edition of the illustrated guide to the aquarium has been printed, for which Dr D. P. Wilson kindly supplied an additional eight of his excellent photographs. The guide, which now includes sixteen of his photographs, thus has added attraction and has been selling unusually well.

The cold wet summer has resulted in very good attendance and on one day in August a record number of 1934 (of whom 723 were children) visited the tank room.

Research Ships

The Association's three vessels R.V. 'Sarsia', R.V. 'Sula' and M.L. 'Gammarus' have worked continually throughout the year except for routine overhauls.

The year's sea research has been very successful in spite of the unusually bad weather. A number of critical cruises have been carried out under severe conditions and valuable information obtained on the effects of the cold winter.

The Todd Bequest

Under the will of the late Mrs F. M. Todd the following bequest is made free of death duties to the President and Council of the Association.

> £500 to provide a special fund to be known as the Todd Fund out of the income thereof for the purchase of rare and costly books (other than current serial publications or periodicals) connected with or related to the objects of the said Association for the library of the Plymouth Laboratory.

The bequest is made in memory of Mrs Todd's late husband Reginald Austen Todd, a member of the Association's staff from 1899 to 1910 and well known for his research on the fauna of the Salcombe and Exe estuaries and the food of fishes.

Staff

The Director, Dr F. S. Russell, F.R.S., has been promoted to the grade of Chief Scientific Officer on grounds of individual merit as from 26 November 1962.

Dr Mary W. Parke has been promoted to the grade of Senior Principal Scientific Officer on grounds of individual merit as from 1 July 1962.

Dr E. D. S. Corner and Dr T. I. Shaw have been promoted to the grade of Principal Scientific Officer as from 1 April 1962.

Dr F. S. Russell, F.R.S., has been elected an Honorary Member of the Physiological Society.

Dr E. J. Denton has been elected Honorary Secretary of the Physiological Society.

Dr A. J. Southward has been awarded the degree of D.Sc. of Liverpool University.

Mr F. A. J. Armstrong has been elected a Fellow of the Royal Institute of Chemistry.

Mr E. I. Butler has been elected a Licentiate of the Royal Institute of Chemistry.

Mr F. J. Warren has been promoted to the grade of Senior Experimental Officer as from 1 April 1962.

Mr L. G. Hummerstone and Mr T. R. Tozer have been promoted to the grade of Experimental Officer as from 1 April and 1 October 1962 respectively.

Mr J. E. Green has been promoted to the grade of Senior Scientific Assistant as from 1 October 1962.

Mr S. M. Nunn retired from the staff of the Plymouth laboratory on 3 September 1962. Mr Nunn joined the staff in April 1921, and thus served the Association for more than 41 years. During that period he always gave loyal and devoted service for which the Council are pleased to record their appreciation. His presence in the laboratory will be missed by his many friends.

Dr A. G. Davies joined the staff of the Plymouth laboratory on 1 September 1962 in a special temporary appointment.

Dr L. H. N. Cooper visited Iceland in April 1962 where a special meeting was held at Reykjavik under the auspices of N.A.T.O. to discuss problems of the hydrography of the Denmark Strait.

Dr E. J. Denton visited New Zealand and a number of laboratories in Canada and the United States on a Royal Society and Nuffield Foundation Commonwealth Bursary during October 1962 to February 1963. During this period he worked in Lifou and New Caledonia on the buoyancy of *Nautilus*, and visited the Great Barrier Reef of Australia. On his return journey Dr Denton travelled through India where he lectured at a number of university and fishery laboratories at the request of U.N.E.S.C.O.

Mr N. A. Holme attended a Symposium on Antarctic Biology held in Paris in September 1962 under the auspices of the Special Committee for Antarctic Research of the International Council of Scientific Unions and the Académie Françaises des Sciences, at which he read a paper.

Dr T. I. Shaw and Mr J. V. Howarth attended the International Congress of Physiological Sciences in Leiden in September 1962. Dr Shaw gave the special lecture on nervous conduction, by invitation.

Dr T. I. Shaw left Plymouth in January 1963 to take up a temporary appointment for one year as Associate Professor in the Department of Zoology in the University of California at Los Angeles. Before leaving Dr Shaw lectured at the Max Planck Institute for Medical Research, Heidelberg, and at the University of the Saarland, Homburg. In America he has lectured in New York and Urbana.

Mr Q. Bone attended the meeting of the International Council for the Exploration of the Sea in Copenhagen in October 1962.

At the invitation of the Academic Council of the University of London, a series of three lectures on different aspects of marine biology were given in November by the following members of the Plymouth laboratory staff: Mr F. A. J. Armstrong, Mr N. A. Holme and Dr T. I. Shaw.

International Paints Research Fellowship

The Directors of International Paints Ltd. have, by arrangement with the Council of the Association, again continued the endowment of their Research Fellowship at the Plymouth laboratory. Dr G. B. Williams has been appointed to the Fellowship, and he started work at Plymouth on 1 October 1962.

Occupation of Tables

The following one hundred and twenty eight workers have occupied tables at the Plymouth Laboratory during the year.

Prof. B. C. Abbott, Urbana, U.S.A. (Heat production of crab nerve; visual physiology of euphausiids).
E. Adams, Plymouth (Library).
K. A. Ahmad, Karachi (Chemistry of Sea Water).
Dr J. S. Alexandrowicz, Plymouth (Nervous system of invertebrates).
Dr C. Amirthalingam, Khartoum (Library).
R. Bailey, Oxford (Testing plankton sampler).
P. F. Baker, Cambridge (Biochemistry of squid axon).
M. W. Baldwin, Plymouth (Library).
Dr R. H. Bate, London (Marine ostracods).
Dr B. Battaglia, Padua (Osmoregulation in genetic polymorphs of *Tisbe reticulata*).
J. M. Bedford, London (*In vitro* fertilization of dogfish ova).
Dr A. J. Bernatowicz, Hawaii (Systematics of marine algae).
Dr E. J. Binyon, London (Water vascular system of *Asterias rubens*).
Dr G. T. Boalch, International Paints Research Fellow (Effects of toxic substances on algae).
Dr B. P. Boden, La Jolla (Visual physiology of euphausiids).
Dr A. D. Boney, Plymouth (Ecology of red algae and effects of carcinogens on sporeling developments).
Miss J. K. Bowman, Plymouth (Library).
P. G. Brewer, Liverpool (Chemistry of Sea Water).
Dr C. Burdon-Jones, Menai Bridge (Library).
Dr P. C. Caldwell, Bristol (Physiology of *Maia* muscle).
Dr J. N. Carruthers, N.I.O., Wormley (Testing new gear at sea).

H. CECCALDI, Marseilles (General).
Dr K. CHANDLER, Cambridge (Physiology of squid axon).
D. M. CHAPMAN, Cambridge (Electron microscopy of coelenterates).
R. F. J. CHIPLEN, Plymouth (Library).
Mrs J. M. CLAYTON, Torquay (Library).
Dr KATHLEEN M. COLE, Vancouver (Algal cytology).
J. W. COLES, London (Free-living marine nematodes).
J. A. COLLINS, Birmingham (Spermatogenesis in dogfish).
C. COPIN-MONTÉGUT, Paris (Chemistry of Sea Water).
C. A. COSWAY, Torquay (Library).
C. B. COWEY, Shinfield (Amino acid analyses of phytoplankton).
Dr A. S. G. CURTIS, London (Re-aggregation mechanisms in sponges).
Dr R. P. DALES, London (*Amphitrite*).
P. M. DAVID, N.I.O., Wormley (Testing plankton samplers).
P. S. B. DIGBY, London (Pressure sensitivity in marine animals).
Dr R. J. DONATO, Sunbury-on-Thames (Submarine geology).
A. E. DOREY, Cambridge (Structure of Turbellaria).
M. EDMUNDS, Oxford (Defence mechanisms in nudibranchs).
Dr MARIA M. FELINSKA, Ashby de la Zouche (Marine ciliates).
Dr H. F. FORSTNER, Vienna (Biology of decapod crustacea).
J. D. GAGE, Southampton (Commensal copepods).
J. M. GEE, Swansea (Spirorbinae).
R. N. GIBSON, Menai Bridge (Shore fish).
Dr D. R. GLASSON, Plymouth (Library).
Dr I. GOODBODY, Jamaica (Library).
Dr C. DEN HARTOG, Yerseke, Holland (Library).
Prof. J. E. HARRIS, F.R.S., Bristol (Library).
Dr H. W. HARVEY, F.R.S., Plymouth (Library).
J. C. HARVEY, Yelverton (Library).
D. HEDDLE, Aberdeen (Histology of asteroids).
Dr J. H. HICKMAN, Plymouth (Library).
Prof. A. L. HODGKIN, F.R.S., Foulerton Research Professor of the Royal Society (Physiology of squid axon).
O. D. HUNT, Torpoint (Library).
M. JAMES, Bristol (Submarine geology).
R. S. P. JEFFERIES, British Museum (Natural History) (*Lima*).
Dr PENELOPE M. JENKIN, Bristol (Library).
Dr ELISABETH M. KAMPA, La Jolla (Visual physiology of euphausiids).
Miss J. E. KANE, N.I.O., Wormley (Amphipoda).
G. C. KEARN, Birmingham (Monogenean parasites of fish).
Dr G. Y. KENNEDY, Sheffield (Chlorophyll pigments).
Dr R. D. KEYNES, F.R.S., Cambridge (Physiology of squid axon).
Miss B. KIRTLEY, N.I.O., Wormley (Marine bacteriology).
Prof. E. W. KNIGHT-JONES, Swansea (Spirorbinae).
Dr F. B. KRASNE, Cambridge (Shadow response of *Branchiomma*).
Mrs E. W. LACKEY, Gainesville, U.S.A. (Library).
Prof. J. B. LACKEY, Gainesville, U.S.A. (Colourless flagellates).
Dr R. LASKER, La Jolla (Physiology of larval fishes).
Dr MARIE V. LEBOUR, Plymouth (Library).
Dr J. G. E. LEWIS, Khartoum (Littoral centipedes).
Miss E. LINFORD, Southampton (Lipid content of *Calanus*).
Dr J. LLEWELLYN, Birmingham (Monogenean parasites of fishes).

Dr N. A. LOCKET, London (Neurohistology of cephalopods).
Dr A. P. M. LOCKWOOD, Southampton (General).
G. F. LOSSE, Zanzibar (General).
Miss K. M. LYONS, Birmingham (Biology of monogeneans).
G. I. MANN, Plymouth (Library).
Miss V. A. MATHER, Reading (Polychaetes).
M. J. MCCARTNEY, N.I.O., Wormley (Chemistry of Sea Water).
Dr H. MEVES, Homburg, Saar (Physiology of squid axon).
H. MICALLEF, London (Behaviour of trochids).
P. J. MILLER, Glasgow (Shore fishes).
Dr J. W. MURRAY, Bristol (Ecology of Foraminifera).
M. R. S. NEGUS, Reading (Parasites of molluscs).
Prof. G. E. NEWELL, London (Behaviour of trochids).
Dr K. W. OCKELMANN, Copenhagen (Lamellibranch spat).
J. E. PALING, Birmingham (Monogenean parasites of fishes).
Prof. C. F. A. PANTIN, F.R.S., Cambridge (Nervous system of *Calliactis*).
P. D. PARKS, Oxford (Marine illustrations).
J. A. PETERSEN, Menai Bridge (Library).
Dr R. L. C. PILGRIM, Christchurch, N.Z. (Crustacean stretch-receptors).
W. POPLE, Ghana (Physiology of *Holothuria* muscle).
Dr HILDEGARD PORTZEHL, Bern (Physiology of *Maia* muscle).
Cdr. C. F. B. POWELL, R.N. (Rtd.), Plymouth (Library).
Dr J. PREBBLE, London (Carotenoids in crabs).
Dr D. G. RAYNS, Development Commission Research Fellow (Algal cytology).
P. REDFEARN, London (General; Antarctic biology).
Dr J. M. RITCHIE, New York (Heat production of crab nerve).
B. L. ROBERTS, Cambridge (Electrophysiology and behaviour of spinal elasmobranchs).
Dr R. ROBERTSON, Philadelphia (Benthic gastropods).
Dr ELAINE A. ROBSON, Cambridge (Nervous system of *Calliactis*).
Dr J. C. RUEGG, Heidelberg (Physiology of *Maia* muscle).
P. D. V. SAVAGE, Plymouth (Library).
B. SINGER, Cambridge (*Ampelisca*).
Dr A. J. SMITH, Bristol (Submarine geology).
J. A. SÖDERSTRÖM, Göteborg (Taxonomy and ecology of *Cladophora*).
Dr EVE C. SOUTHWARD, Plymouth (Pogonophora: polychaetes).
B. W. P. SPARROW, Newton Ferrers (Library).
Dr C. P. SPENCER, Menai Bridge (Pigment extraction).
J. F. SPENCER, Central Electricity Generating Board (Chemistry of Sea Water).
Miss F. A. STANBURY, Plymouth (*Cladophora*).
Dr H. P. STANLEY, Naples (Elasmobranch reproductive system).
Dr MURIEL F. SUTTON, London (Embryology of salps).
Dr I. M. THOMAS, Adelaide (Iodine metabolism in *Amphioxus*).
C. H. THORP, Newton Ferrers (Library).
Dr B. L. TONGE, Plymouth (Library).
G. TOPPING, Liverpool (Chemistry of Sea Water).
Dr BETTY M. TWAROG, New York (Molluscan muscle).
R. C. VERNON, London (Library).
Dr H. G. VEVERS, London (Library).
G. E. WALSTER, Plymouth (Library).
B. WEBBY, Bristol (Submarine geology).
Prof. W. F. WHITTARD, F.R.S., Bristol (Submarine geology).
Dr J. H. WICKSTEAD, Department of Technical Co-operation (East African plankton).

G. B. WILLIAMS, International Paints Research Fellow (Settling of fouling organisms).
Dr BEATRICE A. WITTENBERG, New York (Respiratory pigments in *Aphrodite*).
Prof. J. B. WITTENBERG, New York (Respiratory pigments in *Aphrodite*).
J. D. WOODLEY, Oxford (Morphology of ophiuroids).

Among the many scientists who have visited Plymouth during the year to see the general work of the laboratory and to discuss problems with members of the scientific staff, the following have come from overseas: Prof. D. H. Davies (S. Africa), M. Flores (Mexico), Dr E. L. Hamblyn (Hong Kong), Dr A. M. Rapson (Papua), Dr C. M. Tarzwell (U.S.A.), M. Unar (Indonesia), Dr E. L. Aplen (U.S.A.), J. E. Dewar (Canada), J. Storm Mathisen (Norway), Dr H. Takana (Japan), Dr E. S. Reese (U.S.A.), M. G. Hadfield (U.S.A.), C. Love (U.S.A.), Dr N. K. Panikkar (India), Miss H. Krause (Australia), Dr D. Kennedy (U.S.A.), Prof. Renzy Toden (Turkey), Dr R. Repelin (France), Dr R. Geldiay (Turkey), Prof. D. J. Reish (U.S.A.), Dr C. Ray (U.S.A.), Dr R. F. Nigrelli (U.S.A.), Dr E. C. Haderlie (U.S.A.), Dr S. Krishnaswamy (India), D. N. F. Hall (Zanzibar), A. N. Sastry (U.S.A.), C. F. Lim (Malaya), Dr I. E. Wallen (U.S.A.), I. Hallgrimsson (Iceland), C. Norgarb (S. Africa).

On 26 April 1962 the Mayor of Cherbourg and his party on an official visit to the City of Plymouth were shown round the laboratory.

A meeting of the Physiological Society was held at the Plymouth laboratory on 27 and 28 April at which about 120 members and guests attended. The Society was entertained at the Laboratory and demonstrations were given by members of the staff.

On 16 June about 50 members of the Institute of Electrical Engineers were shown some of the work of the laboratory.

A meeting of the Society for Experimental Biology was held at the Plymouth laboratory on 17–19 July at which, apart from members of the staff and visitors, 60 or more members attended. Delegates were entertained at the Laboratory and the Lord Mayor of Plymouth kindly gave a Reception in the new Council House. Demonstrations of research in progress were given by members of the staff.

On 7 February 1963 members of the Plymouth and District Freshwater Angling Association spent an evening at the laboratory, and on 8 February about 30 Medical Officers of Health from the south-west of England were shown some of the work in progress. Among other organizations which have made visits to the laboratory during the year have been parties from the Institute of Medical Laboratory Technology and the Royal Naval Hydrographic School, St Budeaux.

The Easter Vacation Courses were conducted by Mr G. M. Spooner and Mr N. A. Holme and were attended by 41 students from the following universities: Oxford, Cambridge, London, Aberystwyth, Bangor, Durham,

Edinburgh, Galway, Hull, Leicester, Nottingham, Reading, Sheffield, Swansea, and Regent Street Polytechnic.

During the Easter vacation also a party of seven students from the Botany Department of Bristol University attended a course under the supervision of Dr F. E. Round.

After the University Easter courses the following advanced and school parties held courses: Mr G. Dolman with 13 students from Westminster Teachers' Training College, Oxford; Mr P. Fielden with 7 boys from Warwick School; and Dr R. J. Jones with 4 boys from Whitgift School.

In June a week's course for 7 girls from Nôtre Dame High School, Crawley, was held under the supervision of Sister Joseph.

During August two large parties of students from the Inter-Schools Camp at Salcombe visited the Plymouth laboratory and were shown some of the work.

Two courses on the Physiology of Marine Organisms were held in August and September under the supervision of Dr E. J. Denton and Dr T. I. Shaw, with the assistance of Mr J. V. Howarth. Twenty-four students attended from the following universities: Oxford, Cambridge, London, Southampton, Aberdeen.

A course on Marine Biology was held at the Plymouth laboratory in September for students from Queen Mary College and others under the supervision of Prof. G. E. Newell.

Scientific Work of the Plymouth Laboratory Staff

Sea Water and Plankton

Dr L. H. N. Cooper is still working on the data collected deep in the Bay of Biscay in May 1960 and May 1961. There is no need to retract any of the conclusions drawn from the much less precise data of earlier years. There is no doubt that the deeper waters are very strongly stratified and that there are marked vertical oscillations of the boundary layers due to internal waves or to surges. There were also notable replacements of waters by very different waters in short periods of time. The layers between 1800 and 2050 m were again remarkable for marked stratification and variability. There remains no doubt of the complexity of the water masses which occupy this stratum. Confirmation of this pattern of distribution was found by Mr A. J. Lee and Mr P. G. W. Jones of the Lowestoft Laboratory working in conjunction with Dr Cooper (*Ann. biol.* Vol. 17, p. 73).

In 1945–46 Dr Cooper had co-operated with Major Grange Moore of the Army Photographic Research Unit and with the late Dr W. R. G. Atkins, F.R.S., on an intercomparison of three methods of measuring underwater illumination in coastal waters. The three methods gave very different extinction coefficients. For green light the Pulfrich photometer yielded coefficients 1·8 times that found by Moore's brightness profile method and 3·8 times that

by submarine photometers. With red light the ratios were 1·3 and 2·0 respectively. Consequently the ratios between brightness profile and submarine photometric methods is 2·2 for green and 1·5 for red light. This work, together with an explanation of the large discrepancies in terms of the geometry of the various measuring systems, has now been presented in Volume 41, No. 3, of the *Journal*.

Mr F. A. J. Armstrong and Mr E. I. Butler have continued the monthly cruises to the International Hydrographic Station E 1, and as in recent years have extended the hydrographic work off Plymouth by making this position part of a network comprising four lines of stations across the English Channel. This network, now enlarged to include the area between 3° 40′ W. and 5° 10′ W., has been worked six times in 1962. The usual determinations of phosphate and silicate have been supplemented by nitrate determinations and also by some chemical measurements of the standing crop of plankton or, at least, that part which is retained on a glass-fibre filter-paper of pore size approximately 2 μ. For this work Mr Armstrong has developed methods for determination of carbon, nitrogen and phosphorus on the material filtered from about 5 l. of water. Quantities in the ranges 60–240 μg C/l., 10–50 μg N/l., 1·3–5·0 μg P/l. have been found, representing quantities of perhaps 1–4 mg plankton/l. On these cruises samples of zooplankton have been collected for Dr A. J. Southward, and Dr J. H. Wickstead of the Department of Technical Co-operation, and of phytoplankton for Dr G. T. Boalch. It is hoped to continue this work regularly so as to accumulate observations on this cross-section of the English Channel. Mr Armstrong and Mr Butler have published accounts, in Vol. 42, No. 2 and Vol. 43, No. 1 of the *Journal*, of the chemical changes occurring at Station E 1 in 1960 and 1961, and of the surveys of the area off Plymouth during 1959 and 1960.

In consequence of results obtained by the grid surveys made by Mr Armstrong and Mr Butler, Dr Cooper undertook at the end of the very cold winter of 1961–62 an oceanographical survey of Lyme Bay and of the nature of the water movements around Start Point. Water labelled by low temperature was present along the south coast of Cornwall which made it worth while in May to make with Mr Butler an intensive survey of the distribution of properties around Lands End. The corner current consisting of South Cornwall coastal water was recognized, though very narrow, and followed around to North Cornwall. Much information was obtained on the effect of the semi-diurnal tidal cycle upon the several water masses recognized in the neighbourhood.

Mr N. A. Holme, assisted by Mr E. I. Butler, has started a series of seasonal hydrographic surveys of the inshore waters between Bolt Tail and the Lizard. Although conditions in the offshore area of this part of the Channel are now well known, this coastal area has not previously been studied in detail. The survey covers the regions from which specimens for the Laboratory are usually collected, and it is hoped that the surveys will also reveal any

differences in the waters along the Cornish coast. The first survey, at the end of July 1962, failed to show any marked differentiation in water masses, but it is hoped that the greater salinity differences to be expected in autumn and winter may be more revealing.

Dr Mary Parke has during the year continued her study of the structure and life-histories of some of the more puzzling nanoplankton forms. Particular attention has been paid to the genus *Halosphaera* and at the same time forms, probably closely related to this genus, have also been studied in an attempt to elucidate the complete life-histories and the phylogenetic relationships of this problematic series. In co-operation with Prof. Irene Manton, F.R.S., and Mr K. Oates of Leeds University a paper on the fine structure of the *Halosphaera* motile stages and three *Pyramimonas* spp. has been prepared and published in Vol. 43, No. 1, of the *Journal*. Very large numbers of *Halosphaera* cells have been picked out from the tow-net samples for Prof. R. D. Preston, F.R.S., of the University of Leeds, who has offered to co-operate on this problem by trying to determine the composition of the tough elastic wall of the *Halosphaera* cell since preliminary tests showed it to be of unknown composition. In this work much assistance has been given by Mr Armstrong and in particular by Mr Butler in the collection of the living material.

Work has continued also on the Chrysophyceae and some benthic forms (probably non-motile stages of inshore coccolithophorids) have already been recorded from the Devon coast. These forms have been brought into culture for future investigation and for relating to their flagellate stages. A study of two new species of *Chrysochromulina* has been completed. The papers have been published, in collaboration with Prof. Manton, in Vol. 42, No. 1, of the *Journal*.

During the Western Channel cruises of Mr Armstrong and Mr Butler, Dr G. T. Boalch has taken phytoplankton samples and these are now being worked up. He has examined daily tow nettings taken by R.V. 'Sula' in order to become acquainted with the local planktonic diatoms.

Cytological investigations have been carried out by Dr D. G. Rayns on several planktonic organisms, using both bright field and anoptral contrast microscopy.

The green alga *Halosphaera* has a motile and non-motile stage in its life-history, motile cells being liberated from a large non-motile cell following a series of nuclear divisions. Isolations of this organism were made from many stations from Plymouth Sound west along the Channel and south to the Bay of Biscay. All isolations had nuclei with the same chromosome number. All divisions in both phases were mitotic except for a few instances where possible meiotic configurations were seen. The staining reaction of *Halosphaera* chromosomes is interesting. In the non-motile cell prophase chromosomes, which are very long and of considerable diameter, stain over the surface only, leaving a wide unstained core. This appearance is lost at metaphase but the

differentiation is clearly seen again at anaphase. In the flagellate stage this appearance at prophase is not seen but it is suggested at anaphase.

A number of Chrysophyceae were examined. These have the usual type of nuclear division although in only one species has a spindle been demonstrated. In *Cricosphaera carterae* it was found that there was a chromosomal alternation of generations, which corresponded to the described morphological alternation. The motile stage is diploid and the non-motile stage is haploid. The establishment of this fact forms the basis of a paper in Vol. 42, No. 3, of the *Journal*.

C. carterae, *Pleurochrysis scherffelii* and a species of *Chrysochromulina* showed a number of interesting phenomena. Anaphase nuclei frequently showed uncoordinated movements of chromosomes and massive chromosome bridges which persist into telophase. Multinucleate cells are found in which the nuclei are in different stages of mitosis. A variable chromosome number has been found in the *Chrysochromulina* species and possible meiotic configurations have been seen in all species examined. These unusual phenomena could be due to culture conditions or possibly to the presence of a virus. Two strains of *Prymnesium* species were obtained, one carrying a virus and the other virus-free. Nuclear divisions were compared in the two strains. The only difference found was the occasional doubling of the chromosome number in the virus strain.

Dr E. D. S. Corner has continued his study of the nutrition of the copepod *Calanus helgolandicus*. Experiments with adult females have shown that the respiration rate of *Calanus* markedly varies throughout the year, the mid-winter value being less than half that found during spring and summer months.

In collaboration with Mr C. B. Cowey, of the Development Commission Biochemical Unit at the National Institute for Research in Dairying, Shinfield, Dr Corner has completed analyses of the amino acid composition of *Calanus* and particulate material in the sea at Station L4 throughout all seasons of the year. The relative quantities of amino acids in *Calanus* remain remarkably constant, but there is a sharp fall in the levels of both lysine and histidine during mid-winter. The relative quantities of amino acids in particulate material are more variable, but again there is a sharp fall in the levels of both lysine and histidine during mid-winter.

The daily losses of individual amino acids by adult female *Calanus* in both summer and winter have been measured in starvation experiments, and estimations made of the filtering rates the animals must sustain in order to replenish these losses. The relatively high quantity of lysine lost each day in the winter experiments, and the high filtering rate needed to replace it, suggest that lysine deficiency may be an important factor limiting *Calanus* productivity at Plymouth.

A preliminary account of these findings was presented to the Society for Experimental Biology at the Plymouth meeting in July 1962. It is hoped to

carry out further studies along similar lines with zooplankton and particulate material collected from other sea areas.

Dr A. J. Southward has now completed and published in Vol. 43, No. 1, of the *Journal* the third part of his report on the distribution of macroplankton indicator species in the English Channel and approaches, the second part having been published in Vol. 42, No. 2. Long-term biological changes that have occurred in the area during the last 60 years are described, the various theories that have been put forward to account for the changes are discussed, and the status of herring and pilchard defined as far as is possible. It is concluded that although recent fluctuations in sea temperature may at present provide the simplest explanation of the changes in plankton and fisheries in the area, more work, or further changes, are needed to decide which theory, if any, is correct.

By permission of the Director of Fisheries Research, Dr Southward was able to accompany Mr R. J. H. Beverton, of the Lowestoft Laboratory, on two cruises of F.R.V. 'Clione', during which some comparative tests of high-speed samplers were carried out, and methods devised for the rapid sorting at sea of fish egg catches. Further tests of a plastic version of the Gulf III high-speed sampler and of a high-speed version of the 1 m ring-trawl have been carried out on the Association's vessels. However, it has been found impossible to replace the routine hauls of the 2 m ring-trawl by regular high-speed sampling owing to lack of sea-going time. Instead, the 2 m ring-trawl is being improved by the use of synthetic fibres, and difficulties with diesel-engined ships overcome by towing at higher speeds with a depressor fitted below the ring, and by installing a flow meter in the mouth of the net.

Macro-fauna and Flora

During the breeding season of *Echinus esculentus* Dr D. P. Wilson and Mr F. A. J. Armstrong again used the larvae to test waters from different localities and to try out various ideas. Unfortunately, all natural waters used this year were so closely similar, and all good, that experiments planned in anticipation that there would be differences produced results of little consequence. Some water in which larvae of *Sabellaria alveolata* had been reared did appear to be better for *Echinus* larvae than did some natural sea waters, but results are too few for firm conclusions to be drawn.

Dr Wilson continued the work begun last year on the study of the ecology of the larvae of *Sabellaria alveolata* and has been gathering data concerning natural settlement on the shore and on the growth of colonies and their ultimate destruction. This work will of necessity be prolonged, because colonies seem to survive for a number of years and because of natural impediments to regular observation. Tide and weather conditions often prevent regular monthly visits to the chosen sites at low levels on the shore on the coast of Cornwall north of Bude.

More experiments have confirmed the effect on the larvae of *Sabellaria* of the toxic properties of filtrates of *Gymnodinium veneficum* as reported last year. Some toxicity has also been noted in filtrates from cultures of *Prorocentrum micans*, but in this case the effects are somewhat different: usually it is only the swimming speed of the larvae which is reduced though morphological changes may also take place. Unlike the toxin from *Gymnodinium* that from *Prorocentrum* has equal effect whether the *Sabellaria* larvae in a dish are many or few. In contrast with these two dinoflagellates, filtrates from thick cultures of the Chrysomonad *Isochrysis galbana*, the organism used to feed the larvae, have no effect whatever on the latter.

In continuation of last year's report it can now be stated that eventually large numbers of larvae were reared through metamorphosis and many experiments made to determine the factors responsible for inducing settlement and metamorphosis. When larvae first began to metamorphose in any number they were about 4 months old and some did not metamorphose until $6\frac{1}{2}$ months old. First results indicate that larvae will not settle or metamorphose in still water even in the presence of sand or of adult tubes with or without living adult worms. They will settle on the upper surfaces of glass plunger plates raised and dropped at half-minute intervals in water contained within small glass dishes, and probably also on the bottoms of the dishes as well. They settle most readily in such dishes when sand is provided so that sand grains are swirled around in the water disturbed by the plungers. They are most prone to settle on and alongside the tubes of recently metamorphosed worms, though many settle singly. It would appear that larvae in the exploratory crawling phase discover these settled worms by chance contact with them. Larvae still settle and metamorphose on newly settled worms even in still water and in the absence of loose sand grains. Confirmation of these and other preliminary results is desirable and other factors also require investigation. Thus there is some evidence that a surface covered with a biological slime film is more attractive than an absolutely clean surface; such a film may indeed be a necessity before settlement will take place. The results obtained so far relate well to settlement and colony formation as seen on the shore, where relatively clean rocks, clean sand and regular wave-wash appear to be a necessary combination of physical factors for the development of the largest colonies. A new series of experiments is planned and larvae are now being reared for the purpose.

Mr G. M. Spooner has continued to examine likely samples of the sea-bed for interstitial fauna. An interesting ground has been located off the Lizard Peninsula in 17 fathoms, where a fine shelly gravel produced a fauna closely resembling that of the Eddystone shell gravel. Among mesopsammal malacostracans *Ingolfiella britannica* and two bogidiellids occurred, this being the second known locality for these species. This ground also provided a further locality for the isopods *Microcharon harrisi* and *Microjaera anisopoda*, the

acochlidacean gastropods *Microhedyle lactea* and *Hedylopsis spiculifera*, and nudibranch *Embletonia pulchra*. By contrast, apparently promising *Lithothamnion* gravel off Falmouth was unproductive, apart from two specimens of *Microjaera*.

Work on the Eddystone shell gravel and other coarse deposits is showing that some interesting differences occur in the proportions of young stages of larger benthic animals to the pygmy species with which they have to compete. Whereas such young form a very small proportion of malacostracan crustaceans, they contribute the great majority of lamellibranch molluscs encountered. Gastropod molluscs are mainly small species and not spat, while polychaetes are about equally represented by both types.

Mr P. G. Corbin has continued his investigation on sand-eels. In the week of 23–27 July 1962, he made a young fish trawl survey in R.V. 'Sarsia' of 26 stations close in to the north coast of Cornwall from Lundy to Scilly and off the south coast between Scilly and the Lizard. The object of the cruise was to catch good quantities of post-larvae of the greater sand-eel, *Ammodytes lanceolatus*, of which only very few examples were caught on the 1937–39 Celtic Sea surveys. From the little data then obtained it is fairly certain that the cruises were too early in the year and too far out off the coast to sample well the main peak and distribution of post-larvae of this species. The 1962 catches have not yet been examined fully, but in many of them sand-eel post-larvae are numerous.

Mr Corbin continues to serve on the Devon Sea Fisheries Committee of which he has now been a member for many years. In this connexion he made a brief survey in the Torridge estuary in relation to the possible effects of gravel dredging on the fish population. For the same Committee Mr Corbin is engaged in an assessment of the mortality and damage to other commercial species during the winter sprat fishery mainly in the Torbay area.

Mr N. A. Holme has now finished collecting material for his survey of the bottom fauna of the English Channel. During the winter of 1961–62 a number of lines of dredge stations were worked across the Channel and also around the Channel Islands, so that the whole area has now been covered. The samples are still being worked up, but the results would appear to substantiate the conclusions incorporated in last year's report.

Since the spring of 1962 Mr Holme and Dr T. I. Shaw have been examining the squid taken in trawl catches off Plymouth in order to investigate the seasonal occurrence, migrations, growth and general biology of *Loligo vulgaris* and *L. forbesi*. In March and April *L. vulgaris* was the only species taken, but in May it was replaced by a population of *L. forbesi*, which has remained through the summer. *L. vulgaris* has been absent from the majority of catches in the summer, but occasional specimens have been taken in Bigbury Bay. Large specimens of *L. forbesi* have been rather rare during the summer,

but have occurred regularly in samples obtained from near the mouth of the Channel.

Dr E. J. Denton has continued his study of the life-history of the cuttlefish *Sepia officinalis* and has for the year 1961–62 determined the rates of growth of the cuttlefish, the growth of their gonads and the rate at which the chambers of the cuttlebone are laid down. He finds that *Sepia* in both its 0-year and 1-year groups grows very quickly in the summer months and very slowly in the winter. The 0-year group grows relatively at about three times the speed of the 1-year group. The animals matured during the winter of the 1-year and not at all in the 0-year. A study of the change in the form of the cuttlebone through the year shows that the *S. officinalis* and *S. filliouxi* are one and the same species. The chambers of the cuttlebone are laid down very quickly—in the 1-year group at the rate of about two a week during the summer. This explains why such low pressures of gas were found in the newly formed chambers by Dr Denton and Dr Gilpin-Brown. Liquid is actively extracted from a newly formed cuttlebone and gas only slowly diffuses into the space formed.

Mr G. R. Forster has completed an account of the underwater survey of ormers (*Haliotis*) undertaken for the States of Guernsey Committee for Agriculture and Fisheries; this has been published in Vol. 42, No. 3, of the *Journal*. A stock of ormers has been kept in a small tank in the laboratory for almost a year, without great mortality. It is possible that the species could be usefully introduced to Devon or Cornwall. It is hoped to undertake some tagging work in Guernsey during the summer of 1963.

Diving at Plymouth has been carried on when possible from April onwards, but the work is handicapped by the lack of a suitable launch. A few underwater counts have been made of the numbers of *Holothuria*, these animals being very abundant near the Tinker shoal.

The deep-sea line fishing mentioned in last year's report has been continued during a cruise on R.V. 'Sarsia' in July to the continental slope. Nine hauls were made, and various species of squaloids obtained for use in experiments by Dr Nicol. Two hauls were made in roughly 1200 fm, producing several large chimaeras (*Hydrolagus affinis*) and two interesting brotulids, one over 30 in. in length, which have been sent to Dr N. B. Marshall of the British Museum for identification. An account of the method of working a line in deep water is being prepared for publication in the *Journal*.

Mr Forster continues to serve on the Cornwall Sea Fisheries Committee of which he has been a member for some years.

Dr A. J. Southward has continued observations on the distribution and abundance of barnacles and other intertidal organisms. In the south-west there were no marked changes in populations in spite of the cold spring and summer of 1962, though a slight increase in *Elminius modestus* was noticeable at stations around Plymouth. Further field work has been carried out in the

Hebrides in collaboration with Dr D. J. Crisp, with the aid of a grant from the Browne Research Fund of the Royal Society. The outer Islands were visited in May, and Tiree and parts of the mainland in September; it should now be possible to complete an account of the distribution of the commoner intertidal organisms on the west coast of Britain.

In collaboration with Dr E. C. Southward, Dr Southward has made further observations on the biology and distribution of the Pogonophora. By permission of the Director of the National Institute of Oceanography, Dr Southward was able to accompany Mr R. I. Currie on a cruise of R.R.S. 'Discovery II' and carry out deep dredging on a line from Plymouth to Madeira. The hauls amply demonstrated the extreme paucity of the abyssal plain fauna, but some interesting catches, including some pogonophores, were made in shallower water near Madeira. On a later cruise of R.V. 'Sarsia' to an area of the continental slope previously found to have a rich fauna (vicinity of 48° 30′ N., 10° W.) many specimens of several species of pogonophores were captured and it was possible to make some interesting observations on the living animals. In particular it was established from absorption spectra that the blood contains haemoglobin. These results have been published in Volume 43, No. 1, of the *Journal*. Unfortunately, all specimens were damaged in some way by the dredge and hence the general behaviour of the whole live animal is still obscure. It is hoped to overcome this difficulty of damage by working on some relatively large pogonophores that have recently been discovered in very shallow water in the Arctic Ocean off North America.

Physiology of Fish and other Marine Organisms

Studies on the physiology of vision in the selachian eye have been continued by Dr J. A. C. Nicol, in collaboration with Dr E. J. Denton. Their researches have been concerned with: the efficiency of the *tapetum lucidum* as a light reflector; absorption of light by the retina; regulation of occlusion of the tapetum of coastal sharks; structure and functioning of the tapetum of deep-sea sharks; and visual pigments of deep-sea sharks. The dogfish *Scyliorhinus canicula* has a non-occlusible tapetum and its static character offers advantages for some quantitative studies. After removal of the retina the tapetum is exposed and its reflexion characteristics can be measured. It shows high reflectance throughout the visible spectrum; values rise from 77% at 425 mμ to a peak of about 86% at 510 mμ, and fall off to about 60% at 600 mμ. In the region of maximal reflectance—the blue-green—the amount of light reflected by the tapetum is remarkably high indeed, and compares well with the specular reflexion of a good metal surface (sputtered aluminium, 92%). It is in this region of the spectrum that dogfish rhodopsin absorbs the greatest amount of light ($\lambda_{max.}$ = 500 mμ). The eyes of selachians (*Scyliorhinus*, *Saualus*) have fairly short rods, and the density of visual pigment

in their retinae is fairly low, around 0·3, compared with other fishes, the conger, for example, where it is 0·58. Since the selachian retina absorbs only 50% of blue-green light (at 500 mμ) falling upon it, the significance of the tapetum lucidum can be understood. Some 45% of the light falling upon the retina is reflected back by the tapetum and 22% is absorbed in the second passage through the retina. The tapetum, therefore, increases the amount of light absorbed from 50 to 72%. In the dogfish, where the pupil closes rapidly when exposed to light, reflectivity of the tapetum does not alter. But in the spur-dog, where the size of the pupil changes very little on illumination, the tapetum lucidum becomes concealed by migratory chorioidal pigment when the eye is exposed to light. The course of occlusion (or covering) of the tapetum has been followed: in the anaesthetized fish by measuring, with a photocell, changes in the amount of light reflected by the tapetum through the pupil; in isolated tapeta from dark-adapted eyes by measuring, with a photomultiplier, changes in light-reflexion; by photographing the surface of the isolated tapetum at short intervals after excision; and by the examination of a large series of histological sections from eyes of light- and dark-adapted fish. Movement of the pigmented processes is well under way within 15 min and is largely completed by 1 h, when the tapetum appears quite dark.

The eyes of several species of deep-sea sharks (*Deania*, *Centrophorus*), captured on a line by Mr G. R. Forster on a cruise of R.V. 'Sarsia', were examined by Dr Nicol. Their visual pigments (visual gold or chrysopsins) also have densities of around 0·3. On the same cruise it was discovered that a chimaeroid from deep water (*Hydrolagus affinis*) also contains a golden visual pigment, the spectral and absorption characteristics of which were measured. All these deep-water chondrichthians (squalids and chimaerid) had bright tapeta over the entire chorioid, and their tapeta stayed bright when illuminated, i.e. they are non-occlusible. This makes sense in an environment that is always dimly illuminated, either by residual daylight or by the weak luminescent flashes of other animals or even their own light.

Further material has been collected by Dr Nicol for his studies of retinomotor changes in teleosts, and histological preparations are being made by Mr A. C. G. Best. It has been ascertained that the migration of pigment and movement of cones which occur in soles are normal occurrences in the eyes of other pleuronectids (merry sole, plaice, dab); the extent of these movements differ in various regions of the eye, and from species to species.

Dr E. J. Denton and Dr Nicol have begun a study of the reflecting layers of animals. They have devised a simple method of studying reflectivity, for various wavelengths and various angles, of surfaces such as the side of a fish or the tapetum of the elasmobranch eye. Both these tissues have numerous reflecting plates and since these are, in general, inclined to the surface of the tissue the usual methods of measuring reflectivity are not convenient.

This apparatus together with a hypothesis as to 'why fish have silvery sides' has been demonstrated to the Physiological Society in Cambridge.

Dr Denton and Dr Nicol have also studied the orientation of the tapetal plates in the eye of *Squalus acanthias*. They find that although these plates are sometimes very inclined to the plane of the retina yet, because the pupil limits the light entering the eye, the plates are always approximately perpendicular to the light which can reach them.

Extracts from the retinae of three species of deep sea sharks (*Centrophorus*, *Deania* and *Centroscymus*) caught by the long line devised by Mr G. R. Forster have been made by Dr Denton and Dr T. I. Shaw. They find that all three species have golden coloured photosensitive pigments absorbing maximally at around 480 mμ. The elasmobranchs as well as the teleosts seem therefore to obey the general rule found by Denton and Warren that deep-sea fishes have golden pigments which absorb maximally at those wavelengths of light to which the ocean is most transparent. This work has been published in Vol. 43, No. 1, of the *Journal*.

Dr Denton and Dr T. I. Shaw have published a short account of their work on the buoyancy of gelatinous animals in the *Journal of Physiology*, Vol. 161. Dr Denton has contributed a chapter on buoyancy to a forthcoming book on *The Physiology of Mollusca* edited by Prof. C. M. Yonge, F.R.S., and Prof. K. Wilbur.

In collaboration with Dr D. W. Taylor of Aberdeen University (now at the University of Otago, New Zealand) Dr Denton has analysed the gas in different regions of the cuttlebone. While, as was previously shown, the gas in the older chambers is almost entirely nitrogen, the gas in the newly formed chambers contains much more oxygen (up to 17%). These results are in good accord with the 'osmotic' hypothesis for the functioning of the cuttle-bone put forward by Denton and Gilpin-Brown in Vol. 41 of the *Journal*.

Mr Q. Bone has continued work upon the histology of the nervous system in cyclostomes; an account of certain aspects of the peripheral nervous system in *Myxine* has been published in Vol. 43, No. 1, of the *Journal*; an account of the central nervous system in the same animal is also ready for publication. The innervation of the muscle units in the petromyzont myotome has been studied, and a description of this, and of the motor innervation of the eye-muscles, is being prepared. Mauthner cells have been identified in adult petromyzonts, and information upon this system will be incorporated in a general account of co-ordinating systems in the spinal cords of lower chordates. In elasmobranchs, what are probably Rhode cells (but as yet, no Mauthner cells) have been found in certain species, but not in others. It seems at present that the presence of Rhode-type elements in the elasmobranch spinal cord is linked with the ability of the fish to swim after the spinal cord has been transected behind the medulla.

The pattern of muscular innervation has been studied in various elasmobranchs, some of the results obtained have been summarized in a review account of the innervation of striated muscle in the lower chordates, which has been accepted for publication in the *International Review of Neurobiology*. This account also contains observations upon the myotomal innervation in *Polypterus* and *Protopterus*. A detailed account of the motor and sensory innervation of striated muscle in elasmobranchs is being prepared; it is hoped to include information upon the innervation of the eye-muscles, as well as upon the myotomal and fin musculature. Some experiments upon different 'spinal' elasmobranchs have been carried out in connexion with this study.

Dr T. I. Shaw, in collaboration with Prof. A. L. Hodgkin, F.R.S., and Mr P. F. Baker, has extended the observations on perfused giant nerve fibres of *Loligo*. The variation of the action potential with changes in the internal sodium concentration has been investigated and, in accord with the ionic hypothesis, it was found that the overshoot diminished with increasing internal sodium concentrations; according to a simple though incomplete theory it appeared that the fibre at the peak of the spike was behaving as though it were some ten times more permeable to sodium than potassium. It was found that fibre potassium could be replaced by rubidium without abolishing nerve conduction, under these circumstances the action potential was prolonged and its rate of fall particularly slowed. Replacement of potassium sulphate in the fibre by caesium abolished the spike and markedly depolarized the fibre. These experiments supported the view that fibre potassium plays a specific role in nerve conduction. A theory of the resting potential, based on the Hodgkin and Huxley equations, was developed and it gave a fairly satisfactory account of experiments in which the KCl of perfused fibres was replaced by NaCl and also of results by other workers who had altered the external potassium concentration about intact fibres. These results together with other information on the electrical properties of perfused fibres have been presented for publication in two papers in the *Journal of Physiology*.

Also in collaboration with Prof. Hodgkin and Mr Baker, Dr Shaw has carried out studies upon the efflux of radioactive sodium from perfused fibres. The first objective was to determine the feasibility of re-establishing active transport in perfused fibres. In this connexion it was shown that when fibres were with natural axoplasm the sodium efflux persisted unchanged. Evidently the sodium transport mechanism is sufficiently robust to withstand the manipulation associated with extrusion and perfusion. A preliminary investigation of the efflux of radio-sodium from fibres perfused with artificial axoplasm has also been undertaken; the results show that certain special precautions are necessary in handling the preparations during such experiments.

Dr Shaw has also started a study on the net movements of sodium and potassium in the perfused fibre preparations. Such studies, though useful, must be expected to proceed rather slowly.

Mr J. V. Howarth has been engaged in research on the heat production of nerve. Previous work on the limb nerves of *Maia squinado* showed that the heat production occurred in two phases, a positive heat production during the first 100 msec after the action potential, followed by heat absorption during the succeeding 300 msec. The absorption (negative) phase is interesting because it cannot at present be related to any other known physical event in the nerve. In the present work the heat has been recorded in a variety of conditions which are known to act on the action potential. So far it appears that treatment with veratrine at room temperature followed by cooling to 0° C does not abolish the heat absorption. Replacing the sodium of the physiological medium by barium enhances both the action potential and the positive heat production, but does not greatly affect the heat absorption. Replacement of the sodium by lithium at 0° C does not change either the positive or negative phases of heat production. The implication of these experiments is that the negative heat at least is not a consequence of the physical heat of mixing of the ions, as postulated by one theory.

Most of our knowledge of the physico-chemical events in nerve depends on investigation of the squid giant axon. That nerve is not suitable for heat measurements so the question arises: can one rightly interpret heat measurements made on the crab limb nerve in the light of physico-chemical data obtained on squid? It would be a help to know if the heat absorption is a general property of nerves or a special property of a particular type or size of nerve. Therefore a comparative study is being made to examine the heat production in suitable nerves from a wide variety of animals. Nerves suitable for the present apparatus are not common and so far only the fin nerve of *Loligo* and the lateral line nerve of dogfish have been tried. At the moment nothing can be said with certainty about either save that the heat production in both is very small.

Dr G. W. Bryan has nearly completed work on the accumulation of radioactive caesium by marine and brackish water invertebrates. An account of the accumulation of ^{137}Cs in relation to potassium metabolism in the common lobster, the prawn and in freshwater crayfish, which was carried out in collaboration with Mrs E. E. Ward of the United Kingdom Atomic Energy Authority, Radiobiology Group, Windscale, has been published in Vol. 42, No. 2, of the *Journal*.

In collaboration with Dr B. Battaglia of the University of Padua, experiments have been carried out to compare the permeabilities to alkali metals of the *violacea* and *trifasciata* forms of the polymorphic copepod *Tisbe reticulata*. These two forms, which differ by one gene, have different abilities to breed in normal and diluted sea waters. The uptake of the isotopes ^{22}Na, ^{42}K and

^{137}Cs was followed in adult females which were acclimatized to 100, 75, 50 and 33% sea water. Isotope levels at equilibrium showed that in diluted sea water the whole-body Na concentration is proportionally reduced while the K concentration is maintained at a relatively high level. Whole-animal concentration factors reached for ^{137}Cs were always rather higher than those for ^{42}K at all external concentrations and were reached in about 16 h. This is by far the most rapid accumulation of ^{137}Cs which has been found in the present work and the animals are the smallest (20 μg each) which have been used. Consistent slight differences in uptake rates for ^{42}K and ^{137}Cs were found between the two polymorphic forms. The reason for this could be due to differences of permeability of the body surface and tissues but, equally well, it might be the result of one form perhaps having larger ovaries and relatively less body fluid than the other.

A study of zinc metabolism in the crab *Carcinus maenas* and in the lobster *Homarus vulgaris* has been started. Concentrations of Zn in the blood and tissues of *Carcinus* lie in the region of 20–40 μg/g wet weight while in the lobster there is only about 5 μg/g in the blood plasma but up to 300 μg/g in the hepatopancreas. These figures are very high compared with the values of 1–24 μg/l. which have been found in English Channel sea water. The isotope ^{65}Zn, either absorbed from sea water or injected, combines initially with plasma proteins in both species and cannot be removed by dialysis against sea water. In *Carcinus*, however, ^{65}Zn is virtually not excreted whereas the urine ^{65}Zn concentration in a lobster may be of the same order as that of the plasma. Excretion of ^{65}Zn in *Carcinus* can be induced by injecting the chelating agent EDTA. This produces a dialysable fraction in the plasma and the concentration of ^{65}Zn in the urine, after correcting for water reabsorption, is equal to the concentration of this fraction. Possible differences between the binding of ^{65}Zn in the plasma of the two species are being examined in detail. In both species ^{65}Zn in the plasma is absorbed by other tissues and in particular by the lobster hepatopancreas. A further difference between the species is that concentrations of ^{65}Zn in the gut fluid in relation to the plasma are relatively high in *Carcinus* and low in the lobster. Experiments on the uptake of ^{65}Zn from sea waters with different inactive Zn concentrations have been carried out in *Carcinus* and the earliest results suggest that the amount of Zn which is absorbed may be proportional to the seawater concentration. This work is the first phase in a study of the way in which Zn can be obtained and of the mechanisms by which control of the body Zn content might be achieved.

Experiments have been carried out with manganese in lobsters at the Windscale Radiobiological Research Laboratory in collaboration with Mrs E. E. Ward. Inactive levels of Mn in the soft tissues are highest in the hepatopancreas which has about 3 μg/g wet weight. As much as 30 μg/g wet weight has been found associated with the shell. The isotope ^{54}Mn can be absorbed from sea water into the blood while at the same time considerable adsorption

on to the body surface appears to take place. Absorption from the gut fluid is extremely rapid and may be an important pathway for uptake. Injected or absorbed ^{54}Mn does not appear to be bound by blood plasma in a comparable way to Zn and this is being examined. Following injection, ^{54}Mn is lost fairly rapidly from the blood as it is absorbed by other tissues and is usually excreted at a concentration which exceeds that of the plasma. The role of excretion in the control of the manganese content of lobsters is being examined.

Dr E. D. S. Corner has continued his studies with Dr A. D. Boney of the Plymouth College of Technology on the role of the accessory pigment phycoerythrin in sporelings of mid-littoral red algae. Earlier experiments with sporelings of *Plumaria elegans* indicated that the function of phycoerythrin in protecting sporelings of the plants from the growth-inhibiting effects of excess green light in the wave-band 500–540 mμ would vary with the ecological distribution of the plants, and this has now been confirmed in experiments with sporelings of *Antithamnion plumula* and *Brongniartella byssoides*. Thus, using experimental methods similar to those described earlier in Vol. 42, No. 1, of the *Journal* evidence has been obtained consistent with the view that the protective function of phycoerythrin is most marked in the case of sporelings of *Antithamnion* grown under conditions approximating to normal daylight illumination; but absent in the case of sporelings of the completely submerged species, *Brongniartella*.

Dr Corner and Dr Boney have completed their preliminary investigation of the possible use of red algal sporelings in a rapid screening test for carcinogens. Results obtained so far are encouraging in that low concentrations of various carcinogenic polycyclic hydrocarbons, particularly derivatives of benzanthracene, have been found to cause a considerable increase in cell production, whereas similar concentrations of structurally related non-carcinogens inhibit it. An account of this work has been published in Vol. 42, No. 3, of the *Journal*.

Dr G. T. Boalch has continued his investigations as International Paints Research Fellow on the toxicity of heavy metals to bacteria-free cultures of the fouling algae *Ectocarpus* and *Enteromorpha*. Progress has been considerably hampered by persistent fungal contamination of experimental cultures. However, a small room has now been fitted with an ultra-violet sterilizing lamp and it is hoped that by using this room for inoculation this problem will be overcome and the work for International Paints brought to completion. Regular investigation of the plates on the test rafts at Newton Ferrers has proved interesting this year as the normal fouling sequence has not been apparent. This may have been a result of the low seawater temperatures in winter and early spring.

Library

The thanks of the Association are once more due to many foreign Government Departments, to Universities and to other Institutions at home and abroad for copies of books and current numbers of periodicals either presented to the Library or received in exchange for the *Journal* of the Association.

Thanks are also due to those who have sent books or reprints of their papers, which are much appreciated.

Published Memoirs

Vol. 42, No. 2, of the *Journal* was published in June, Vol. 42, No. 3, in October, and Vol. 43, No. 1, in February 1963.

The following papers, the outcome of work done at the Plymouth laboratory, have been published elsewhere than in the *Journal* of the Association:

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Membership of the Association

The total number of members on 31 March 1963 was 1369, being 95 more than on 31 March 1962; of these the number of life members was 171 and of annual members 1198. The number of associate members is four. During the year Dr J. S. Alexandrowicz was elected an associate member.

Gift

The Council wish to record their thanks to Dr Anna M. Bidder for the gift of two seats to be placed in the garden of the Plymouth laboratory and for making possible the re-covering of the armchairs in the Common room.

Finance

General Fund. The thanks of the Council are again due to the Development Commissioners for their continued support of the general work of the laboratory.

Private Income. The Council gratefully acknowledge the following generous grants for the year 1962–63:

Fishmongers' Company (£500), The Royal Society (£100), British Association (£50), Physiological Society (£100), The Cornwall Sea Fisheries Committee (£10), The Universities of London (£210), Cambridge (£125), Oxford (£100), Bristol (£50), Birmingham (£31. 10*s*.), Leeds (£25), Durham (£10. 10*s*.), Manchester (£10. 10*s*.), Sheffield (£10. 10*s*.), Southampton (£15. 15*s*.), Reading (£15. 15*s*.), Nottingham (£10. 10*s*.), Hull (£10. 10*s*.), Exeter (£10. 10*s*.), Leicester (£10. 10*s*.), Gonville and Caius College, Cambridge (£5) and the Zoological Society of London (£10. 10*s*.).

PRESIDENTS, VICE-PRESIDENTS, OFFICERS AND COUNCIL:

The following is the list of those proposed by the Council for election for the year 1963–64:

President

Prof. C. F. A. PANTIN, Sc.D., D.Sc., Dr. Univ., F.R.S.

Vice-Presidents

THE EARL OF IVEAGH, K.G., C.B., C.M.G.
SIR NICHOLAS WATERHOUSE, K.B.E.
SIR EDWARD J. SALISBURY, Kt., C.B.E., D.Sc., F.R.S.
Major E. G. CHRISTIE-MILLER
MORLEY H. NEALE, C.B.E.
Prof. Sir JAMES GRAY, Kt., C.B.E., M.C., Sc.D., LL.D., F.R.S.
G. M. GRAHAM, C.M.G., O.B.E.
Prof. A. V. HILL, C.H., O.B.E., Sc.D., LL.D., F.R.S.
Prof. Sir ALISTER HARDY, Kt., D.Sc., F.R.S.
Prof. C. M. YONGE, C.B.E., D.Sc., F.R.S.

COUNCIL

To retire in 1964

Prof. A. V. HILL, C.H., O.B.E., Sc.D., LL.D., F.R.S.
J. W. G. LUND, Ph.D., D.Sc., F.R.S.
Prof. Sir JOHN T. RANDALL, D.Sc., F.R.S.
H. G. VEVERS, M.B.E., D.Phil.
Prof. C. M. YONGE, C.B.E., D.Sc. F.R.S.

To retire in 1965

Prof. J. E. HARRIS, C.B.E., Ph.D., F.R.S.
Prof. B. KATZ, M.D., D.Sc., F.R.S.
R. D. KEYNES, Ph.D., F.R.S.
C. E. LUCAS, C.M.G., D.Sc.
Prof. J. E. SMITH, Sc.D., F.R.S.

To retire in 1966

H. A. COLE, D.Sc.
R. I. CURRIE
C. H. MORTIMER, Dr.phil, D.Sc., F.R.S.
N. TEBBLE
Prof. W. F. WHITTARD, D.Sc., F.R.S.

Hon. Treasurer

Sir EDWARD CHADWYCK-HEALEY, Bt., M.C.,
The Mill House, Hook, Basingstoke, Hants

Secretary

F. S. RUSSELL, C.B.E., D.S.C., D.F.C., D.Sc., LL.D., F.R.S.
The Laboratory, Citadel Hill, Plymouth, Devon

The following Governors are also members of the Council:

H. GARDNER, C.B.E. (Ministry of Agriculture, Fisheries and Food)
The Worshipful Company of Fishmongers:
The Prime Warden
Major E. G. CHRISTIE-MILLER
Sir EDWARD CHADWYCK-HEALEY, Bt., M.C.
Prof. Sir ALISTER HARDY, Kt., D.Sc., F.R.S. (Oxford University)
S. SMITH, Ph.D. (Cambridge University)
EDWARD HINDLE, Sc.D., F.R.S. (British Association)
Prof. G. P. WELLS, Sc.D., F.R.S. (Zoological Society)
Prof. Sir JAMES GRAY, Kt., C.B.E., M.C., Sc.D., LL.D., F.R.S. (Royal Society)

BALANCE SHEET 1962–63

THE MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

BALANCE SHEET

31 MARCH 1963

	£	£
CAPITAL RESERVE ACCOUNT:		
As at 31 March 1962	168,086	
Add: Expenditure on fixed assets recovered	2,785	
	170,871	
Less: Transfer to surplus account being an amount equivalent to the depreciation provided on assets acquired out of Development Fund grants	3,674	167,197
SURPLUS ACCOUNT:		
As at 31 March 1962	17,185	
Add: Transfer from Capital Reserve Account	3,674	
Decrease in provision for diminution in value of General Fund investments	187	
	21,046	
Deduct:	£	
Stock adjustments in respect of prior years	632	
Excess of expenditure over income for the year ...	1,443	
	2,075	18,971
		186,168
BALANCES ON SPECIAL FUNDS (see annexed statement)		5,818
CURRENT LIABILITIES:		
Sundry creditors and accrued expenses	2,117	
Subscriptions and grant received in advance	401	
		2,518

Note: Capital commitments outstanding amount to approximately £7,700 (1962 £15,600) of which £7,500 (1962 £15,000) is recoverable

O. D. HUNT
F. S. RUSSELL } *Members of the Council*

£194,504

	£	£	£
FIXED ASSETS:	Cost or Valuation	Depreciation	
Boats and equipment:			
At cost:			
R.V. 'Sarsia'	137,761	19,615	118,146
M.F.V. 'Sula'	12,500	2,395	10,105
R.L. 'Gammarus'	200	60	140
	150,461	22,070	128,391
Laboratory apparatus, equipment and machinery:			
At cost	32,860	12,462	20,398
Library at valuation in 1941 plus additions as valued by the Director	27,140	—	27,140
	£210,461	£34,532	
			175,929
INVESTMENTS AT MARKET VALUE:			
General Fund (including Composition Fees) at book amount (Market value £2,152; last year £1,714)		2,523	
E. T. Browne Bequest Funds at cost (Market value £4,165; last year £3,654)		5,422	
Todd Fund, at cost (Market value £484)		500	
		8,445	
Less: Provision for diminution in value of investments		1,644	
			6,801
CURRENT ASSETS:			
Stocks on hand at the lower of cost and estimated realizable value		6,560	
Sundry debtors and prepayments		2,109	
Balances at bankers and cash in hand		3,105	
			11,774
			£194,504

AUDITORS' REPORT TO THE MEMBERS OF THE MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM:

Capital expenditure on the erection of buildings on land held on lease from the War Department is excluded. Subject to the foregoing, in our opinion the above balance sheet and annexed income and expenditure account give a true and fair view of the state of the Association's affairs as at 31 March 1963 and of its excess of expenditure over income for the year ended on that date.

We have obtained all the information and explanations which we considered necessary. In our opinion the Association has kept proper books and the said accounts which are in agreement with them and with the said information and explanations, give in the prescribed manner the information required by the Companies Act 1948.

Norwich Union House
2 St Andrew's Cross
Plymouth
17 May 1963

PRICE WATERHOUSE & Co.
Chartered Accountants

INCOME AND EXPENDITURE ACCOUNT

FOR THE YEAR ENDED 31 MARCH 1963

	£	£
SALARIES, NATIONAL INSURANCE, SUPERANNUATION SCHEME CONTRIBUTIONS AND SUPPLEMENTARY PENSIONS		53,152
LABORATORY AND BOATS' CREWS' WAGES, NATIONAL INSURANCE, SUPERANNUATION SCHEME CONTRIBUTIONS, PENSIONS AND EMPLOYERS' LIABILITY INSURANCE		44,261
UPKEEP OF LIBRARY		900
SCIENTIFIC PUBLICATIONS, LESS SALES		2,409
UPKEEP OF LABORATORIES:		
Buildings and machinery	1,205	
Electricity, gas, coal, oil and water	2,384	
Chemicals and apparatus	3,308	
Depreciation of laboratory apparatus, equipment and machinery	2,281	
Rates	1,469	
Rents and insurances	482	
Travelling expenses	1,371	
Audit fee	227	
Stationery, postage, telephone and sundries	2,052	
Specimens	153	
Collecting expenses and upkeep of truck	281	
		15,213
MAINTENANCE AND OPERATION OF BOATS:		
Petrol, oil, paraffin, etc.	1,821	
Maintenance and repairs	6,101	
Depreciation	3,674	
Insurances	2,460	
Hire of Decca Navigator—R.V. 'Sarsia'	395	
		14,451
ENTERTAINMENT EXPENSES		122
BANK INTEREST AND CHARGES (NET)		3
BALANCE being excess of income over expenditure for the year ...		
		£130,511

	£	£
GRANTS AND TABLE RENTS:		
Ministry of Agriculture, Fisheries and Food—Grant from Development Fund	117,180	
Fishmongers' Company	500	
Miscellaneous (including Royal Society £100, British Association £50, Physiological Society £100, Zoological Society of London £10. 10*s.*, Universities of London £210, Cambridge £125, Oxford £100, Bristol £50, Birmingham £31. 10*s.*, Leeds £25, Southampton £15. 15*s.*, Durham £10. 10*s.*, Exeter £10. 10*s.*, Leicester £10. 10*s.*, Manchester £10. 10*s.*, Nottingham £10. 10*s.*, Hull £10. 10*s.*, Reading £15. 15*s.*, and Sheffield £10. 10*s.*, and Gonville and Caius College, Cambridge £5)	1,514	
		119,194
SUBSCRIPTIONS (including Composition Fees £252; 1962, £252) ...		1,427
SALES:		
Specimens	4,078	
Fish	528	
	£	
Nets, gear and hydrographical equipment	3,415	
Less: Cost of materials	2,634	
	781	
		5,387
INCOME FROM INVESTMENTS		88
AQUARIUM:		
Admission fees	3,320	
Sale of guides	170	
	3,490	
Less: Maintenance, printing and advertising	518	
		2,972
BALANCE being excess of expenditure over income for the year ...		1,443
		130,511

MOVEMENTS ON SPECIAL FUNDS DURING THE YEAR TO 31 MARCH 1963

	E. T. Browne Bequest			Library Reserve Fund	Todd Fund (Library)	Rockefeller Foundation Fund	Aquarium Reconstruction Fund	Main Laboratory Extension Fund	South Building Repair Fund	Research Funds*	TOTAL
	Library	Special Apparatus	Scientific Publications								
	£	£	£	£	£	£	£	£	£	£	£
BALANCES AT 31 MARCH 1962 (after providing £1,664 for diminution in value of investments)	1,013	1,970	916	232	—	—	839	—	—	768	5,738
Add: Income during year											
Todd Fund Bequest	—	—	—	—	500	—	—	—	—	—	500
Grants	—	—	—	—	—	1,964	886	11,500	1,070	5,361	20,781
Income from investments	45	94	46	—	11	—	—	—	—	—	196
Bank deposit interest	—	—	—	6	1	—	25	—	—	—	32
Other income	—	—	63	—	—	904	—	—	—	—	967
Reduction in provision for diminution in value of investments	99	202	106	—	(16)	—	—	—	—	—	391
	1,157	2,266	1,131	238	496	2,868	1,750	11,500	1,070	6,129	28,605
Deduct: Expenditure during year	—	169	—	—	—	2,784	1,525	11,500	1,070	5,739	22,787
BALANCES AT 31 MARCH 1963	£1,157	£2,097	£1,131	£238	£496	£84	£225	£ —	£ —	£390	£5,818

* Including International Paints Limited Research Fellowship.