New Ser.—Vol. I, No. 4—issued November, 1890.] [Price 3s. 6d.

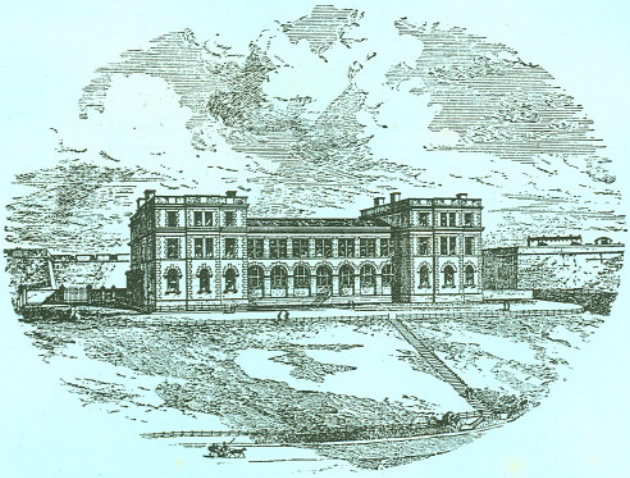
Journal

OF THE

MARINE BIOLOGICAL ASSOCIATION

OF

THE UNITED KINGDOM.



THE PLYMOUTH LABORATORY.

LONDON:

PRINTED FOR THE MARINE BIOLOGICAL ASSOCIATION BY ADLARD AND SON,

AND

PUBLISHED BY THE ASSOCIATION AT ITS OFFICES ON THE CITADEL HILL, PLYMOUTH.

SENT FREE BY POST TO ALL MEMBERS OF THE MARINE BIOLOGICAL ASSOCIATION: ANNUAL SUBSCRIPTION FOR MEMBERSHIP, ONE GUINEA.

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Journal of the Marine Biological Association.

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1888 Nicholson, Henry Martyn, 38, *Torrington Place, Plymouth* ..... *ann.*
1884 Noble, John, *Park Place, Henley-on-Thames* ..... *ann.*
†1884 Norman, Rev. Canon, M.A., D.C.L., F.R.S., *Burnmoor Rectory, Fence Houses* ..... *ann.*

1885 Oliver, Prof. F. W., *Royal Gardens, Kew* ..... *ann.*
1884 Ommanney, Admiral Sir Erasmus, C.B., F.R.S., 29, *Connaught Square, W.* ..... *ann.*
1884 Ormerod, G. W., M.A., F.G.S., *Woodway, Teignmouth* ..... *ann.*

1885 Paget, Sir James, Bart., F.R.S., 1, *Harewood Place, Hanover Square, W.* ..... *C.*
1884 Parker, J. J., 54, *Eaton Terrace, S.W.* ..... *ann.*
1884 Parker, Prof. W. Newton, *University College, Cardiff* ..... *ann.*
1884 Parsons, Chas. T., *Norfolk Road, Edgbaston, Birmingham* ..... *ann.*
1887 Pechey, Miss Edith, M.D., *Cumballa Hill, Bombay* ..... *ann.*
1888 Peek, Sir Henry W., Bart., F.Z.S., *Wimbledon House, Wimbledon* ... *C.*
1885 Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.* ..... *C.*
1889 Phillips, George, 1, *Victoria Place, Stonehouse* ..... *ann.*
1885 Pochin, H. D., *Bodnant Hall, Eglwysbach, Denbighshire* ..... *C.*
1884 Potter, Michael C., M.A., *Herbarium, New Museums, Cambridge* ... *ann.*
1884 Powell, Thos. Harcourt, *Drinkstone Park, Woolpit, Bury St. Edmunds* ..... *C.*
1886 Power, D'Arcy, M.A., F.R.C.S., 26, *Bloomsbury Square, W.C.* ..... *ann.*
1886 Power, Henry, F.R.C.S., 37A, *Great Cumberland Place, W.* ..... *ann.*
1888 Prance, C. R., M.D., 18, *Princess Square, Plymouth* ..... *ann.*
1885 Pritchard, Urban, 3, *George Street, Hanover Square, W.* ..... *ann.*
1884 Pye-Smith, P. H., M.D., 54, *Harley Street, W.* ..... *C.*

1884 Radford, Daniel, *Mount Tavy, Tavistock* ..... *ann.*
1884 Ralli, Mrs. Stephen, *Cleveland House, Clapham Park* £30
1885 Ransom, W. B., *Trinity College, Cambridge* ..... *C.*
1888 Rawlings, Edward, *Richmond House, Wimbledon Common* ..... *ann.*
1887 Riley, W., *Newcastle House, Bridgend, Glamorganshire* ..... *ann.*
1884 Rowe, J. Brooking, F.S.A., F.L.S., *Mulgrave Street, Plymouth* ..... *ann.*
1885 Ruscoe, John, *Albion Works, Henry Street, Hyde, near Manchester* ... *ann.*

1889 Sanford, W. A., *Nynehead Court, Wellington, Somerset* ..... *ann.*

1885 Saunders, Rev. J. C., M.A., *Downing College, Cambridge* ..... *ann.*
1884 Schäfer, Prof. E. A., F.R.S., *University College, Gower Street, W.C.* .. *ann.*
1888 Scharff, Robert F., Ph.D., *Science and Art Museum, Dublin* ..... *ann.*
*1884 Sclater, P. L., F.R.S., Sec. Zool. Soc., 3, *Hanover Square, W.* ..... *ann.*
1884 Sclater, W. L., *Indian Museum, Calcutta* ..... *ann.*
1885 Scott, D. H., M.A., Ph.D., *The Laurels, Bickley, Kent* ..... *C.*
*1884 Sedgwick, A., M.A., F.R.S., *Trinity College, Cambridge* ..... *C.*
1888 Serpell, E. W., 19, *Hill Park Crescent, Plymouth* £50
1885 Sheldon, Miss Lilian, *The Field, Stroud* ..... *ann.*
1884 Shipley, Arthur E., M.A., *Christ's College, Cambridge* ..... *C.*
1886 Shore, T. W., M.D., *Sunny Bank, Church Lane, Hornsey, N.* ..... *ann.*
1889 Simpson, Francis C., *Maypool, Churston Ferrers, R.S.O., S. Devon* *ann.*
1889 Slade, Lieut. E. J. Warre, R.N., *H.M.S. Rodney, Chatham* ..... *C.*
1884 Sladen, W. Percy, Sec. Linn. Soc., *Orsett House, Ewell, Surrey* ..... *ann.*
1884 Sowerby, William, *Royal Botanical Society, Regent's Park, N.W.* ... *ann.*
1884 Spencer, J., 121, *Lewisham Road, Lewisham, S.E.* ..... *ann.*
1888 Spencer, Prof. W. Baldwin, M.A., *University of Victoria, Melbourne* *ann.*
1884 Spring-Rice, S. E., 9, *Wilton Street, Grosvenor Place, S.W.* ..... *C.*
1884 Stalbridge, The Rt. Hon. Lord, 12, *Upper Brook Street, W.* ..... *ann.*
1884 Staples, Alderman, 87, *Avenue Road, Regent's Park, N.W.* ..... *ann.*
*1884 Stewart, Prof. Chas., P.L.S., *Royal College of Surgeons, Lincoln's Inn Fields, W.C.* ..... *ann.*
†1884 Sutherland, The Duke of, K.G., *Stafford House, St. James', S.W.* ... *C.*
1888 Swain, W. Paul, M.R.C.S., *The Crescent, Plymouth* ..... *ann.*

1889 Taylor, Thomas George, 6, *St. Mary Street, Stonehouse* ..... *ann.*
1884 Thompson, Prof. D'Arcy W., *University College, Dundee* ..... *ann.*
1890 Thompson, Herbert, B.A., 35, *Wimpole Street, W.* ..... *ann.*
1884 Thornycroft, John I., *Eyot Villa, Chiswick Mall* ..... *ann.*
1888 Thurston, Edgar, *Government Central Museum, Egmore, Madras* ... *ann.*
1888 Tripe, Major-General, 3, *Osborne Villas, Stoke, Devonport* ..... *ann.*
1889 Tweedy, W. Gage, 8, *Athenæum Terrace, Plymouth* ..... *ann.*
1885 Tylor, E. B., D.C.L., F.R.S., *Museum House, Oxford* ..... *ann.*

1884 Upcher, Henry R., *Sherringham, Cromer* ..... *ann.*

1888 Vallentin, Rupert, 18, *Kimberley Road, Falmouth* ..... *ann.*
1884 Venning, Mrs., 3, *Wingfield Villas, Stoke Devon* £50
1884 Vines, Professor Sydney H., M.A., D.Sc., F.R.S., *Botanical Gardens, Oxford* ..... *ann.*
1888 Vosper, Samuel, *Stonehouse, Plymouth* ..... *ann.*

1884 Walker, Alfred O., *Nantyglyn, Colwyn Bay, N. Wales* ..... *ann.*
1884 Walker, P. F., 36, *Princes Gardens, S.W.* ..... *ann.*
†1884 Walsingham, Lord, F.R.S., *Merton Hall, Thetford* £20
1890 Waterhouse, Edwin, *Feldemore, Dorking* ..... *ann.*
1888 Weiss, F. Ernest, *Birch Bank, Christ Church Road, Hampstead, N.W.* ..... *ann.*
1884 Welch, H. Kemp, 32, *Onslow Gardens, S.W.* ..... *ann.*
1890 Were, Nicholas, 9, *Osborne Place, Plymouth* ..... *ann.*
1890 Wilson, J. B., *Grammar School, Geelong, Victoria* ..... *ann.*

1884 Wilson, Scott B., *Heather Bank, Weybridge Heath* ..... *C.*
1884 Woodall, John W., M.A., F.G.S., *St. Nicholas House, Scarborough*... *ann.*
1888 Woods, G. W., F.I.C., F.C.S., *Ballagawne, Riggindale Road, Streatham, S.W.* ..... *ann.*
1884 Woollcombe, W. G., M.A., F.R.A.S., F.L.S., *Cathedral Close, Exeter* *ann.*
1886 Woollcombe, Surgeon-Major R. W., 14, *Acre Place, Devonport* ..... *ann.*

IV.—Associate Members.

1889 Alward, George, 11, *Hainton Street, Great Grimsby.*
1889 Caux, J. W. de, *Great Yarmouth.*
1889 Dannevig, Capt. G. M., *Arendal, Norway.*
1889 Dunn, Matthias, *Mevagissey.*
1889 Olsen, O. T., F.L.S., F.R.G.S., *Fish Dock Road, Great Grimsby.*
1889 Ridge, B. J., 3, *Gainsboro' Place, Mutley, Plymouth.*
1890 Roach, W., *Sussex Street, Plymouth.*
1889 Shrubsole, W. H., 62, *High Street, Sheerness-on-Sea.*
1889 Sinel, Joseph, 2, *Peel Villas, Cleveland Road, Jersey.*
1890 Spencer, R. L., *L. and N.W. Depôt, Guernsey.*
1890 Wells, W., *The Aquarium, Brighton.*
1889 Wilcocks, J. C., *May Cottage, Shoreham, Sussex.*
1890 Wiseman, Fred., *Buckland House, Paglesham, Rochford, Essex.*

MARINE BIOLOGICAL ASSOCIATION.

Report of the Council, May, 1890.

The Council has met nine times during the past year, and the attendance has been fully up to the average of previous years.

The business transacted by the Council has had reference—

1. To the maintenance and general efficiency of the Laboratory.

2. To the prosecution of special investigations on economic subjects.

3. To the financial position of the Association.

1. It was found necessary to alter the communications between the storage reservoirs and the pumps of the Laboratory at Plymouth, and orders were given to Messrs. Leete, Edwards, and Norman to supply a new valve-box, connection-pipes, &c. The cost of these alterations has been considerable, but it is satisfactory to note that the results have been very beneficial, and have produced a marked improvement both in the working of the pumps and in the water in circulation.

The Director reports that there was some little trouble over the sea water in June and July, 1889, during the hot weather, and during the alterations to the supply-pipes, which prevented more than one of the storage reservoirs being in use; but that since then, and especially after the alterations were completed, the water has been of admirable quality, and all the animals have done remarkably well.

Great improvement has lately been effected in the Aquarium at a very trifling cost, by hanging curtains between the top of the fronts of the tanks and the ceiling, so that all the light reaching the spectator must pass through the tanks. Previous to this there appears to have been an excess of light in the tanks, and the fish now appear to be much more comfortable, and keep nearer to the glass fronts.

The following fish, molluscs, and crustacea have spawned in the tanks during the past year :—

The Plaice (*Pleuronectes platessa*).
The Flounder (*Pleuronectes flesus*).
The Pouting (*Gadus luscus*).
The Poor Cod (*Gadus minutus*).
The Rockling (*Motella tricirrata*).
The Lucky Proach (*Cottus bubalis*).
The Spotted Dog-fish (*Scyllium canicula*).
Chiton cinereus.
The Whelk (*Buccinum undatum*).
The Purple (*Purpura lapillus*).
The Sea-hare (*Aplysia punctata*).
The Sea-lemon (*Archidoris tuberculata*).
Goniodoris nodosa.
The Lobster (*Homarus vulgaris*).
The Crawfish (*Palinurus vulgaris*).
The Shrimp (*Crangon vulgaris*).
The Prawn (*Palæmon serratus*).
Idotea tricuspidata and *emarginata,*

as well as other species not so well known.

The personnel of the staff and servants remains unchanged, with the exception of the fisherman, W. Roach, who left in October. His place has been filled by E. G. Heath, a trawl fisherman of great experience.

The Council sanctioned the purchase, in July, 1889, at a cost of £250, of a small steam-launch, the "Firefly," which has been of great service. Being half decked, and only thirty-eight feet long, this launch is only suitable for local expeditions, and its purchase in no wise diminishes the necessity for a sea-going steam-vessel for carrying on investigations on food-fishes. The "Firefly" is very economical in coal and water, and has entailed no extra expense in working. The Association now possesses three boats—the "Firefly," the "Mabel," a three-ton hook and line fishing-boat presented by Mr. Bourne, and the "Anton Dohrn," a rowing-boat bought in 1889.

Trawling, dredging, surface netting, and shore hunting have been carried on continuously during the year, and examples of interesting species, many of which are new to the district, have been added to the list since the last report.

The standard collection of species is making good progress, the collection of Decapod Crustacea being remarkably complete.

2. The researches on food-fishes and crustacea carried on under the direction of the Council have made considerable progress.

The Director of the Association, Mr. G. C. Bourne, has continued his observations on the pelagic fauna in the neighbourhood of Plymouth, and was also able through the courtesy of Capt. Aldrich, R.N., to make an expedition off the south-west coast of Ireland in H.M.S. "Research" in July last, for the purpose of comparing the surface fauna at the entrance of the Channel with that of the Channel itself. Some interesting observations have been made in connection with the presence of multicellular floating algæ in spring months and the presence of mackerel, which it is hoped may lead to practical results.

The Director has made observations and collected notes on the destruction of immature fish in various localities, and has been able, with the kind co-operation of the medical staff of the Deep Sea Mission to Fishermen, to arrange an extensive inquiry into the presence of immature fish in deep waters in the North Sea, and their movements and destruction by beam trawling. This inquiry is in progress, and promises to be full of interest.

In connection with the destruction of immature soles in the estuary of the Thames the Director has been making arrangements for keeping young soles in enclosed ponds with the view of rearing them to a marketable size, as is done in the Adriatic. For various reasons these experiments have been delayed, and are not yet in progress.

Experiments are also being made on the possibility of cultivating soles in fresh water, and it has been proved that the adult sole may be kept in fresh water.

In conjunction with Dr. G. H. Fowler, the Director has studied the natural history of the oyster, and through the kindness of Lord Revelstoke he has been able to arrange a series of practical inquiries on the natural history and propagation of the oyster in the river Yealm.

The Naturalist of the Association, Mr. J. T. Cunningham, has been chiefly occupied during the past year with a treatise on the common sole, which is now ready for publication.

Mr. Cunningham also has gathered much valuable information about the occurrence of the anchovy in English waters, and the possibility of an English anchovy fishery. A full account of the anchovy is given in the last number of the Journal, vol. i, No. 3.

In the early spring of this year Mr. Cunningham made several expeditions to procure the ova of soles and other flat-fishes. He was able to secure and artificially fertilize a much larger number of soles' ova than on any previous occasion, and the fertilized ova were successfully hatched and the larvæ reared, up to the period of the absorption of the yolk-sac, in the aquarium.

On the 13th March this year the plaice in the aquarium were found to be breeding. The Director and Mr. Cunningham collected a large number of their fertilized ova and transferred them to suitable hatching apparatus. The ova hatched out by the 18th March, and the larvæ were kept alive in specially isolated tanks till April 2nd. By this time the yolk-sac was completely absorbed, but the larvæ, although apparently healthy, could not be induced to feed. They died off very suddenly, evidently for want of food, on April 3rd and 4th, having lived fifteen days after hatching.

A second batch of ova was procured on March 28th, and the eggs were hatched out on April 3rd and 4th. These larvæ were placed in a tank and fed with the pelagic organisms caught in the tow-net. They paid no attention to this food, so on April 22nd they were fed with crushed crab, which they appeared to like, for on the following day their intestines could be seen full of food. In spite of this they began to die on April 24th, and all were dead by the 26th.

Thus in the second experiment the larvæ were kept alive twenty days after hatching, a considerably longer period than in previous experiments at Plymouth, and, what is more important, they were induced to feed. These experiments show that some steps have been made towards success. None of the larvæ underwent metamorphosis, but Mr. Cunningham has procured some young plaice, flounders, and brill, already "flattened," and these are thriving in the tanks and feeding regularly.

Arrangements have been made with the Fishery Board for Scotland for carrying on an investigation on the food of the common sole in connection with the work done by the Board on the food of other fishes.

Mr. W. Bateson was working on the sense-organs and habits of fishes, with the view of showing the possibility of using artificial or preserved baits in sea fishing, from April to October, 1889. The results of Mr. Bateson's investigations have been published in the Journal, vol. i, No. 3.

Mr. Weldon continued his investigations on the artificial rearing of lobsters last year. His experiments were apparently turning out successfully when an accident caused the loss of his larvæ and apparatus. This year the artificial rearing of lobsters is being proceeded with by means of a different form of apparatus suggested by Dr. Fowler's successful method of raising the young of *Idotea*.

In addition to his experiments on lobsters Mr. Weldon is engaged on important scientific investigations on the variation and natural history of the Decapod Crustacea.

The following gentlemen and ladies have been engaged on inde-

pendent scientific researches in the Laboratory since the date of the last report :—

Mr. W. F. R. Weldon, M.A., F.R.S., St. John's College, Cambridge (*Decapod Crustacea*) ; Dr. G. H. Fowler, B.A.Oxon. (Studies in Descent) ; Mr. M. C. Potter, M.A.Cantab. (Marine Algæ) ; Mr. S. F. Harmer, M.A.Cantab. (Development of *Polyzoa*) ; Mr. T. T. Groom, B.A.Cantab. (*Cirrhipedia*) ; The Rev. Canon A. M. Norman, D.C.L. (Crustacean Fauna) ; Mr. A. O. Walker, F.L.S. (*Amphipoda*) ; Prof. T. Johnson, B.Sc.Lond. (*Florideæ*) ; Mr. A. E. Shipley, M.A.Cantab. (*Gephyrea*) ; Dr. Hans Driesch, Jena (Heliotropism in *Hydroidea*) ; Mr. P. C. Mitchell, B.A.Oxon. (Histology of *Tunicata*) ; Mr. T. H. Riches, B.A.Cantab. (Nephridia of *Mollusca* and *Crustacea*) ; Mr. Herbert Thompson, B.A.Cantab. (Development of *Crustacea*) ; Miss Marion Greenwood, Newnham College, Cambridge (Physiological Studies) ; Miss L. Ackroyd, Newnham College, Cambridge (Morphology of *Nebalia*).

3. Among the receipts of the past year the Council have to acknowledge the following subscriptions and donations :—£100 from Lord Revelstoke ; £100 from Sir Henry Thompson ; £100 from the Grocers' Company ; £200 from the Fishmongers' Company (annual grant for five years) ; £500 from H.M. Treasury (annual grant for five years).

From annual subscriptions and compositions £143 was received, £61 interest on investments, and £185 for rent of tables and sale of specimens.

The expenditure, as shown in the Treasurer's account presented herewith, amounted to £2924, of which £398 was paid to Mr. Inglis for balance of his fees as engineer, £417 for structural alterations and additions, £112 for bait investigation, and £250 for a steam-launch.

The Association now has in hand, in cash and invested, £1398, excluding the trust funds.

The Council have great pleasure in acknowledging the generous assistance which has lately been afforded to the Association by the Fishmongers' Company, by Mr. J. P. Thomasson, M.P., and Mr. Frank Crisp.

The Fishmongers' Company, in addition to substantial grants which they have already made to the Association, have undertaken to contribute £400 per annum to the funds of the Association for a period of five years from the present date.

Mr. J. P. Thomasson has kindly offered a sum of £250, to enable the Council to retain the services of the Naturalist, Mr. J. T. Cunningham, for another year.

Mr. Frank Crisp has kindly given a sum of £120 (£60 per annum

for two years) to meet the expenses of special investigations on the culture of sea fishes in enclosed ponds. The Council take this opportunity of placing on record their appreciation of the interest and confidence shown in the work of the Association by these liberal donations.

The thanks of the Association are due to Prof. Haeckel for a copy of his work on the *Siphonophora ;* to Col. Richardson, R.A., for a number of ichthyological works from the library of the late Sir J. Richardson ; to Mr. J. W. Clark for back numbers of the Philosophical Transactions of the Royal Society and other books ; to Messrs. J. and A. Churchill for the current numbers of the Quarterly Journal of Microscopical Science ; and to Messrs. Agassiz, Giard, Marion, the United States Fish Commission, the Naples Zoological Station, the officers of the Norwegian North Atlantic Expedition, and other individuals and societies for copies of their publications.

The Council desire to express the indebtedness of the Association to the Council of the Royal Society for kindly permitting the Association to hold the periodical meetings of the Council and Association in their rooms.

In July and August, 1889, the Council was in correspondence with the Fishery Board for Scotland and the Fisheries Department of the Board of Trade, with reference to the possibility of procuring scientific information on the alleged destruction of immature fish by beam trawling in deep waters.

Subsequently the Council determined to make an application to H.M. Treasury for a further grant of money in aid of special researches on food-fishes. The Chancellor of the Exchequer kindly consented to receive a deputation on the subject on May 15th.

The deputation was introduced by the Right Hon. Joseph Chamberlain, M.P., and Sir Edward Birkbeck, Bart., M.P.—Prof. Burdon Sanderson, F.R.S. ; Dr. John Evans, F.R.S. ; Mr. Ed. Marjoribanks, M.P. ; Mr. E. L. Beckwith, and Prof. E. Ray Lankester spoke in favour of the objects of the deputation.

The following were also present :—Lord Montagu ; Admiral Mayne, M.P. ; Sir W. Bowman, Bart., F.R.S. ; Sir Henry Thompson ; Mr. T. B. Bolitho, M.P. ; Sir Lyon Playfair, K.C.B., M.P. ; Mr. E. B. Poulton, F.R.S. ; Prof. Flower, C.B., F.R.S. ; Mr. Palmer; Mr. E. W. H. Holdsworth ; Mr. Adam Sedgwick, F.R.S. ; Mr. G. W. E. Loder, M.P. ; Mr. W. Bickford Smith, M.P. ; Prof. Jeffrey Bell ; Prof. Michael Foster, F.R.S. ; Mr. P. L. Sclater, F.R.S. ; Prof. Chas. Stewart ; Mr. G. F. Romanes, F.R.S. ; and Mr. Howorth, M.P. The Duke of Abercorn, the Earl of Ducie, the Earl of Morley, and several others were unavoidably prevented from attending.

The Council regret to have to announce that Prof. Huxley, who

since the foundation of the Association has been its President, has found it necessary to withdraw from the office which he has held with so much honour and advantage to the Association. The Council desire to express their warm appreciation of the eminent services rendered by Prof. Huxley to the Association, and their great regret that he should be unable to continue his office.

The following is a list of Officers and Vice-Presidents as proposed by the Council for the year 1890–1.

President.—Prof. E. Ray Lankester, F.R.S. (elected October 8th, 1890).

Vice-Presidents.—The Duke of Argyll, K.G., F.R.S.; The Duke of Sutherland, K.G.; The Duke of Abercorn, C.B.; The Earl of St. Germans; The Earl of Morley; The Earl of Ducie; Lord Revelstoke; Lord Walsingham, F.R.S.; The Right Hon. A. J. Balfour, M.P., F.R.S.; The Right Hon. Joseph Chamberlain, M.P.; Prof. G. J. Allman, F.R.S.; Sir Edward Birkbeck, Bart., M.P.; Prof. Flower, C.B., F.R.S.; Prof. Huxley, LL.D., F.R.S.; Sir John Lubbock, Bart., M.P., F.R.S.; Prof. Alfred Newton, F.R.S.; Sir Henry Thompson; Rev. Canon Norman, D.C.L., F.L.S.; Captain Wharton, R.N., F.R.S.

Council (*elected members*).—Prof. F. Jeffrey Bell, F.Z.S. (British Museum); W. H. Caldwell, Esq., M.A.; Frank Crisp, Esq., V.P. and Treas. Linn. Soc.; W. T. Thiselton Dyer, Esq., C.M.G., F.R.S. (Royal Gardens, Kew); John Evans, Esq., D.C.L. (Treasurer R.S.); Prof. C. Ewart, M.D. (Edinburgh); A. C. L. G. Günther, Esq., F.R.S. (British Museum); E. W. H. Holdsworth, Esq., F.L.S., F.Z.S.; E. B. Poulton, Esq., M.A., F.R.S.; G. J. Romanes, Esq., F.R.S.; P. L. Sclater, Esq., F.R.S. (Sec. Zool. Soc.); Adam Sedgwick, Esq., F.R.S.; Prof. Charles Stewart, P.L.S.; W. F. R. Weldon, Esq., M.A., F.R.S.

Hon. Treasurer.—E. L. Beckwith, Esq.

Hon. Secretary.—Prof. E. Ray Lankester, LL.D., F.R.S.

Dr. *Statement of Receipts and Payments for Year ending 31st May, 1890.* Cr.

Receipts.	£	s.	d.	£	s.	d.
To Balance from last year, made up as follows:						
Trust Fund, Bait Investigation	500	0	0			
„ Steam Launch	340	4	0			
	840	4	0			
Less Deficit on General Account	142	16	9			
				697	7	3
„ H. M. Treasury				500	0	0
„ Fishmongers' Company (2 years)				400	0	0
„ Annual Subscriptions				127	18	0
„ Founders				300	0	0
„ Composition Fees				15	15	0
„ Rent of Tables, Sales of Journal, Specimens, &c.	185	5	0			
„ Interest on Investments and Deposits	61	9	1			
				246	14	1
„ Sale of Investment: £500 North-Eastern 4½% Debenture Stock				705	1	2
				£2992	15	6

Payments.	£	s.	d.	£	s.	d.
By Buildings, Plant, &c.:						
Leete, Edwards, & Co.—Tanks, &c.	267	11	6			
I. C. Inglis—Balance of Fees as Engineer	193	3	0			
„ Disbursements	205	12	3			
Berry & Co.—Additions and Alterations	147	7	6			
				815	14	3
„ Trust Funds:						
Expended for Bait Investigation	112	10	3			
Purchase of Steam Launch	250	0	0			
				362	10	3
„ Salaries and Wages:						
Director	200	0	0			
Naturalist	250	0	0			
Wages and Salaries of Assistants, &c.	357	3	8			
				807	3	8
„ Stationery, Office Printing, Postage, &c.				95	6	1
„ Printing and Illustrating Journal				145	2	8
„ Gas, Water, Coal, Oil, &c.	128	2	10			
„ Stocking Tanks with Fish, Feeding and Maintenance	75	2	9			
„ Glass, Chemicals, Apparatus, &c.	130	13	3			
„ Maintenance and General Repairs	45	2	4			
„ Rates and Taxes	30	17	6			
„ Boat Hire	28	4	6			
„ Travelling Expenses	2	10	0			
„ Library	53	2	6			
				493	15	8
„ Balance forward, made up as follows:						
Trust Fund, Bait Investigation	387	9	9			
„ Steam Launch	90	4	0			
	477	13	9			
Deficit on General Account	204	10	10			
				273	2	11
				£2992	15	6

Examined and found correct,

STEPHEN E. SPRING RICE,
C. STEWART,
W. PERCY SLADEN,
EDWIN WATERHOUSE,
} *Auditors.*

20th June, 1890.

Investment held 31st May, 1890:
£900 Forth Bridge Railway 4% Debenture Stock at 125... 1125 0 0

(N.B.—The above price is that current on 1st June, 1890.)

The Director's Report.—No. 4.

During the summer months the Laboratory has been well filled, the following gentlemen having occupied tables *in addition to six* of those named in the Report of the Council (p. 360) :

Dr. W. B. Benham, University College, London (*Polychæta*).

Mr. M. F. Woodward, Normal School of Science, South Kensington (*Mollusca*).

Mr. E. A. Minchin, Keble College, Oxford (*Porifera* and *Gregarinida*).

Mr. W. G. Ridewood, British Museum of Natural History (*Clupeidæ*).

Mr. W. W. Welch, Oxford (*General Zoology*).

Besides these gentlemen Mr. W. T. Hughes, Mr. E. de Hamel, and Mr. G. W. Tait spent a fortnight at the Laboratory in general zoological study.

The two years during which the Laboratory has been open have been by no means unproductive of permanent result. In addition to the papers published in this first volume of the Journal and in the two numbers of the old series, which constitute in themselves a serious contribution to science, those in the list following embody the results of work done here, while several more are, of course, in progress :

Sanderson, Prof. W. Burdon, and **F. Gotch**.—*The Electrical Organ of the Skate*, part ii. Journ. Physiology, x.

Harmer, S. F.—*On a New Species of Dinophilus.* Proc. Camb. Phil. Soc., vi.

Weldon, W. F. R.—*The Variations occurring in certain Decapod Crustacea.* 1. *Crangon vulgaris.* Proc. Roy. Soc., xlvii.

Driesch, Dr. Hans.—*Heliotropismus bei Hydroidpolypen.* Zoologische Jahrbücher, v.

Beddard, F. E.—*On certain Points in the Structure of Clitellio.* Proc. Zool. Soc., 1888.

Beddard, F. E.—*Notes on some British Species of Pachydrilus.* Proc. Roy. Phys. Soc. Edinb., 1889.

Cunningham, J. T.—*On Secondary Sexual Characters in Arnoglossus.* Proc. Zool. Soc., 1890.

Johnson, Prof. T.—*Dictyopteris; Remarks on the Systematic Position of the Dictyotaceæ.* Journ. Linn. Soc., 1890.

Johnson, Prof. T.—*Observations on Brown and Red Seaweeds.* Rep. Brit. Assoc., 1890.

MacMunn, C. A.—*Contributions to Animal Chromatology.* Quart. Journ. Micr. Sci., xxx.

Thirty naturalists have occupied tables in the Laboratory for longer or shorter periods, several of them on more occasions than one. There is every reason to hope that this number will grow steadily larger; the existing accommodation for eleven (including the staff) can easily be increased when necessary at small cost. It is also worthy of notice that live and dead specimens have been supplied to nearly every University and College which offers a zoological course to its students, and to many private individuals.

With this constantly enlarging sphere of usefulness, however, **the want of a suitable vessel is every day more strongly felt**; even in the best of weather it is not advisable to go more than two or three miles from shore in our little steam-launch, and it is frequently impossible to go outside the Breakwater. With a larger vessel, not only would it be possible to supply material to the naturalists working in the Laboratory in greater abundance and variety (commanding as we could the rich stretch of coast from Mount's Bay to Tor Bay), but it would be *in the power of the Association for the first time to undertake* **continuous and systematic investigations** *into the problems of the spawning-grounds, nurseries, and migrations of food-fish,* valuable work such as the "Garland" is at present doing for the Scottish Fishery Board. A Laboratory is only half, although a necessary half, of the equipment required to attack fishery problems. As far as possible its work has been supplemented by occasional expeditions on trawlers, &c., but observations made in this way are necessarily scattered and incomplete. A vessel able to keep the sea in any weather with the fishing fleets would cost between £2000 and £3000, and if maintained the whole year round with a full crew would probably not cost less than £1200 per annum. *The "Special Steamboat Fund" was practically exhausted by the purchase of the steam-launch,* and the Association has no funds sufficient either to purchase or to maintain this absolute necessity of its efficiency.

With regard to the present number of the Journal, which completes the first volume, special attention is called to Mr. Cunningham's successful rearing of larval fish (p. 370), which is of the

greatest importance in connection with the destruction of immature fish in the estuaries of many rivers by shrimpers and others. The removal of young and comparatively helpless fish from the reach of their natural enemies and the rearing of them at small cost, which Mr. Cunningham shows to be perfectly practicable, may easily develop into a profitable industry. The notes on the Plymouth herring fishery by Mr. Wm. Roach (p. 382), who was for more than two years the fisherman in the employ of the Association, are also of the greatest interest.

Several investigations, to which reference has been made in previous journals, are still in progress.

Mr. G. C. Bourne resigned the post of Director of the Laboratory in August last.

G. HERBERT FOWLER,
Director ad interim.

Notes on Recent Experiments relating to the Growth and Rearing of Food-fish at the Laboratory.

Reference has been already made in the Report of the Council to the successful (artificial) fertilization and hatching of the eggs of the sole, and to the study of the plaice eggs which were *naturally* fertilized and hatched in the aquarium. With regard to the rearing of lobsters, Mr. Weldon and Mr. Fowler have contributed the following notes on their experiments :

I. The Rearing of Lobster Larvæ.

In the intervals of other and more pressing work we have made during the months of June and July a few experiments on the rearing of lobster larvæ; and although for various reasons these experiments were not successful, a few notes on the methods pursued and the conclusions deduced may prove of use to others engaged in the same task. It is possible that the cause of failure was merely that the eggs had suffered in being brought in, from the struggles of the mother lobsters; certainly a very large number of larvæ died in the act of hatching, too weak to extricate themselves from the shell. The shortness of the hatching season, however, prevented the undertaking of new and special arrangements for carrying them. Other possible causes of failure were want of space and the difficulty of providing a suitable food. As to the question of space, most pelagic organisms cannot bear to be confined within narrow limits, whether vertical or horizontal; they must, if they are to thrive, have a large superficial range, as well as a considerable depth of water to which they may sink when such physical conditions as light and heat demand it. As the Association had unfortunately no funds to place at our disposal for this special purpose, the largest body of water available was a tank of sixty-three feet superficial area, and containing about 600 gallons; the water was in constant circulation, and formed part of the

general system of the aquarium. Rock-work was arranged for the mother lobsters, and the inflow and outflow were guarded by "smut-wire" screens; the surface was constantly broken by a current through a fine "rose." In this tank the larvæ flourished better than elsewhere, but we were unable to keep them alive for more than twelve days after hatching. Part of the tank was boarded over for shade, but the larvæ appeared to avoid this dark part, and to select shady corners in the well-lit area. So long as they were strong they remained at the surface, and only sank to the bottom when beginning to turn red (the recognised symptom of weakness). They exhibited no liking for the rock-work.

The problem of a suitable food was not entirely solved in spite of many experiments. The yolk of a hard-boiled egg, crushed crab (*Carcinus mœnas, Portunus depurator*), boiled liver, the contents of the tow-net (at that period chiefly *Noctiluca* and Copepoda), and live shrimp larvæ, were all partially, none absolutely, successful. The first three are *seen* and eaten with avidity when floating as small particles about one to six inches below the surface; when at the surface or on the bottom they are apparently not touched, and it was not advisable to keep pouring finely divided food constantly into the tank owing to the danger of fouling the water; shrimps placed in the tank to eat the sunken food ate the larvæ by preference: shore-crabs were found to answer better as scavengers, but cannot take up fine particles. Finding that food is only taken when at this position in the water, we caused small brackets to be suspended about four inches below the surface, on which the food (crushed crab) was placed in common red flower-pot saucers; the larvæ swarmed into the saucers, and perished miserably. This occurred partly because they were attracted by the bright colour and unable to leave it, partly because the sides of the saucer were so steep that they found difficulty in getting out. An ordinary white saucer, however, with less steep sides produced nearly the same mortality. That the brightness of the saucer was largely the cause of death was demonstrated by placing an *empty* saucer on the bracket, into which they crowded and died. The brackets were then blackened by charring, and the food placed directly upon them; it was not touched. Large pieces of food suspended from wooden spits were seldom touched. It was definitely concluded from these experiments that whatever food is used must be floating in the condition of small particles at a short distance below the surface, *i.e.* in the same position as the natural pelagic food of the larvæ at sea, whether this consist of Copepoda, other Decapod larvæ, trochospheres, fish ova, or other members of the pelagic fauna. As to the other two forms of food tried, the Noctilucæ were

apparently eaten, the shrimp larvæ (Mysis stage) certainly were attacked; and from the fact that the young lobsters attack and devour each other it is probable that Decapod larvæ form at any rate part of their usual food. The contents of a tow-net taken near the Eddystone on August 6th, which held a young lobster, consisted chiefly of Megalops and Mysis stages of Decapoda.*

The qualification for success in all experiments of this kind is the reproduction, on a small scale and under the control of the experimenter, of the essential factors in the environment of the animal to be reared. The conditions which seem to us most likely to yield success, both in hatching fish and lobsters, are the following :—The establishment of a large and deep pond (say 1000 square feet in area, and 2—3 fathoms deep at some places) on a rocky coast, the levels being so arranged that it should stand always about four fifths full, while the remaining fifth should fill through filters on the top of ordinary and spring floods, emptying slowly on the ebbs. A flora should be allowed to form in the pond for a year or so before it is required for hatching purposes; and all predatory animals should of course be kept down. At a higher level than this pond should be two or three lesser ponds, kept well stocked with breeding animals whose larvæ are likely to serve as food (crabs and shrimps), communication with the lobster pond being maintained by guarded siphons which would carry over the larvæ, but not the adults. While these would supply one element of food, the daily tide would bring an additional quantity of pelagic organisms, which could be supplemented by the tow-net, and, if necessary, by artificial food (crushed crab, &c.). The ova and embryos of common fish would probably prove a most appropriate pabulum, cheaply and easily obtainable by artificial fertilization; but we had no opportunity of experimenting with them during this hatching season.

The mere hatching of the eggs of the lobster, whether they are left on the mother, or are stripped from her and hatched in appropriate apparatus, presents, of course, no difficulties; it is easy to turn myriads of young lobsters loose in the sea with a very small expenditure; but the general belief that over-fished grounds can be replenished in this way is still open to very serious criticism. There is as yet no proof that this procedure has produced or can produce any effect whatever in restocking depopulated areas. We do not desire to discuss this question here. Our experiments were a preliminary attempt to ascertain in what manner young lobsters might best be reared in large numbers to the age at which they assume the characters and habits of the adult; to achieve this is simply

* Young stages of the lobster have been rarely taken in the surface tow-net by the Association both by day and by night, but never elsewhere than at the surface.

a matter of experience, *i. e.* of continued experiment. It has already once (1885) been done by Captain Dannevig in Norway; and if any benefit come to the lobster fishery by turning the newly hatched larvæ loose in their most helpless phase, greater success will certainly attend the planting of over-fished grounds with young lobsters at the age at which they sink to the bottom and assume the habits of concealment of the adult.

II. The Rearing of Larval Fish.

By J. T. Cunningham, M.A., F.R.S.E.

The Flounder (*Pleuronectes flesus*, Linn.).—On May 3rd of the current year I received from Mr. Dunn, of Mevagissey, about 200 young flounders (*Pleuronectes flesus*), collected in the shallow pools left in Mevagissey Harbour at low tide; and on May 7th Mr. Dunn sent another large consignment of the same kind of fish. I put the greater number of them into two shallow table-tanks, one of these tanks being in the aquarium and exposed to a good deal of light, the other in the Laboratory and somewhat dark.

These young flounders were at the stages of development represented in fig. 5, Pl. XVII, and fig. 1, Pl. XVIII of my *Treatise on the Sole*, the great majority at the younger of these two stages. They were very transparent with the exception of the eyes, which were fully pigmented and had a brilliantly metallic appearance. The metamorphosis in these was begun, but by no means completed; the left eye was approaching the edge of the head, and nearly all the pigment-cells had disappeared from the left side of the body. They rested for the most part on the bottom, but frequently swam about in the water in a slanting position. One of these was measured, and found to be 12·7 mm. ($\frac{1}{2}$ inch) in length, 5·1 mm. ($\frac{7}{32}$ inch) in breadth.

Some of them were slightly more advanced; these were much more opaque, with more pigment on the upper side, and with the eye of the lower side on the very edge of the head. One of them measured 11·5 mm. in length and 5 mm. in breadth.

The tanks in which these young flounders were placed were arranged thus: the bottom was covered with fine sand, except where at one end there was gravel, separated from the sand by a wooden plank, and filling up a space below the slate partition which separated this tank from the next. Water, flowing into the tank in a couple of small jets, passed through the layer of gravel, so that the level in the tank containing the flounders was always the

same as in the next tank, which contained an overflow pipe. In this way a constant flow of water was maintained in the tank without causing any strong current at the outflow, so that the small fish could neither escape nor be injured by a strong current of water towards the outflow.

I fed these young fish at first with minute Crustacea, procured by sifting a quantity of weeds from the shore in water. In this way numbers of small Copepods, Amphipods, and Isopods were separated from the weeds, and were then put into the flounder-tank. The little fish took this food eagerly, but the labour of preparing it was considerable. I therefore soon gave up this method, and fed the fish with chopped worms (*Nereis*, *Nephthys*, &c.). The minced worms were strained through a vulcanite sieve, and only the smaller particles were given to the young fish. As the fish grew older other kinds of food, such as chopped Pecten and pilchard, were occasionally given, but the fish always took worm with most eagerness. During my absence from the Laboratory between July 1st and August 13th the fish were regularly fed by the attendant, and on my return I found that they were all in a healthy condition, and that they had grown very considerably, although the size of different individuals varied very much. On August 19th, of two specimens from the tank in the aquarium one measured 6·7 cm. ($2\frac{5}{8}$ inches) in length, the other 8 cm. ($3\frac{3}{16}$ inches). These specimens were not the largest in the tank, but I believe that they were above the average size of the whole number. As the fish are very active, and always more or less concealed by the sand, it is, of course, impossible to ascertain the minimum and maximum size, or the average size, without killing the whole number. But it is clear that in three and a half months many of these fish have grown from about $\frac{1}{2}$ inch in length to 3 inches.

The Brill (*Rhombus lævis*, Gottsche).—On May 21st of the current year boys and fishermen brought to the Laboratory a number of the young of this species. They were found swimming near the surface of the water in Sutton Pool, and were taken out either by hand or with a tin pot. There had been a south wind on that and the previous days, and the fish were found at flood tide. I put twenty of these into the tank in the aquarium, where the young flounders were.

On June 11th I received fourteen more of the same species in about the same stage. Those placed with the flounders were observed to catch and devour them, so that I had another tank prepared after the same fashion, and placed all the brill in this by themselves. I could only find seventeen in the flounder-tank, so that the total number of brill isolated in the tank devoted to them

was thirty-one. After the brill were separated from the flounders they were fed with chopped worm, which they ate very sparingly. I was unable to get any other living fish which they seemed to appreciate; to small shore-fish such as gobies they paid no attention. I was afraid that they would not eat enough of the worm to nourish themselves, but on my return to Plymouth after my holiday I found that they were alive and had grown a great deal. They still continue to live on worms, occasionally varied by Pecten and pilchard, but they never feed eagerly and voraciously as the flounders do. It is possible that in the natural condition young brill prey upon smaller fishes, and that then they grow faster than my specimens have on the diet supplied to them. But I could not afford to feed them on living young flounders, and I shall have to find some future opportunity of comparing the growth of the captive specimens with that of free individuals.

These young brill when brought to the Laboratory were 2·2 to 2·56 cm. ($\frac{7}{8}$ inch to 1 inch) in total length. They all possessed a large air-bladder, and were able to sustain themselves for an indefinite time at the surface or in mid-water; but they frequently rested on the sand at the bottom of the tank, and after a few days they swam less and less above the bottom. Their metamorphosis was nearly complete, but the eye of the lower side (the right) was either on the edge of the head or only slightly within the edge on the upper side. The dorsal fin did not extend forwards in front of the right eye as it does in the adult, but only overlapped that eye for about one third of its longitudinal diameter. The anterior dorsal fin-rays were simple and undivided externally. Scales in the skin were not visible externally.

On August 23rd I took out one of these brill and preserved it in spirit. It measured 6·65 cm. ($2\frac{5}{8}$ inches) in total length, 4·45 cm. ($1\frac{3}{4}$ inches) in greatest breadth. It was in all respects closely similar to the full-grown adult. The first five of the dorsal fin-rays were divided into two branches at the ends; and, in the first two, indications of further subdivision were visible. The dorsal fin extended forwards in front of the transverse level of the right eye. The circular scales were distinctly visible all over the upper (left) side by the aid of a simple lens.

Thus these brill have grown from about 1 inch to over $2\frac{1}{2}$ inches in length in two and a half months.

Five-bearded Rockling (*Motella mustela*, Linn.).—Several specimens of the young of this species were brought to the Laboratory on May 21st, having been caught in Sutton Pool along with the young brill. When brought in they were about an inch long. One species of *Motella* was spawning in our tanks in April of the present year,

and the present species probably spawns about the same time, so that the young specimens obtained from Sutton Pool were probably three or four weeks old. They were placed with the young flounders, and throve well, feeding on the chopped worm supplied to the latter. One killed on August 19th was $3\frac{1}{8}$ inches long (7·9 cm.).

Grey Mullet (*Mugil chelo*, Cuvier).—Last year a number of the young of this species were brought to the aquarium by Mr. W. Bateson, and are mentioned in his paper in the previous number of this Journal. These little fish were taken in the open sea, but there can be no doubt that they were hatched the same year, though in which month it is not easy to decide. When obtained by Mr. Bateson in July and August they were about $\frac{3}{4}$ of an inch long. I obtained some of the same species this year in Cawsand Bay on May 14th, which were 11 mm. ($\frac{7}{16}$ inch) in length. These were, in all probability, from their almost larval appearance, not more than one month old, so that probably the species spawns in April.

Some of Mr. Bateson's specimens have been living in the aquarium tanks up to the present time (August, 1890). One of these killed on August 25th measured 5·7 cm. in length ($2\frac{1}{4}$ inches). Another specimen, brought in from the sea this year, is somewhat larger, but not more than 3 inches long; this specimen is doubtless also in its second year, and has probably grown a little more in its free condition than the captive specimens.

Both these young mullet and the adults in the tanks are fond of a kind of food which no other fish has ever attempted to eat, namely, the dirty-looking, fleecy vegetable growth which covers the sides of the tanks and the rock-work.* I have watched both the young and old individuals browsing almost like cattle on this growth. The stuff is of a dark brown, almost black, colour, and has a ragged offensive appearance. Examined by the microscope it was found to consist chiefly of Diatomaceæ. It was composed of interlacing filaments, formed by the filamentous species of Diatoms, covered by sessile or separate forms; among the Diatom filaments were also some others belonging to another class of Algæ, the Cyanophyceæ; these resembled the genus *Tolypothria*, and were of a bluish-green colour. (The plants were examined by Professor T. Johnson, who is at present studying at the Laboratory.) This vegetable growth was found in abundance in the stomach and intestines of the young mullet killed on August 25th. It is somewhat surprising to find a fish, which belongs to the highest class of animals, living directly on Diatoms, which are among the most lowly organised of plants.

The mullet in our tanks will eat sparingly of other kinds of food,

* This growth occurs also in other aquaria; for instance, at Amsterdam and at the Crystal Palace.—Ed.

provided it be soft. Mr. Bateson fed his young specimens on minced worm ; the adults will also eat worms, chopped Pectens, roe or milt of herring and pilchard. In fact, they nibble at almost any kind of soft food, but never swallow large pieces greedily, as many species of fish do.

Our mullet are also occasionally seen to take up a little of the gravel at the bottom of the tank, and eject it again from the mouth.

It is well known that grey mullet are usually found in the neighbourhood of docks, piles, piers, harbours, &c., and that they ascend estuaries. It is probable that they always live close to the shore, and never go into deep water far from land. Considering this natural habit and the mode of feeding observed in our tanks, it may reasonably be inferred that this species feeds largely on Diatoms and other lowly organised Algæ, which always form a coating over the surface of submerged masonry, wood, or iron, and over rocks. It is interesting to note that the structure of the fish is peculiarly adapted for such a mode of feeding. In the first place, the jaws, instead of projecting to a point as they do in predatory fishes, are extremely blunt, so that the lips form almost a straight line transverse to the axis of the body. This form of the mouth, as in the muzzle of herbivorous ruminants, is especially adapted for browsing on vegetable growths covering a flat, hard surface. Secondly, there are no teeth in the jaws ; the edge of the lower jaw is sharp and straight, while the upper lip forms a thick elastic pad against which the lower jaw can bite. This arrangement reminds one of the jaws of a ruminating animal, such as a sheep or an ox, in which the cutting edge formed by the incisors of the lower jaw bites against the hard toothless pad formed by the gum of the upper jaw.

But these and other peculiarities in the structure of the grey mullet are not exclusively adapted to feeding off hard surfaces. Dr. Günther states that the fishes of this genus feed on organic substances which are mixed up with the sand or mud. Day mentions that they are observed in an aquarium to suck in the sand, the coarser portion of which they again eject. They are frequently seen to do this in our tanks, but they never feed industriously in this way as they do off the surface of the rocks and sides of the tanks. Day also mentions that various minute molluscs, both bivalves and Gasteropods, small Crustacea, and fragments of Zostera and Confervæ, have been found in mullets' stomachs.

It is evident, therefore, that, unlike most marine fishes, the grey mullet lives largely, though not exclusively, on plants, and particularly on the lowest forms of Algæ, especially the Diatomaceæ. The internal organs of these fishes, which differ so much from those of the majority of fishes, and resemble in many respects those of grami-

nivorous birds, are especially adapted to this peculiar kind of food. Teeth are entirely absent, those of the pharyngeal bones being replaced by horny papillæ above and horny ridges below. The gill rakers have the form of lamellæ running transversely to the gill arches, and the whole pharynx thus forms a filtering apparatus, minute nutritious organisms being prevented from passing through the gill apertures and swallowed, while coarse hard substances are ejected from the mouth. The pyloric portion of the stomach forms a globular gizzard, lined with a tough epithelium and surrounded by a thick and strong muscular layer, and thus similar to the gizzard of the majority of birds. The intestines are also extremely long and convoluted, as, for example, in a common fowl; and there is also some resemblance to the entrails of the latter in the soft texture and yellowish-green colour.

The fact that grey mullets feed on Diatoms probably explains the following. On May 9th Mr. Dunn sent me a young specimen $\frac{7}{8}$ of an inch long, on which there was a tuft of brownish-yellow threads projecting from the side of the head. At first sight it seemed as though an abnormal growth of the gills had taken place. But on examination I found that the tuft was attached by a kind of stem to the ventral edge of the right operculum, and had nothing to do with the gills. Under the microscope the growth was seen to consist of branched transparent gelatinous tubes filled with frustules or cells of a Diatom; the Diatom itself forms the branching tubes. It is a Schizonema; the species is probably *S. Dilwynii*. It is likely that a frustule of this Diatom had at some time or other passed by accident from the pharynx of the fish through the gill clefts, and had then adhered to the operculum and commenced to grow.

Breeding of the Poor Cod and Pouting.—Several specimens of each of these two species, *Gadus minutus* and *Gadus luscus*, have been living together in a tank of the aquarium since the summer of 1889. In March of the present year most of them were seen to be swollen with ova, and floating eggs were found in the tank. I was too much engaged to collect a number of the eggs and hatch them, but in order to determine the character of the eggs I squeezed a female of each species on April 8th, and examined the ripe ova which were thus expelled. The eggs of both species resembled those of the cod, whiting, and haddock in all respects except size; that is to say, the yolk was perfectly homogeneous and without oil-globules, and the perivitelline space, or space between the egg and its envelope, very small. The diameter of the egg of *G. minutus*, including the envelope or shell, was 1·02 mm.; that of *G. luscus* very slightly larger, namely, 1·05 to 1·15 mm.

Report on the Surface Collections made by Mr. W. T. Grenfell in the North Sea and West of Scotland.

By

Gilbert C. Bourne, M.A., F.L.S.

With Plate XXV.

Mr. Wilfrid Grenfell, the Superintendent of the Mission to Deep Sea Fishermen, has most kindly arranged to carry on a series of observations on the pelagic fauna and the fishes of the seas traversed by the Mission boats in the course of their work. The following report gives an account of the pelagic fauna collected in the North Sea during the early spring, and in the west of Scotland and Kinsale Harbour during the summer. The collections were preserved in picro-sulphuric acid and spirit, and were forwarded to Plymouth for examination. Owing to pressure of work, and to my leaving Plymouth somewhat unexpectedly, I have not been able to make a thorough investigation of all the collections, but have worked out the Copepoda with care, and have confined myself to short notes on the other species.

Fourteen bottles were sent from the North Sea, the stations being—

No. 1.—February 28th. East of Winterton shoal. The surface-net was used for twenty minutes just below the surface at 10.15 a.m. Temperature of the air 35·5°, of the surface 42°, of the bottom 39° F. A heavy swell.

No. 2.—February 28th. Three to four miles W. of No. 1. Net sunk some fathoms below the surface. Temperature at surface 41·5° F.

No. 3.—March 1st, 10 a.m. Winterton shoal. Temperature of air 38·5°, of surface 42°. Wind N.N.W.

No. 4.—March 1st, 12.30 a.m. Within a mile or so of No. 3. About fifty miles E. of Yarmouth.

No. 5.—March 3rd. On Winterton shoal, Yarmouth bearing W.S.W. forty-five miles. Net sunk below surface. Temperature the same as No. 3. Bright sun.

No. 6.—March 3rd, 8.30 p.m. N.E. edge of Winterton shoal, about sixty miles E.N.E. of Yarmouth. Temperature of air 30°, of surface 41·2°. Wind E., moderate.

No. 7.—March 4th, 9.40 a.m. Fifty miles due E. of Winterton shoal. Lat. 52° 41′. Wind W. Temperature of air 41·5°, of surface 41·5°, of bottom 39·5°. "Strong sickly smell."

No. 8.—March 5th, 10.5 a.m. On Winterton shoal. Forty-five miles W. of Yarmouth. Temperature of air 43°, of surface 41·25°, of bottom 40°. Wind N.N.W., fresh. Bright sun after snow and sleet on previous night. Contents of tow-net had offensive smell.

No. 9.—March 6th, 5.30—6.30 p.m. Lat. 53° 12′, about sixty miles E. of Cromer on shoals of the Lemon. Temperature of air 40·25°, of surface 38·5°. Strong breeze from N.W. by W. with a heavy swell.

No. 10.—March 6th, 7.30—8.30 p.m. Lat. 53° 14′, on Black Bank. Temperature of air 41°, of surface 40·5°.

No. 11.—March 7th, 7.30—8.30 a.m. Between Black Bank and shoals of Lemon. Temperature of air 44·5°, of surface 40°, of bottom 38·5°.

No. 12.—March 9th, 1.15—2.15 p.m. East of shoal of Lemon. Temperature of the air 39°, of the surface 40°. Weather squally, with sunshine in intervals. Heavy gusts from N. by W.

No. 13.—March 9th, 7.30—8.30 p.m. About one mile N.W. of No. 12. Temperature of air 37°.

No. 14.—March 10th, 7.30—8.20 p.m. The Lemon shoal bearing N.W. by W. Temperature of air 47°, of surface 42°. Heavy wind from W.S.W.

The collections made in the first eight stations are described by Mr. Grenfell as smelling sickly and offensive. This was evidently due to the floating Algæ which cause the well-known "foul water" on many parts of our coast during the spring months. There was abundant evidence of these Algæ in the collections, but when the ship moved further north to Station 9 the offensive smell was not noticeable, and there are but few Algæ and Diatoms in the catch.

The first eight gatherings contained an abundance of Teleostean ova and larvæ in different stages of development. It is nearly impossible to identify the ova after they are preserved in spirit, but a considerable proportion may safely be identified as plaice ova from their large size. The greater part of the newly hatched larvæ were Pleuronectids, of what species could not be determined. In No. 6 there were several larvæ of *Clupea harengus*. One larval

herring about an inch long was taken in No. 12, and herring larvæ were abundant in the last haul, No. 14. As a considerable proportion of the ova showed only a small blastodisc, it is evident that they must have been emitted not far from where they were taken, viz. on Winterton shoal.

The bulk of material taken in each haul was considerable (with the exception of No. 2), but consisted mostly of the commoner species of Calanidæ. The other contents were as follows:

Appendicularia. Not abundant, in 3, 4, 6, and 8.

Sagitta. All the gatherings; most abundant in 1, 5, 10.

Larvæ of *Pagurus.* 1, 2, 3, 4, 6, and very abundant in 5 and 13.

Cumacea. A few specimens in each gathering. I am not able to determine these with certainty before going to press for want of Sars' works, but they appear to be *Eudorella truncatula.*

Mysidæ. No. 14 consisted chiefly of *Euphausia.*

Proto ventricosa, O. F. M. Isolated specimens occurred in the first six gatherings.

Evadne Nordmanni. A few in 5 and 9.

Tomopteris. A single specimen in 4 and in 13.

Cyphonautes. In 1, 3, and 5. Not numerous.

Bipinnaria. A few in 9 and 11.

Ctenophora. Several Cydippidæ too much damaged for recognition in 4, and a single *Pleurobrachia* in 8.

Medusæ. Several damaged beyond recognition in 4.

Coscinodiscus concinnus. All the gatherings; particularly abundant in 11.

The Copepods consisted chiefly of Calanidæ, the species represented being—

Cetochilus septentrionalis, Goodsir.

Clausia elongata, Boeck.

Paracalanus parvus, Claus.

Temora longicornis, Müller.

Temora velox, Lljb.

Centropages hamatus, Lljb.

Centropages typicus, Kröyer.

Dias longiremis, Lljb.

Cyclopidæ.

Cyclopina littoralis, Brady. A few specimens were taken in most of the gatherings, but a very large proportion of the Copepoda in No. 9 consisted of this species, which, according to Brady, is rarely taken in large numbers.

Oithona spinifrons, Boeck.

HARPACTIDÆ.

Longipedia coronata, Claus. A few specimens in 1, 6, and 11.
Euterpe gracilis, Claus.
Stenhelia ima, Brady.

HERSILIIDÆ.

Hersiliodes Canuensis, nov. sp. Pl. XXV, figs. 1—6.

Form of the body cyclopoid, robust. The first thoracic segment united with the head, the remainder free. Pleuræ of the thoracic segments well developed and prominent. Abdomen of three somites, the first swollen, with the posterior angles produced into short spines, with a small moveable spine exteriorly. Second abdominal somite also produced posteriorly into short spines. Second and third abdominal somites equal in length, the length of the first being relatively to the second as 4 to 3. Furca very short, half as long as the last somite, with three long hairs, and one shorter internally; two short spines on the outer edge. Antennæ 6-jointed, the first, second, fourth, fifth, and sixth joints subequal in length, the third joint twice as long. Mandibles, maxillæ, and maxillipedes characteristic of the genus. Fifth pair of swimming feet flattened as in *H. Thompsoni*, and provided with three flattened and serrated spines, with a single seta internal to the innermost spine.

Two specimens in No. 11. These are probably at a young stage, as shown by the 6-jointed antennæ, but they differ so markedly from the described species of the genus, that I have felt justified in ranking them as a separate species, and have named them after M. Eugène Canu, whose researches have greatly improved our knowledge of the family. In the form of the fifth pair of swimming feet and in the internal maxillipedes *H. Canuensis* closely resembles *H. Thompsoni*, but differs from it in the details of the second antennæ, mandibles, and maxillæ, and in the shape of the cephalothorax and free thoracic and abdominal segments.

In addition to the collections from the North Sea, Mr. Grenfell sent me four bottles collected in the west of Scotland, and one from Kinsale Bay.

A. June 6th. Oban Bay. Midnight. Wind N.W., slight. Contents: *Hormiphora plumosa* abundant. Many Medusæ, unrecognisable.

COPEPODA.

CALANIDÆ.

Cetochilus septentrionalis, Goodsir.
Clausia elongata, Boeck.
Temora longicornis, Müller.

CYCLOPIDÆ.

Oithona spinifrons, Boeck.

HARPACTIDÆ.

Stenhelia ima, Brady.

Diosaccus tenuicornis, Claus.

Westwoodia nobilis, Baird.

Harpacticus chelifer, Müller.

Peltidium interruptum, Goodsir.

Oniscidium armatum, Claus. As far as I am able to determine, this is the first record of *O. armatum* from British coasts.

Idya furcata, Baird.

B. Great Minch. Ten miles S. of Stornoway in Lewis. Temperature of air 57°, of surface 51·5°. Calm. Full of bad-smelling green Algæ.

Contents: Many Teleostean ova. Many Medusæ and Ctenophora, too much damaged for recognition. Megalopa stages of Brachyura. *Euphausia*. Very few Calanidæ, mostly *Temora longicornis* and *Clausia elongata*. A single young Gadoid, probably *Gadus merlangus*.

C. June 14th, 8 p.m. N.W. of Cape Wrath. Temperature of air 49·5°, of surface 51·25°.

Consisted almost entirely of the commoner species of Calanidæ, with *Cyphonautes*, *Evadne Nordmanni*, and *Podon intermedius*.

D. Ardnamurchan Point. Temperature of air 53°, of surface 51°. Calm.

A single young Gadoid, probably *Gadus carbonarius*, and a single young *Trigla*. Abundant Ctenophora, probably *Hormiphora plumosa*. Large numbers of young stages of *Corystes cassivelaunus*. A few common Calanidæ, and *Westwoodia nobilis*, *Harpacticus chelifer*, and *Trebius caudatus*.

E. Kinsale Bay. May 15th. Temperature of air 50·25°, of surface 50·75°. Wind S.W., light.

Contents: Larval Pleuronectidæ, including one *Solea*. Larvæ of *Terebella* and *Holothuria*. *Veliger* larvæ very abundant. Many Medusæ damaged beyond recognition. Megalopa stages of Brachyura, Copepods, Calanidæ, chiefly *Temora longicornis* and *Dias longiremis*. Cyclopidæ, *Oithona spinifrons*. Corycæidæ, *Corycæus anglicus*.

Fig. 4.

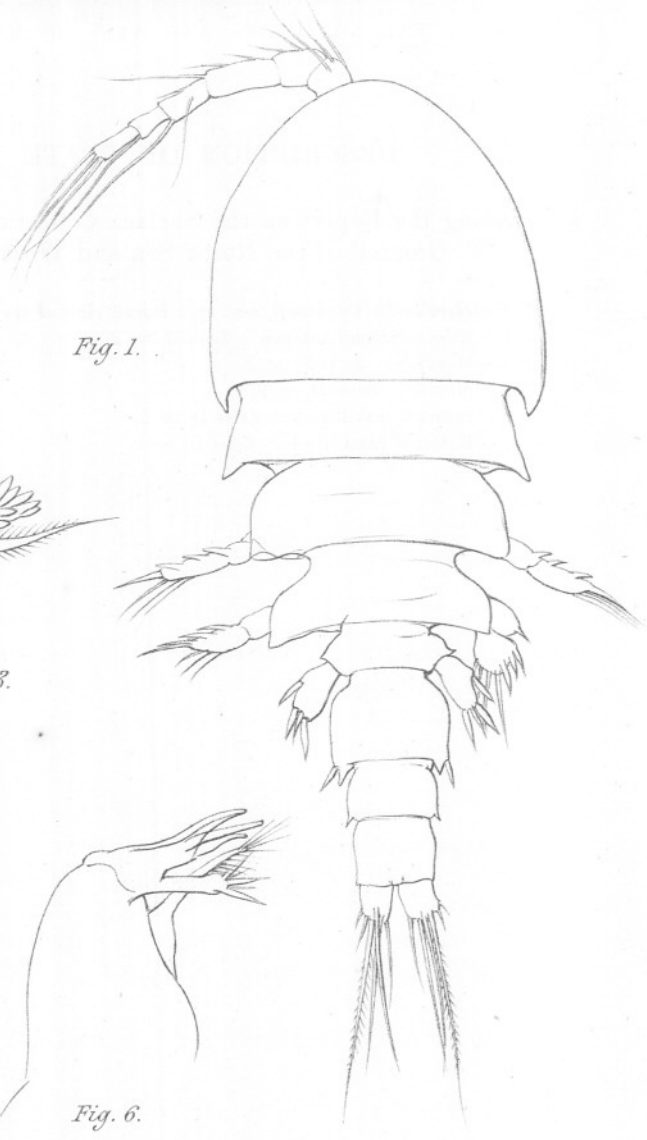

Fig. 1.

Fig. 3.

Fig. 6.

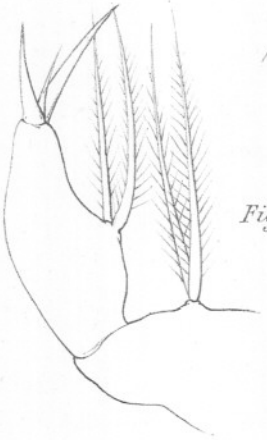

Fig. 5.

Fig. 2.

DESCRIPTION OF PLATE XXV,

Illustrating the Report on the Surface Collections made by Mr. W. T. Grenfell in the North Sea and West of Scotland.

FIG. 1.—*Hersiliodes Canuensis*, nov. sp. Dorsal view of the entire animal.
FIG. 2.—*Idem*. Second antenna. Zeiss D, oc. 2.
FIG. 3.—Mandible. Zeiss F, oc. 2.
FIG. 4.—Maxilla. Zeiss D, oc. 2.
FIG. 5.—Internal maxillipede. Zeiss D, oc. 2.
FIG. 6.—External maxillipede. Zeiss D, oc. 2.

Notes on the Herring, Long-line, and Pilchard Fisheries of Plymouth during the Winter 1889-90.

By

William Roach,
Associate Member, Marine Biological Association, Plymouth.

I. The Herring Fishery.

[The herring fishery is carried on at Plymouth during the winter months, when the adult herring seek the inshore waters for spawning. Besides these, however, the so-called "harbour herring" are taken in the summer and autumn; these appear to be the produce of the last spawning season, *i. e.* six months to a year old. Mr. Cunningham has shown me specimens taken in the Cattewater in May, 1889, which vary from 3½ to 5 inches in length. Those which are at present being brought to the Laboratory (September, 1890) are 9 or 10 inches in length, but their reproductive organs are still at an extremely early stage of development. Further observations on these harbour herring are much needed, and are being gradually made.

The nets used up at Saltash for these harbour herring are, Mr. Roach informs me, used three to a boat, 7 score 7 meshes in depth and 44 fathoms to the rope, that is, 132 fathoms long, with buoy-lines 1 fathom deep. Those used in the Sound vary with the size of the boat. The smaller boats have two or three nets, 12—13 score meshes in depth, and each 40—42 fathoms long; buoy-lines 4—5 fathoms apart, and 2 fathoms long; the latter are shortened up a fathom at low water. The boats used outside the Breakwater have three to four nets each, 13—14 score meshes deep. The next boats (9-ton dandy hookers, 36 feet long, 10 feet beam, worked by 4 men) use ten to twelve nets, 15—16 score meshes deep. The largest boats are decked, use sixteen to eighteen nets, 16—18 score meshes in depth, with 3-fathom buoy-lines; they are worked by 6 men. The proper herring mesh for full-roed fish is

33 meshes to the yard. The Cawsand fishermen who fish in Cawsand and Whitsand Bays use moored nets.—G. H. Fowler.]

Note.—The symbol > implies that the number given was the greatest catch by any single boat; a number without this implies the total amount of fish landed.

Date.	Number per boat.	Locality.	Price per 100.	Remarks.
1889.				
Oct.				
23	40 >	Rum Bay	—	—
24	500 >	Batten Bay	5/6	Quality good.
26	400 >	,,	4/6	Very scarce up to 10 p.m., when the fish rose in the slack water.
30	1000 >	Cattewater	4/6	—
31	1500 >	Inside Batten Breakwater	4/6–5/0	These are probably not the coast fish, but harbour fish which have been driven down by foul water following the heavy rains.
Nov.				
1	500 >	Inside Mallard Buoy	4/0–5/0	—
2	400 >	Rum Bay	6/0	Quality good.
	2000	Cawsand Bay	—	Taken in moored nets.
4	400 >	Rum Bay	5/0	No fish from Cawsand Bay.
5	300 >	Sound, East Channel	4/6	Wind W.; threatening.
	700	Cawsand Bay	—	
6	Very few	—	—	Fine, calm. Herring fishing discontinued for a time, as the coast fish had not made their appearance.
11	200–300	Saltash and St. Germans	3/6	—
	500 >	Cattewater	3/3–3/6	These fish used to be taken in large quantities some years ago at Laira with long seine nets. Now the fish do not appear to go so far up, and the seining industry in the estuaries has diminished.
12	3000 >	Saltash Bridge	3/6	These fish were probably caught in tuck seines, as they were so small that they would have passed through the meshes of the large seines.
13	None	—	—	Wind S.E.; very fine.
14	—	—	—	No herrings in Plymouth Sound or the Cattewater, but a few thousands taken by 27 small boats near Carr Green, 3 miles above Saltash. The fishermen there use 3 nets, threescore and seven meshes in depth, and 44 fathoms to the rope, making a total length of 132 fathoms. The buoy-lines are one fathom deep. They only fish in slack water, because, when the tide is running strong, they drift against the ships. Herrings are always taken there at this time of year when the weather is fine, and they only come to the Sound when there is a great freshet after rain.
18	None	—	—	Many of the boats took out their nets, and dried and put them away, anticipating a bad season.

Date.	Number per boat.	Locality.	Price per 100.	Remarks.
Nov. 27	600 >	Rum Bay	3/0	No quantity of fish arrived yet, probably owing to the east winds, which are noticed to keep not only herring but whiting off the coast.
28	100 >	Batten Bay	2/0	The low price is due to large consignments from W. Cornwall, which are two days old on arrival, and are sold at 1/0 per 100, depreciating the home catch.
29	3000 >	Cawsand Bay	1/6	Caught in moored nets. These are not the same fish as those caught by the Saltash fishermen; the scales of the latter come off much more readily than those of the coast herrings, caught for the first time to-day. Since the beginning of the month from 60,000 down have been taken by large and small boats in St. Ives Bay. They have since decreased there, and increased at Penzance, where they had from 20,000 down. Finally, they have fallen off at Penzance, and have appeared at Plymouth, their last spawning place, but they are still very hard.
30	6000 >	Cawsand Bay	—	Caught in moored nets. They have not yet appeared in the Sound.
Dec. 2	3000 >	2 miles S.W. of Penlee Point	1/3	Caught by six large boats.
	10,000 >	Cawsand Bay	1/2	Moored nets.
3	4000 >	2 miles S.W. of Penlee Point	1/3	—
	8000 >	Cawsand Bay	1/2	Moored nets. Owing to the strong S.E. winds it has been difficult to underrun the moored nets in Cawsand Bay; otherwise the catches would have been better.
4	10,000	Whitsand Bay	3/0–1/6	Wind E.N.E. No herrings in the Sound or in Cawsand Bay. The Cawsand fishermen made the whole catch, having moved their moored nets to Whitsand Bay. The herring is a "lee fish," moving backwards with the wind. They will remain in Whitsand Bay till the wind shifts and drives them out. A west wind is the best for Plymouth Sound.
6	800 >	N. of Eddystone	2/0	
	1200	Whitsand Bay	1/6	
7	4000	Off Rame Head	1/11	Wind E.N.E. The fish in Whitsand Bay are caught in moored nets, the others by the large drift-boats.
	10,000 to 12,000	Whitsand Bay	1/6	
9	—	—	—	Moored nets taken from Whitsand Bay. Wind W., very light. 10,000 herrings brought in by pilchard-boats, made 2/0 per hundred.
10	Several thousand	Cawsand Bay	1/8	Moored nets. Wind W., fresh. The drift herrings always make more money than those taken in moored nets, the latter being so many hours dead in the water.
	Several hundred	Plymouth Sound	1/11	—

Date.	Number per boat.	Locality.	Price per 100.	Remarks.
Dec.				
11	400	Plymouth Sound	1/11	No great quantity as yet in the Sound.
	8000	Cawsand Bay	—	Moored nets.
12	400 >	Plymouth Sound	2/1	—
	6000	Cawsand Bay	1/10	—
13	Small catches	Plymouth Sound	—	—
	2000–3000	Cawsand Bay	—	—
14	3000 >	Plymouth Sound	1/6	New grounds to Melampus Buoy.
15	3000 >	N.W.–N.E. of Breakwater	1/6	—
16	3000 >	West Channel	1/7–1/8	New grounds to Melampus Buoy; largest catches on the slack water (flood), 10 p.m. Wind W.
17	4000 >	N. & S. of the Breakwater	1/6–2/0	—
	6000	Cawsand Bay	1/6	—
18	3000 >	½ mile S. of the Breakwater Fort to E. end of Breakwater	2/0	—
19	1800–2000	Outside Breakwater	2/9-3/3	Owing to stormy weather from the west the large boats had to return without shooting their nets.
	500 >	West Channel	2/9-3/3	
	8000	Cawsand Bay	2/6	
20	1000 >	Outside Breakwater	2/6–3/9	Rise in price due to diminished catches in the west.
	400 >	Inside Sound	2/6–3/9	
	9000	Cawsand Bay	2/6	—
21	Few hundreds	Mid Sound	4/9	Stormy.
	8000	Cawsand Bay	2/6	
23	2000 >	Near Melampus Buoy	4/4	Fish very fine; will spawn in about a fortnight.
24	2000 >	Inside Breakwater	3/4–3/6	150 sail in the Sound. Fish full.
	10,000	Cawsand Bay	2/6	—
	10,000 >	6 miles S. of Mothecombe	2/6	All full-roed.
25	1500 >	E. of Melampus	3/4–3/9	—
26	20,000 >	Off Mothecombe	2/6	Taken by large-decked boats from Penzance.
	Few hundreds	Cawsand Bay	1/7	—
27	30,000 >	Mothecombe; Breakwater Light, clear of Mewstone to S.	1/4–1/9	Taken by large boats on the evening slack water. Twilight, midnight, and daybreak, the best three times for herring. Some of these fish are already shotten; they then go away, probably into the Channel, as the mackerel men fishing 15–20 miles S.S.W. of the Eddystone get them in their nets in April, after which they begin to fill again. Very few herrings now being taken in the Sound; they have probably gone up the harbour to spawn, the weather being fine and the water clear. The Saltash fishermen are taking several thousand. If the weather keeps fine they will come down, nearly all shotten.

Date.	Number per boat.	Locality.	Price per 100.	Remarks.
Dec.				
27	6000	Cawsand Bay	1/7	—
28	400 >	Sound	—	—
	7000	Cawsand Bay	1/3	—
	20,000 >	Mothecombe	1/3	Taken again by the large-decked boats.
30	20,000 to 5000	„	1/3	The Sound fishery has completely stopped, owing to a strong, cold east wind for 2 or 3 days. If the present S. wind continues the fish will probably return.
	Few hundreds	Cawsand	—	—
31	40,000 >	S. of Mothecombe	3/0	—
1890. Jan.				
1	7000 >	S.S.W. of Mothecombe	4/0–4/9	—
2	4000 >	„	5/2 best, 2/6 seeds.	—
	1500	½ mile S.E. of Breakwater	4/10	—
3	5000	Mothecombe	2/8–2/10	The Sound fish are in good condition, and therefore make more money than the outside fish, which are mostly shotten.
	450	E. Channel	4/10	
	Few hundreds	Cawsand Bay	3/0	—
4	20,000 >	S. of Mothecombe	2/0–2/6	Very stormy; few boats out.
	200–300	Sound	3/0–3/3	Too bright a moon for a good catch at night.
	2000	Cawsand	2/0	—
6	400–500	Sound	3/0–4/0	No large boats out; strong wind and rain from the south.
	7000	Cawsand Bay	4/0–2/0	—
7	300–400	Sound	3/0–4/0	Stormy; never many taken in bad weather. Three parts of these herrings are shotten now.
	9000	Cawsand Bay	3/0–4/0	Nearly all shotten.
8	2000 >	Sound	3/3–3/6	New Grounds to Melampus Buoy. Nearly all shotten, and yet fetching a good price, as there is no other fish in the market.
	10,000	Cawsand Bay	2/0–2/4	—
9	3000 >	W. Channel	2/0–3/6	Strong wind and rain.
10	800 >	„	2/0–3/4	The heavy seas have driven the herring out of Cawsand Bay. None being taken at St. Germans and Saltash.
11	3000 >	E. Channel	—	The herrings have left the Sound; none with the large boats in Bigbury Bay. Only one or two per cent. full.
	Few hundreds	Cawsand Bay	—	—
14	Few hundreds	Sound	—	Shotten.
	5000 >	Outside Breakwater	5/0–5/4	A fresh shoal of fish, three parts full, taken just after midnight. Fine; night wind S.W.
16	3000 >	„	Full 3/6-4/0 Shotten 2/0	—
18	500 >	Sound	1/5–1/11	—
	2000 >	Outside Breakwater	4/6–5/6	Full-roed, and now spawning. Very stormy; wind S.
	4000 >	Cawsand Bay	1/6	Shotten.

Date.	Number per boat.	Locality.	Price per 100.	Remarks.
Jan. 21	1000 >	Sound	2/8–3/4	Small boats trying all round and outside the Sound; the large shoal which was outside last week has been broken up by the bad weather, and has come inside the Sound; only about 25 per cent. full. Stormy; wind S.
23	1000	W. Channel	3/0–3/8	Stormy. 10 per cent. still full.
24	400 >	Sound	3/2–3/4	Wind W.S.W., very squally. Nearly all fish shotten.
25	300 >	W. Channel	3/0	—
27	1800 >	Outside Breakwater, Panther to Shagstone	4/7–4/8	20 per cent. of these full; those inside the Breakwater all shotten.
30	8000 >	Panther to Shagstone	1/9–2/0	Sound fishery abandoned. The fish outside so ripe that the ova run out when touched; the buyers do not care for them when so ripe.
31	6000 >	½ mile S. of Panther to Mewstone	2/4–3/4	Fresh shoal of full-roed fish; now 6 or 7 years since full-roed fish appeared so late; last year none a fortnight after Christmas.
Feb. 1	1000 >	Shagstone to Mewstone	2/0–2/6	Half were shotten. The former shoal between Panther and Shagstone have spawned and gone into deeper water. The fishing has not been so good this year, the old localities (*e. g.* Bovisand, Cawsand, and Batten Bay) have been failures; probably because of the heavy ground seas prevalent this year, which seem to have driven the fish on to rockier ground, such as between the Panther and the Shagstone. Wind W., calm.
2	700 >	,,	2/0	Wind N.W., slight.
4	300–100	W. of Shagstone	2/0–2/2	Calm.
6	400 >	E. Channel	1/0	Shotten. Wind E., strong.
7	1000–300	,,	2/6 full 1/4 shotten	Wind E., strong.
8	500–100	,,	1/4–1/8	—
11	800–500	New Grounds to Melampus	2/0	20 per cent. still full.
12	800 >	,,	—	—
13	800–100	New Grounds	1/4	2 per cent. full.
14	200 >	—	0/10	Only 4 or 5 boats working; the fishery is practically over.

II. The Long-line Fishery.

Long-lining no longer pays in this port, as there is so much time wasted in waiting for bait. The boats are worked by four men, and the profits are divided in five and a half shares, apportioned thus :— To the four men one share each; to the owner, for the boat, one share; for the long-line or bolter a half-share. The owner, there-

fore, apparently takes one and a half shares, but of this he pays a quarter of a share to the skipper, while at least half a share must be devoted to the expense of maintaining the bolter in proper condition; he receives, therefore, only three quarters of a share clear for the boat and bolter. Years ago it used to pay; the boats were then much smaller, and only used from 600 to 800 hooks; now they have 1500 to 2000 hooks per boat.

On February 4th, for instance, I find from my notes that all the long-liners were in harbour for want of bait. The same thing happened on March 1st. Bait was scarce almost all the winter, while at the close of March matters were so bad that pilchards had to be sent by train from Falmouth, costing 12*s*. per 1000 and 5*s*. per 1000 for carriage, each boat requiring 800 (the large pilchards make two baits, the smaller only one). One boat on this occasion used a bait of half squid and half pilchard, and took 4½ cwt. of conger, two dozen rays and skates, and six ling, making £6. The other boats had pilchard bait only, and took 2 cwt., ¾ cwt., and three conger respectively, making £2 to £3. One who took only one conger made £7 by rays and skates. The mixed bait of pilchard and squid is found to be the best; the latter, however, depends upon the trawlers, in their turn dependent on the weather; while the scarcity and expense of the former will be seen from the tables given below.

III. The Pilchard Fishery.

Date.	Number per boat.	Locality.	Price per 1000.	Remarks.
1889. Oct.				
23	20,000	—	17/0	Taken by one boat; 3 other boats took 700–800 per boat.
25	10,000 >	Penlee to Eddystone	15/0	Hake, 3 dozen and less, 8/0–10/0 per doz.
26	200 >	Eddystone	25/0	Stormy, cold; wind E.
30	200 >	—	—	—
Nov. 1	300 >	W. of Eddystone	25/0	—
5	8000 >	„	20/0	Spur dog-fish (*Acanthias vulgaris*) innumerable, eating both fish and gear.
6	—	—	—	Very scarce, not enough for bait; 3 doz hake in 15 fath.
7	5000 >	5 miles outside Eddystone	11/0–15/0	5–6 doz. hake, at 9/0 per doz.
8	7000 >	Outside Sound	12/0	7–8 doz. hake, 9/0–9/6.
9	6000 >	4 miles outside Breakwater	10/0	Few doz. hake, at 8/0.
11	20,000 >	10 miles S. of Plymouth	9/0–10/6	—

Date.	Number per boat.	Locality.	Price per 1000.	Remarks.
Nov.				
12	5000 >	2 miles N. of Eddystone	10/0	—
13	9000 >	2 miles N.W. of Eddystone	15/0–16/0	Taken by Mevagissey boats. As the seine fishery in the W. has so far proved a failure, it is so much the better for the drift-nets, as all the buyers are at Plymouth.
14	8000 >	,,	15/0–16/0	Good demand, as there are ships here waiting to be loaded for W. Cornwall.
15	3000 >	E. of Eddystone	15/0–16/0	—
16	Few hundreds	N. of Eddystone	17/6	Mostly purchased by the hook-and-line whiting-boats, of which there are 60–70 sail here.
18	1000 >	6 miles E. of Eddystone	15/0	—
19	1000 >	—	—	Very bad season; 200 sail of boats here, the large boats taking out the pilchard-nets, and substituting mackerel-nets. Hake also fallen off; a W.S.W. wind wanted, as the E. wind always keeps the fish off this coast.
20	1000 >	E.S.E. of Eddystone	16/0	—
21	2000 >	—	—	Most boats had no fish at all.
22	Very scarce	—	—	Three boats out of a hundred landed 300 fish each.
29	5000 >	N.W. of Eddystone	—	—
30	2500 >	,,	17/6	—
Dec.				
2	8000 >	5 miles S.W. of Penlee	17/6	—
3	15,000 >	2 miles outside Eddystone	16/6	Only 8 boats with good catches.
6	800 >	N.W. of Eddystone	17/4	8 boats.
7	Few hundreds	—	—	—
10	10,000	4 miles S. of Rame Head	17/0	—
11	20,000 >	6 miles S.W. of Penlee	17/0	—
12	5000	,,	17/6	—
13	Few hundreds	—	—	—
14	30,000 >	Between Penlee and Eddystone	11/0–16/6	—
16	15,000 >	8–10 miles S. of Mewstone	15/0	—
17	25,000 >	6 miles S. of Stoke Pt.	14/0	—
18	15,000 >	—	13/0–15/0	—
21	20,000–10,000	—	17/0	Only 4 boats out, the weather being so bad from S.W. They saw what almost always indicates a good catch, viz. the gannets diving from a great height.
24	17,000	2 miles N.W. of Eddystone	14/0–15/0	Very stormy.
26	20,000 >	Rame Head to Eddystone	14/0–15/0	20 boats.

Date.	Number per boat.	Locality.	Price per 1000.	Remarks.
Dec.				
27	20,000 >	½ mile S. of Penlee	12/0–13/0	30 boats. One boat took 40,000, which carried the nets to the bottom; got them back without much damage.
28	20,000 >	Rame Head to Eddystone	11/0	Half the boats are now in the East Channel for herring. Hake very scarce, 33/0 per doz.
30	30,000 >	S. of Penlee	11/6	—
31	40,000 >	,,	10/6–11/0	Smallest boats almost sinking under their catches. Weather very fine. Taken at midnight after the moon went down.
1890. Jan.				
1	10,000 >	S. of Mewstone	9/0–11/0	—
2	10,000 >	3 miles outside Breakwater	4/0–11/0	—
3	7000 >	Various localities	8/0	Most of these fish taken by briming (cf. p. 250). Market glutted.
4	Few thousand	—	8/0	—
11	50,000 >	3–5 miles S.W. of Rame Head	8/0–10/0	The fish seem to be travelling S.W. Wind S.W., light.
15	20,000 >	S. of Rame Head	5/0–8/0	—
16	None	—	—	Stormy; wind S.

[*These extremely valuable notes will be continued in the next number of the Journal.*—G. H. F.]

Notes on the Hydroids of Plymouth.

By

Gilbert C. Bourne, M.A., F.L.S.

With Plate XXVI.

During the two years which I spent at Plymouth I collected a number of notes on the occurrence and distribution of the Hydroidea of the district, with the intention of giving a full account of the representatives of the group in the Plymouth area. My unexpected departure has prevented my carrying out this intention, but it has seemed to me worth while to publish my notes, fragmentary as they are, in the hope that they may be useful to my successors, and particularly because the list of the Hydroidea given in Part ii of the first series of this Journal is very imperfect. The list of species now given is incomplete, and had I had the time to search more closely for the inconspicuous and deep-water forms I should have been able to add largely to it. One species, which I only succeeded in obtaining twice, appears to be new to science.

Gymnoblastea.

Family CLAVIDÆ.

Clava multicornis, *Forskål.*

This well-known species is very common in tide pools on the rocks below the Hoe, and inside Penlee Point. I have also found it in Wembury Bay.

Clava cornea, *T. S. Wright.*

A small colony with ripe gonophores growing on *Fucus serratus*. Drake's Island, February 11th, 1888.

Family HYDRACTINIIDÆ.

HYDRACTINIA ECHINATA, *Fleming.*

Fairly common on shells of *Buccinum undatum*, from ten to twenty fathoms. Duke Rock. Mewstone. Bigbury Bay.

Family PODOCORYNIDÆ.

PODOCORYNE CARNEA, *Sars.*

A few specimens from old shells, ten to twenty fathoms. The Medusa is common outside the Breakwater in summer months.

Family CORYNIDÆ.

CORYNE VAGINATA, *Hincks.*

Several fine colonies of this species from rock pools in Wembury Bay, June and July, 1890. Also on previous occasions from Drake's Island and Bovisand Bay. Gonophores May to August.

CORYNE PUSILLA, *Gaertner.*

Drake's Island, May, 1890. A good specimen, with gonophores, from Whitsand Bay, July 11th, 1887, appears to belong to this species.

CORYNE FRUTICOSA, *Hincks.*

A few polypes, without gonophores, collected by Mr. Heape, appear to belong to this species.

SYNCORYNE EXIMIA, *Allman.*

A fine specimen, with gonophores, on an old piece of rope, one mile south of the Mewstone, May 11th, 1889.

Family MYRIOTHELIDÆ.

MYRIOTHELA PHRYGIA, *Fabricius.*

This fine and interesting species is common in the neighbourhood of Plymouth. The gonophores are large and ripe from May to

August, and the peculiar free zooid may easily be procured during these months. Habitat on the under sides of stones near low-water mark. East side of Drake's Island. Near Picklecombe Fort. Bovisand Bay. Mewstone. Wembury Bay, very common immediately below Wembury Church. Duke Rock, seven fathoms.

Family EUDENDRIIDÆ.

EUDENDRIUM RAMEUM, *Pallas.*

From the Eddystone, thirty fathoms. Not common.

EUDENDRIUM RAMOSUM, *Linn.*

Very common. Duke Rock. Off the Mewstone.

EUDENDRIUM CAPILLARE, *Alder.*

Growing on worm tubes and on *Antennularia antennina* off Stoke Point, April, 1889. Duke Rock.

Family ATRACTYLIDÆ.

PERIGONIMUS REPENS, *T. S. Wright.*

Growing on the legs of a crab, deep water, July 19th, 1888. From *Turritella* shells, two miles south-west of Rame Head.

PERIGONIMUS VESTITUS, *Allman.*

Brought in by a trawler, May, 1890.

BOUGAINVILLEA RAMOSA, *Van Beneden.*

Drake's Island, August 11th, 1888.

Family TUBULARIIDÆ.

TUBULARIA INDIVISA, *Linn.*

Not common at Plymouth. Rock pools, south side of Drake's Island, August 11th, 1888. Whitsand Bay.

TUBULARIA LARYNX, *Ellis and Solander.*

Growing profusely on the Duke Rock Buoy, and on other buoys in the East Channel, September, 1889.

TUBULARIA BELLIS, *Allman.*

Growing in profusion on stones at extreme low-water mark, north side of Breakwater, May, June, and July, 1890.

CORYMORPHA NUTANS, *Sars.*

Five specimens of this species were taken by Mr. Heape in Whitsand Bay in about three fathoms, below Fort Tregantle, on May 17th, 1887. Though we have dredged constantly in the same locality, we have never succeeded in obtaining another specimen.

Calyptoblastea.

Family CAMPANULARIIDÆ.

CLYTIA JOHNSTONI, *Alder.*

Ubiquitous on algæ and on other hydroids.

OBELIA GENICULATA, *Linn.*

Very common, growing preferably on *Laminaria.* It has appeared in the aquarium, and covers many of the standpipes and gratings where there is a steady and continuous current.

OBELIA DICHOTOMA, *Linn.*

Attached to worm tubes, Whitsand Bay; and from trawl refuse near the Eddystone.

OBELIA LONGISSIMA, *Pallas.*

From trawl refuse outside the Eddystone.

CAMPANULARIA VOLUBILIS, *Linn.*

From shells, Duke Rock Buoy.

CAMPANULARIA RARIDENTATA, *Alder.*

On weeds, trawl refuse, May, 1890.

CAMPANULARIA FLEXUOSA, *Hincks.*

Very common in rock pools beneath the Hoe, and on weeds.

CAMPANULARIA ANGULATA, *Hincks.*

From the shore, Bovisand Bay, July 27th, 1889.

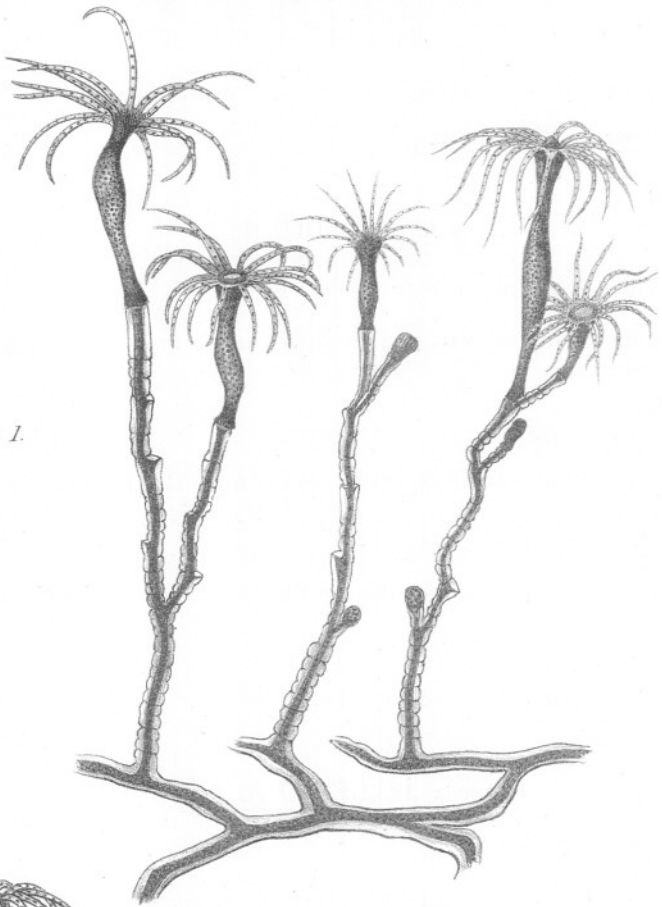

Fig 1.

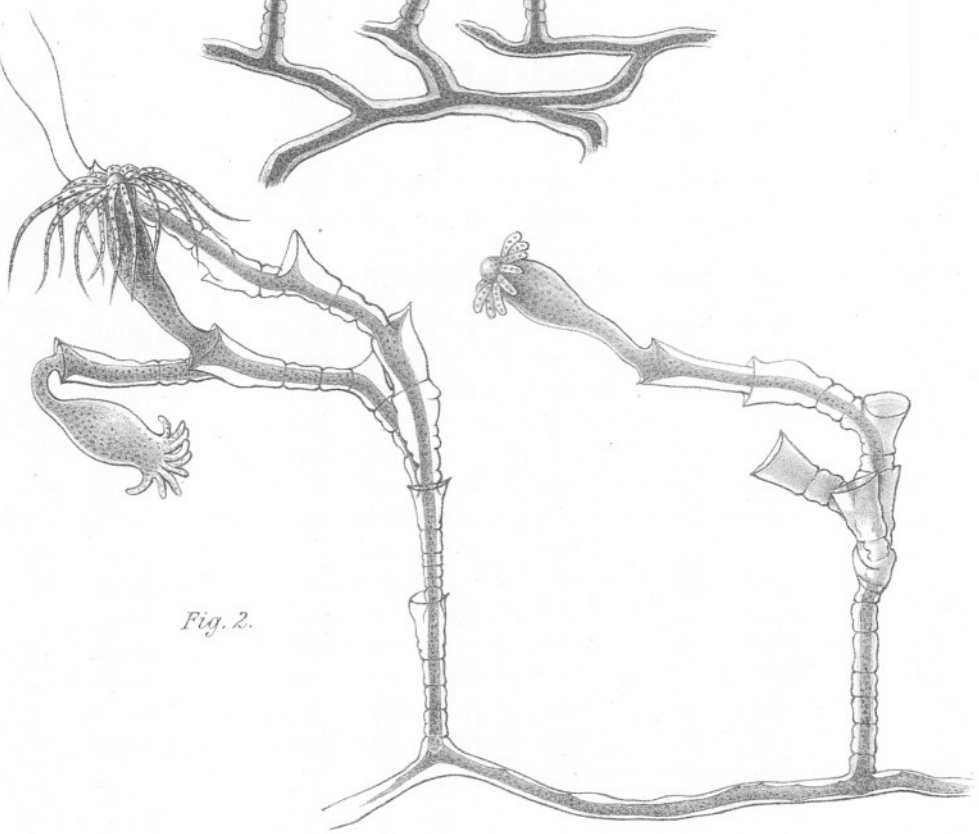

Fig. 2.

CAMPANULINA ACUMINATA, *Alder*.

From trawlers, May, 1890.

Family LAFOËIDÆ.

LAFOËA DUMOSA, *Fleming*.

This species, var. *robusta*, is not uncommon in twenty fathoms near the Eddystone.

LAFOËA FRUTICOSA, *Sars*.

From Stoke Point and from trawl refuse near the Eddystone.

CALYCELLA SYRINGA, *Linn*.

A very common species, growing profusely on roots of *Laminaria*.

CUSPIDELLA COSTATA.

Growing on weed, trawl refuse, May, 1890.

Family HALECIIDÆ.

HALOIKEMA, nov. gen.

Generic Characters.—Stems erect, simple or sparingly branched, ringed. Hydrothecæ pedicillate, hydranths large, non-retractile.

HALOIKEMA LANKESTERII, n. sp. Pl. XXVI, figs. 1, 2.

Shoots erect, springing from an interlacing creeping stolon, composed of many distinct joints, simple or sparingly branched. Hydrothecæ alternate, sometimes borne on a short pedicel, one or a pair separated by a variable number of joints, generally not more than three, tubular, with a slightly everted rim. Hydranth very large, elongated, fusiform, with a single circlet of sixteen to twenty filiform tentacles, non-retractile. Hydranths and cœnosarc of a deep brown colour. Reproduction unknown.

I have only obtained this species twice—near the Duke Rock Buoy, May, 1889, and at the southern end of Jennycliff Bay, May, 1890. I kept the last specimen alive for some weeks in the aquarium in the hope of studying the reproduction, but all the specimens eventually died without producing gonophores.

This is a fine and very distinct species, easily recognisable from

its very large, deep brown, and absolutely non-retractile polyps. It grows on flat stones at a depth of seven fathoms. It is closely allied to the genus *Halecium*, which it resembles in the form of the polyp and the character of the hydrothecæ; in habit it comes nearest to *H. tenellum*. The ringing of the stem, the pedicillate hydrothecæ, and the non-retractile polyp, which is relatively much larger than the partially retractile polyps of the genus *Halecium*, are sufficient to warrant its being placed in a distinct genus. I have named the species after Professor E. Ray Lankester, to whose energy and enthusiasm the Marine Biological Association owes its existence, and to whom I am personally indebted for much kindness and advice.

HALECIUM BEANII, *Johnston*.

Very common. Duke Rock. Bigbury Bay. Off the Mewstone.

HALECIUM HALECINUM, *Linn*.

Very common, and generally taken with the preceding species.

Family SERTULARIIDÆ.

SERTULARELLA POLYZONIAS, *Linn*.

Common and generally distributed on clean stony ground, seven to twenty fathoms.

SERTULARELLA GAYI, *Lamoureux*.

Wembury Bay. Cawsand Bay. Duke Rock. Eddystone. Common.

DIPHASIA PINASTER, *Ellis and Solander*.

Very common in trawl refuse. South of Eddystone.

SERTULARIA ARGENTEA, *Ellis and Solander*.

Plymouth Sound. Start Point. Trawl refuse from Eddystone.

SERTULARIA PUMILA, *Linn*.

Growing in profusion on rocks and weeds between tide-marks.

SERTULARIA CUPRESSINA, *Linn*.

Common in trawl refuse from the Eddystone, and very common in forty fathoms near the Wolf Rock.

SERTULARIA ABIETINA, *Linn.*

Common in trawl refuse.

HYDRALLMANIA FALCATA, *Linn.*

Very common in twenty fathoms. Two specimens only taken inside the Sound, north of Batten Breakwater, and probably thrown overboard by trawlers.

THUIARIA ARTICULATA, *Pallas.*

Wembury Bay. Stones and shells off Mewstone.

Family PLUMULARIIDÆ.

ANTENNULARIA ANTENNINA, *Linn.*

This and the next species are common, growing on rocky ground inside the Sound, and outside up to twenty fathoms.

ANTENNULARIA RAMOSA, *Lamarck.*

Hincks gives, as a diagnostic character of this species, "Hydrothecæ separated by a single joint." This is not correct. It is invariably correct for the basal portion of a branchlet, but towards its termination two joints are often seen between two hydrothecæ. The same author erroneously says, "Gonothecæ single;" they are in fact paired, one pair at the base of each branchlet. The gonothecæ are single in *A. antennina*, and this difference affords a good specific character.

AGLAOPHENIA TUBULIFERA, *Hincks.*

August to October. Not uncommon from Wembury Bay and off the Mewstone. I am not quite sure of the identity of this species. In most of the specimens I examined the corbula has invariably the spur mentioned by Hincks as characteristic of this species, but the hydrothecæ are exactly those of *A. pluma*, everted, patulous, and strongly dentated, quite unlike those of *A. tubulifera*, Hincks.

AGLAOPHENIA PLUMA, *Linn.*

Common on the fronds of *Halidrys siliquosa*, Bovisand Bay, and off Mewstone.

AGLAOPHENIA MYRIOPHYLLUM, *Linn.*

A few specimens brought in by trawlers from deep water.

PLUMULARIA FRUTESCENS, *Ellis and Solander.*

From Wembury Bay.

PLUMULARIA CATHARINA, *Johnston.*

Not uncommon. Duke Rock. Winter Shoal. Off Stoke Point.

PLUMULARIA SETACEA, *Ellis.*

Common in the Sound. The variety of branched and luxuriant habit mentioned by Hincks (Brit. Hydroids, p. 297) is very common, generally growing on *Halichondria panicea.*

PLUMULARIA SIMILIS, *Hincks.*

Jennycliff Bay. Rocks below Laboratory. Common.

PLUMULARIA ECHINULATA, *Lamarck.*

Growing on weed; not very common.

PLUMULARIA PINNATA, *Linn.*

Common. Duke Rock. Barnpool. Off Mewstone.

A Complete List of the Opisthobranchiate Mollusca found at Plymouth;

WITH FURTHER OBSERVATIONS ON THEIR MORPHOLOGY, COLOURS, AND NATURAL HISTORY.

By

Walter Garstang, M.A.,
Jesus College, Oxford; Assistant to the Director, M.B.A.

With Plates XXVII and XXVIII.

THIS paper is intended to furnish a complete list of all the species of Opisthobranchiate Mollusca found up to this time by the Marine Biological Association at Plymouth, together with various notes upon their morphology and natural history. The Nudibranchiate section of the group has, however, already formed the subject of a preceding report published in this Journal,[1] so that species which have not since been taken are recorded here by their names only, a fuller account of them being given in the previous report. All the species there recorded are distinguished in this paper by asterisks (*) affixed to their names. I have had the advantage of several works upon the classification of the group which have recently appeared, notably Carus's excellent Prodromus Faunæ Mediterraneæ, vol. ii, part 1, 1889; Bergh's *Die cladohepatischen Nudibranchien* (Zoolog. Jahrbüch., v, 1890; for a copy of this admirable work I am indebted to the author); and Norman's *Revision of British Mollusca* (Ann. Mag. Nat. Hist., VI, vol. vi, No. 31, 1890, pp. 60—91). I must also mention Vayssière's *Recherches Zoologiques sur les Mollusques Opistobranches du Golfe de Marseille—I. Tectibranches* (Ann. Mus. Hist. Nat. Marseille, Zool., II, 1885, Mém. No. 3) as having been of great service; and I regret that up to the time of going to press the second part of M. Vayssière's work has not arrived at the Laboratory, and I have been unable to refer to it.

Since my Report on the Nudibranchiata was in type last year Prof. Herdman[2] has published several papers upon the value of

[1] Garstang, *Report on Nudibranchiate Mollusca of Plymouth Sound*, Journ. Mar. Biol. Assoc., N. S., vol. i, No. 2, 1889, pp. 173—198.

[2] Herdman, *On the Structure and Function of the Dorsal Papillæ in Nudibranchiata*,

colour in this group of animals, extending the observations of Giard upon protective colouration, and supporting Wallace's view that the colours of Æolids are generally "warning colours as a sign of inedibility." In conjunction with Mr. Clubb[1] he has also published an account of a number of experiments designed for the verification of these views. Having been myself occupied from time to time in similar experiments, a few of the decisive results were communicated to Mr. Poulton, who has inserted them in his recent work on The Colours of Animals (Int. Sci. Series, London, 1890, pp. 199, 200). I hope soon to give an account of the results of other experiments.

In this paper I have taken the opportunity of correcting some mistakes of classification and nomenclature which had not been avoided in my report on the Nudibranchiata.

It is a pleasant task to express my sincere thanks to those who have generously helped me in the investigations here described, and particularly with regard to *Aplysia*. I am especially indebted to Dr. Norman and to Mr. A. R. Hunt.

OPISTHOBRANCHIATA.

Sub-order 1.—TECTIBRANCHIATA

(= OPISTHOBRANCHIA PALLIATA, Lankester).

A. *CEPHALASPIDEA.*

Family—SCAPHANDRIDÆ.

1. SCAPHANDER, *Montfort.*

1. SCAPHANDER LIGNARIUS, *Linnæus.*

This species is frequently obtained by trawlers on the Eddystone trawling-grounds; it does not live in the Sound, but has been taken off Penlee Point.

Family—BULLIDÆ.

2. HAMINEA, *Leach.*

2. HAMINEA HYDATIS, *Linnæus.*

Several large specimens were dredged in the estuary of the river

Rep. Brit. Assoc., 1889, Section D; and Quart. Journ. Micr. Sci., xxxi. Prof. Herdman kindly sent me copies of these papers, which, though containing views similar to some expressed in my previous Report, were written for the most part before its publication.

[1] Herdman and Clubb, *Third Report on Nudibranchiata of L.M.B.C. District*, Trans. Liverpool Biol. Soc., iv, 1890, pp. 150—163; and Nature, June 26th, 1890, pp. 201—203.

Yealm in August of this year, and were brought back alive to the Laboratory. About twelve more specimens were obtained there on another occasion in September. Empty shells may often be found on the shores of the Yealm; probably, therefore, the species frequents this estuary.

Clark states, in his History of the British Marine Testaceous Mollusca, 1855, "Twenty years ago I observed hundreds of these creatures swimming [by means of their pedal flaps] and creeping on the fine mud in the lakes of the Mount Pleasant Warren, near Exmouth; they, however, suddenly disappeared from the locality, and not one has been seen for many years."

Cocks, in 1849, recorded the species as common in Falmouth Harbour.

Family—PHILINIDÆ.

3. PHILINE, *Ascanius.*

3. PHILINE APERTA, *Linnæus.*

This species is common on sandy bottoms, in Cawsand Bay and especially in Whitsand Bay. The animal is said to be able to swim, but I have not myself seen it progress in this way.

4. PHILINE PUNCTATA, *Clark.*

I have only seen one specimen of this small species, found among some *Bowerbankia* dredged in the Sound. Clark recorded it as inhabiting the littoral zone at Exmouth along with *P. catena*, which was "rare amongst algæ in the sheltered pools." Cocks found it among shell sand at Falmouth, rare.

B. *ANASPIDEA.*

Family—APLYSIIDÆ.

4. APLYSIA, *Linnæus.*

5. APLYSIA PUNCTATA, *Cuvier.*

APLYSIA PUNCTATA,	*Cuvier.*	Blochmann, Mittheil. Zool. Stat. Neapel, v, 1884, pp. 28—49.
—	— *Cuvier.*	Vayssière, Ann. Mus. Hist. Nat. Marseille, 1885, Mém. No. 3, pp. 68—71.
—	— *Cuvier.*	Gwyn Jeffreys, British Conchology, v.

APLYSIA HYBRIDA, *Sowerby*. Forbes and Hanley, British Mollusca, iii, pp. 554—556.
— DEPILANS, *Pennant*. Clark, Brit. Mar. Test. Moll., pp. 271, 272.
? — — *Linnæus*. Blochmann, l. c., pp. 32, 33.
? — — *Linnæus*. Vayssière, l. c., pp. 65—68.

The specimens of *Aplysia* in our collection have been taken as follows:

I. North of the great Breakwater, November, 1886: two young ones, in trawl.
II. Mouth of the river Yealm, July 18th, 1887: six, large and small, in dredge.
III. North of the Shagstone, February 2nd, 1888: one dredged.
IV. Mouth of the Yealm, October 20th, 1888: many little ones, dredged or trawled.
V. North of Batten Breakwater, November 12th, 1888: nine or ten, all young, in trawl.
VI. Estuary of the Yealm, opposite coastguard station, May 25th, 1889: a dozen very large specimens.
VII. Mouth of the Yealm, September 20th, 1889: one small specimen, of pure brown colour with white spots.
VIII. Cawsand Bay, October 3rd, 1889: one, much smaller in size, about $\frac{3}{4}$ inch long, bright rose-red in colour, with white spots.
IX. Duke Rock, May 8th, 1890: one considerably larger specimen, of a bright pinkish-red colour, dredged with a quantity of *Delesseria sanguinea*, of exactly the same colour.
X. Middle of Sound, August 14th, 1890: one very small specimen, $\frac{3}{16}$ inch in length, found by Mr. Tate on a stone brought up in the trawl. In this beautiful little individual the shell was still uncovered, being without any reflexed fold of the mantle. The colour of the animal was almost the amethyst-purple of Alder and Hancock's figure of *Æolis Landsburgii*, but deeper and redder.

In addition to these a few other small or moderate-sized specimens (1—2 inches) have been taken, but have not been recorded. In the summer of last year several such individuals were generally brought up on weeds at each haul of the trawl along the inside (north) of the great Breakwater.

All our specimens belong to the second of the two subdivisions of the genus *Aplysia* defined by Blochmann (l. c., p. 29). The pleuropodia[1] ("epipodia," "parapodia," *Schwimmlappen*) are fused

[1] See under *Oscanius membranaceus*, infra, p. 419.

posteriorly from their origin on the foot to the level of the exit of the pallial (anal) siphon. The edge of the mantle-folds, reflexed over the shell and fused, bounds a circular aperture conducting to the shell, but is never raised up into a tubular prominence. The opaline gland behind the genital aperture is not lobulate (grape-shaped) with a single pore, but consists of a number of large unicellular bottle-shaped glands opening separately to the exterior. Anteriorly, however, as Vayssière has observed in *A. punctata* (l. c., p. 54), these elongate gland-cells are bunched together, and in my specimens have a single excretory pore which it is quite easy to discover.

Colour.—The colour of our smallest specimens has always been of a more or less bright and deep rose-red, generally if not always sprinkled with opaque white spots. At this stage our *Aplysiæ* correspond with Rathke's "species" *rosea* and Thompson's *nexa*. Our largest specimen measures (preserved in alcohol and consequently much contracted) 3 inches in length, $1\frac{5}{8}$ inches in height, and $1\frac{1}{4}$ inches in breadth. Its shell is figured of the natural size on Pl. XXVIII, fig. 9; the structure of the central teeth of its radula is shown in fig. 7. When alive this individual probably measured rather more than 6 inches in length in a state of complete extension. The colour of this specimen and of the other large ones dredged in May last year was olive-green,[1] of various shades and intensities. An individual which was living in the tank in the Laboratory for some time in the autumn of last year, and measured about 4 inches in length during extension, was of a pure brown colour; while the specimen dredged on the 8th of May this year was kept alive for some time, and being of a bright pink-red colour at the time of capture had changed in a month's time (June 6th) to a brownish red, and by the 23rd of June to a deep red-brown. Its colour when captured was just that of the alga *Delesseria sanguinea*; on the 6th of June it was exactly that of *Iridæa edulis*. Thus this species changes its colour with growth from a violet, purplish, or rose-red colour, through brownish red and brown to olive-brown or olive-green. There is considerable variation, as is well known, but these are, I believe, the chief changes which occur. Vayssière attributes the different colours of specimens of *A. punctata* at Marseilles to the nature of the bottoms upon which they are found (l. c., p. 69), but I may remark that the living *Aplysia* whose colour-changes I observed was kept under the same conditions for the two months during which it was under observation.

[1] In recording a specimen found on the shore at St. Andrews, Prof. McIntosh remarks, "No spots or other markings were present on the dull olive hue of the body" (Mar. Inv. and Fish, St. Andrews, p. 84).

Markings.—The markings of our specimens I have studied only in the preserved condition. In some of the smaller specimens no markings at all are to be observed, but as others preserved in the same way show very conspicuous markings it is probable that conclusions drawn from these preserved specimens are valid. The largest of the small specimens in which markings are absent, measures $1\frac{3}{4}$ inches long in a fair state of extension. Where present, the marking of the integument is always due to small grey dots, either pale or dark, slightly elongate in form, which may be grouped in various ways. They may be evenly dispersed over the whole of the integument, forming no rings and leaving no clear spaces, or, though arranged in the same way, may be distributed over only a limited portion of the integument, viz. on the back of the head and on the upper portion of the sides of the body. It is, indeed, generally the case that, as Brock has described for *A. punctata* (Blochmann, l. c., p. 34), the marking does not extend to the foot and inner side of the pleuropodia, but is limited to the upper surface of the body. The most usual type of marking, however, consists in the dots being so distributed (either over the whole surface of the integument or over the upper portion only) as to leave round or elliptical clear spaces from which all markings are absent. The spaces may be either definitely bounded by a close series of dots or not very definitely bounded; there is every gradation between these two conditions. The former of these conditions is represented in Mrs. Gray's Figures of Molluscous Animals, vol. ii, pls. cxxxviii, cxxxix, and cxlii, both for *A. depilans* and *A. punctata;* the latter condition is shown on pl. cxlii* for *A. depilans*. The dots in most specimens show a great tendency to be arranged in a certain order, either in straight or curved lines, or in the form of hexagonal, circular, elliptical, or irregular markings, enclosing clear spaces of small diameter. But there is every gradation between these small dot-bounded spaces and the large ones mentioned above. In a number, though not the majority, of individuals, the dots enclosing these small circular spaces may be so continuous as to produce very definite ring-like spots. These are chiefly to be found on the head and neck, and more rarely on the sides of the body. In our largest specimens the marking consists largely of a reticulum formed by lines of pigment-dots running in all directions, crossing one another and anastomosing, here and there leaving large or small clear unpigmented spaces, with indefinitely bounded edges.

So far as the marking is concerned, therefore, some of our smaller specimens have the positive characters of *A. punctata* as described by Blochmann and Vayssière; but many of the smaller ones, as well as all the largest ones, could equally well be placed—so far as the

marking is concerned—in the species *A. depilans* (= *fasciata*) of their descriptions.

Radula.—In 1875, 1877, and again in 1878, Mr. A. R. Hunt,[1] of Torquay, obtained a number of *Aplysiæ* in Torbay of various sizes, some of which were of the ordinary English type, the species *punctata* of Blochmann and Vayssière, the largest of these having a radula with fifteen completely formed lateral teeth on each side in a single transverse row, while others were of very much larger size, and are referable to the species *depilans* of the same naturalists, the smallest having, according to Mr. Hunt, twenty-six completely formed lateral teeth on each side of the median row. Mr. Hunt, however, by examining a series of radulæ of different sizes found that the number of lateral teeth as well as the number of transverse rows was dependent upon the age (size) of the individual, and arrived at the conclusion that probably his large specimens were not specifically distinct from the smaller ones, but were simply unusually large individuals of the common English species, *A. punctata*, Cuvier.

I owe to Mr. M. F. Woodward, of South Kensington, my acquaintance with Mr. Hunt's papers, which were published in a journal not generally known to zoologists, and had escaped my notice. Mr. Woodward had intended to re-investigate the matter himself, but upon finding that I was engaged in an examination of the Plymouth *Aplysiæ* very courteously referred me to Mr. Hunt's papers, and, as I am pleased to acknowledge, helped me in various other ways.

As to growth of the radula in either *Aplysia depilans* or *punctata*, the comparatively recent papers of Blochmann and Vayssière render little assistance. Blochmann figures the radula and teeth of a single average-sized specimen of each "species," and gives their respective formulæ; while Vayssière remarks upon the variability in the dental formulæ of *A. punctata*, and describes the structure of the teeth of an average specimen, but for *A. depilans* gives a similar description, and regrets having obtained no young individuals (l. c., pp. 67, 61). From Blochmann's account, again, I cannot gather that he has examined young specimens of this latter species, for he gives the size of the animal as from 10 to 20 cm., and only mentions "quite young individuals" as being *possible* exceptions to the general rule as to the markings of the species (l. c., p. 32).

Is there a possibility that the young *Aplysia depilans* is no other than *Aplysia punctata?*

On Pl. XXVIII the structure of the central tooth and of three

[1] Hunt, *On some Large Aplysiæ taken in Torbay in* 1875, Trans. Devonshire Assoc., vol. ix, 1877, pp. 400—403; *On the Growth of Aplysiæ in Torbay*, Trans. Devonshire Assoc., x, 1878, pp. 611—617.

adjacent lateral teeth of a median transverse row is represented for five Plymouth *Aplysiæ* of different sizes. Fig. 3 represents these teeth in a very small specimen, whose radula measures 1·05 mm. in length by 0·6 mm. in breadth, and consists of twenty transverse rows, its formula[1] being (8·1·8) × 20. The central tooth consists of a broad but short basilar portion, deeply excavated behind, and a transverse projecting ridge, arising from the basilar portion in its anterior half, directed posteriorly, and made up of five well-developed cusps, of which the median is the largest and has five serrations on each side, while the internal and external lateral cusps are smooth, the external cusp being smallest. The posterior excavation of the basilar portion of the tooth will be referred to as the "posterior bay;" a similar but smaller excavation in front will be called the "anterior bay." The structure of the tooth in a very young specimen being understood, the modifications entailed by further growth can be most accurately shown by a series of measurements, although the striking nature of the changes is more graphically shown on Pl. XXVIII.

Mr. Hunt has very kindly lent me a number of the preparations made by him in 1877 and 1878, so that I have been able to incorporate the results of a re-examination of them with those obtained from Plymouth specimens. These results are contained in the accompanying tables. For the "species" *A. punctata* (Nos. 1—10) the measurements and observations show—

(1) That the radula may attain a size of 8·8 mm. in length by 5·4 mm. in breadth, considerably larger than that figured by Blochmann (6 × 4), and may consist of forty-four transverse rows of teeth, the lateral teeth numbering (according to age) from eight to nineteen. Blochmann gives twenty rows and thirteen lateral teeth for this species at Naples, while Vayssière has observed from thirty-five to thirty-six rows and sixteen lateral teeth at Marseilles.

(2) That the basilar portion of the central teeth may increase in breadth (according to age) from 0·15 mm. to about 0·4 mm., when it begins to be reduced in width (Nos. 9 and 10), and that it increases in height regularly (with age) from 0·025 mm. to 0·15 and even 0·2. In several of the radulæ (Nos. 5, 6, 8, 9, and 10) this increase can be actually observed by comparing the heights of the central teeth in front and of those

[1] In my formulæ for the teeth of *Aplysia* the three, or sometimes four, rudimentary lateral teeth at the extremities of the transverse rows are always included. In comparing these formulæ with those given by Mr. Hunt it should be remembered that Mr. Hunt counts only the perfectly developed lateral teeth.

further behind. This increased height is due to additional chitin formation at the *posterior* margins of the teeth, and it thus comes about that the "posterior bay" may be entirely obliterated (Pl. XXVIII, fig. 7). This has not before been observed for *A. punctata*, and breaks down one of the previously maintained distinctions between the central teeth of *A. punctata* and *A. depilans*.

(3) That with age the central cusp of the central tooth becomes less prominent and much more obtuse (Nos. 7, 9, and 10); that the external lateral cusp becomes reduced in size, and may even disappear (Nos. 5, 9, and 10); and that the internal lateral cusp also becomes reduced in size, and, while quite smooth in young individuals, may become in older specimens irregularly serrated on its external edge (Nos. 6, 9, and 10).

Turning now to the results in the case of the few radulæ of *A. depilans* which I have been able to examine, it is seen that, as in *A. punctata*, the radula varies in size and number of rows very largely according to age. My smallest radula (No. 11) is a fragment only, and possesses thirty-one lateral teeth. It is obviously, however, an older specimen than my largest *punctata*, for it is 1·6 mm. wider, and probably possessed fifty rows of teeth originally. The central teeth differ remarkably from those of my largest *punctata* in being of much smaller size in every way.

The next (No. 12) is a little larger (0·5 mm. wider), and possesses fifty-six rows of teeth, while the number of lateral teeth increases remarkably in passing from the front to the back of the radula. There are thirty-two lateral teeth behind and twenty-three in front. This radula in this respect, therefore, approaches *A. punctata* very closely, for in No. 10 the lateral teeth were seventeen in front and twenty behind. As regards number of teeth, therefore, there is no ground for specifically separating these two forms. The width of the central teeth is still much smaller than in Nos. 9 and 10, but, as in them, the width shows a crescendo followed by a remarkable diminuendo in size, passing from the front to the back of the radula. It is impossible to avoid the inference that in the growth of this individual the width of the central tooth has never exceeded that which it attains at the climax of its crescendo (0·3 mm.), and therefore Nos. 9 and 10 (in which the tooth attains a width of 0·4 mm.) cannot easily be regarded as stages in its growth. This inference is also strengthened by the other measurements of the central teeth of the radula, and by comparison with Nos. 13 and 14, which exhibit an *increase* in the size of their teeth with age. This

increase indicates growth through stages possessing central teeth of smaller, not of larger, size.

At the same time I cannot place the same confidence in inferences drawn from measurements of the teeth in Nos. 12, 13, and 14, for these teeth are shrunken and distorted, owing to the method in which the radulæ were mounted. No. 8 was also mounted dry, and it may be noticed that the teeth in this specimen show a considerable reduction in width compared with Nos. 7 and 9. As it has been shown above that in many points of structure increased age brings about a closer and closer resemblance of the teeth of *A. punctata* to those of large examples of *A. depilans*, I am inclined to give more weight to this trustworthy evidence than to that afforded by the shrunken teeth of Nos. 12, 13, and 14; and in the absence of any definite statements upon the matter by Mediterranean zoologists I think considerable grounds are afforded by this examination of the teeth for regarding *A. depilans* as merely *A. punctata* modified by further growth. I trust that the subject may receive more conclusive treatment in the hands of a naturalist upon a coast where large *Aplysiæ* are more common than they are with us in England. It is especially needful that the young *A. depilans* should be identified and described.

While upon the subject of the teeth of *Aplysia* I may add that Dr. J. E. Gray, in his Guide to the Distribution of the Mollusca in the British Museum, 1857 (p. 200), gives a description of the teeth of *A. depilans* and *A. punctata* which is very difficult to understand. For *A. depilans* he describes a radula having a formula 12·1·12, of which the central tooth is "distinct and truncated, *triangular, dilated beneath*,[1] with an arched front edge; apex truncated, reflexed; reflexed part subcordate, dark, with three large toothlets in front." Is this a true *depilans* at an early stage? For *A. punctata* he says, "Central tooth with the base on each side expanded; apex recurved, *with one sharp point lobed on both sides;* lateral teeth about thir een."

Curiously enough, this latter description is very applicable to the figure given by Mr. Jabez Hogg[2] of the central tooth of an *A. hybrida* from Torbay, which numbered "seventy-two rows of divergent teeth," but possessed "numerous laterals." Certainly I have seen no *A. punctata* having this number of rows of teeth or this structure, although Mr. Hogg's figure closely corresponds with that given by Vayssière for *A. punctata*. I wish to thank Mr. Hogg for his kindness in lending me a copy of his original paper at a time when it was impossible to obtain one from the libraries. Fig.

[1] The italics are mine.

[2] *The Lingual Membrane of Mollusca*, Trans. Micr. Soc., xvi, N. S., pl. x, fig. 42.

41 of his paper represents the teeth of an *Aplysia* taken in Vigo Bay, having "forty rows of divergent teeth; the median broad, produced at the base, reflexed, *tricuspid; centre cusp prolonged and serrated.*" This *Aplysia* received no specific name in print, but Mr. Hogg has added in his own copy the word *punctata*, an identification which there is every reason to believe to be correct, although the shape of the posterior margin of the basilar portion of the tooth is unusual. Mr. Gwyn Jeffreys, however, confused matters by taking this radula for that of an *A. depilans*, and that of Mr. Hogg's *A. hybrida* (Fig. 42) as the normal one of *A. punctata*. Mr. Hunt follows Gwyn Jeffreys' identification, but suggests that "70" is an accidental misprint (l. c., 1877, p. 401), or that the numbers 40 and 70 should be transposed. The latter of these suggestions is impossible, because the central tooth of the radula of an *Aplysia depilans* numbering seventy rows is not so distinctly tricuspid, nor is the centre cusp prolonged and serrated. It is best, I think, to leave this confusion unsolved, and to hope that the radulæ of *Aplysia*, as well as the other structures, may be investigated and described again for the different species *at different stages of growth.*

Shell.—The shell of our Plymouth *Aplysia punctata* is figured on Pl. XXVIII (figs. 8 and 9) for two individuals of different ages, the larger shell (represented of the natural size) being taken from the individual numbered "10" in the table of measurements. This shell is considerably larger than that figured by Vayssière for *A. punctata*, and is intermediate in character between that shell and the shell of *A. depilans*, just as Vayssière's shell is intermediate in character between those shown in my figs. 8 and 9. Canon Norman has kindly forwarded to me a shell of *A. depilans* from Palermo, which I have represented by fig. 10. It is much broader than that of the same species figured by Vayssière, and its left edge is much more curved, the margin of the anal excavation also sloping continuously forwards (in the natural position), and not forming a true "bay" like that of Vayssière's. As Dr. Norman has stated (Rev. Brit. Moll., l. c., p. 69), Mr. Hunt's large shells closely correspond with those of Mediterranean *A. depilans*. I have been favoured with three of the shells of the Torbay *A. depilans*, and the two largest agree in character with the shell sent me by Dr. Norman, the curvature of the left side being a little less convex; but the smallest of the three, measuring 1½ inches long by 1 inch wide, has its anal margin sloping away much more and is less flattened than the larger ones. It approaches the shell of *A. punctata* in this respect. Indeed, when the shell of the young *A. depilans* is described I doubt if it will be distinguishable from that of *A. punctata*, even if it is not the same.

Gill.—The gill of our specimens corresponds with Blochmann's figure of the gill of *A. punctata*, except that it is larger in our larger individuals. It is divided, of course, into a series of lamellæ, but it shows even in our largest specimens no trace of the bilobed appearance figured by Blochmann for *A. depilans*.

Mantle.—I have cut sections of the mantle of four specimens, large and small, but cannot confirm Blochmann's statements as to the presence of cilia over the upper surface.

Breeding Habits.—I have only one fact to adduce under this head as regards Plymouth specimens. An individual of a brown colour, measuring nearly 4 inches when extended, was living in the Laboratory for some time in the autumn of last year, and several times deposited eggs in the form of slender gelatinous strings of a brown-pink colour.

Lo Bianco[1] states that *A. depilans* spawns at Naples from March to August, and *A. punctata* from April to August. *A. limacina*, on the other hand, spawns all the year round, although especially in the summer.

Dr. Norman has observed *Aplysia punctata* spawning at Connemara, and some of the shells of these individuals, according to Mr. Hunt,[2] measure only $\frac{5}{8}$ inch in length.

Mr. Hunt has also called my attention to a statement by Gwyn Jeffreys, which is in itself a strong argument for the unity of the two species *punctata* and *depilans*. In a *Report on Dredging among the Channel Islands*,[3] prepared for the British Association, Mr. Jeffreys states, "It was also noteworthy that *Aplysia depilans* and *punctata* (usually considered distinct species) copulated when a pair was placed in a vessel of sea water."

Attitude.—I have often observed small *Aplysiæ* of about an inch in length, when kept in a dish or aquarium, attach themselves firmly by the posterior portion of the foot to the sides of the dish, extend their bodies out at full length, and remain in this condition motionless for hours together. As these small *Aplysiæ* have just the colour of many red seaweeds among which they are generally dredged, I am inclined to compare this habit with that of *Geometer* larvæ, which extend themselves also in a similar way, and are coloured like the twigs upon which they are attached. These little *Aplysiæ* have a very inanimate appearance in this condition, their tentacles and pleuropodia being rendered prominent (the latter being generally compressed or rolled together), and simulating the stunted branches of many

[1] *Notizie Biolog. rig. spec. il Periodo di maturità, ecc.*, Mitt. Zool. Stat. Neap., viii, 1888, pp. 415, 416.

[2] Loc. cit., 1878, p. 615.

[3] Rep. Brit. Assoc., vol. xxxv, Birmingham, 1865.

weeds. It is often extremely difficult to distinguish a small *Aplysia* when among red weeds. The colour of large *Aplysiæ* is generally that of the littoral *Fuci*, and of somewhat smaller specimens that of *Laminaria*. It is perhaps significant that an *Aplysia* migrating with growth from deep water to the shore would pass through algæ coloured first red, then brown, and finally olive-green. These are the stages of its own colour-changes.

MEASUREMENTS OF TEETH OF

ANIMAL (inches).		RADULA (millimetres).	
No.	Length × breadth × height.	Length × breadth.	Formula.
1	L. $\frac{3}{16}$ × B. $\frac{3}{32}$	1·05 × 0·60	(8·1·8) × 20. Three lateral teeth on each side rudimentary
2	$\frac{7}{16} \times \frac{3}{16} \times \frac{5}{16}$ (contracted)	2·0 × 1·5	(12·1·12) × 23. Four laterals rudimentary
3	$\frac{13}{16} \times \frac{3}{8} \times \frac{3}{8}$ (extended)	3·0 × 2·5	(12·1·12) × 25. Three laterals rudimentary
4	Mr. Hunt's No. 11, loc. cit., 1877, p. 402. Shell (wet) $\frac{3}{8}$ inch long	4·30 × 2·75	($\frac{13}{14}$·1·$\frac{13}{14}$) × 31. One lateral tooth more behind than in front. Three rudimentary laterals
5	$2 \times \frac{7}{8} \times 1\frac{3}{16}$ (contracted)	5·4 × 3·2 (the breadth ought to be a little more, owing to a crease in the mounted radula)	(16·1·16) × 33. Four lateral teeth rudimentary
6	$2\frac{5}{8} \times 1\frac{1}{8} \times \frac{3}{4}$ (extended)	5·3 × 3·4. This radula is of about same breadth behind as No. 5, but is narrower anteriorly	(15·1·15) × 35. Four laterals rudimentary
7	$1\frac{1}{4} \times \frac{1}{2} \times \frac{7}{8}$ (much contracted). From Yealm, 18th July, 1887	4·5 × 3·6. More short and broad than usual	(16·1·16) × 30
8	Mr. Hunt's No. 12, loc. cit., 1877, p. 402. Shell (wet) $\frac{7}{8}$ inch × $\frac{3}{4}$ inch	6·6 × 4·4 (mounted dry and somewhat shrunk)	13·1·13 (front). 15·1·15 (middle). 17·1·17 (behind). Three rudimentary laterals, 44 rows

Aplysia punctata AND *depilans*.

	Central teeth (millimetres).				
	Basilar portion.		Cusped ridge.		Notes.
	Breadth.	Height.	Breadth.	Height.	
	0·15	0·025	0·085	0·06	Central cusp with 5 serrations on each side. External lateral cusps well developed. Posterior bay large. (Pl. XXVIII, fig. 3.)
	0·25	0·05	0·11	0·08	Serrations as in No. 1. External lateral cusps reduced, in several teeth almost indistinguishable, being fused with the inner laterals. Posterior bay reduced. (Pl. XXVIII, fig. 4.)
	0·28	0·095	0·12	0·11	Serrations 5 or 6. External lateral cusps still more reduced. Posterior bay much filled up. (Pl. XXVIII, fig. 5.)
	0·30	0·12	0·125	0·09. Thus the median cusp does not project into the posterior bay	Serrations more variable in number than in above, from 3 to 7, but usually 4. External lateral cusps very rudimentary. Inner lateral cusps reduced and obtuse. Posterior bay nearly filled up; almost the condition of fig. 7.
	0·33	0·09 anteriorly to 0·12 or 0·13 in the middle and posteriorly	0·13 to 0·14	0·1 to 0·11	Serrations reduced in size, and only 3 or 4 distinct in most teeth. External lateral cusp lost in many teeth, very rudimentary in the others. As the numbers show, the median cusp projects into the posterior bay anteriorly, but does not reach it posteriorly. No irregular serrations on the lateral cusps.
	0·35	0·1 anteriorly to 0·2 and 0·4 in the middle of the radula and posteriorly	0·13 anteriorly to 0·15 posteriorly	0·13. Projects into the bay in front, not so behind; just as in No. 5	Serrations 3—5. Inner lateral cusps fairly well developed; occasionally bifid, or sometimes notched with small irregular serrations. External lateral cusps not so rudimentary as in No. 5. (Pl. XXVIII, fig. 6.)
	0·36	0·11 (throughout)	0·17	0·15 in front, reducing through 0·13 to 0·12, and even 0·11 behind	Central teeth closely resemble in general form those of No. 6 (Pl. XXVIII, fig. 6). Median cusp prolonged and acute in front of the radula; broader and shorter behind. Serrations well developed, usually 6. Inner lateral cusp well developed. External lateral cusp rudimentary, but distinct, and of same size as the most anterior serration of the median cusp.
	0 31	0·12 in front to 0·13 and 0·14 behind	0·13	0·11	Cusps normal, the central being a little obtuse, and having 5 or 6 serrations on each side. Posterior bay almost completely filled up; shape of basilar portion resembling that of Vayssière's fig. 58 (*A. depilans*).

Animal (inches).		Radula (millimetres).		
No.	Length × breadth × height.	Length × breadth.	Formula.	
9	$3 \times 1\frac{1}{4} \times 1\frac{5}{8}$ (contracted)	7·5 × 4·9	$(\frac{13}{16} \cdot 1 \cdot \frac{13}{16}) \times 42$	
10	$3 \times 1\frac{1}{4} \times 1\frac{5}{8}$ (much contracted, and altogether a considerably larger individual than No. 9). Shell (wet) $1\frac{1}{4}$ inches long. (Pl. XXVIII, fig. 9)	8·8 × 5·4	$(\frac{17}{16} \cdot 1 \cdot \frac{17}{16}) \times 44$	
11	Size ? Oxford specimen	Length ?, breadth 7·0	(31·1·31) × ? A fragment only. The 30 posterior rows are partially preserved, but only 20 have central teeth	
12	Mr. Hunt's No. 1 or 2, loc. cit., p. 402. Shell (wet) $1\frac{3}{4}$ inches long	9·5 (in median line) × 7·5. Short and broad. Teeth a little distorted, having been mounted dry originally	23·1·23 in front, increasing posteriorly to 32·1·32. 56 rows	

	Central teeth (millimetres).				
	Basilar portion.		Cusped ridge.		Notes.
	Breadth.	Height.	Breadth.	Height.	
	0·38 in front, increasing regularly to 0·4, then reducing regularly to 0·37	0·12 in front, increasing to 0·15 behind	0·15 or 0·16	0·14 in front, decreasing gradually to 0·12, and even 0·115 behind	As in No. 7, the median cusp is prolonged and relatively acute in front, becoming more obtuse and shorter behind. Posteriorly it becomes remarkably broad and short, the angle made by its two sides being no longer acute, but almost or quite 90°. Serrations 3, 4, or 5. They form now a continuous series with the lateral cusps, being in the same straight line. External lateral cusp extremely reduced, indistinguishable in many of the teeth. Inner lateral cusp frequently showing irregular serrations.
	0 40 in front, 0·42 in middle, 0·37 behind	0·16 in front, increasing through ·17 to 0·19 behind; a few teeth even measure 0·20	0·15, increasing posteriorly to 0·18	0·16, decreasing not quite regularly through 0·15 to 0·14 behind	The median cusp does not project into the posterior bay in any tooth, although it touches the edge anteriorly. Hardly a trace of the external lateral cusps. Serrations of median cusp fairly strong. The external edge of inner lateral cusps generally shows irregular serrations as in Nos. 6 and 9. The cusped ridge arises, as in all the above radulæ, in the anterior half of the tooth. (Pl. XXVIII, fig. 7.)
	0·28, decreasing regularly to 0·26 behind	0·15, constant	0·10	0·15 in front, decreasing to 0·14 behind	This is the first indubitable *depilans*. The radula is imperfect, but by comparing with No. 12 it probably possessed 50 rows originally. Central cusp broad, short, and blunt, trilobed, without serrations. Inner lateral cusps broad, short, with small irregular serrations as in Nos. 9 and 10. External lateral cusps entirely absent. Posterior bay quite filled up; shape very much as in the posterior teeth of Nos. 9 and 10. Anterior bay is partially obliterated, owing to additional deposit of chitin in front. Cusped ridge posterior in position.
	0·26, increasing to 0·30, then decreasing a little irregularly through 0·26 to 0·22 behind	0·12 in front, rising to 0·14 and 0·15, with variations probably due to distortion	0·11, constant	0·10 in front, rising to 0·12 and 0·13, then decreasing to 0·11 and 0·10 (the cusps are completely worn down in front; allowing for this, there is probably a decrease in height from the very front of the radula)	Posterior margin of basilar portion convex (as in Blochmann's figure of *A. limacina*) or arcuate, much as in my fig. 7. The cusped ridge arises in the posterior half of the tooth, owing largely to the additional chitin deposited anteriorly. Central cusp very rudimentary, as also the inner lateral. No trace of external lateral. Serrations, where present, in form of a variable number of small projections on each side of the median cusp, and on the diminished representative of the inner lateral (cf. Nos. 9 and 10). Anteriorly, and in the middle of the radula, the cusps form a broadly V-shaped serrated ridge; posteriorly they are merely serrations on a nearly straight line, as in Vayssière's figure of *A. depilans*.

Animal (inches).		Radula (millimetres).		
No.	Length × breadth × height.	Length × breadth.	Formula.	
13	Mr. Hunt's No. 4, loc. cit., p. 402. Shell (wet) 2¼ inches long	12·7 × 10·0	30·1·30 in middle, 34·1·34 behind. 70 rows	
14	Mr. Hunt's No. 5, loc. cit., 1878, p. 613	14·7 × 12·3	33 lateral teeth in front, increasing to 37 behind. 80 rows	

Postscript.—The word "height" in reference to the central teeth is used in these Tables to denote what is in reality their "length." The "height" of the basilar portion is its antero-posterior dimension in the middle line, *i.e.* the length of the line joining the median points of the anterior and posterior bays. The "height" of the cusped ridge is the length of the same line terminating posteriorly at the apex of the central cusp. The breadth of the basilar portion is its maximum breadth posteriorly.

Such a formula as $\frac{13}{16}\cdot1\cdot\frac{13}{16}$ was suggested to me by Mr. Weldon, to indicate the number of lateral teeth in an anterior and posterior row of the radula at the same time. This formula denotes an

	Central teeth (millimetres).				
	Basilar portion.		Cusped ridge.		Notes.
	Breadth.	Height.	Breadth.	Height.	
	0·23, increasing, with variations due to distortion, to 0·38 behind	—	0·14 to 0·15	0·09 to 0·10	It is impossible to give accurate measurements for comparison with the preceding results, owing to the radulæ having been mounted dry, and the teeth being distorted. Posterior margin occasionally convex as in No. 12 (probably due to distortion), generally arcuate. The shape of the teeth closely corresponds with Vayssière's figure of *A. depilans*. The cusped ridge consists of a median unserrated projection, short and thick, and lateral wings bearing numerous minute irregular serrations. No trace of true lateral cusps.
	0·38, fairly constant	0·12 to 0·14	0·16	0·08, varying slightly; never more than 0·10	The teeth are very low and broad; the posterior margin is generally arcuate. The most posterior teeth are very small and degenerate. In all the teeth the cusped ridge is prolonged into a line curved posteriorly on each side, which meets the posterior margin of the tooth, as shown in Blochmann's figure of *A. depilans*. The ridge is very simple, as in No. 13. No such definite cusps are to be found as are figured by Blochmann, whose specimen was probably much younger.

increase in the number of lateral teeth from 13 to 16 on each side, passing from the front to the back of the radula.

I have seen, through the kindness of Mr. H. M. Gwatkin, the radula of a Guernsey *Aplysia* 9·5 mm. long by 6 mm. broad, distinctly intermediate in its characters between Nos. 9 and 10 on the one hand, and Nos. 11 and 12 on the other. Formula (21·1·21) × 53. Teeth resemble those of 9 and 10, but the breadth decreases from 0·37 mm. in front to 0·34 behind, without the anterior crescendo. This points also towards the unity of the two "species."

C. *NOTASPIDEA.*

Family—PLEUROBRANCHIDÆ.

5. Oscanius, *Leach.*

6. Oscanius membranaceus, *Montagu.*

Examples of this species have been occasionally brought to us by fishermen from the refuse of the beam trawl, but have been obtained very rarely in the Sound. A very large specimen was caught in a drift-net in 5 or 6 fathoms water off Jennycliff on January 24th this year, and another large one was trawled in the Sound exactly a month later. A few others had been taken in previous years.

The habits of congregation and migration of this species, as of other Opisthobranchs, are worthy of notice, and I add here therefore some observations made by other naturalists on the Devon and Cornish coasts.

Clark states,[1] "These animals are frequently met with in the coralline zone in summer, and in the winter are often washed ashore on the Warren sands at Exmouth in considerable numbers."

At Falmouth, thirty years ago, Cocks[2] found the species rare at Gwyllyn Vase under stones, and not uncommon in the Helford River.

At Torbay, according to Mr. A. R. Hunt,[3] "in December, 1873, and January, 1874, *Pleurobranchus* (*Oscanius*) *membranaceus* was very abundant in the bay." On February 7th Mr. Hunt took a large specimen with a landing-net "at the back of the new pier, floating about four feet below the surface." Immediately afterwards rough weather came on, and for more than four years Mr. Hunt saw only one specimen in Torbay. "The species was swept out of the bay, and probably driven on shore."

The broad foot ("pedal disc") of this species serves for swimming as well as for creeping. When swimming freely the animal is generally upon its back, but sometimes turns over either partially or completely. It moves slowly forwards in this way, alternately flapping, with wave-like contractions from before backwards, the two halves of its broad foot. The mantle-flaps assist also in the action. This power of swimming explains the capture of one of our specimens in a drift-net, as it does also of one of Mr. Hunt's with an ordinary landing-net.

[1] Clark, loc. cit., p. 269.

[2] Cocks, *Contributions to the Fauna of Falmouth*, Trans. Cornwall Polytech. Soc., 1849.

[3] Hunt, *Notes on Torbay*, Trans. Devon. Assoc., vol. x, 1878, pp. 189, 190.

The structure of the foot of *Oscanius* and its habits of locomotion are of interest as indicating the way in which the lateral folds of the foot (epipodia) of *Aplysia*, *Lobiger*, and other Opisthobranchs have probably arisen. As Cuvier originally pointed out, these lateral folds in reality correspond to the lateral portions of the undifferentiated foot of such forms as *Scaphander*, *Oscanius*, and *Haminea*. In *Oscanius* the sides of the foot are frequently folded over the body of the animal when at rest, and this habit is still more marked in *Haminea*. Now the animals are found to live on muddy bottoms, and a broad flexible expanse of foot is obviously advantageous for gliding over such surfaces (cf. *Alderia modesta*, which also creeps upon mud). But the habits of *Aplysia* are different. *Aplysia* lives upon algæ, and for creeping over the narrow stems and fronds of seaweeds a wide plantar surface would be not only unnecessary but disadvantageous; so we find that the median portion of the originally broad foot has become specialised for creeping purposes, while the lateral portions no longer form part of the plantar surface, but arise from the vertical sides of the median portion, and retain only their power of flapping for the purpose of natation. The series of forms illustrating the evolution of the lateral folds of *Aplysia* is so complete as to leave no doubt about the truth of this view; but at the same time it becomes almost impossible[1] to regard the epipodia of Opisthobranchs and those of *Haliotis* and the lower Prosobranchs as strictly homologous. On this account Von Jhering has proposed for the folds of *Aplysia* the term "parapodia," which has been adopted by Pelseneer, and in part by Vayssière. Professor Herdman[2] still regards the homology as possible, and therefore retains the name "epipodia" for the lateral folds of Opisthobranchs; but he justly objects to the term "parapodia," as being "already appropriated by a totally different structure in another group of animals." Perhaps the term "pleuropodia" would at the same time be free from this objection, and also prevent confusion with the epipodia of the *Rhipidoglossa*.

This species is well known to secrete from its general body-surface a fluid containing sulphuric acid, which reddens blue litmus strongly. As Bateson[3] has shown that food otherwise palatable is refused by fishes generally when it "has been soaked for a few minutes in dilute acids," there can be no doubt that this secretion is a great means of protection to the species from the attacks of fishes. I have tasted this fluid, and it is strongly acid; but I have

[1] See Pelseneer, *Sur l'Epipodium des Mollusques*, Bull. Sci. Fr. Belg., 1888, p. 192, &c.

[2] Herdman and Clubb, *Third Report on the Nudibranchiata*, Trans. Liverpool Biol. Soc., iv, p. 147.

[3] Bateson, *The Sense Organs and Perceptions of Fishes*, this Journal, N. S., vol. i, p. 247.

found no trace of it in either *Scaphander, Haminea,* or *Philine aperta.* Now the two latter forms, at any rate, are largely eaten by fishes,[1] and are inconspicuously coloured; while *Oscanius membranaceus* is not eaten by fishes, and is handsomely coloured with red-brown and yellowish markings. I am not sufficiently acquainted with this animal to be able to assert anything with regard to the degree of conspicuousness of these markings amid natural surroundings; but they would appear to be conspicuous, and to assist fishes in the recognition of a distasteful animal.

6. PLEUROBRANCHUS, *Cuvier.*

7. PLEUROBRANCHUS PLUMULA, *Montagu.*

A specimen of this species was dredged in the autumn of last year, south of the Mewstone, adhering to the under side of one of the valves of a dead *Pecten.* Mr. Bourne found another specimen on the shore at Wembury Bay early in May this year, and Dr. Fowler brought back another from the same shore in September.

At Falmouth, Cocks used to find it "not uncommon" under stones at Gwyllyn Vase, Swanpool, &c.

Family—RUNCINIDÆ.

7. RUNCINA, *Forbes,* 1853

(= *Pelta,* Quatrefages, 1844; not Beck, 1838).

8. RUNCINA CORONATA, *Quatrefages.*

RUNCINA HANCOCKI, *Forbes.* In Forbes and Hanley, Brit. Moll., iii, p. 612, pl. ccc, fig. 2.

This species was first obtained at Plymouth by Mr. Heape, who secured a single specimen. It was very abundant in the middle of April this year in tide-pools below the bathing pond, not far below high-water mark. The animals were to be seen creeping over brown muddy areas and weeds, but did not frequent the green weeds. The brown colour of the molluscs, although somewhat deeper than that of the surfaces upon which they were crawling, rendered them difficult to detect for some little time, but when once detected it was easy to find many more. When fully extended large specimens measured nearly $\frac{3}{8}$ of an inch in length.

These pools contained, besides *Runcina,* large numbers of *Lima-*

[1] Verrill, *Rep. Invert. Anim. Vineyard Sound,* U.S. Fish. Rep., 1873, pp. 371, 372.

pontia crawling over the tufts of *Cladophora*. Curiously enough, when the largest pool was examined again in the following August not a specimen of *Limapontia* or *Runcina* was to be found, while I obtained several specimens of *Actæonia corrugata*.

On a subsequent visit (September 26th) I found half a dozen small ones, measuring from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch in length, in this large pool and in another. Plainly the large specimens of April were congregating for spawning purposes, and afterwards probably died. In August the young *Runcinas* were too small to notice easily, while by the end of September they had grown to the size recorded. On this latter visit I found no *Limapontia* and no *Actæonia*.

Mr. Cocks records this species as not uncommon at Gwyllyn Vase, Falmouth, on algæ in pools, half-tide and low-water mark, May, 1852.

Sub-order 2.—NUDIBRANCHIATA

(=OPISTHOBRANCHIA NON-PALLIATA, Lankester).

Section A.—ASCOGLOSSA, Bergh.

Family—ELYSIIDÆ.

8. ELYSIA, *Risso.*

9. *ELYSIA VIRIDIS, *Montagu.*

The bright green variety of this species occurs in the estuary of the Yealm and Wembury Bay.

Inside the Sound several specimens have been taken of the variety named *olivacea* by Gwyn Jeffreys. On August 14th Mr. Tate discovered one of these upon a stone dredged near the Duke Rock, and Prof. Johnson brought me one found by him among some algæ trawled on the same day in the middle of the Sound. A week later I found two more crawling over *Cladophoræ* in a large tide-pool near high-water mark below the bathing pond. In this pool they were highly inconspicuous among the tufts of algæ. Other specimens were found in this and neighbouring pools during the same month. The colour of these littoral forms was always dull, either dark olive-green or brownish ; in one specimen the colour was reddish brown.

M. Giard[1] has found in the spring of the year little *Elysiæ* hardly more than a centimetre in length, of a vivid red colour with blackish

[1] Giard, Bull. Sci. France et Belg., 1888, p. 502.

markings, the foot being of a clear yellowish red. This variety he terms *aurantiaca*.

Family—LIMAPONTIIDÆ.

9. LIMAPONTIA, *Johnston*.

10. *LIMAPONTIA CAPITATA, *Müller*.

LIMAPONTIA NIGRA, *Johnston*. See Norman, loc. cit., p 91.

Large numbers of this species were found creeping over the tufts of *Cladophoræ* in tide-pools on the north-west side of Cawsand Bay, March 26th, 1890, and on the same green weeds in pools near high-water mark south of the bathing pond in the middle of April. In these latter pools I could not discover a single individual during August and September, although I visited them on several occasions.

Early in August a number of specimens were found creeping upon *Bryopsis plumosa* at low water, south-east of Drake's Island.

It cannot be stated of this species that it is inconspicuous when creeping over the green weeds which it usually frequents ; its black colour renders it at once noticeable.

Mr. Thomas Scott[1] has recorded this species from "pools among the stones left dry at low water a little east of Newhaven Pier, August, 1887," and observes that it is not easily perceived except when crawling. I have myself found it at Lytham, on the Lancashire coast, in shallow muddy pools which receive fresh sea-water only at spring tides and are dried up during neap tides. The specimens were either creeping over the mud or over small green *Confervæ*. They were buried in the mud during the dry seasons, and appeared to survive them.

10. ACTÆONIA, *Quatrefages*.

11. ACTÆONIA CORRUGATA, *Ald. and Hanc.*

Six specimens were found creeping over *Cladophoræ* in a tide-pool south of the bathing pond on August 19th, 1890. None were to be found a month later. This species is one of Mr. Cocks's discoveries at Falmouth.

[1] *Some Additions to the Fauna of the Firth of Forth, with Notes of some Rare East Coast Forms*, Seventh Ann. Rep. Fish. Board for Scotland, 1889, pt. 3, pp. 324, 325.

Family—PHYLLOBRANCHIDÆ.

11. HERMÆA, *Lovén.*

12. HERMÆA BIFIDA, *Montagu.*

A single specimen of this very interesting species was discovered by Prof. Johnson creeping over a frond of *Delesseria hypoglossum* obtained at St. Peter's Point below St. German's River, on September 26th, 1889. In length it was $\frac{3}{16}$ inch. The head, tentacles, and body were of a pale, delicate, transparent green colour; the lateral hepatic canals and their branches to the pleuropodial cerata were of a pink colour, exactly resembling that of the alga upon which the animal was feeding. The right hepatic canal extended almost to the posterior end of the body, the left ceased more anteriorly. The cerata (homologous in a general sense with the pleuropodial folds of *Elysia*, the lateral fins of *Lobiger* and *Aplysia*, and the dorso-lateral processes of *Lomanotus* and *Tritonia*) consisted of five large ones on each side alternating with one or sometimes two small ones. I cannot speak with any emphasis, having examined only this one specimen, but if this alternating disposition of the large and small cerata exists regularly in young individuals (cf. *Hermæa cruciata*, Agassiz[1]), a comparison can be made between the pleuropodia of this genus and the pleuropodial folds of *Tritonia*, which are also arranged in a waved line down each side of the back with alternately larger and smaller processes. The cerata were coloured like the hepatic canals, but differed in being transparent.

As Mr. Poulton has already stated in his recent work, The Colours of Animals (pp. 70, 200), I found that when a shadow was caused to pass over this active little Nudibranch it at once contracted itself, drawing in its head and erecting briskly its cerata. The reaction to shadows is correlated with the unusually large eyes of this species, and is paralleled by a similar reaction, as I shall show below, in a true Æolid, *Coryphella gracilis*.

The pink colour of the hepatic canals and their intra-ceratal branches disappeared in my specimen entirely after twelve days' captivity, apparently owing to its refusing to feed any longer upon the *Delesseria* which was placed in the same dish of sea water with it. On September 29th the colour was paler than at first, and a number of opaque white spots (mucous glands?) became conspicuous upon the rhinophores. Next day the colour of the hepatic branches was very much paler, hardly noticeable, but the faint rosy colour of the larger cerata and the greenish colour of the rhinophores were still persistent. The opaque white spots had attained a great development upon the rhinophores, head, and cerata. On October 8th

[1] See Verrill, *Rep. Invert. Vineyard Sound*, 1873, pl. xxv, fig. 175.

the animal was perfectly colourless and quite transparent except for numbers of opaque white spots on the rhinophores and cerata.

13. HERMÆA DENDRITICA, *Ald. and Hanc.*

We owe again our only examples of this species to Prof. Johnson, who, while examining some *Bryopsis plumosa* from a tide-pool from the south-east side of Drake's Island, discovered two individuals creeping on the weed, August 5th, 1890.

They applied themselves usually to the stem of the weed, and crawled about actively among the tufts and branches, being excellently concealed from observation by their form and the green colour of their hepatic canals. The mucus of the foot is very adhesive, and this enables the animals to cling tightly to the weed ; it is indeed a most difficult thing to remove one forcibly from it. I repeatedly tried the experiment of passing a shadow over them, both when in the weed and when creeping openly on the bottom of a capsule, but never obtained the reaction of the cerata described above in *H. bifida*. The eyes, though conspicuous for a Nudibranch, were not so large, if I remember rightly, as in the latter species. The erection of the cerata may, however, be produced by touching the head with a blunt needle.

I tried also the experiment of adding a number of differently coloured algæ to the dish of sea water in which the *Hermææ* were living. On the first night the green weeds supplied were *Enteromorpha*, *Ulva*, and *Bryopsis*, and representing the red weeds was a tuft of *Antithamnion plumula*. Next day the *Hermææ* were on the *Enteromorpha* and *Ulva*, not on the *Antithamnion*. Some additional red weeds, *Rhodymenia laciniata* and *Spondylothamnion multifida*,[1] were then put in to afford more chance of the *Hermææ* meeting the red weeds in their peregrinations. In spite of this, on the next day, August 8th, one was crawling on the sides of the dish, the other was on the *Bryopsis*. Next day one was again on the *Bryopsis*, the other was swimming inverted at the surface of the water. Indeed, within the fortnight during which they were kept alive, they were frequently observed upon the green weeds, especially the *Bryopsis*, never on the red ones. This indicates with much probability that the green species of *Hermæa* avoids the red weeds upon which it would be conspicuous, and does not avoid the green weeds upon which it is concealed from observation.

As with *H. bifida*, the distinctive colour of these specimens faded entirely after a certain time of captivity. By August 13th the green

[1] I need hardly say that I owe the identification of many of these algæ to my friend Prof. Johnson, who has rendered me much help in this way during his visits to Plymouth.

colour had all disappeared, and the hepatic cæca were pure brown in one individual, yellowish brown in the other. This loss of the green colour was probably due to the creatures eating no more of the green weeds, for several days previously the *Bryopsis* had turned brown and died, and the *Hermæas* were not seen upon the *Enteromorpha* after August 7th.

Section B.—CLADOHEPATICA, Bergh.

Sub-section—CERATONOTA, *Lankester.*

Family—TRITONIIDÆ.

12. TRITONIA, *Cuvier.*

14. *TRITONIA HOMBERGII, *Cuvier.*

This species is common on the trawling-grounds. Early in August I found half a dozen young specimens in various stages of growth feeding upon a large colony of *Alcyonium digitatum* brought in from the fishing-grounds.

I kept these young individuals (one inch and under) for several weeks in a dish containing algæ only—no *Alcyonium*—to see the effect of starvation upon their colour. They gradually lost almost all their characteristic flesh-colour, and became very transparent.

13. CANDIELLA, *Gray.*

15. *CANDIELLA (TRITONIA) PLEBEIA, *Johnston.*

This species has not occurred so frequently this year.

Family—DENDRONOTIDÆ.

14. DENDRONOTUS, *Alder and Hancock.*

16. *DENDRONOTUS ARBORESCENS, *Müller.*

This species has not again been taken.

Family—LOMANOTIDÆ.

15. LOMANOTUS, *Verany.*

17. *LOMANOTUS GENEI, *Verany.*

LOMANOTUS GENEI, *Verany.* Cat. Anim. Invert. Mar. Golf. di Genova e Nizza, Genova, 1846.

— MARMORATUS, *A. and H.* Monograph.

— FLAVIDUS, *A. and H.* Monograph.

LOMANOTUS PORTLANDICUS, *Thompson*. Ann. Mag. Nat. Hist., 3rd ser., v, 1860, pp. 48—51.
— HANCOCKI, *Norman*. Ann. Mag. Nat. Hist., 4th ser., xx, 1877, p. 518; 6th ser., 1890, pp. 80, 81.
— GENEI, *Ver*. Bergh, Verh. Zool.-Bot. Ges. Wien, xxxii, 1882, pp. 66, 67.
— VARIANS, *Garstang*. Journ. Mar. Biol. Assoc., New Ser., I, ii, 1889, pp. 185—189.
— EISIGII, *Trinchese*. J. V. Carus, Prodr. Faun. Mediterr., II, i, 1889, p. 207.

In my previous Report three specimens of *Lomanotus* dredged in June last year were externally described, and the inference was drawn that the specimens previously obtained on the English coasts (although originally described as possessing specific differences from one another), together with our three specimens, really were members of one and the same species; and I proposed to give this species a new name, *L. varians*, though in this proposal, as Dr. Norman points out in his recent Revision, and as others have mentioned to me, I was breaking a recognised "law of nomenclature." Dr. Norman, however, admits the probability of my conclusions except as regards *L. Hancocki*, which he holds to be distinct. Bergh,[1] on the other hand, brackets together *L. flavidus*, *Portlandicus*, *Hancocki*, and *varians*, leaving *L. genei* and *marmoratus* distinct, by which, however, he may have wished to indicate rather his views upon the degree of affinity between the "species" than his agreement upon the question of their unity.

What seemed to myself to be a remarkable thing on the supposition of there being but one English species was the fact recorded in my original account (l. c., p. 187) of two individuals, whose length did not exceed half an inch, bearing "pieces of spawn." The form of the spawn was certainly unusual, but as nothing was known about the spawning of *Lomanotus* there was no valid *a priori* objection to the view that this spawn was deposited by themselves. I was unwilling at the time to dissect the specimens or otherwise alter their appearance, but I have since found that the egg-strings belonged not to the *Lomanotus*, but to a remarkable parasitic Copepod, probably a species of *Splanchnotrophus*, which was buried in the viscera of the molluscs, its egg-sacs only being protruded.

Thus the possible physiological objection to the unity of the British species, viz. that two specimens had been stated to deposit eggs at an unusually early age—when only one fifth of the extreme size—cannot be now urged; and the question remains to be settled upon morphological grounds only.

On August 21st of this year I had the good fortune to meet with

[1] Bergh, *Die cladohepatischen Nudibranchien*, Zool. Jahrbüch., Abth. f. Systematik, Bd. v, 1890, p. 50.

eight additional specimens of *Lomanotus*. They were all small in size; the majority were $\frac{3}{16}$ inch long, while the smallest was only $\frac{1}{8}$ inch and the largest was $\frac{1}{4}$ inch—just the size of Alder and Hancock's *Lomanotus flavidus*. They were fixed on the stem and branches of a colony of *Antennularia antennina* dredged in seven fathoms water between the Breakwater lighthouse and the Queen's Grounds buoy: their elongate and low form and pale orange colouration—exactly that of the Hydroid—rendered them so inconspicuous that similar specimens have probably been more than once passed over.[1]

Bergh,[2] in his recent revision of the *Cladohepatica*, remarks upon the absence of any knowledge of the bionomics of this genus; but it should be noticed that the occurrence of so many as eight young individuals upon a single hydroid colony points very strongly towards the conclusion that *Lomanotus* attaches its spawn upon or very near to the stems of zoophytes, and that the veliger-stage in the development is passed through in the egg, or that the free-swimming stage is of very short duration, for otherwise the larvæ would be dispersed over a wide area, and the chances would be greatly against the congregation of the young metamorphosed individuals upon a single hydroid stock. I have already shown that *Lomanotus* possesses a power of rapid motion through the water (l. c., p. 189), so that even if a free-swimming larval stage is absent in this genus the dispersal of the species can be readily effected by the movements of the adult.

The structure of these young specimens is shown very fairly by figs. 1 and 2 of Pl. XXVIII, representing two different individuals of the same size ($\frac{3}{16}$ inch long), one seen from the side, the other from above. The *form* in a healthy and active individual is elongate and slender, being broadest just behind the rhinophores, and tapering gradually to the posterior extremity. Fig. 2 was drawn from a very active specimen, while alive, and shows the characteristic shape. *Colour*, a pale transparent orange, exactly that of the majority of healthy colonies of *Antennularia*. In some of the specimens the colour was enriched by red-brown spots on the tubercles of the rhinophoral sheaths and on the papillæ of the lateral (pleuropodial) folds. This red-brown pigmentation was quite absent in the smallest individual ($\frac{1}{8}$ inch), but in the two largest was considerably developed, and gave the animal a more conspicuous appearance (not on the Hydroid, however, for the small oval sporosacs situated all down the stem have also a deeper colouration than the stem itself, and the

[1] I have indeed since found two other specimens in the preserved collection of *Antennularia ramosa*.

[2] Loc. cit., p. 50: "Die Lomanoten scheinen ziemlich träge Thiere zu sein, über deren biologische Verhältnisse nichts bekannt ist."

development of the pigment patches on the papillæ of the larger *Lomanoti* really served to render them inconspicuous). *Veil* absent in the smaller specimens, very small in the largest, but bearing two short tentacular processes on each side; these processes of the head appear before the veil itself, and existed in all except the smallest specimen, where the corresponding region was almost perfectly semicircular in outline, and in the specimen next it in size, in which the future oral tentacles were, however, indicated by short and broadly rounded prominences. In one individual, however, there appeared to be only a single velar process on each side, corresponding in position to the inner of the two normally present. *Rhinophores* clavate, laminated; the laminæ six to ten in number, not so closely set as in Alder and Hancock's *marmoratus*, and ceasing a little below the tip of the tentacle, which is smooth, conical, and not so sharply truncate as in the latter "species." Rhinophores in the larger specimens retractile within calyx-like sheaths, whose edges were produced into four, five, or six somewhat irregular processes, of either simple, papilla-like, digitate, or compressed triangular form; of these the postero-external papilla was in all cases the largest (see Pl. XXVIII, figs. 1 and 2, and cf. the descriptions of *L. flavidus* and *Portlandicus*). During life the rhinophores were constantly being retracted and protruded from the calyx-like sheaths, but some individuals kept their rhinophores retracted for hours at a time, while others were never seen to protrude them at all. In these latter cases the only part of the rhinophore visible was the smooth conical apex.

On account of the similarity in appearance between this condition of the rhinophores and that which Dr. Norman described as being the most striking feature of his *L. Hancocki* (l. c., 1877, p. 518; 1890, p. 81), I wrote to him to ask if the rhinophores of his specimen had been actually dissected out. With his usual courtesy he has informed me that he did not extract the rhinophores for examination, so that I cannot but be convinced that the appearance which these structures presented in his specimen of *Lomanotus* was due not in reality to the absence of laminæ upon them, but to a temporary state of retraction within the sheaths.

Pleuropodium (= "pallial margin," "branchial curtain," "*margo dorsalis*," "*membrana papilligera*," "epipodial ridge") on each side in the form of an undulating ridge extending from the sheath of the rhinophore (at the part produced into the large postero-external rhinophoral papilla) very nearly to the posterior termination of the foot, where it approaches the corresponding structure of the other side. The ridge is produced into irregular, flat, triangular papillæ, of which four are larger than the rest, and mark the centres of the inward undulations. The ridge in reality consists, as was pointed

out in my former paper, of a series of four arcuate lobes having their concavities external (cf. *Hancockia*), and this statement is borne out by the development. In the smallest specimen ($\frac{1}{8}$ inch long) the pleuropodium is represented only by a series of three small, broadly triangular processes on each side, the smallest posterior, recalling the condition of this fold in *Scyllæa*, *Glaucus*, and *Lobiger*;[1] the connecting ridge appears later, as in the case of the veil. In slightly larger individuals ($\frac{3}{16}$ inch) an additional smaller process has appeared on each side of the first three (see Pl. XXVIII, fig. 1), and another triangular papilla has arisen posteriorly. The posterior papillæ are more separated, since the continuous ridge is formed first in front. The papillæ of the pleuropodia and rhinophoral sheaths of the two largest specimens were pigmented exactly as in Alder and Hancock's *L. flavidus*; and on account of their flexibility and contractility there is not in my own mind the least doubt as to the specific identity of these specimens and the so-called "*flavidus*," which was also obtained upon *Antennularia*. *Foot* normal in the larger specimens, although the transverse groove was not observed; in the two smallest individuals the anterior angles of the foot were not produced into recurved processes, but simply rounded.

It remains to add that the *eye-spot* is round and black, and situated under the transparent integument beneath the large postero-lateral tubercle of the rhinophoral sheath on the outside (Pl. XXVIII, fig. 1); and that in the smallest individual the *sheath of the rhinophore* consisted merely of a thickening of the skin around its base, whose only tubercle was this postero-lateral one. This tubercle was in direct continuity with the primary papillæ of the pleuropodial series—another detail in the resemblance of the young *Lomanotus* to *Scyllæa*.[2] This continuity persists throughout life, and can be seen in fig. 1 of my plate (cf. also Bergh, l. c. supra, 1882, p. 67).

Alder and Hancock's otherwise beautiful figures of *L. marmoratus* are seriously wrong in representing a continuity between the pleuropodium and the oral veil. There is a figure of a preserved *L. genei* in Mrs. Gray's Figures of Molluscous Animals, 1874 (*Gastropoda*, pl. ccxxi, fig. 2), which, though not so artistic, is much more correct in this respect. The continuity between the rhinophoral sheath and pleuropodium exists also in *Tritonia* and *Dendronotus*;[3] it is

[1] The pleuropodial fins of *Lobiger* are, according to M. Vayssière, folded over the back of the animal when at rest, as in *Aplysia*, *Haminea*, &c. It is of interest to notice that this habit is still persistent in *Lomanotus* (see Thompson, l. c., p. 50; and previous Report, l. c., p. 187).

[2] Cf. Alder and Hancock on *Scyllæa* (Monograph): "The orifice [of the rhinophoral sheath] inclines forwards, and there is a thin, arched, crest-like appendage behind it."

[3] Cf. Bergh (l. c., p. 5), *Bei den Dendronotiden, Bornelliden, und Scyllæiden verschmelzen die vordersten Papillen mit dem Stiele der Rhinophorien.*

especially well seen in *Candiella plebeia;* while in the Holohepatica a series of forms (*Idalia Leachii, I. elegans,* and *I. aspersa*) illustrates conclusively the transformation of the anterior portion of the pleuropodium on the one hand into rhinophoral filaments (*Ancula cristata*), and on the other into an almost complete rhinophoral sheath (*Thecacera pennigera*). A survey of the group, indeed, leads to the generalisation that wherever the pleuropodia extend into the head region, their anterior extensions either unite in front of the rhinophores (*Idalia, Triopa, Ægirus, Polycera, Goniodoris, Archidoris, Proctonotidæ,* &c.), or enter into special relations with them (*Ancula, Thecacera, Scyllæa, Lomanotus, Dendronotus,* &c.) ; and since rhinophoral sheaths do not occur in the forms with a closed pleuropodium (except in cases like *Lamellidoris sparsa* and *Ægirus punctilucens,* where the tuberculate character of the whole body surface is also shown in the raised margins of the rhinophoral fossæ), it appears probable that rhinophoral sheaths in all cases contain a pleuropodial element.

The *veil* of *Lomanotus* must not be confused with the apparently similar structure existing in (*e. g.*) *Polycera quadrilineata,* which is of pleuropodial nature. It is a true "oral veil," strictly homologous on the one hand with that of *Lamellidoris, Acanthodoris,* and *Ægirus,* with the paired "oral tentacles" of *Archidoris, Goniodoris, Triopa,* and *Ancula* (the rudiments of which also exist in *Polycera* and *Idalia*), and on the other hand with the oral veil of *Embletonia* and the paired "oral tentacles" of the *Proctonotidæ* and *Æolididæ.* It is of course homologous with the veil of *Tritonia, Dendronotus,* and *Doto;* but although the veil in these genera has not the form of the pair of elongate tentacles of the majority of Æolids, it is so plainly the same morphological structure that Bergh's[1] distinction between the two should not be too finely drawn, especially as his term "margo frontalis" (*Stirnrand*) could be applied with equal correctness to the pleuropodial veil of *Polycera,* with which the former structure has nothing to do. The same objection can be urged against the use of Fischer's[2] term "voile frontal."

The *anal papilla* is situated on the right side of the body, under the second primary pleuropodial papilla; it is not easily seen in the living animal, but is readily perceived in one which is well preserved as a slight projection.

The *heart* could be seen through the integument of these individuals as an oval structure situated at the level of the interspace between the first and second pleuropodial lobes; in one individual it was observed to beat sixty-five times in the minute.

[1] L. c., pp. 4, 49, &c.

[2] Manuel de Conchyliologie, pp. 526, 535, &c.

The largest individual was observed on one occasion, after irritation, to contract itself vigorously from side to side; but it did not actually progress in this way.

These new specimens of *Lomanotus* throw considerable light upon the question of the number of species. There can be no doubt that they are members, with *L. flavidus*, *L. Eisigii*, *L. Portlandicus*, and *L. Hancocki*, of one and the same species; and the largest of the three specimens described in the previous Report so plainly connects *L. Eisigii* with *L. marmoratus*, and this latter through our two other specimens is brought so near to *L. genei*, that I have very little hesitation in referring all the known forms to the species *L. genei* possessing the characters of the genus.

These specimens will form the material for some notes upon the anatomy of the genus at no distant date.

Family—DOTONIDÆ.

16. Doto, *Oken*.

18. *Doto fragilis, *Forbes*.

This species has been frequently taken as before.

19. Doto pinnatifida, *Montagu*.

I am glad to be able to add this rare species to the fauna. Two specimens, $\frac{3}{8}$ inch long, were dredged by Dr. Benham adhering to *Antennularia antennina* on the Queen's Grounds, opposite Picklecombe Fort, in August. One had eight, the other nine pairs of cerata. I carefully examined these specimens, and the colour and structure were in every respect as described by Alder and Hancock. On the stem of the Hydroid was some *Doto* spawn, no doubt deposited by one of these individuals. It was of a pale rose-pink colour, and arranged on the stem in a regularly zigzag line, as is often the case with the spawn of *D. coronata*.

20. *Doto coronata, *Gmelin*.

Prof. Herdman[1] finds this species at Hilbre Island "invariably creeping on the under surfaces of ledges and stones on which are large colonies of the zoophyte *Clava multicornis*;" and in these conditions the molluscs are efficiently concealed, on account of the re-

[1] Herdman, *On the Structure and Function of the Dorsal Papillæ in Nudibranchiata*, Report Brit. Assoc., 1889, Sect. D, and Quart. Journ. Micr. Sci., xxxi, p. 56.

semblance of their cerata in brightness and similarity of colour and external form to the upper ends of the zooids of *Clava*.

It is an interesting fact that at Plymouth this species has never been found upon gymnoblastic Hydroids, but always upon Calyptoblasts, chiefly *Plumularia*, *Antennularia*, and *Sertularia*[1] (especially *S. pumila*). *Clava cornuta* and *multicornis* are to be found covering the under sides of stones and the bottoms of certain rock-pools on the shore, but I have searched these colonies in vain for a single specimen. Correlated with this dissimilarity of habit, Plymouth specimens very rarely show much of the bright rose-colour generally found in the species elsewhere. One such individual, however, was found creeping over a brightly coloured scallop-shell (*Pecten maximus*) upon which colonies of *Halecium* were growing. The *Halecium* had large quantities of the spawn of *D. coronata* attached round the bases of its stems, some of which no doubt had been deposited by this individual. If so, the *Doto* either was wise in keeping near the brightly coloured shell to deposit its eggs, or had been creeping over the Hydroid, in spite of its conspicuous coloration, with impunity.

Family—ÆOLIDIDÆ.

Sub-family 1.—ÆOLIDINÆ (= ÆOLIDIADÆ PROPRIÆ, *Bergh*).

17. ÆOLIS, *Cuvier* (*sens. strict.*).

21. *ÆOLIS PAPILLOSA, *Linn.*

Three specimens only have been taken this year, under stones at low water; one in April at Drake's Island, another in May immediately below the Laboratory, and the third was found by Dr. Fowler on July 16th at the east end of Drake's Island. Mr. Vallentin found it abundant in the spring in Falmouth Harbour, on the under side of rocks at low water.

In my former Report[2] I had occasion to refer to the resemblance of this species in colour and form to the Actinian *Sagartia troglodytes*, noticed and recorded by M. Giard, who also observed that the two creatures were frequently to be found in the same situations. As this is one of the most important of the "tests of mimicry" given by Wallace, I was inclined to regard *Æolis papillosa* as an instance

[1] Cf. McIntosh, Mar. Inv. and Fishes, St. Andrews, 1875, p. 86. Mr. Vallentin finds the species common at Falmouth on *Obelia geniculata*. I have found it on this Hydroid occasionally at Plymouth.

[2] L. c., pp. 175, 191. *Sagartia parasitica* on the former page was obviously an error, and I take this opportunity of correcting it.

of a species of Æolid evolved by the selection of the most *troglodytes*-like individuals of each generation. Since, however, it is only at Wimereux that the relations noticed by Giard to exist between the two animals are known even to approach constancy, and as similarly coloured specimens occur abundantly elsewhere, this view can be entertained at present only doubtfully. But as local colour-varieties of this species are not rare, the question could be settled almost conclusively if naturalists on the different coasts would notice whether the local race has or has not the special relations of mimicry to some locally abundant Actinian upon which it feeds or near which it lives. The colours of the local races ought to vary with the colours of such locally abundant species of Actinian. It they should be found to do so, then a strong case for true mimicry could be made out; if not, then selection of the individuals most resembling the locally abundant Actinian cannot have taken place, and the species, like its varieties, must find its causal explanation elsewhere.

18. Æolidiella, *Bergh.*

22. Æolidiella Alderi, *Cocks.*

This rare species, discovered at Falmouth in 1848 by Mr. W. P. Cocks, and not recorded from any other part of the English coast (Mr. Cocks himself never saw it after 1849), was found in large numbers by Mr. Bourne and Dr. Fowler on the shores of the Yealm estuary between Fox Cove and Thorn Cove late in October, 1889, at low water; and has been taken on subsequent occasions, though in less abundance, from the same locality. The ground here is fairly firm, consisting chiefly of small stones with an admixture of coarse, slightly muddy sand, while old oyster-shells are scattered about, Most of the specimens have been found under these shells or under stones. A yellowish-white species of Actinian, *Sagartia* (sp. incert.). is very common here also, being found attached to the pebbles or even free, but generally in either case half buried in the sand, and shrinking into it at the slightest touch. It is very probable that this anemone constitutes a chief source of the Æolid's food. Curiously enough, the Æolid and the Actinian are very like each other in colour and form, and it was easy when collecting the former to mistake at times half-buried specimens of the *Sagartia* for the Nudibranch. This case may be, like that of *Æolis papillosa* and *Sagartia troglodytes*, one of true mimicry, and I am collecting facts bearing upon the matter.

Early in February this year, upon another visit to this locality, I could find only a few specimens of the Æolid, but whether the

reduction in numbers was due to migration into deeper water or to death (the weather just previously to my visit had been extremely cold) it was impossible to determine. One of the specimens secured on this occasion had probably been attacked a day or two previously by some fish, for its cerata were all extraordinarily small. They had plainly been knocked or bitten off,[1] and were in course of recrescence, for next day they were larger in size. These observations support the views proposed in my former Report (l. c., pp. 175 and 191) as to the significance of the structure, colouration, erectile power, and fragility of the dorsal cerata in Æolids. If the head of this species be touched with a blunt needle, it is at once withdrawn (almost telescoped into the body), and the cerata rise up from their recumbent position and become very prominent, like the quills of a porcupine. This reaction is instantaneous if the stimulus be strong enough.

The size of fifteen specimens taken on October 24th, 1889, varied from $\frac{1}{4}$ inch to a little over 1 inch in length, only two specimens being under $\frac{1}{2}$ inch. The smallest specimen, $\frac{1}{4}$ inch long, had seven or eight rows of papillæ, while the anterior angles of its foot were rounded, not produced into recurved processes. In a specimen $\frac{7}{8}$ inch long the number of rows of cerata was fifteen or sixteen. The white "ruff" round the neck, as Mr. Cocks stated, is a good and permanent specific character. It appears to be caused by the cerata of the first two rows having each a very short hepatic diverticulum, instead of one reaching to the tip of the papilla.

The colour of the dorsal papillæ varies from a pale greenish fawn-colour to a dark brown. The tips are yellowish, sometimes almost white. The basal portions of the cerata of the ruff are always coloured like those behind, the colour being in all cases due to the hepatic cæca.

23. Æolidiella glauca, *Ald. and Hanc.*

I found a single specimen of this species, nearly an inch in length, under a stone at low water on the shore beneath Lord Mount Edgcumbe's winter villa on October 11th, 1890. The animal was white in colour, the hepatic cæca being of a fawn-colour, deeper below than above. Much opaque white was scattered on the back of the head and body, on the oral tentacles, and on the cerata. The curious vermicular character of the cerata, the suddenly attenuated extremity of the broad foot, and other points, readily dis-

[1] The same was the case with a number of the posterior cerata in one of the individuals taken on October 24th.

tinguish this species from its allies. In general appearance this specimen much resembled an *Æ. Alderi*.

Sub-family 2.—CRATENINÆ.

19. CRATENA, *Bergh*.

24. CRATENA VIRIDIS, *Forbes*.

MONTAGUA VIRIDIS, *Forbes*. Ann. Nat. Hist., v, 1840, p. 106.
EOLIS VIRIDIS, *Forbes*. Alder and Hancock, Monograph, Fam. 3, pl. xxxii.
— GLOTTENSIS, *Alder and Hancock*. Monograph, Fam. 3, pl. xxix.
— ARENICOLA, *Forbes, MS.* Alder and Hancock, Monograph, Fam. 3, pl. xxxi.
— NORTHUMBRICA, *Alder and Hancock*. Monograph, Fam. 3, pl. xxxi.

Four individuals of this species have been taken. One small one was dredged on September 24th, 1889, in about ten fathoms water, a quarter of a mile south-south-east of the Mewstone, on weedless ground. It was found by Mr. Bourne creeping on a mass of *Lepralia foliacea*. It possessed nine transverse rows of cerata, the first half-row consisting of two very small cerata, the second half-row of three, the third and its successors of four, while the eighth and ninth half-rows consisted of three and of two cerata respectively. The four anterior rows were set closely to one another, and were separated by an interval from the posterior rows, which were placed behind each other at regular distances. The hepatic cæca were very dark green in colour, and all the tissues were permeated with a green tinge.

The second specimen, of the same size and colour, was dredged on similar weedless ground in October.

The third was considerably larger, and was found among Polyzoa and Hydroids by William Roach inside the Sound during the first week of November.

The fourth was a very young individual, dredged near the Duke Rock on a stone covered with *Eudendrium capillare*, February 18th, 1890. The colour—a greenish yellow—was confined to the hepatic cæca. The cerata were as contractile and muscular as the tentacles.

The three "species," *glottensis, arenicola*, and *northumbrica*, described in Alder and Hancock's Monograph, appear to be merely slight varieties or different stages of *Cratena viridis*. Only a single example of each type has been recorded. Our first specimen was undoubtedly of the same species as the type of *glottensis*, but differed from it in not having the tips of the cerata orange-coloured, nor were the rhinophores thickened at the tip. *Eolis arenicola* may be distinct, but Forbes's specimen was probably an exceptionally large

Cratena viridis. In contrasting *Eolis northumbrica* with *Eolis viridis,* Alder and Hancock entirely overlooked the fact that in Forbes's original specimen of the latter species the rhinophores were described as being "rugose, or wrinkled concentrically." It is a very common occurrence for an Æolid possessing "smooth" rhinophores to contract them so as to give them the appearance of being "ringed" or annulate in structure; and I cannot help regarding the appearance described in *Eolis northumbrica* as being probably a transient, and not a specific difference.

Cratena viridis has been found in greatest abundance at St. Andrews by Prof. McIntosh,[1] who notices how readily this species loses its characteristic coloration in captivity. I can confirm Prof. McIntosh's statement by my observations on our Plymouth specimens.

25. *Cratena olivacea, *A. and H.* (= *Cavolina olivacea* of 1st Rep., p. 183).

This species has not again been obtained.

Sub-family 3.—Tergipedinæ.

20. Tergipes, *Cuvier.*

26. *Tergipes despectus, *Johnston.*

This species has not been noticed since my former Report.

21. Galvina, *Ald. and Hanc.*

27. Galvina exigua, *A. and H.*

This species has been taken on two occasions. One specimen was found among *Halecium* and *Eudendrium* on stones dredged near the Duke Rock, March 27th, 1890. It possessed five rows of cerata, the first half-row consisting of three cerata, the middle half-rows of two, and the posterior of one. The dorsal tentacles were twice as long as the oral. The cerata and tentacles were banded transversely with belts of olive-green, and there were reticular patches of the same pigment upon the dorsal integument.

Another specimen, quite colourless, was taken on *Halecium* dredged near the same spot on April 9th. It was some time before this individual was noticed, owing to the perfect resemblance of its cerata in form and colour to the white elongate gonophores of the Hydroid.

[1] Loc. cit., p. 5.

28. *Galvina tricolor, *Forbes* (= *Cavolina Farrani* of 1st Rep., p. 193).

Eolis tricolor, *Forbes*. Ald. and Hanc., Monograph, Fam. 3, pl. xxxiv.
— Farrani, *Alder and Hancock*. Monograph, Fam. 3, pl. xxxv.
— Adelaidæ, *Thompson*. Ann. and Mag. Nat. Hist. (3), vol. v, 1860, p. 49.
— — *McIntosh*. Mar. Inv. and Fish, St. Andrews, p. 86, pl. ii, fig. 11.
— Andreapolis, *idem*. Proc. Roy. Soc. Edin., 1864–5.
— Robertianæ, *idem*. Do. do.
— Farrani, *idem*. The Marine Invertebrates and Fishes of St. Andrews, 1875, pl. ii, figs. 12, 13.
— tricolor, *Forbes*. Friele og Hansen. *Bidr. til Kundsk. om de Norske Nudibranchier*, Vidensk. Selsk. Forhandl., 1875.

I have followed Friele and Hansen in uniting *G. Farrani* with *G. tricolor*.

Three individuals were found feeding upon *Obelia geniculata*, growing on *Laminaria*, on September 30th, 1889, measuring from $\frac{3}{8}$ to $\frac{1}{2}$ inch in length. One was quite white in colour, except for a faint tinge of fawn-colour in the cerata (due to the hepatic cæca), another was entirely orange-coloured, and in the third specimen the body was white, with deep orange-yellow patches on the back and on the front and sides of the head; the larger cerata near the median line were orange-coloured with a few markings of purplish umber, and the rest were of a much paler yellowish colour. All the cerata had white tips, bounded below by a narrow purplish ring, merging below into a ring of orange.

On October 2nd two more specimens were obtained under similar conditions, one being $\frac{5}{16}$, the other $\frac{7}{16}$ inch long. The former was exactly like the first specimen here described, while the latter was white, with orange-tipped cerata and tentacles, the orange pigment being also traceable on the back as well as over the surface of the cerata.

Three days later four more individuals were found upon *Laminaria saccharina* dredged in the Cattewater, the weed having no *Obelia* growing upon it, but quantities of slender branching algæ and of a calcareous Polyzoan. They were from $\frac{5}{16}$ to $\frac{3}{8}$ inch long. In one individual the back was of a semi-transparent white, with patches of deep orange-red and a certain amount of reticulating purplish pigment. There was a broad patch of deep purple on the front of the head, while in front and at the sides of the rhinophores there were patches of deep orange-red. The oral tentacles and tip of the "tail" were orange-coloured. The cerata were of a violet colour, faint below, with conspicuous orange tips. Two other individuals were white with fawn-coloured cerata, spotted profusely with microscopic opaque white spots, and having white tips. One had

seven rows, the other eight, of cerata. In the latter specimen there was one reticulating violet spot on the anterior part of the back, and another more compact orange spot about the middle. The fourth individual was white, with orange-tipped cerata. The oral tentacles were entirely orange-coloured. The distal halves of the rhinophores were orange-coloured, the proximal white. The back showed a number of orange-coloured spots and faint traces of violet.

When an individual of this species is in motion the oral tentacles are kept in a nearly horizontal plane, constantly touching the surface upon which the animal is creeping; on the other hand, the rhinophores are kept erect, extending outwards and somewhat forwards, in this way testing obstacles in the water, which are out of the range of the oral tentacles. If the tentacles or dorsal integument be touched, the animal at once contracts and erects its cerata: this reaction cannot usually be produced by touching the cerata themselves, which possess little power of sensation. There is a slight break in the regular sequence of the rows of cerata after the fourth (or sometimes the third) row; here the heart may be seen beating.

The curious fact that all the specimens of this Æolid obtained by us in 1888 and 1889 were found during a limited period in late autumn, from the end of September to the commencement of November, coupled with the fact that the individuals taken at the beginning of this period were slightly smaller in size than those found in November, led me to make particular search for the species during the spring of this year. I examined repeatedly blades of *Laminaria* for this purpose, but found not a single specimen, but a bottom tow-net devised by Mr. Cunningham and worked in Cawsand Bay during May and June brought up, among the filamentous algæ so abundant there, a number of Æolids which I cannot but regard as the more advanced stages in the growth of this species. I was unable to devote much attention to them, but give here some notes drawn up after an examination of two individuals.

Rhinophores long; almost, if not quite, equalled in length by the oral tentacles. *Cerata* in about nine or more rows, four cerata in each lateral half of a transverse row, perhaps five in some, the external cerata being much smaller than the internal; inflated, semi-transparent, with tips orange-coloured in one specimen, whitish in the other. *Hepatic cæca* slender, sacculated, running up to the tips of the cerata; over the cerata a faint sage-green pigment spread. *Body* very slender when thoroughly entended, approaching $\frac{3}{4}$ inch in length. The back covered with large conspicuous orange-red or almost crimson spots, each spot surrounded by an area of sage-green pigment consisting of a mass of microscopic sage-green dots. These also give rise to the faint sage-green pigment of the cerata.

There were no orange spots on the cerata. The rhinophores had a band of reddish pigment in the same region as the band of brown in *G. picta*.

In motion the oral tentacles were kept horizontal upon the bottom, and were then generally flattened out at the tips (cf. McIntosh on *Eolis Andreapolis*, l. c.). When the light was suddenly cut off from these individuals the action was followed by a slight erection of the tentacles, and by short restless movements of the head and anterior cerata—the animals having previously been quite still. But the cerata were not erected by this stimulus, although they were by touching the head as above described. The eyes were distinct, but not unusually large.

These two individuals were taken on May 14th. Two days later they had laid two ribbon-like pieces of spawn, which were not attached to the sides of the dish, but floating on the surface of the water.

On June 25th a smaller individual was obtained from the same place, orange-coloured all over, but possessing patches of a deeper reddish-orange and brownish colour on the back. The tips of the cerata were also more intensely orange-coloured.

On October 16th two very small specimens (2 mm. long) were found among *Obelia* on *Laminaria* trawled at Batten.

29. *Galvina cingulata, *Ald. and Hanc.*

Another individual of this species was found on August 21st among *Cladophora* from either Drake's Island or below the bathing pond. It measured $\frac{5}{16}$ inch in length. The lateral lines of olive-brown between the cerata were well marked, as also the patch of the same pigment behind the rhinophores. The cerata were arranged abnormally. Usually the rows of cerata on one side of the body are in the same transverse lines as those of the other side; but in this individual only the first and second rows were so arranged; the five succeeding pairs of lateral rows were arranged alternately, not in the same transverse lines. The heart was situated in the centre of the second transverse row of cerata.

Sub-family 4.—Coryphellinæ.

22. Coryphella, *Gray.*

30. *Coryphella rufibranchialis, *Johnston.*

No additional examples of this species have been taken during the past year, unless further observations should confirm Trinchese's view that the two following "species" are merely varieties of *C. rufibranchialis*. Herdman[1] and Clubb, however, have had good

[1] *Third Report on Nudibranchiata*, l. c., pp. 140—143.

opportunities of investigating this question, and are convinced of the distinctness of the species *rufibranchialis* and *Landsburgii*.

31. Coryphella gracilis, *Ald. and Hanc.*

Two individuals, agreeing with Alder and Hancock's description of this species, have been taken this year. One small specimen was dredged on May 13th in the Sound between the Duke Rock and Jennycliff, and another individual was obtained with the bottom tow-net in Cawsand Bay, July 7th. This latter specimen was kept alive for several weeks, and some time after its capture it was noticed that the hepatic cæca were of a ginger-yellow colour, like the original example of Alder and Hancock. I believe, however, that the colour was more reddish at the time of capture, and that it faded under the conditions of its captivity.

I was very much surprised to find that this individual responded to shadows as stimuli for the erection of its cerata, unlike any other nematocyst-bearing Æolid with which I have experimented. The reaction was like that exhibited in *Hermæa bifida* (*supra*), although not quite so rapid and complete. The eyes are conspicuous in this species, and relatively larger than in other Æolids which do not respond to this stimulus.

The opaque white spots at the tips of the cerata were not very regularly distributed: they were mostly in the form of semicircular patches on their anterior faces, as in *Facelina coronata* and *Drummondii*.

32. *Coryphella Landsburgii, *Ald. and Hanc.*

Another individual of this species, half an inch in length and of an extremely slender and attenuated form, was trawled on the 25th September this year by Mr. Cunningham among Hydroids (*Obelia geniculata* on *Laminaria*, *Sertularella Gayi*, and a little *Antennularia*) near the Duke Rock. In colour and markings it was quite normal and very transparent.

Sub-family 5.—Favorininæ.

23. Favorinus, *Gray.*

33. Favorinus albus, *Ald. and Hanc.*

Two individuals were found together on the under surface of a large flat stone at the east end of Drake's Island, low water, spring tide, November 22nd, 1889. On the same stone was the spawn of some Nudibranch (probably *Polycera quadrilineata*), in five or six circular ribbon-like patches; upon this spawn in captivity the

Æolids fed (cf. Alder and Hancock, Monograph). One of the individuals, more closely examined, was found to be $\frac{3}{8}$ inch long, and was entirely of an opaque white colour except for the rhinophores, which were deeply pigmented brown over the lower two-thirds of their length. The distal portion was pointed at the tip, and opaque white in colour. The infra-apical bulb never assumed the form of the "button-like expansion" figured by Alder and Hancock; indeed, there was no trace of it at times. Just below the bulb, at the junction of the white and brown portions, the left rhinophore was curiously and abruptly bent forwards, and this condition was persistent. The rhinophores over their pigmented portion were finely perfoliate, the laminæ apparently resembling those of *Facelina punctata*.

The cerata react to stimuli upon the head, as in *Galvina tricolor*; there is no reaction upon touching the back or the cerata themselves, or to shadows.

Opaque white spots were distributed upon the back, as described in the Monograph; they existed also at the tips, and occasionally over the whole external integument of the cerata.

This individual spawned on a stone a week after its capture, the spawn being exactly as described by Alder and Hancock.

Another small specimen, $\frac{1}{4}$ inch in length, was taken with the bottom tow-net in Cawsand Bay on the 7th of July. The infra-apical bulb of the rhinophores was quite absent.

Sub-family 6.—Facelininæ.

24. Facelina, *Ald. and Hanc.*

34. *Facelina coronata, *Forbes.*

Two more specimens have been dredged near the Duke Rock; one on September 23rd, 1889, the other in July, 1890. Another fine specimen, $1\frac{1}{8}$ inches in length, was found among *Obelia geniculata* on *Laminaria* dredged near the end of Batten breakwater (west of the Cobbler Buoy) on October 2nd, 1889: on the same piece of weed were two *Galvina tricolor*. The hepatic cæca were fawn-coloured, red at their extremities. Down the front of each of the cerata was a streak of opalescent blue; this characteristic coloration also existing, though more faintly, on the head, oral tentacles, and in patches on the back of the body. There was a more or less regular semilunar patch of opaque white on the anterior face of each of the cerata near the tip, and this was generally continued as a streak of white down the anterior face for a short distance.

On October 8th, 1890, a small specimen, not quite $\frac{5}{16}$ inch in length, was found again among *Obelia* on *Laminaria* dredged in the Cattewater. The *foot* of this individual was broad and thin as in *F. Drummondii*,

not elongate and narrow as usually in *F. coronata;* its anterior angles were produced into long processes. The *oral tentacles* were very long and slender, rather over $\frac{1}{8}$ inch in length (cf. A. and H. on this character in young specimens of *F. Drummondii*). *Rhinophores* perfoliate, with numerous laminæ alternately larger and smaller, resembling those described and figured by Alder and Hancock for *F. Drummondii* much more than for *F. coronata* (where they are less numerous). When contracted the rhinophores appeared to be annulate, not perfoliate. *Cerata* very numerous, clustered, the first cluster being very large; very contractile and changeable in shape, capable of much elongation. *Colour* of body transparent white, with patches of opalescent blue spots on the head, back, along the oral tentacles, and on the anterior faces of a few of the larger cerata. *Hepatic cæca* granular, yellowish brown; no pink or red at all in this specimen. Crescentic patches of opaque white on the anterior faces of the tips of the cerata.

In all points of external form and in the colour of the hepatic cæca this specimen agrees much more with the descriptions of *F. Drummondii* than with those of *F. coronata,* but on account of its possessing the opalescent blue markings, characteristic of the latter species, and not known to occur in the former, I have referred it with some hesitation to the species *coronata.* The specimen described in my former Report under the provisional name of *Eolis Huxleyi* (l. c., pp. 194, 195) I am inclined now to regard as a young *Facelina coronata,* in which some of the cerata had been broken off anteriorly. In very many points it agrees perfectly with the young individual just described.

The long oral tentacles of *F. coronata* are naturally employed very differently from the short tentacles of *Galvina tricolor;* they are not kept motionless and flat in locomotion, but are swayed about, feeling the surface and the surrounding medium on all sides. It may be noticed in Æolids that the oral tentacles are as a rule particularly long where the dorsal tentacles are laminated or otherwise distinctively specialised for olfactory purposes. This increased development of the oral tentacles probably saves the rhinophores from many liabilities to danger. That this view of the correlation is not merely fanciful is borne out by the condition of the same parts in the *Holohepatica,* where the rhinophores are protected either by being retractile into sheaths (*Doridid*æ *cryptobranchiat*æ), provided with special tactile appendages (*Ancula cristata, Idalia*), correlated with special development for tactile purposes of the oral tentacles (*Goniodoris*) or anterior extensions of the pleuropodia (*Triopa claviger, Polycera*), or by having the laminated portion bent backwards (*Acanthodoris pilosa, Polycera*). When a *Facelina coronata* also is at rest

the rhinophores are frequently thrown back on the dorsum between the lateral halves of the first cluster of cerata.

35. *Facelina punctata, *Ald. and Hanc.* (= *Flabellina punctata*, 1st Rep., p. 192).

This species has not again been taken.

Sub-family 7.—Antiopinæ.

25. Antiopa, *Ald and Hanc.*, 1848 (=*Janus*, Verany, 1844 ; not Stephens, 1835).

36. *Antiopa cristata, *Della Chiaje.*

Two more specimens have been taken : one, an inch in length, was trawled in the Sound between the Mallard Buoy and the Merchants' Anchorage on July 26th by Prof. Johnson, who found it among red branching weeds and *Laminaria ;* the other, also a large specimen, was discovered by Mr. Minchin in a tide-pool near the bathing pond late in August. It was creeping near the surface of the water over the *Cladophoræ* and other weeds of the pool, the delicate blue tips of its cerata being very conspicuous.

It is said by M. Giard[1] to be, at Wimereux, like *Thecacera pennigera*, particularly an autumn species feeding upon *Bugula*. Curiously enough, my friend Mr. Vallentin dredged an individual of each of these species at the same haul in Falmouth Harbour in the spring of this year, along with numerous oyster-valves covered with *Bugula flabellata*.

Section C.—HOLOHEPATICA, Bergh.

Sub-section—Anthobranchiata,[2] *Goldfuss*, 1820 (= Pygobranchia, *Gray*, 1821).

Family—DORIDIDÆ.

Sub-family—Doridid æ cryptobranchiatæ, *Bergh.*[3]

26. Archidoris, *Bergh.*

37. *Archidoris tuberculata, *Cuvier.*

As the colours of this species have a general resemblance to those

[1] Giard, Bull. Sci. France et Belg., 1888, p. 502.

[2] For the classification of the *Anthobranchiata*, cf. Abraham, Proc. Zool. Soc., 1877, pp. 196—269, pls. xxvii—xxx.

[3] Bergh, *Gattungen nordischer Doriden*, Arch. f. Naturgesch., Jahrg. 45, Bd. i, pp. 340—369.

of the sponges upon which it usually feeds, and as these sponges are themselves very variable in colour, a number of differently coloured specimens of this Nudibranch were kept in one of the small tanks in the Laboratory, and fed under similar conditions upon the same pieces of *Halichondria*, which were obtained of as uniform a colour as possible. After several months no change was detected in the colouration of the Nudibranchs. The species cannot therefore be regarded as possessing the power of variable protective resemblance.[1]

My friend Mr. Rupert Vallentin has several times sent me large individuals of this species from Falmouth, which have been of a much paler colour than is usual at Plymouth, although such individuals occur.

With regard to the spawning period of this mollusc, I may add to my previous account that specimens which had been living in the aquarium for some time last winter were found to have deposited spawn early in January.

38. Archidoris flammea, *A. and H.*

Near the Duke Rock a sponge of *Desmacidon*-like appearance, with prominent oscula, but of a bright red colour, is very common; and while looking over a quantity of the sponge early in April last I found an individual of this species feeding upon it, in dimensions just under three quarters of an inch long and half an inch broad. The colour of the Nudibranch closely approached that of the sponge, but had a more orange tinge. There were a few scattered purplish spots in the middle of the back. The animal was very flattened in form and very changeable in shape. Rhinophoral fossæ very wide and capacious, and tuberculated at their edges. Rhinophores and branchiæ completely retractile. It was occasionally seen to float inverted at the surface of the water.

On a piece of the sponge preserved in alcohol for identification I subsequently found another, rather smaller specimen of the same species. It was in a conspicuous position on the sponge, and I must have overlooked it when alive owing to the similarity of its colour to that of the sponge.

If this species should be found to feed generally upon red sponges, the adaptation will be of considerable interest. Perhaps its rarity may be due, as in many other cases, to an insufficient knowledge of its peculiar habits. I am inclined to believe that the red Dorises

[1] Mr. Poulton (The Colours of Animals, 1890, p. 108) has mentioned the probable existence in this species of the power of adjustment of its colour to that of its surroundings. Prof. Stewart's specimens, however, were in all probability not *tuberculata*, but a distinct species.

which Prof. Stewart found upon *Hymeniacidon sanguineus* (cf. my previous Report, p. 177) were large specimens of this species.

Another specimen, half an inch long, was again dredged on the same ground early in June.

It is important to prevent any confusion between this species and *Doris* (*Rostanga*) *coccinea*, which is also red in colour. The best character by which to distinguish them at once is the structure of the anterior portion of the foot: in *flammea* this is entire, and separated from the rest of the foot by a transverse groove only; but in *coccinea* it is split into two lateral portions, as in *Doris* (*Jorunna*) *Johnstoni* and *Doris* (*Platydoris*) *planata*. Alder and Hancock's two specimens were dredged in shallow water, Rothesay Bay, adhering to *Pecten opercularis*. Prof. Ed. Forbes dredged it off the Isle of Man in 25 fathoms. Dr. Norman has also found the species at Cumbrae, and Mr. Cocks recorded it in 1849 as "very rare, on stones at extreme low-water mark, spring-tide," at Gwyllyn Vase, Falmouth.

27. Jorunna, *Bergh.*

39. *Jorunna Johnstoni, *A. and H.* (= *Archidoris Johnstoni*, 1st Rep., p. 177.)

Three more specimens of this species have been obtained. One, half an inch in length, was found under a stone in a pool at Rum Bay on March 7th, and was very sponge-like and inconspicuous. Mr. Bourne also found two specimens on the shore at Wembury Bay, one early in May, and the other a month later.

The dark spots on the back of this animal have been constantly present, but very variable in position; they have the effect of rendering the darkly coloured rhinophores less conspicuous.

28. Platydoris, *Bergh.*

40. *Platydoris planata, *Alder and Hancock* (= *Archidoris planata*, 1st Rep., p. 178.)

Two additional specimens have been taken. One, found at Drake's Island, August 14th, 1889, measures (preserved in spirit) 1⅛ inches long by $\frac{9}{16}$ broad. The gill-plumes are six in number, the third on each side being deeply bifurcated. They were completely retractile, and when protruded appeared to be composed of two distinct lateral halves. The underside of the pleuropodium and the foot were orange-coloured; the pleuropodium in life was often upturned at the edge, showing its orange-coloured under-side. The radula of this specimen is very abnormal, there being three longitudinal series of great irregular teeth formed by the fusion of several of the slender normal ones. On one side two teeth in each row are thus

fused, being united by their bases and at their tips, leaving an enclosed space in the middle. The tips of these double teeth are broad, flat, and triangular. On the other side of the radula there is a row of double teeth resembling those just described, and also a row of large teeth formed in exactly the same way by the fusion of three of the ordinary slender hook-like teeth.

Another specimen was dredged near the Duke Rock on September 24th, 1890, measuring $1\frac{1}{8}$ inches long by $\frac{11}{16}$ broad when at rest, and $1\frac{1}{4}$ inches by $\frac{9}{16}$ inch when *en marche*. Colour precisely as in Alder and Hancock's figure. Gill-plumes, exactly as in the previous specimen, protruded from the wide fossa in two separate tufts, one on each side. Each of these lateral tufts was formed of three plumes, the third on each side being distinctly trifid and very broad, and all the plumes very pinnate in character. On several occasions I saw the tuft of one side retracted independently of the other, pointing to a power of independent contraction of the branchial retractors of each side. This division of the branchial plumes into two independently retractile halves is a very marked character, and has not, I believe, been recorded before.

This genus is distinguished from the *Aldisa*[1] of Bergh, among other characters, in having the anterior lip of the foot deeply split into two lateral halves. This species has comparatively long, slender, and pointed oral tentacles, and the teeth of its radula are not serrulate—characters which also distinguish it from species of *Aldisa*.

29. Rostanga, *Bergh*.

41. *Rostanga coccinea, *Forbes* (= *Archidoris coccinea*, 1st Rep., p. 178).

This species is taken so rarely that its habits remain still uncertain. Mr. Bourne found a fine specimen, $\frac{3}{4}$ inch long and $\frac{5}{16}$ inch broad, on the 1st of August at Drake's Island, low water. It was under a stone resting on black mud with weeds attached, along with *Nebalia Geoffroyi*. There was no sponge or other red substance near. Cocks, and Alder and Hancock found the species fairly common at Falmouth forty years ago.

Sub-family—Doridide phanerobranchiatæ, *Bergh*.

Goniodorinæ.

30. Acanthodoris, *Gray*.

42. *Acanthodoris pilosa, *Müll*.

In addition to the previously recorded specimens, one was taken

[1] Bergh, *Gattungen nord. Doriden*, Arch. f. Naturgesch., lv, p. 348.

on the shore at Wembury by Mr. Bourne on the 5th of May this year, and on the 16th August Dr. Fowler dredged one large specimen, 1½ inches long, of a dark steel-grey colour, and five small ones, ½ inch long, of which two were almost entirely white in colour, and the rest were dark steel-grey.

Mr. Vallentin finds this species abundant at Falmouth on the Helford mud-flats, where young specimens are to be taken from the under sides of *Fucus*. Friele and Hansen (l. c.) also notice this habit.

31. Lamellidoris, *Alder and Hancock.*

43. *Lamellidoris aspera, *A. and H.*

This species has not been obtained since the date of the previous Report. It was not found by Cocks at Falmouth, and seems to be essentially a northern species.

44. *Lamellidoris bilamellata, *Linnæus.*

This species is common at Plymouth, as on most rocky coasts of the North Atlantic; curiously enough, it is not recorded by Cocks from Falmouth.

45. *Lamellidoris sparsa, *A. and H.*

This species has not been taken during the past year.

32. Goniodoris, *Forbes.*

46. *G. nodosa, *Montagu.*

This beautiful little species is very abundant at Plymouth, and I have made use of it for the purpose of testing some of Alder and Hancock's statements about the habits of migration of Nudibranchs. In his account of the Nudibranchiate Mollusca of St. Andrews Prof. McIntosh wrote concerning this species, "There is little to be met with at St. Andrews in support of the statement of the able authors of the Monograph in regard to the disappearance of the adult animal and the growth of the young; for the varying sizes occur throughout the entire year, fine full-grown specimens (1¼ inches) being found in December as well as in March, April, and May."

In order to examine into this matter, therefore, I began in the early spring of last year (1889) to keep a record of all the specimens of this species observed or captured. During February, and especially during March, April, and May, large individuals (1 inch long) were extremely abundant on the rocks below the Laboratory and

under the Hoe whenever they were visited at low water. They were congregated generally in groups of five or six together, but not infrequently I found isolated couples. They were most plentiful on rocks covered with the red gregarious Tunicate, *Styela grossularia*, and on this and elsewhere their spawn was abundant. Small individuals (*i. e.* of ½ inch and under) were not found upon the rocks at all, nor were they to be obtained with the dredge in deeper water. Veligers, however, were regularly taken during the early spring months in the surface-net. During June the numbers of mature individuals found on the shore, and at the same time the quantity of spawn, became appreciably reduced, and July found them more or less rare. Very small specimens were noticed in the contents of the dredge in June, and were frequently taken during July and August. My observations were here interrupted for several weeks, but on October 8th a specimen rather over ½ inch in length was trawled in the Cattewater; next day one of the same size was dredged on *Zostera* in Cawsand Bay, and on the 10th I found one also under a stone at extreme low water (spring tide) in Rum Bay. The dredge continued to bring up specimens between ½ and ¾ inch long off the Duke Rock and elsewhere, but they were never in such numbers as were those of July. On November 22nd during a spring tide I found a large one on a stone at Drake's Island, and on the 25th in a small crevice of rock under West Hoe, rather high up between tide-marks, I found two large ones together. I could find none at this time under the bathing pond. I brought the two large ones to the Laboratory, and placed them in an aquarium; on the 6th of December one of them deposited some spawn, and another piece was laid three days later. On the 20th of February this year, full-sized mature specimens, in considerable numbers, were copulating and depositing eggs on the rocks below the Laboratory, below the bathing pond, and at Drake's Island. At Drake's Island one individual was under ⅔ inch in length.

It is obvious from these facts that at Plymouth the habits of the species and its rate of growth are very much as Alder and Hancock found to be the case on the coast of Northumberland; and this induces me to believe that at St. Andrews also more detailed observations would lead to a similar conviction.

The rate of growth of the species is to some extent indicated by the following measurements of the individuals dredged at Plymouth during the present year up to the end of August.

June 26th.—One specimen dredged off the Duke Rock, just over ⅛ inch in length, and having three branchial plumes only on each side.

June 27th.—One specimen $\frac{3}{16}$ inch long, taken among weeds with the bottom tow-net in Cawsand Bay.

July 7th.—Eight specimens taken in Cawsand Bay with the bottom tow-net, varying in size from $\frac{1}{8}$ inch to nearly $\frac{1}{4}$ inch when completely extended. The largest individuals had seven branchial plumes only, the largest being median and anterior.

July 11th.—One, $\frac{3}{16}$ inch long when not fully extended (probably $\frac{5}{16}$ inch when extended), dredged off the Duke Rock. I found it on a colony of the compound Ascidian *Fragarium elegans*, and it was apparently feeding upon it.

July 24th.—One, $\frac{3}{8}$ inch long, on a stone dredged off the Duke Rock.

August 6th.—Three, the largest just over $\frac{1}{4}$ inch long, dredged off the Duke Rock.

August 7th.—Two, just over $\frac{1}{4}$ inch in length, dredged off the Eddystone in 25—40 fathoms, one mile south of the Hand Deeps.

August 11th.—Eight specimens, from $\frac{3}{16}$ inch to just over $\frac{3}{8}$ inch long, on stones dredged off the Duke Rock.

August 13th.—Three specimens dredged two miles south of the Mewstone, one being $\frac{3}{16}$, one $\frac{3}{8}$, and one $\frac{7}{16}$ inch long. The first specimen possessed an unusually broad foot, which, when the animal was viewed from above, extended beyond the pleuropodial frill on each side. This specimen agrees, therefore, with Montagu's *Doris marginata*, and shows the probable correctness of his figure—contrary to the opinion which Alder and Hancock expressed in their Monograph.

August 18th.—One specimen, $\frac{3}{8}$ inch long, on a stone covered with encrusting polyzoa and algæ, extreme low water, spring tide, east end of Drake's Island.

August 24th.—Two specimens, each $\frac{7}{16}$ inch long and with eleven branchial plumes, found under a stone in Bovisand Bay at low water, neap tide, by Mr. M. F. Woodward.

August 25th.—One, $\frac{3}{8}$ in. long, dredged between Picklecombe Fort and the Breakwater.

These statistics, in conjunction with the facts concerning last year's specimens, show conclusively that the eggs laid in the early spring have passed through their metamorphoses, assumed the specific form, and attained an average size of $\frac{1}{8}$ inch towards the end of June. The young Nudibranchs grow in size, being $\frac{1}{4}$ inch in length by the middle of July and $\frac{3}{8}$ inch by the middle of August. In October the average size[1] is $\frac{2}{3}$ inch, and by the end of November the specimens most frequently found are nearly $\frac{3}{4}$ of an inch in length, while they may attain to maturity in December under exceptionally warm conditions.

[1] This average is probably a little too high for the individuals which are still some distance from the shore. On October 16th, of seven specimens dredged near the Duke Rock, one was $\frac{3}{16}$ inch, one $\frac{1}{4}$ inch, four $\frac{5}{16}$ inch, and one $\frac{3}{8}$ inch in length.

The same statistics show that the veligers are carried out to considerable distances from the shore and that after falling to the bottom and undergoing their metamorphoses they gradually make their way to the shore. This year I found the first individual which had so migrated on August 18th at Drake's Island; and a few days later, as we were doing some collecting on the shore at Bovisand, Mr. Woodward found two more. During July and August I could not find a single large or mature individual either on the shore or with the dredge; and this leads to the conclusion that the disappearance of the old individuals after the spawning has been accomplished is due, not to a re-migration into deeper water or to habits of concealment, but to death. *Goniodoris nodosa* is an annual, and dies when it has ceased to deposit its eggs in the spring and early summer (cf. Woodward, Manual of Mollusca, 4th ed., p. 12).

Young specimens differ from full-grown individuals in several points of structure as well as in size. The pleuropodial frill is relatively larger, and is generally freely scalloped at the edge. I have given a representation of the animal at this stage ($\frac{1}{4}$ inch in length) on Pl. XXVII (fig. 4). The points formed by the scalloping are to be compared homologically with the filaments of *Idalia* and allied forms: they generally contain special aggregations of opaque white gland-cells, comparable with those of the pleuropodial filaments of *Ancula*, *Triopa*, &c. (cf. Herdman and Clubb, 3rd Rep., pp. 136 and 184; Friele and Hansen on *G. Danielsseni*, l. c., p. 72).

The specimens of the so-called *Doris Barvicensis* of Johnston which were found by Allman among the roots of *Laminaria digitata* in Courtmasherry Harbour in August and September, 1838 (see Thompson, 'Ann. Nat. Hist.,' vol. v, p. 87), and the *Goniodoris emarginata* of Forbes dredged in twenty fathoms off the Isle of Man in October, 1839 ('Ann. Nat. Hist.,' vol. v, p. 105), were undoubtedly young specimens of *Goniodoris nodosa* migrating to the shore.

Another difference of considerable morphological importance between the young and adult *Goniodoris nodosa* is to be found in the condition of the posterior portion of the pleuropodial frill. In young specimens the lateral portions of this structure are invariably discontinuous posteriorly, as represented in my figure: this condition is persistent in *Goniodoris castanea* throughout life, as it is in the closely allied genus *Idalia*. But as the animal grows the basal portions of the posterior terminations of these folds become connected together, and give rise to a continuous circular fold like that of *Archidoris*, which differs from the latter, however, in being deeply notched or emarginate posteriorly. This has been hitherto regarded as the final character assumed by the fold in the species, and ex-

cellent figures of this condition are to be seen in Alder and Hancock's Monograph. I find, however, that in very large individuals continuous growth may entirely obliterate all trace of the fusion which has taken place, so that a continuous, even, and circular fold is formed around the back (*nothæum*) of the animal, exactly as in *Archidoris, Lamellidoris,* &c. Pl. XXVII, fig. 6, represents this condition in a preserved specimen measuring $\frac{13}{16}$ inch in length and $\frac{1}{2}$ inch in breadth.

The process of growth thus described as taking place in the individual *Goniodoris nodosa* throws considerable light upon the question of the origin of the circular fold of *Archidoris*. It is many years since Huxley[1] suggested its homology (in part) with the paired "epipodia" of *Aplysia;* but although the suggestion has met with approval[2] little direct evidence has been collected in support of the view. The ontogeny of *Goniodoris nodosa,* however, shows conclusively that the circular fold has been arrived at by a process of posterior fusion of a pair of lateral folds; for the anterior union is clearly also secondary: the primitively discontinuous condition is persistent in *Polycera lessonii.* Therefore the origin of the circular fold of *Archidoris* and its allies from primitively paired lateral folds can no longer be considered as doubtful; and the existence of transition forms like the *Lomanotidæ* and *Ascoglossa* renders the homology of these paired folds with the "epipodia" (or better, "pleuropodia") of *Aplysia* almost certain.

In some way, perhaps, related to the fusion of the pleuropodia posteriorly is a curious transparent spot shown in my figure of the young *Goniodoris nodosa,* situated between the anus and the terminations of the folds. This was mistaken by Johnston (Ann. Nat. Hist., vol. i, p. 55) for a pore, but there is no perforation. Alder and Hancock rightly corrected this mistake, but fell into error in adopting Allman's explanation of it. Allman informed Mr. Thompson (Ann. Nat. Hist., vol. v, p. 88) that the pore-like appearance was "merely formed by the partial apposition of the edges of a slit existing in the posterior margin of the mantle, and which approximation is dependent on the will of the animal;" and Alder and Hancock followed him in stating that the spot was merely "caused by a deep indenture of the cloak." This is not the case, for the spot in question is simply an oval area from which the minute

[1] Huxley, *Morphology of the Cephalous Mollusca,* Phil. Trans., 1852.

[2] Cf. Lankester, *Mollusca,* Encycl. Brit., 9th ed., vol. xvi; Fischer, Manuel de Conchyliologie, 1887, p. 518 (Fischer's view is that the nothæum of *Doris* represents at the same time both the "epipodial" lobes of *Elysia* or *Aplysia* fused in the median line and the cephalic disc of *Philine*); Herdman and Clubb, *Third Report on the Nudibranchiata,* l. c., p. 147; also my *Report on the Nudibranchiata,* l. c., p. 181.

33. Idaliella, *Bergh.*[1]

48. *Idaliella (Idalia) aspersa, *A. and H.*

Only the two specimens described in my previous Report have been obtained by us.

34. Ancula, *Lovén.*

49. *Ancula cristata, *Alder.*

Only four additional specimens have been obtained. Three were found on the north side of Drake's Island at low water, one about the middle of May and two on the 3rd of June. These individuals were mature, but a small one $\frac{5}{16}$ inch long was taken with the bottom tow-net in Cawsand Bay on the 7th July. It bore a specimen of the remarkable parasitic Copepod, *Splanchnotrophus*, whose egg-sacs protruded through the back of the animal just in front of the anus. Two days later the parasite with its long tentacle-like processes had crawled out of the *Ancula*, which was only half its original size, and was being steadily devoured.

Professor Herdman[2] has found this species in extraordinary profusion at Hilbre Island during the breeding season; on one reef of rocks "for yards it was impossible to walk without treading on them, and handfuls were readily collected by scraping the specimens together from the mud-covered rocks." He also finds that the animal loses much of its conspicuous yellow coloration with age, and records some interesting observations on its means of defence against waves and strong currents (cf. A. R. Hunt, Journ. Linn. Soc., xviii, p. 265).

Polycerinæ.

35. Thecacera, *Fleming.*

50. *Thecacera pennigera, *Montagu.*

We have not yet obtained another specimen of this species. Mr. Vallentin dredged a single specimen in Falmouth Harbour during the spring among oyster-valves covered with *Bugula flabellata.*

[1] Bergh, *Ueber die Gattung* Idalia, Arch für Naturgesch., xlvii, i, p. 7. See also Norman on the name *Idalia*, loc. cit., p. 74.

[2] Herdman and Clubb, Third Report, p. 134; cf. also the Second Report, p. 227, and First Report, 1886, p. 270, and Thompson, Ann. Mag. Nat. Hist., 1860, p. 51.

36. Polycera, *Cuvier*.

51. *Polycera quadrilineata, *Müller*.

Mr. Cunningham's bottom tow-net, designed for catching young flat-fish, brought up several specimens when shot in Cawsand Bay on May 14th and June 25th. The bottom here is sandy, and *Zostera marina*, *Ceramium*, *Antithamnion*, and other weeds are abundant[1] over certain areas. The Nudibranchs were among these weeds when caught. One individual possessed six frontal filaments, and no tubercles at all. The yellow colour was confined to the frontal and "branchial" (pleuropodial) processes, the rhinophores, and tips of the branchiæ.

Three fine specimens were taken by Dr. Fowler on a piece of drift weed at low water, east end of Drake's Island, on July 16th; and three more were found upon *Fucus* and *Ulva* by Mr. De Hamel between tide-marks near the same spot on August 18th. There was much spawn near them at the time of capture, and they continued to deposit it for many days. In captivity, though healthy and with plenty of weeds, they were reduced in size by the end of the month.

This species, as Alder and Hancock inferred, is undoubtedly herbivorous in habit; one or two of the specimens mentioned in my former report were dredged in weedless ground, but all the others have come from localities where algæ are abundant.

52. *Polycera Lessonii, *D'Orb., var.* ocellata,[2] *A. and H.*

At extreme low water on the north side of Drake's Island, June 3rd, I found what was almost certainly another specimen of this variety under a small stone. Unfortunately it was lost, owing to the breakage of a collecting bottle, and was not very closely examined beforehand.

37. Triopa, *Johnston*.

53. *Triopa clavigera, *Müll.*

Another specimen was again dredged off the Mewstone, about two miles south, in the middle of April. The pigment spots on the

[1] See Prof. Johnson's paper on *The Flora of Plymouth Sound*, this Journal, New Series, I, iii, pp. 297, 298.

[2] I have followed Dr. Norman in placing *ocellata* as a variety of *Lessonii*. Herdman and Clubb (Second Report, 1889, p. 227) have noticed the intermediate variations, but it is interesting to note that the type and the variety seem to live, as a rule, under different conditions of depth and food (see Alder and Hancock, Monograph).

back, as in the former specimen, were confined to a median row, excepting two or three small spots to the side.

38. ÆGIRUS, *Lovén.*

54. *ÆGIRUS PUNCTILUCENS, *D'Orbigny.*

A single specimen of this Nudibranch was taken near the Duke Rock on September 26th of this year.

DESCRIPTION OF PLATES XXVII AND XXVIII,

Illustrating Mr. W. Garstang's "Complete List of the Opisthobranchiate Mollusca found at Plymouth, with further Observations on their Morphology, Colours, and Natural History."

PLATE XXVII.

FIG. 1.—*Goniodoris castanea*, A. and H. A young individual, enlarged, possessing oral tentacles of simple, semi-crescentic form.

FIG. 2.—*Goniodoris castanea*, A. and H. Head-region of a full-grown individual, enlarged, showing the double sinuous curve of the anterior edge of the oral tentacles. After Alder and Hancock.

FIG. 3.—*Goniodoris castanea*, A. and H. A coil of spawn of unusual form. Nat. size.

FIG. 4.—*Goniodoris nodosa*, Mont. A young individual, enlarged. The pleuropodial folds are freely scalloped, but, as in *G. castanea* (fig. 1), are discontinuous posteriorly. Between the anus and the posterior termination of these folds is an oval unpigmented spot, represented rather too conspicuously in the figure.

FIG. 5.—*Goniodoris nodosa*, Mont. *α*. Two transverse rows of the radula of a full-grown individual, magnified. Zeiss, obj. A, eye-piece No. 2, *cam. luc.* The denticulations of the inner side-plates ought to be about 24 in number. *β*. The external side-plates of a young individual, $\frac{7}{16}$ inch long, more highly magnified. Zeiss, obj. A, eye-piece No. 4, *cam. luc.* The denticulations of the inner side-plates were 17 in number. In reality, the dimensions of the external side-plates are only $\frac{2}{3}$ those of *α*.

FIG. 6.—*Goniodoris nodosa*, Mont. Posterior region of a large individual ($1\frac{3}{16}$ inch long × $\frac{1}{2}$ inch broad, preserved in spirits), enlarged, showing the complete continuity of the pleuropodia behind.

PLATE XXVIII.

FIG. 1.—*Lomanotus.* A young individual, $\frac{3}{16}$ inch long, somewhat contracted, seen from the right side, and enlarged. The figure shows the continuity between the pleuropodial ridge and the postero-lateral tubercle of the sheath of the rhinophore. In this region of the sheath a diverticulum of the liver is seen to exist, as well as in each of the triangular papillæ of the pleuropodium. The eye-spot lies under the sheath of the rhinophore; the anal papilla is not represented. The two short oral tentacles of the right side are shown, as well as the right anterior process of the foot. Drawn from life; the animal, however, was not very healthy.

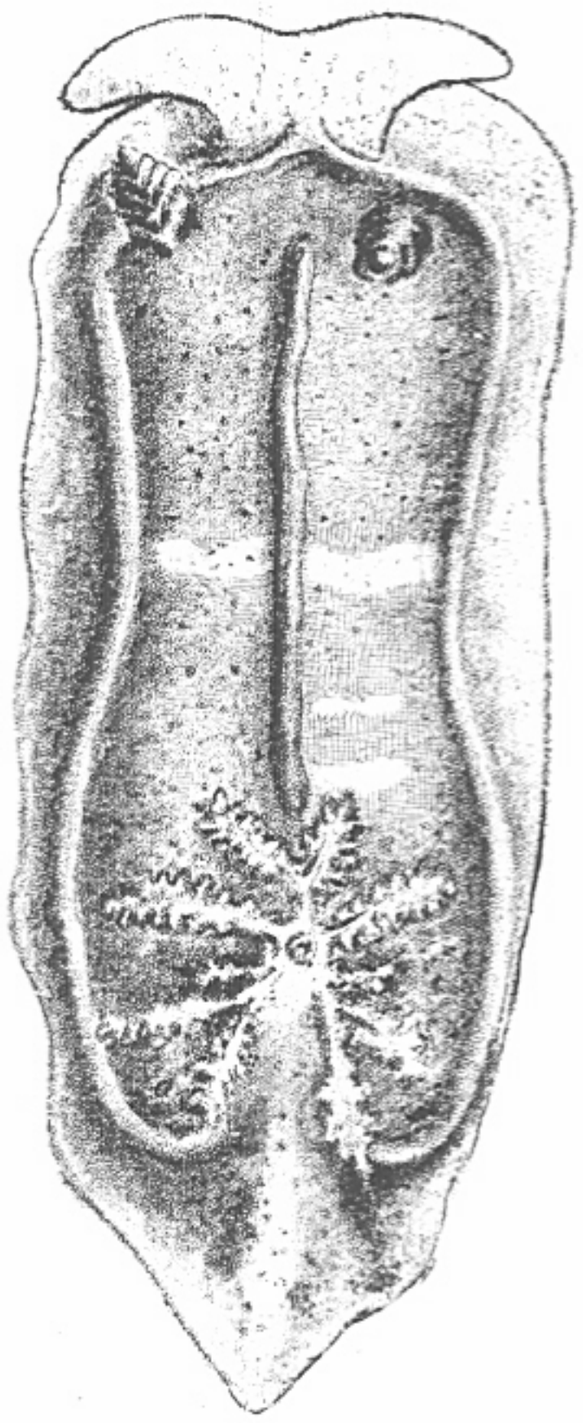

Fig. 1.

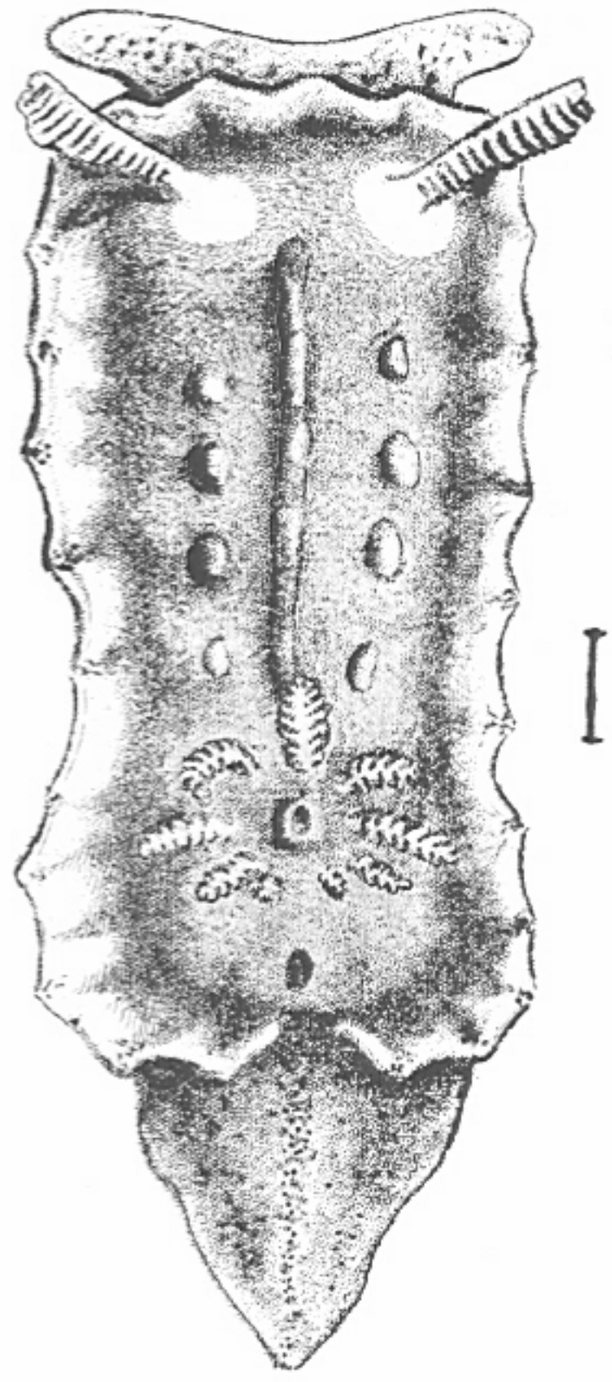

Fig. 4.

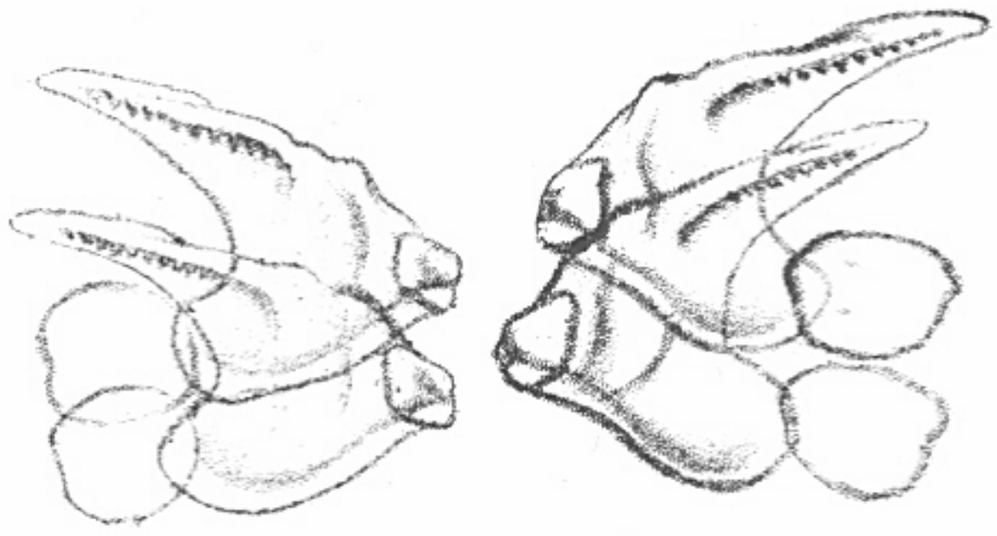

Fig. 5. α.

Fig. 5. β.

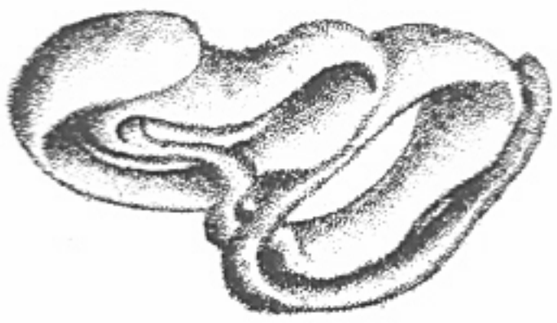

Fig. 3

Fig. 2.

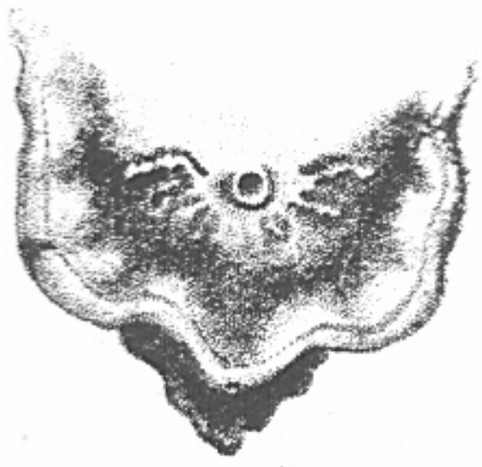

Fig. 6.

Goniodoris.

W.R. autogr.

NOTES AND MEMORANDA.

Colour-changes in Cottus bubalis.—On May 10th a specimen of this fish, of a brilliant carmine-red colour, was brought to the Laboratory. It had been caught in a lobster-pot in deep water. The ground colour was a very vivid carmine-red, and this was interrupted at places by black, white, and yellow markings. The black markings were distributed as follows :—There were streaks and bands on the head, a pair of irregular blotchings at the sides of the first dorsal fin, another pair at the sides of the second dorsal, and a pair at the base of the tail, also a pair of black patches on the bases of the pectorals. The white marks were opaque, and had a chalky appearance : there was a pair of these in the sides of the body opposite the first dorsal, and a pair of large patches on the sides of the first dorsal fin itself ; there was a similar arrangement of white patches in the region of the second dorsal, and a patch on the middle of each pectoral, also a small white spot on the middle of the dorsal side of the head, and another at the dorsal part of each pectoral. Yellow bands alternated with red along the rays of the pectoral fins.

This specimen was placed in one of the table tanks in the Laboratory ; at the bottom of the tank was coarse yellow gravel, while the sides were of black slate, and there were one or two large dark stones in the tank, behind which the fish usually concealed itself. The tank is very dimly illuminated.

On June 24th I examined the specimen, and found it was deep black all over the back and sides with the exception of the white markings, which were unaltered ; there was not a trace of red about it. The ventral surface was of course light throughout the experiment.

I then placed the specimen in a pan painted red and strongly illuminated. In a day or two the colour was much lighter, having become a slightly yellowish brown without any red tinge. But the specimen died from accidental stoppage of the circulation in the pan before further observations could be made.

The ordinary specimens of the shore are black or dark brown on

FIG. 2.—*Lomanotus.* Representation of another, a very lively individual of the same size, *en marche.* The right rhinophore is retracted into the sheath, the left protruded. The pleuropodial papillæ are shown as naturally as possible. The diverticula of the liver are seen through the transparent skin. The heart is on a level with the letters N.S. in the figure. Drawn from life. N.S. = natural size.

FIGS. 3—7.—*Aplysia punctata,* Cuvier. The central tooth and three adjacent lateral teeth of a row about the middle of the radula of five individuals of different sizes, the outlines being determined by means of a *camera lucida.* Figs. 4—7 are all to scale, as seen with a Zeiss microscope, objective A, eye-piece No. 4. Fig. 3 represents teeth seen under higher magnification with a Zeiss, obj. D, eye-piece No. 2. All the radulæ were taken from specimens preserved in spirits; the buccal masses were boiled in a solution of caustic potash, the radulæ being mounted in glycerine jelly.

FIG. 3.—Animal, $\frac{3}{16}$ inch long × $\frac{3}{32}$ inch broad. Without markings in spirit.

FIG. 4.—Animal, $\frac{7}{16}$ inch long × $\frac{3}{16}$ inch broad × $\frac{5}{16}$ high. Without markings.

FIG. 5.—Animal, $\frac{15}{16} \times \frac{3}{8} \times \frac{3}{8}$. Markings.—Integuments deeply pigmented with thick, somewhat elongate, black spots, arranged over the whole surface, but here and there leaving clear, unpigmented, round spaces, with indefinitely bounded edges. Small black rings on the head and sides of the neck, but inconspicuous owing to depth and regularity of the other markings.

FIG. 6.—Animal, $2\frac{5}{8} \times \frac{3}{4} \times 1\frac{1}{8}$. Markings.—Finely pigmented all over, like the preceding, with a few unpigmented spaces.

FIG. 7.—Animal, $3 \times 1\frac{1}{4} \times 1\frac{5}{8}$. See text, p. 403.

FIGS. 8 and 9.—Shells, from under side, of Plymouth specimens of *A. punctata,* natural size. Owing to the method of preservation the calcareous layer cannot be shown.

FIG. 8.—Animal, $1\frac{1}{4} \times \frac{1}{2} \times \frac{7}{8}$. Markings as in the animal of Fig. 5, but without the small black rings.

FIG. 9.—Animal, the same as that of Fig. 7.

FIG. 10.—Shell of an *Aplysia depilans,* L., from Palermo, in Dr. Norman's collection, natural size, seen from below. The inner line represents the edge of the calcareous layer.

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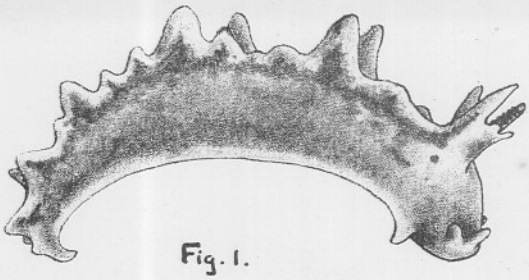

Fig. 1.

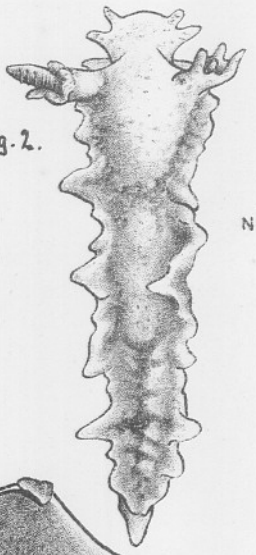

Fig. 2.

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Fig. 8.

Fig. 3.

Fig. 4.

Fig. 5.

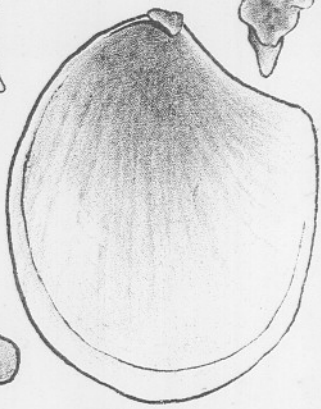

Fig. 10.

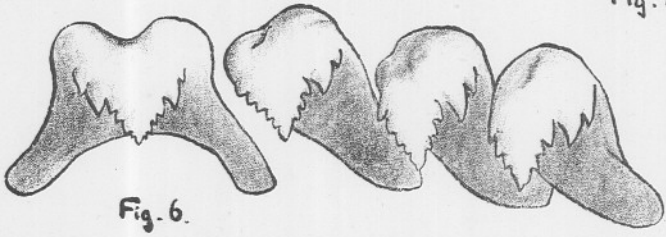

Fig. 6.

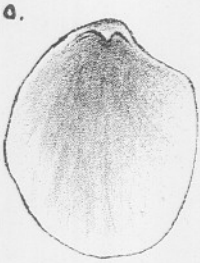

Fig. 9.

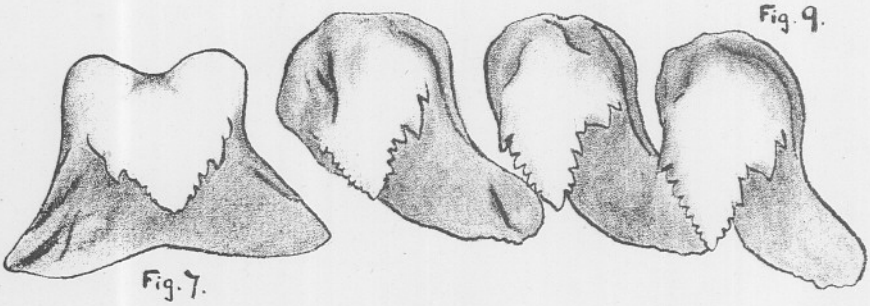

Fig. 7.

W. G. autogr.

Lomanotus & Aplysia.

the back, the sides being spotted or blotched with the same colour, while there are light markings similar in position to the white markings in the specimen described above, but yellow in colour, with brown spots scattered over them.

The occurrence of red specimens is mentioned by Day, who describes a male specimen of a brilliant carmine colour with white markings. My specimen was a female, so that the colour has nothing to do with sex. We have received several other specimens of the same red colour, but only the one above described has been yet subjected to careful observation.

It is evident from the above that the red colour is not permanent, so that red specimens do not represent a colour variety; the red colouration is evidently a temporary condition due to the action of light. Whether an ordinary shore specimen can be made to turn red by being exposed to light reflected from red surroundings has not yet been proved, but it has been shown that a red specimen soon loses its peculiar colour under the conditions above described. At the same time the change is not very rapid; in the above case it occupied more than a month. It seems probable that the red colour in nature is determined by the fact that the fish lives among red seaweeds. Probably in this case there is no alteration in the quantities of the differently coloured pigments in the skin, but merely an alteration in the expansion and contraction of the differently coloured chromatophores.—J. T. Cunningham.

Palæmonetes varians in Plymouth.—The estuary of the river Plym is connected, especially upon its left (eastern) side, with a number of small tributaries, whose waters are, even at their mouths, of very low density. In many of these tributaries *Palæmonetes varians* abounds. I have examined especially a large number of individuals from a stream which runs through Saltram Park, in the water of which I have found variations in density ranging from 1·010 to 1·018. From the position of the stream it is improbable that its density is ever much greater than 1·018, though a continuous rain might possibly reduce its specific gravity to a limit below 1·010.

The variability of the adult individuals from Saltram is very great. The following statement of variations observed in the characters of the rostrum will show how enormously the variations in this race exceed those indicated by the current diagnoses of the species.

Among 915 individuals of both sexes—

The apex was simple in	432	cases.
The apex was bifid in	483	,,

One dorsal tooth only was present in	2	cases.
Two dorsal teeth only were ,,	18	,,
Three ,, ,,	123	,,
Four ,, ,,	372	,,
Five ,, ,,	349	,,
Six ,, ,,	50	,,
Seven ,, ,,	1	case.

Ventral teeth were absent in	3	cases.
One ventral tooth present in	276	,,
Two ventral teeth ,,	630	,,
Three ,, ,,	6	,,

The range of variation being so considerable, it is evidently unprofitable to compare this race with the published accounts, which are based on examination of ten or a dozen specimens of other races. Such a comparison will therefore be deferred until it is possible to obtain an extended series of observations, from which a fuller knowledge of the diagnostic characters and range of variation of the species may be obtained.

The development of *Palæmonetes* has been shown by P. Mayer,* Boas,† and others to present a series of interesting variations. The races which inhabit those countries surrounding the Mediterranean —and which are found almost exclusively in fresh water—exhibit, as is well known, a more abbreviated development than the races of Northern Europe, which inhabit exclusively waters containing at least some admixture of salt.

It is curious that the attempt to grow the southern forms in salt water has not been successful.

In June last several gravid females were taken from the stream at Saltram, whose specific gravity was then 1·010, and placed in an aquarium in the Laboratory at Plymouth. The density of the water was diminished by 0·001 daily, so that in ten days it became quite fresh. The adult individuals fed freely, and seemed in no way disturbed by the change of density, while the eggs hatched in due course.

The larvæ at hatching were about 4 mm. long ; the rostrum was in some cases, though not in others, provided with a single basal spine.

The inner ramus of the second antenna was unsegmented. The mandible was provided with biting teeth, but was not bifid. The exopodite of the second maxilla was large ; and the four endites (of which the distal was divided) were provided with well-developed

* Mitth. Zool. Sta. Neap., Bd. ii, p. 196.

† Spengel's Zoologische Jahrbücher, iv, p. 793.

biting hairs. The maxillipeds were well developed, each having a large exopodite, used in swimming; while the five thoracic legs existed as mere buds, the first four being already bifid, but remaining folded beneath the thorax.

The larvæ moulted three or four times before attaining a proper "mysis" condition. After attaining this condition they were accidentally killed. They fed freely from a few hours after hatching during their whole lives.

The eggs from the abdomen of the mother measured rather less than 1 mm. in long diameter, and each female carried about 150.

The only difference between the larva here described and that shown by Boas to be characteristic of the northern salt-water form of *Palæmonetes* lies in the occasional presence, in the Plymouth larva, of the single rostral spine; and the facts above mentioned as to the variability of the adult rostrum may perhaps be considered to deprive this single difference of any great importance.

We have, therefore, in Plymouth a race of *Palæmonetes* which, while approximating in its habits to the races of Southern Europe, retains, in its development at least, a complete resemblance to those northern forms from which it is probably descended.

W. F. R. Weldon.

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B.

C.

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OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

Professor HUXLEY, the President of the Royal Society, took the chair, and amongst the speakers in support of the project were the Duke of ARGYLL, Sir LYON PLAYFAIR, Sir JOHN LUBBOCK, Sir JOSEPH HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, Professor MOSELEY, Dr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence, the Association has erected at Plymouth a thoroughly efficient laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, at the expense of a small rent for the use of a working table in the Laboratory and other appliances, and have made valuable additions to zoological and botanical science. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing boats, and the salary of the Resident Director. The gentleman holding this post receives £200 a year and a residence. A naturalist has also been appointed at a salary of £250 a year, whose duties are confined to the study of food-fishes, and provision has been made for an assistant to the Director. THESE ARE THE ONLY SALARIED OFFICERS OF THE ASSOCIATION: its affairs are conducted entirely by voluntary service.

The Association has at present received some £15,000, of which £5000 was granted by the Treasury. The annual revenue which can be at present counted on is about £950, of which £500 a year for five years is granted by the Treasury, whilst £180 is in the uncertain form of Annual Subscriptions.

The admirable Marine Biological Laboratory at Naples, founded and directed by Dr. Dohrn, has cost about £20,000, including steam launches, &c., whilst it has an annual budget of £4000.

The ASSOCIATION URGENTLY NEEDS ADDITIONAL FUNDS FOR THE PURCHASE AND MAINTENANCE OF A SEA-GOING STEAM VESSEL, by means of which fishery investigations can be extended to other parts of the coast than the immediate neighbourhood of Plymouth; for the maintenance and completion of the library; and in order to increase the permanent staff engaged at Plymouth. The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association

CONTENTS of NEW SERIES, Vol. I, No. 4.

NOTICE.

The Council of the Marine Biological Association wish it to be understood that they do not accept responsibility for statements published in this Journal, excepting when those statements are contained in an official report of the Council.

TERMS OF MEMBERSHIP.

		£	s.	d.
Annual Members	. per ann.	1	1	0
Life Members	Composition Fee	15	15	0
Founders		100	0	0
Governors		500	0	0

Members of the Association have the following rights and privileges: they elect annually the Officers and Council; they receive the Journal of the Association free by post; they are admitted to view the Laboratory at Plymouth, and may introduce friends with them; they have the first claim to rent a place in the Laboratory for research, with use of tanks, boats, &c., and have access to the books in the Library at Plymouth.

All correspondence should be addressed to the Director, M. B. A. Laboratory, Citadel Hill, Plymouth.