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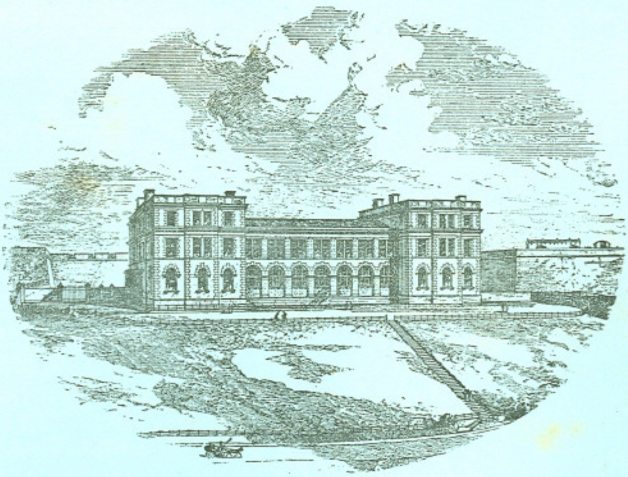
Journal

OF THE

MARINE BIOLOGICAL ASSOCIATION

OF

THE UNITED KINGDOM.



THE PLYMOUTH LABORATORY.

LONDON:

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THE efficiency of a Marine Laboratory being in the highest degree dependent upon the completeness of its Library, the Director wishes to appeal to the Members and friends of the Marine Biological Association for help in forming as extensive a collection as possible of Zoological and Botanical literature.

The literature of Biology is at the present day so enormous that the Association has been able to do little more than form the nucleus of a scientific Library, partly by purchase, largely through the generosity of friends and public bodies.

The Library contains at the present date some 700 volumes. Thanks to the liberal support of English, Colonial, and Foreign Governments, it is fairly equipped with official works on Marine Fisheries. In purchasing books it has been the aim of the Association to procure, in the first place, such works as are obviously necessary for the systematic work of exploring the Fauna of Plymouth Sound.

The sum available for the purchase of new books and binding is not more than £50 a year—half of what was estimated—and nearly the whole of this is spent in the purchase of the leading scientific periodicals and in binding.

It is obvious, therefore, that if the Laboratory is to possess an efficient Library at an early date help must be invited from outside.

The Director wishes to suggest to Members of the Association that many of the extracts from English and foreign periodicals, especially of an early date, which may be of no further use to their possessors, would be particularly useful to the Library of the Marine Biological Association. There must be many naturalists who have numbers of separate papers referring to groups of the animal and vegetable kingdoms in which they take no special interest, and if they would separate such papers and present them to the Library they would be conferring a great benefit on the Association.

The Director will also be much obliged if naturalists will send him separate copies of their scientific memoirs as they are published, and will be very glad to communicate with any gentleman who may wish to give or to leave books to the Association with the view of informing him what works are already in the Library and what are its chief desiderata.

PLYMOUTH;
September 30th, 1889.

Journal of the Marine Biological Association.

LIST

OF

Governors, Founders, and Members.

1st JULY, 1889.

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1884	Bateson, Miss A., 8, *Harvey Road, Cambridge*	*ann.*
1884	Bateson, Mrs. Anna, 8, *Harvey Road, Cambridge*	*ann.*
1884	Bateson, Wm., *Morphological Laboratory, New Museums, Cambridge*	*ann.*
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1884 Caine, W. S., M.P., 132 and 133, *Palace Chambers, Bridge Street, S.W.* £21
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1885 Deck, Arthur, F.C.S., *King's Parade, Cambridge*.......... *ann.*
1885 Dendy, Arthur, B.Sc., *Victoria University, Melbourne, Australia*.......... *ann.*
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1885 Dixey, F. A., M.A.Oxon., *Wadham College, Oxford*.......... £26 5*s.*
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1884 Fayrer, Sir Joseph, M.D., K.C.S.I., F.R.S., 53, *Wimpole Street, W.* *ann.*
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1885 Fowler, G. Herbert, B.A., Ph.D., 12, *South Square, Gray's Inn, W.C.* *ann.*
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1884 Fryer, Charles E., *Board of Trade, S.W.*.......... *ann.*

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*1884 Günther, Albert, F.R.S., *Natural History Museum, Cromwell Road, SW.* .... *ann.*

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1884 Heathcote, Fredk. G., *Trinity College, Cambridge* .... *C.*
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1888 Hodge, H. Cotty, *Redland House, Vinstone, Plymouth* .... *ann.*
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1884 Lloyd, Thomas, *Winchester* .... ann.
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1884 Parker, J. J., 54, *Eaton Terrace, S.W.* .... ann.
1884 Parker, Prof. W. Newton, *University College, Cardiff* .... ann.
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1884 Pittock, George M., M.B.Lond., 23, *Cecil Square, Margate* .... ann.
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1886 Power, Henry, F.R.C.S., 37A, *Great Cumberland Place, W.* .... ann.
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1884 Rowe, J. Brooking, F.S.A., F.L.S., *Lockyer Street, Plymouth* .... ann.
1885 Ruscoe, John, *Albion Works, Henry Street, Hyde, near Manchester*... 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 T., M.D., *Science and Art Museum, Dublin* .... ann.
*1884 Sclater, P. L., F.R.S., 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, *Newnham College, Cambridge* .... ann.
1884 Shipley, Arthur E., M.A., *Christ's College, Cambridge* .... ann.
1886 Shore, T. W., M.D., *St. Bartholomew's Hospital* .... ann.
1889 Simpson, Francis C., *Maypool, Churston Ferrers, R.S.O., S. Devon* ann.
1889 Slade, Lieut. E. J. Warre, R.N., 3, *Outram Terrace, Stoke, Devonport* .... ann.
1884 Sladen, W. Percy, Sec. Linn. Soc., *Orsett House, Ewell, Surrey* .... ann.
1884 Smith, Robert Mackay, *Edinburgh* .... C.
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., *Victoria University, Melbourne*... ann.
1884 Spring-Rice, S. E., 113*a*, *Queen's Gate, 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., F.L.S., *Royal College of Surgeons, Lincoln's Inn* .... ann.
†1884 Sutherland, The Duke of, K.G., *Stafford House, St. James', S.W.* ... C.
1888 Swayne, 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., *Dundee* .... 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.

1884 Walker, Alfred O., *Nantglyn, Colwyn Bay, N. Wales* .... ann.
1884 Walker, Rev. F. A., D.D., *Dun Mallard, Cricklewood* .... ann.
1884 Walker, P. F., 36, *Princes Gardens, S.W.* .... ann.
†1884 Walsingham, Lord, F.R.S., *Merton Hall, Thetford* £20
1884 Welch, H. Kemp, 32, *Onslow Gardens* .... ann.
1884 Wilson, Scott B., *Heather Bank, Weybridge Heath* .... C.
1888 Wood, G. W., F.I.C., F.C.S., *Ballagawne, Riggindale Road, Streatham, S.W.* .... ann.
1884 Woodall, John W., *St. Nicholas House, Scarborough* .... 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.

1889 Yerbury, Major, *Royal Artillery, Devonport* .... ann.

IV.—Associate Members.

1889 Alward, George, *Fish Dock Road, Great Grimsby.*
Caux, J. W. de, *Great Yarmouth.*
Dunn, Matthias, *Mevagissey.*
Olsen, O. T., *Fish Dock Road, Great Grimsby.*
Ridge, B. J., 3, *Gainsboro' Place, Mutley, Plymouth.*

Report of Council, June 26th, 1889.

The Council has met nine times during the past year, and the meetings have been well attended.

The members of the Council have been informed through the periodical reports of the Director (Mr. Bourne) and the Naturalist (Mr. Cunningham), of the condition of the Laboratory and the progress of the work at Plymouth, and the business transacted by them has had reference to the course of work to be pursued at the Laboratory and the provisions necessary for such work.

The Council are able to report a satisfactory year's work since the opening of the Laboratory at the end of June, 1888.

The various arrangements in the tank-room and laboratories have stood the test of a year's work, and prove to be well adapted for their purposes. Some slight defects have come to light and some unavoidable mishaps have occurred, but the former have been remediable and the number of the latter has been fewer than might have been expected. There has been some trouble from the bursting of the feed pipes and delivery pipes of the pumps, but these have been put right.

The Council are glad to report that the system of circulation adopted by them for the aquarium fulfils all their expectations. At first it was feared that the density of the water in Plymouth Sound, which is some degrees below that of the open sea, would interfere seriously with hatching operations. But in the last six months the density has been maintained without trouble at the normal point, and spring-water has to be added every week to make up for evaporation. The water in circulation is perfectly aërated, and marine animals thrive well in it. The tank-room has been thrown open to the public free of charge, every Wednesday afternoon, and the Director reports that it is always crowded on these occasions.

The staff of servants in the employ of the Association consists of an engineer and caretaker (C. Marshall, wages thirty shillings per week), whose wife receives £18 per annum for cleaning and dusting the building; a laboratory servant (J. Walker, fifteen shillings per week), whose duties are confined to attendance in the Laboratory; a gardener (W. Hortop, nine shillings per week, remainder of wages paid by the Director); a fisherman (W. Roach, thirty shillings per week), and a fisherman's boy (ten shillings per week).

The boats used by the Association consist of a hook and line half-decked fishing boat of five tons, hired at £1 per week, and an 18-feet open boat bought by the Association, and called the "Anton Dohrn," after the founder of the Naples station. When long expeditions have been made, a steam-tug has been hired for the occasion. The special fund for the purchase of a steamboat, started last year, has reached the sum of nearly £500, but this amount falls far short of that required for the purchase of a really seaworthy vessel.

Dredging, surface-netting, and rock-hunting have been carried on continuously throughout the year, under the superintendence of the Director and Naturalist. Many species have been added to the list, published last year, of the Fauna of the Sound, and some of these are new to Great Britain.

The area of Plymouth Sound was carefully mapped out into districts and explored by the Director in the summer of 1888. It is found that the Fauna within the breakwater is poorer than it was some years since, and the best dredging-grounds are found south of the Mewstone and eastward into Bigbury Bay, and on the soft ground around the Eddystone Lighthouse.

In connection with the dredging work a collection of standard specimens is being made, a work which will necessarily take some years before it is completed.

The Council has always been mindful of researches bearing directly on fishery questions, and besides collecting all available information on fishery matters, they have directed special researches upon food-fishes and Crustacea.

The Director of the Association (Mr. G. C. Bourne, M.A.), besides his work of superintendence and organisation, is employed on a thorough investigation of the pelagic life of the seas near Plymouth. Special results of his work will appear from time to time, but it must necessarily be long before he can assert any connection between seasons or temperature and the abundance of pelagic life on the one hand, and between the latter and the abundance of certain fish on the other.

The Naturalist (Mr. J. T. Cunningham, M.A.) has continued his researches on the development of Teleostean fishes. The preliminary results of his researches appeared in the first number of the new series of the Journal, and form a very valuable contribution to our knowledge of this subject. Mr. Cunningham, acting under instructions from the Council, is now preparing a monograph of the common sole, which will be published at the end of the year.

The Council have appointed for six months Mr. Wm. Bateson, M.A., Fellow of St. John's College, Cambridge, to conduct a series of experiments and observations on the physiology of the sense organs of food-fishes, with the special view of discovering whether any form of bait can be devised to supplement in times of scarcity the natural baits in general use. Mr. Bateson began his researches early in April.

Mr. W. F. R. Weldon, M.A., Fellow of St. John's College, Cambridge, has spent seven months of the past year in continuing his researches on the Decapod Crustacea of the Plymouth district. An important memoir on larval Decapods by Mr. Weldon is now ready for publication. Mr. Weldon is also engaged in the preparation of a monograph of the spiny lobster or crawfish (*Palinurus vulgaris*), and is conducting experiments on the artificial cultivation of the common lobster. The expenses incident to Mr. Weldon's researches have been defrayed by a grant from the Government Grant Fund of the Royal Society entrusted by the Government Grant Committee to the President of the Association, the Hon. Secretary, Professor Moseley, and Mr. Adam Sedgwick.

Mr. Walter Garstang, B.A., Assistant to the Director, has been employed on faunistic researches, especially upon the Composite Ascidians and the Nudibranchiate Mollusca.

In addition to the above, several volunteer workers have taken advantage of the Laboratory at Plymouth for pursuing zoological studies. In the summer of 1888 the following gentlemen were working at Plymouth: Mr. W. B. Hardy, B.A.Camb. (Development of *Porifera*); Mr. C. A. MacMunn, M.A., M.D. (Colouring Matter of Invertebrata); Mr. F. E. Beddard, M.A., Prosector Zoological Society (Marine *Oligochæta*); Professor Burdon Sanderson, F.R.S.; and Mr. Francis Gotch, M.A. (Electric Organs of Skates and Rays).

In the spring of this year the following gentlemen were at work: Mr. S. F. Harmer, M.A.Camb. (Anatomy and Development of *Dinophilus metameroides*); Mr. P. C. Mitchell, B.A.Oxon. (Histology of *Tunicata*): Mr. W. B. Hardy, B.A.Camb. (Physiology of *Myriothela phrygia*); Surgeon P. W. Fraser, R.N. (General Zoology).

During the summer there will be more than twelve naturalists working in the Laboratory, and the Director has been instructed to have four additional bays fitted up on the south side of the Laboratory to meet their requirements.

In order to keep up a connection with practical fishermen, the Council has submitted bye-laws providing for the admission of associate members, which were passed at a special general meeting called for this purpose on May 8th, 1889.

Amongst the receipts of the past year the Council have to report the following donations and subscriptions:—A donation of £500 from Mr. R. Bayly for bait investigation; a donation of £105 from the Drapers' Company; £100 from Mr. H. Bury; £200 from the British

Association for the Advancement of Science, to complete their contribution of £500 as Governors of the Association; £100 from the Clothworkers' Company, to complete their contribution of £500 as Governors of the Association; £200 from the Fishmongers' Company; and £500 from H.M.'s Treasury, being their Annual Subscriptions for five years from 1888.

From annual subscriptions and compositions £201 was received, in addition to £45 for rent of tables, specimens, &c., £128 interest on investments, and £340 towards a launch.

The expenditure, as shown in the Treasurer's account presented herewith, amounted to £5363, which includes £3735, the balance of the contracts.

The Association has now in hand, in cash and invested, £2550.

The Library has received important additions during the past year, but many works are still required to make it complete. The Lords Commissioners of H.M. Treasury have been pleased as an exceptional measure to present a complete set of the "Challenger" publications to the Association, and the Council wish to record their gratitude for this valuable gift. The thanks of the Association are also specially due to Professor A. A. W. Hubrecht for many zoological works collected in Holland and forwarded by him; to Professor Franz Vejdovský for a gift of his works on oligochaete worms; to Mr. W. T. Thiselton Dyer for a present of the back numbers of the Quarterly Journal of Microscopical Science; to the executors of the late R. Holman Peck for books and scientific materials and apparatus; to Professor G. B. Howes for a complete set of Buffon's Histoire Naturelle; to Messrs. J. and A. Churchill for current numbers of the Quarterly Journal of Microscopical Science; to Sir Henry Acland for several valuable works on zoology; to Mr. Rupert Vallentin for a copy of Forbes' rare monograph of the British Naked-eyed Medusa; to Dr. Brady and the Rev. A. M. Norman for a copy of their recent monograph of the Marine and Freshwater Ostracoda; to Professor Marion for the Annales du Musée d'histoire naturelle de Marseille; to Professor Alexander Agassiz, the Naples Zoological Station, the University of Copenhagen, the Liverpool Marine Biological Society, and the Marine Fisheries Society of Japan, and also to many naturalists for sets of their scientific papers.

The Council desire to record the indebtedness of the Association to the Councils of the Royal Society and the Linnæan Society for kindly permitting the Association to hold the periodic meetings of the Council and Association in their rooms.

The Council regret to have to announce that Mr. Frank Crisp, who has since the foundation of the Association been its Honorary

Treasurer and most valued adviser, finds it necessary, on account of the large demands on his time, to withdraw from the office which he has held with so much advantage to the Association. Mr. Crisp will remain a member of the Council, and continue to give the Association the benefit of his wide experience, but having helped the Association through the heavy work of collecting funds and superintending the contracts and similar matters connected with the erection of the Plymouth Laboratory, he desires to pass on his office to other hands. Mr. Crisp has been a generous subscriber to the funds of the Association, but the legal and administrative work which he has freely given to its service has been of a value which the Council can only indicate by the expression of their warmest gratitude.

The Council propose Mr. E. L. Beckwith, late Prime Warden of the Fishmongers' Company for election as Honorary Treasurer in succession to Mr. Crisp.

The Council of the British Association for the Advancement of Science having acquired the power of electing a Life Governor, have appointed Prof. Flower, C.B., F.R.S., as their representative. Mr. Bazley White, of the Clothworkers' Company, owing to other numerous engagements, has been obliged to resign his post as Governor.

The following is a list of Officers and Vice-Presidents proposed by the Council for the year 1889—1890.

President.—Professor Huxley, LL.D., F.R.S.

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; Lord Walsingham, F.R.S.; The Right Hon. A. J. Balfour, M.P.; 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.; Sir John Lubbock, Bart., M.P., F.R.S.; Prof. Alfred Newton, F.R.S.; Rev. A. M. Norman, D.C.L.; Captain Wharton, R.N., F.R.S.

Council (elected members).—C. Spence Bate, Esq., F.R.S.; Prof. F. Jeffrey Bell, F.Z.S.; W. H. Caldwell, Esq., M.A.; Frank Crisp, Esq., LL.B., B.A.; W. T. Thiselton Dyer, Esq., C.M.G., F.R.S.; John Evans, Esq., D.C.L., F.R.S.; Prof. J. Cossar Ewart, M.D.; A. C. L. G. Günther, Esq., F.R.S.; E. W. H. Holdsworth, Esq., F.L.S., F.Z.S.; E. B. Poulton, Esq., M.A., F.R.S.; G. J. Romanes, Esq., LL.D., F.R.S.; P. L. Sclater, Esq., F.R.S.; Adam Sedgwick, Esq., F.R.S.; Prof. Charles Stewart, F.L.S.; W. F. R. Weldon, Esq., M.A.

Hon. Treasurer.—E. L. Beckwith, Esq.

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

Treasurer's Account of Receipts and Payments for the Year ending 31st May, 1889.

1888.	Receipts.	£	s.	d.	£	s.	d.
June 1.	Balance brought forward :						
	£900 Forth Bridge Railway, 4% Debentures	995	2	6			
	£800 London and North Western Railway 4% Debentures	989	11	7			
	£933 North Eastern Railway 4½% Debentures	1253	3	2			
	Deposit	500	0	0			
	Cash in Bank	1469	11	2			
		£5207	8	5			
	Cash Balance on 1st June, 1888				1969	11	2
	Founder				100	0	0
	Compositions				47	5	0
	Annual Subscriptions				154	7	0
	Donations :						
	General	610	1	0			
	Mr. Bayly's Bait Investigation	500	0	0			
	Launch	340	4	0			
					1450	5	0
	H. M.'s Treasury				500	0	0
	Interest on Investments				128	16	9
	Rent of Tables, Specimens and Journals sold				45	13	10
	Securities sold :						
	£433 North Eastern Railway 4½% Debenture Stock	613	18	4			
	£800 London and North Western Railway 4% Debenture Stock	1050	14	0			
					1664	12	4
					£6060	11	1

Payments.	£	s.	d.
Berry and Co., for Building	1738	6	2
Leete, Edwards and Co., for Tanks, &c.	1014	3	0
Hughes and Lancaster, for Ejector	444	0	0
Parry and Co., for Gas Engine	250	0	0
Mr. Inglis, Fees as Engineer	200	0	0
,, Disbursements for Divers, Blasting Rocks, &c.	55	17	9
Clerk of Works, Salary	33	15	0
Mr. Bourne, Salary (25th May, 1888, to 31st May, 1889)	203	14	0
,, Sundry Disbursements, for Servants' Wages, Fish, Boats, &c.	486	12	1
Mr. Cunningham, Salary	250	0	0
,, Sundry Disbursements	19	12	4
Trade Accounts for Apparatus, Chemicals, Hire of Steamer, Gas, Water, Books, and Stationery	533	7	11
Furnishing Accounts	104	2	3
Mr. Burlase, for Boat	16	11	8
Mr. Hoyle, for Article in Association's Journal	5	0	0
Rent to the Crown (1 year, to Christmas, 1888)	2	5	0
Secretary and Treasurer's Expenses	5	16	8
Balance (net) in hand on 31st May, 1889	697	7	3
	£6060	11	1

Summary of Assets.

	£	s.	d.
Balance as above	697	7	3
£900 Forth Bridge Railway 4% Debenture Stock at 125¾%	1131	15	0
£500 North Eastern Railway 4½% ,, 145%	725	0	0
(N.B.—The above prices are those current on June 1st, 1889.)	2554	2	3

The Director's Report.—No. 2.

THAT most of the memoirs published in the present number of the Journal are purely zoological or botanical may seem to belie the promise made in my first report, that the Journal was to contain scientific memoirs bearing directly or indirectly on economical questions. Some of the papers describing the local Fauna have, in fact, an indirect bearing on fishery questions, for it is only by a study of marine life as a whole and by the knowledge of the habits of a large number of marine animals that we can hope to deal in a satisfactory manner with problems relating to the fisheries. It must not be understood that the papers published in the Journal represent the whole even of the purely scientific work of the Association. Much research is in progress, the results of which will be published in other scientific serials or in the Transactions of the learned societies, and will receive bare mention in these pages; other work is being done which will never be published at all because it is tentative, and it would be a waste of time to publish accounts of a series of fruitless experiments. The late Lord Beaconsfield, when he was laughed down on making his maiden speech in the House of Commons, finished by saying, "I have tried many things many times and I have found that I have generally succeeded in the end." The same saying will apply to scientific researches directed towards particular objects. Many experiments must be made; they must be made many times and they will generally result in failure, but in the end some success will be gained. That the greater part of this number of the Journal is not devoted to fishery matters is due to the fact that the experimental record of the past six months is largely a record of failures, not by any means indicating a waste of time or a want of skill on the part of those who have made the experiments, but showing that the problems which have been undertaken are difficult, and that time, patience, and experience are required before they can be worked out. The report of the Council gives an account of the practical work which is being carried on under its direction, and a further reason for the non-appearance of much fishery work in these pages is that Mr. Cunningham's valuable work on the life-history of the common sole is to be published as a separate volume.

Mr. Bateson's work on the physiology of the sense organs of fishes is in full progress, but it will be some time before he will be in a position to publish on the subject. A few chance observations on the habits of animals other than fishes which have come under Mr. Bateson's notice are given in this number, but his observations on food-fishes are withheld until the publication of his complete work.

A contribution from Mr. Earle, of Jamaica, is published as showing the primitive condition of the fisheries in one of our colonies, and in future numbers similar contributions from other colonies will be published.

In order that the nature of the work carried on by the staff of the Association may be understood, and the difficulties encountered in attempts to cultivate and study sea-fish may be appreciated, a short sketch is here given of the progress of the Laboratory since the beginning of this year.

In the first months of the present year, immediately after my last report was written, the Laboratory was deserted by everybody excepting the permanent staff of the Association, viz. Mr. Cunningham, Mr. Garstang, and myself. Mr. Weldon, who had stayed at Plymouth up to Christmas, was obliged to return to Cambridge to resume his duties as Lecturer on Zoology in the University, and there were no gentlemen who could spare the time to continue their observations through the winter months.

In the months of December and January herrings visit the south coast of England in large numbers and deposit their ova in bays and estuaries. At this time large numbers are taken by small boats working with two or three drift-nets in Plymouth Sound; accordingly the first practical investigation of the year was a renewed study of the habits and development of the herring. The ova of the herring, as is well known, differ from those of the majority of food-fishes in being heavier than sea-water; they adhere in masses to rocks and weeds at the bottom of the sea and can only be obtained by the dredge or, of course, directly from the ripe fish. Mr. Cunningham obtained a number of fertilized ova in the latter manner, and these were hatched in the tanks in the Laboratory. The larvæ lived and were apparently very healthy up to the time of the absorption of the yolk-sac, but after that they all perished, as it seems, from want of suitable nourishment. Mr. Cunningham tried to feed them in many different ways, but none of his experiments met with any success. In January, Mr. Cunningham and I made several expeditions to Bigbury Bay, Cawsand Bay, and the coast near Raeme Head, with the view of obtaining the spawn of the herring by means of the dredge. Although we dredged over a large area in which full and shotten herring were being caught every night we did not succeed in hitting on the spot where ova were deposited. At the same time we obtained numbers of the free-swimming fry of the herring, some of them very recently hatched and with the yolk-sac not yet absorbed, in the surface net.

In March I was present at the explosion of some submarine mines in the mouth of the St. Germans river and obtained a number of young herrings which were killed by the explosion. Some of these were very small and apparently belonged to the January brood of the year, but the majority were larger and must have been hatched out in the early months of 1888.

During the early part of February the weather was very rough and we were for some time prevented from carrying on dredging outside the breakwater. On the 12th of the month, being favoured with a fine northerly breeze, we chartered a trawler and succeeded in making a large haul of plaice, flounders, and other fish. Nearly all the plaice and flounders were ripe, and Mr. Cunningham fertilized and brought back a large number of these species, which were hatched out in the aquarium, and the larvæ lived, as those of the herring had done, until they had absorbed the yolk-sac, after which the same difficulty was found in feeding them and they all perished. At the same time Mr. Cunningham obtained the ova of the sprat and the dragonet (*Callionymus lyra*) and was able to verify some of his previous observations on these species.

The difficulty of feeding the young fry constitutes a serious difficulty to the cultivation of sea-fish. Similar difficulties have been experienced by the American Commissioners of Fisheries, who have had recourse to turning out the larvæ into the sea at the time of the absorption of the yolk-sac. Captain Dannevig, of Arendal in Norway, has been more successful and has hatched out and kept for three years herring, cod, and other valuable fishes. He keeps his fry in a large basin or tidal tank into which the sea is admitted directly by means of sluice gates. In this tank Captain Dannevig is able to grow seaweeds and to mimic the natural conditions of the sea very nearly to perfection. For some reasons which we cannot yet satisfactorily explain we are unable to keep seaweeds in the sheltered tanks of our aquarium, and in consequence we cannot supply that profusion of minute life on which the existence of the young fry depends. Success in rearing fish is probably to be obtained only by the use of tidal ponds into which the newly hatched fry can be turned loose.

In January the surface-net contained little else than Copepods of different species, and when it was attempted to feed the fry of fish with the material collected in the surface-net we found that these Copepods, instead of affording food for the young fishes, were themselves the aggressors, and attacked and destroyed the larvæ. The more delicate pelagic organisms which are so abundant in the summer months, did not make their appearance till the middle of February, when larvæ of Echinids, Asterids, Holothurians, Molluscs and Worms began to make their appearance in great numbers. At the same time many species of Copepoda were breeding, the females carrying ovisacs, and the surface was swarming with the Nauplii of pelagic Copepoda and Cirrhipedes. There can be no doubt that these larval forms afford abundant food for young fish. At a somewhat later date a gelatinous Alga made its appearance in the sea, and proved a great hindrance to the investigation of pelagic animals. With the appearance of the Algæ the surface larvæ began to diminish in numbers, and towards the end of April we obtained little else than Copepods and Algæ in the surface-net. Similar facts have been noticed by the Liverpool Marine Biology Committee off the west coast of Lancashire and Wales.

The temperature of the sea last February was higher than it was in March, 1888, being 45° Fahr. on the 12th February, against 44·6° and 43·88° on March 8th and 16th, 1888. It is possible that the somewhat higher temperature of the sea this year had some effect in pushing forward the development of many marine animals, and also in promoting the growth of the gelatinous algæ, for in a visit made to Plymouth in April, 1888, I do not remember to have heard of any trouble from the presence of the latter.

Up to April in this year the temperatures of the sea and the water in the aquarium had been taken intermittently, but since that date they have been kept regularly and entered in a book, and will be published in a tabular form after a sufficient time has elapsed for making comparisons of the seasonal variations. The water in circulation in the tanks is naturally at a somewhat different temperature to that in the sea, and the following facts may be of some interest. From April 2nd to April 11th the weather was fine and warm, and the water in the tanks varied from 48° to 48·5° Fahr., the sea temperature at the same time varying from 46° to 47° Fahr. On the 12th April the temperature of the tanks fell to 47½°, and remained at this till the 22nd, when it regained its previous temperature and rose to 49·6°, at which it remained till May 4th. During this time the sea thermometers were under repair, and we were unable to take observations. On May 7th the sea near the Shagrock was 50°, and the water in the tanks 50·9°. By the 15th the temperature had risen to 52·3° in the tanks and 54° in the sea, whilst on the 23rd it was 53·6° in the tanks and 56° in the sea. The temperature of the sea rose to 57° on June 4th, 58° on June 8th, and 59° on June 22nd, the tank temperatures for the corresponding days being 53·9°, 58·6°, and 58·8°. By July 1st the sea temperature had risen to 60°, and that of the tanks to 60·8°.

The highest sea temperature recorded by us this year was 62° on July 13th, the tanks on the same day being 60·6°. These observations are interesting chiefly from showing how closely the temperature of the water in the aquarium follows that of the sea. In midwinter, the water in the tanks being sheltered, and to some extent warmed by the hot pipes in the building, stands at a rather higher temperature than the sea, but in the summer it is generally rather below it, though seldom more than a fraction of a degree.

To resume the account of the work carried on at the Laboratory. At the end of February the Laboratory fisherman, W. Roach, was sent to Mount's Bay in a trawler to procure the fertilized ova of the whiting (*Gadus æglefinus*) and pout (*Gadus luscus*). The weather turned out very cold and boisterous, and during his week's work Roach was not only unable to keep alive the ova that he collected but caught a chill and was laid up for some days afterwards, so that dredging operations were nearly at a standstill. On March 15th the Steam Tug "Deerhound" was hired for the day, and we dredged all around the Eddystone Lighthouse in twenty-five to forty fathoms of water. Several interesting specimens were taken on this occasion.

Towards the end of March, the Universities' Lent term being over, several gentlemen came down for a month's work at Plymouth. Mr. Harmer soon discovered a new species of the interesting genus Dinophilus in rock pools below the Laboratory, and the anatomy of this animal forms the subject of a memoir in the present number of the Journal. Mr. Harmer also examined the larvæ of many species of Polyzoa. Early in April the staff of the Laboratory was increased by the arrival of Mr. W. Bateson, whose appointment by the Council for the purpose of inquiring into the physiology of the sense organs of fishes has already been mentioned. The primary object of Mr. Bateson's researches is to discover whether fish are attracted to their food by sight alone, or smell alone, or both, if by smell alone what odours are attractive to them, and the reverse, whether different fishes react differently to the same stimulus, and the like, and it is expected that his observations will be of great practical benefit. It may not be generally known to those who do not live near the sea that hook-and-line fishermen often have the greatest difficulty in procuring bait. A long line or bulter of 2000 hooks requires a large quantity of bait, and this must be fresh, whether it consists of muscles, whelks, pilchards, herrings or squid, these being the baits most sought after by fishermen. But the supply of mussels and whelks has been drawn upon to such an extent that they are very difficult to procure in many places, and for the supply of pilchard and squid the line fisherman is entirely dependent on the drift and seine netters and the trawlers. If after a spell of bad weather or scarcity of net-fish these have brought no pilchard and squid into the market, the hook-and-line men are unable to go out, though the sea may be full of hook-fish. This often is the case, and if by any means a bait could be devised which would make the hook-and-line fishermen independent of supplies from present sources they would be very greatly benefited.

On the 9th of April the Laboratory fisherman when dredging south of the Mewstone brought up an adult specimen of *Amphioxus lanceolatus,* and on the following day I went out with him and obtained another specimen. Since then a few more have been procured. As I mentioned in my last report I took four larval Amphioxus in the tow-net last autumn in nearly the same locality, and there can be no doubt that Amphioxus exists in considerable numbers in this spot, but it is very difficult to catch them. They are found in a bottom of muddy gravel at a depth of sixteen fathoms. Such a depth can only be explored by the dredge, and this does not dig deep enough into the sand to ensure the capture of more than a few chance specimens. The rapidity with which Amphioxus burrows is surprising; one of the specimens caught in April was kept for some time alive in the Laboratory, and it was astonishing to see the speed with which it thrust itself to the bottom of the shingle placed in the vessel which contained it.

Towards the end of April the commencement of the Universities' Summer Term took away most of the gentlemen who had come down to work in the Laboratory. During April and May the dredge brought up a large number of Nudibranch Mollusca, and these, together with other specimens procured at different times, have been studied by Mr. Garstang. No less than nineteen of these are new to the Plymouth district, among them the exceedingly rare species *Idalia aspersa* and *Lomanotus marmoratus*. Mr. Garstang's paper in this number gives an account of the Nudibranchs collected by the Association.

The pelagic Copepoda collected by the surface-net during the past year have occupied my attention, and I am able to add a species new to Great Britain, viz. *Oncæa Mediterranea.* I have also obtained a few specimens of the beautiful Annelid larva *Mitraria,* which, as far as I know, is also new to Great Britain.

In the last number of the Journal I described a Tornaria larva which was obtained in the neighbourhood last autumn. I am now able to include the adult Balanoglossus among the Plymouth Fauna. On July 31st a single specimen was obtained in the dredge about two hundred yards inside the east end of the breakwater. Mr. Bateson believes that it is a male specimen of *B. salmoneus*, but as it has lost its proboscis and is otherwise mutilated, it is difficult to determine its species with accuracy. A fortnight before the discovery of this specimen I obtained later stages of the larva off the south coast of Ireland. Balanoglossus is a genus new to Great Britain, but from the occurrence of the larva in such widely separated localities, it would seem that it has a tolerably wide distribution on the southern coasts of England and Ireland.

Towards the end of June the Laboratory began to fill again, and at the time of writing all the available space is occupied. Amongst the gentlemen working on the Fauna are Canon A. M. Norman and Mr. A. O. Walker, and their researches on the smaller Crustacea have already added several new species to the district. Of these the Stomatopod *Anchialus agilis*, G. O. Sars, may be mentioned as new to Great Britain, and it is interesting to record that two species of Amphipods new to Great Britain, *Lysianax ceratinus* and *Tryphosa gœsii*, found by Mr. Walker in Liverpool Bay a month since have again been discovered by him in the Plymouth district.

Since the General Annual Meeting the Association has acquired a small steam launch, the "Firefly," thirty-eight feet long. This boat is by no means an ideal steamer for dredging purposes, being suitable only for local expeditions in calm weather, but as such she is of great service, for there are many days, and especially many nights, in summer when it is impossible to get about in sailing boats owing to frequent calms.

One of the latest experiments in boats was not fortunate. Mr. Weldon in 1888 failed to rear young lobsters in the tanks beyond a certain stage, and he determined to repeat his experiment this year under more natural conditions. Accordingly he purchased the hull of a disused trawler and converted it into a well-vessel, the central well being separated from the fore and aft portions of the hold by strong bulkheads and communicating with the sea by ports cut in the side of the vessel below the water-line and covered with horsehair cloth. This vessel was moored in a suitable place in the Sound, and at the beginning of July some thousands of larval lobsters were placed in the well. For a fortnight everything went well and the young lobsters were thriving so well that the experiment bade fair to be a complete success. Most unfortunately the vessel sprung a leak on July 20th and before she could be towed ashore she sank in four fathoms of water and all the young lobsters escaped, annihilating the chance of bringing the experiment to a successful issue this year. It might have been better to have constructed a tidal pool similar to that of Captain Dannevig at Arendal, or to have built a new well-vessel rather than convert an old hull, but in either case the expense was prohibitory and the cheaper method proved a failure. This mishap is a good instance of the difficulty of obtaining a definite result in practical investigations in any given year. At the time of the foundering of the welled vessel the breeding season of lobsters was nearly past, and before fresh apparatus could be arranged for hatching and rearing the larvæ the season was fully past and the experiment impossible.

The names of the gentlemen who have worked or are working at Plymouth since January 1st are given in a table below.

G. C. BOURNE.

August 9th, 1889.

Naturalists working in the Plymouth Laboratory from January to August, 1889 (in addition to the permanent staff):

Name.	*Date of arrival.*	*Date of departure.*
W. F. R. Weldon, M.A., St. John's College, Cambridge.	March 20	April 24
S. F. Harmer, M.A., B.Sc., King's College, Cambridge.	March 22	April 20
W. B. Hardy, B.A., Caius College, Cambridge.	March 26	April 9
P. C. Mitchell, B.A., Christ Church, Oxford.	March 24	April 24
W. Bateson, M.A., St. John's College, Cambridge.	April 1	
Surgeon P. W. Fraser, R.N.	May 3	July 2
G. H. Fowler, B.A., Ph.D., Keble College, Oxford.	June 19	
W. F. R. Weldon, M.A., St. John's College, Cambridge.	June 19	
M. C. Potter, M.A. St. John's College, Cambridge.	June 24	July 6
S. F. Harmer, M.A., King's College, Cambridge.	June 26	
T T. Groom, B.A., Christ's College, Cambridge,	July 15	
Rev. A. M. Norman, D.C.L.,	July 23	
A. O. Walker, Esq.	July 29	Aug. 5
T. Johnson, B.Sc.	July 29	
A. E. Shipley, M.A., Christ's College, Cambridge.	Aug. 1	
H. Driesch, Ph.D., Jena, Germany.	Aug. 3	
P. C. Mitchell, B.A., Christ Church, Oxford.	Aug. 3	

Notes on the Anatomy of Dinophilus.

By

Sidney F. Harmer, M.A., B.Sc.,
Fellow and Lecturer of King's College, Cambridge.

With Plates IX and X.

The anatomy of *Dinophilus,* a genus established by Oscar Schmidt in 1848, has formed the subject of several memoirs, amongst which attention must be specially called to the recent papers of Korschelt (6), Repiachoff (12), and Weldon (13). A complete account of the synonymy of the genus was given by v. Graff* in 1882, whilst Korschelt (7) has, within the last year or two, published a review of the facts known with regard to the anatomy of the various species of *Dinophilus.* Full references to the literature of the subject will be found in v. Graff's monograph (loc. cit.) as well as in the memoirs of Weldon (13) and Korschelt (6 and 7). In view of the recent appearance of the above-mentioned papers, it is unnecessary for me either to give a complete list of references or to attempt any historical account of our knowledge of the genus.

The animal which forms the subject of the present paper was found at Plymouth†, and has been described as a new species, under the name *Dinophilus tæniatus,* at a meeting of the Cambridge Philosophical Society.‡

D. tæniatus was found, in very great numbers, in rock-pools far above low-water mark, during the latter end of March and the first half of April. It was unfortunately necessary to interrupt the observations on April 18th, a day or two before which time it was noticed that the eggs which were being produced by the females were rapidly developing. On returning to Plymouth on June 26th no trace of the animal was discovered. Other observers, as Hallez (4) and Weldon (13) have recorded the fact that the species of *Dinophilus* which they have respectively described are only to be found during the spring.

* v. Graff, L., Monographie der Turbellarien. I. Rhabdocœlida. Leipzig, 1882, p. 1.

† The study of the anatomy of *Dinophilus* was greatly facilitated by the excellence of the arrangements of the Laboratory of the Marine Biological Association, to the Director of which, Mr. G. C. Bourne, I desire to express my best thanks for the courtesy with which I have been treated during my visits to Plymouth.

‡ Proc. Camb. Philosoph. Soc., vol. vi, 1889.

It will not be superfluous to call attention to the fact that the bright orange colour which is so conspicuous a feature of *D. tæniatus* (as of certain other species of *Dinophilus*) cannot easily be regarded as a protective colouration. The rock-pools inhabited by this species of *Dinophilus* contain numerous bright green Algæ, and there is not the slightest difficulty in detecting with the naked eye individuals of *D. tæniatus*, whether crawling on this green background or on the mud or rocks which occur at the bottom of the tide-pool.

With regard to the habits of the animal, it may be noted that, so far as I am aware, it never performs those gyrations round a centre formed by the attachment of the tail to a foreign body, which have been described as of frequent occurrence in *D. metameroides*, for instance (4). The animal crawls (no doubt by means of its cilia) with considerable rapidity, but it is able to swim freely in the water; the latter method of progression appears to be specially characteristic of young individuals.

Specific Characters.—*Dinophilus tæniatus* is characterised as follows: Head with two circlets of præoral cilia. Body composed of five segments and a tail. Segments sharply marked off from one another in young individuals, each encircled by two rings of cilia, incomplete ventrally, where they are interrupted by the uniform ciliation of the ventral surface. Anus placed dorsally to the base of the conical unsegmented tail, surrounded by a ring of cilia, incomplete ventrally. Skin containing large numbers of transparent glandular bodies. Sexes not dimorphic. Maximum length, in either sex, about 2 mm. Colour bright orange, usually brighter in the male than in the female. Testes in the male extending nearly the whole length of the body, on the ventral and lateral sides of the alimentary canal; spermatozoa very long and undulating. Vesicula seminalis formed by the modification of the fifth nephridum on each side, opening into a median copulatory organ, whose external aperture is ventral and slightly posterior to the anus. Ovaries in the female four-lobed. Nephridia ten in number (five pairs), the fifth pair modified as a vesicula seminalis in the male. Ventral nervous system segmented.

As characters recognisable in living specimens, and which are sufficient to distinguish this species from all others at present known may be mentioned the following:

(1) The existence of five body-segments (in addition to the tail), each encircled dorsally and laterally by *two* rings of cilia; the segmentation being sharply marked in immature individuals.

(2) The four-lobed condition of the ovaries in the female.

(3) The existence, in the male, of a median penis and of lateral

vesiculæ seminales (in which respect, however, *D. vorticoides* may possibly be found to agree with *D. tæniatus*).

The characters above given appear to be amply sufficient to justify the formation of a new species. The species which most resembles *D. tæniatus* is probably *D. gigas*, Weldon, which, however, differs from it in such important features as the number of the segments, the arrangement of the ciliated rings, the general character of the reproductive organs, and more particularly the absence of a copulatory organ in the male sex.

External Features.—The form of the body is shown in Pl. IX, fig. 1, which represents a rather young individual (the distinctness of the cilia having been somewhat exaggerated). In an old animal, distended with ripe generative products, the external segmentation is not nearly so conspicuous as in the specimen figured. The arrangement of the cilia is often difficult to make out in living specimens, but may be very easily observed after treatment with hot corrosive sublimate, and before the extraction of the orange pigment by means of alcohol. In specimens thus treated, the cilia appear as white bands running over an orange background; when seen from the dorsal surface, the two rings of each segment together give rise to the impression that the middle region of the segment is encircled by a broad band; this appearance has suggested the specific name *tæniatus*.

The ciliation of the head is best studied in a sublimate specimen, seen from the anterior pole (fig. 8). The general surface of the head is not ciliated, the cilia occurring, on the contrary, as two definite præoral rings, between which are situated the eyes, near the dorsal surface. The anterior ring is more or less triangular, the apex of the triangle being directed dorsally.

In looking at the animal from above, it is seen that the posterior cephalic ring passes dorsally across the equator of each of the eyes (fig. 1). This ring, unlike all the other ciliated rings of the animal, is composed of several circlets of cilia. Of these, the first consists of long cilia directed forwards, and the third or last of somewhat shorter, backwardly-directed cilia. Between the two circlets occurs an intermediate series of very minute cilia (figs. 1, 15). It follows from this description that in structure, as in position, the second cephalic ring resembles the præoral ciliated band of a Trochosphere larva. No ciliated pits were observed. The head bears long, stiff sense-hairs arranged in two groups, situated within the area circumscribed by the anterior ciliated ring (fig. 1). Similar sense-hairs occur on various parts of the body and tail.

The study of longitudinal sections, in which, however, the cilia were not very well preserved, appeared to show that the second præoral ring becomes much broader in approaching the ventral surface, and that it becomes indistinguishable from an investment of cilia which clothes the ventral surface of the head and which passes continuously into the ciliated lining of the œsophagus (cf. fig. 3). The examination of the ciliation of the ventral surface of the head is always difficult in fresh specimens, but at the time when these were accessible to me, I believed that I could convince myself that the anterior circlet of the second præoral ring passed completely round the head, as shown in fig. 15. The most satisfactory way, it appears to me, of reconciling the apparent discrepancy between fig. 3 and fig. 15, is to assume that, whilst the anterior circlet of the second præoral ring does really pass continuously round the ventral surface of the head, the middle and posterior circlets become, ventrally, an extensive ciliated area which is continuous with the ciliated lining of the œsophagus.

The arrangement of the five pairs of ciliated rings which occur on the body and of the perianal ring is sufficiently explained by fig. 1. All these rings are interrupted by the cilia which cover, in a uniform sheet, the entire ventral surface of the body and of the tail.

Alimentary Canal.—The mouth occurs on the ventral surface, at the limit between the head and the first segment of the body. The aperture of the œsophagus is guarded by two lip-like structures, an outer and an inner. Of these, the former constitutes the outer wall of a triangular space (fig. 15) which includes in front the aperture into the œsophagus, and behind the end of the tongue-like structure formed by the muscular appendage of the œsophagus. The arrangement of this organ is well seen in the longitudinal section figured (fig. 3), where it will be noticed that the end of the muscular appendage (which is covered by a modified, probably hardened epidermis) projects into the space enclosed by the outer lip. A similar arrangement is figured by Repiachoff (No. 12, pl. iv, fig. 1) in *D. gyrociliatus*, whilst the disposition of the organ appears, from Weldon's description (13), to be somewhat different in *D. gigas*.

In front of the tongue-like structure is seen the aperture into the œsophagus (fig. 15). This aperture is subtriangular, and is bounded by the two richly ciliated inner lips.

The course of the alimentary canal is shown in fig. 3. The œsophagus ascends obliquely towards the dorsal surface, the lateral walls of its first part being thickened (*v.* fig. 10), and passing continuously into the inner lips. The posterior section of the œsophagus lies very near the dorsal skin, and is lined by cells which have a more glandular appearance, and which bear longer cilia than those which line the anterior two thirds of the œsophagus. The posterior division corresponds to the proventriculus ("Vormagen") described by Korschelt in *D. apatris*.

As in other species of *Dinophilus,* racemose salivary glands open into the anterior division of the œsophagus.

The stomach (which, during life, is of a rich orange colour) is ciliated throughout : it ends cæcally on the dorsal side of the commencement of the intestine, as in *D. gigas.*

The intestine, like the rest of the alimentary canal, is ciliated. It opens into the stomach by a narrow aperture situated on the ventral side of the latter.

As will be seen by reference to fig. 1, the œsophagus and its muscular appendage belong to the first segment of the body, the stomach occupying the second, third, and fourth segments, whilst the intestine is found in the fifth and posterior part of the fourth segment.

Nervous System.—Although Korschelt (6) and Repiachoff (12) succeeded in finding the brain of *D. gyrociliatus,* our knowledge of the nervous system of *Dinophilus* is in the main due to Weldon (13), who has not only described the brain, but has shown that this structure is connected with ventral cords, whose arrangement resembles that found in *Protodrilus* (*v.* Hatschek, No. 5).

The nervous system of *D. tæniatus* exhibits a feature which has not hitherto been described in any species of *Dinophilus.* The ventral cords are distinctly segmented, the number of ganglionic enlargements—five—corresponding with that of the segments of the body.

The ventral cords (figs. 3, 10 and 11) are situated outside the basement-membrane of the skin, and lie, widely separated from one another immediately, on the median side of the longitudinal muscles (as in *D. gigas*). The cords seem to be provided with an external investment of ganglion-cells along their whole length. The ganglionic swellings (fig. 3) appear to be shifted backwards, relatively to the segment to which they respectively belong, so that the middle of the segment on the dorsal side (as indicated by the ciliated rings) is in front of the corresponding ganglion.

In transverse section (fig. 10) it may be seen that each pair of ganglia is connected by a transverse commissure. I could not satisfy myself of the existence of ganglion-cells in connection with this commissure, although, as the whole ventral nervous system lies in the ectoderm, it is possible that some of the nuclei which are adjacent to the commissures may really belong to ganglion-cells, and not to the epithelial portion of the skin. No transverse commissures were discovered other than those which pass between the ganglia.

The brain is very large, and fills up nearly the whole of the præoral lobe (figs. 3, 9). It consists internally of fibres, and externally of numerous ganglion-cells arranged in groups. The structure of the brain is very complicated ; its surface appears lobulated, owing to the arrangement of the ganglion-cells. A similar arrangement is figured by Repiachoff (12, pl. ii, fig. 10).

The brain gives off a pair of strong œsophageal commissures (fig. 9), which pass round the sides of the mouth to become connected with the ventral cords, as has been described by Weldon in *D. gigas*. The brain itself is, for the most part, separated from the skin by the basement membrane of the latter. The œsophageal commissures at first lie inside the basement-membrane, but perforate the latter shortly before they become continuous with the ventral cords.

On the ventral side, in front and on the median side of the origin of the œsophageal commissures, the brain becomes continuous with the ectoderm at two points, one on each side of the middle line (cf. fig. 6). It is probable that the tactile organs of the head itself receive their nerve-supply from this region of the brain, which, however, sends off at the same point an œsophageal nerve (figs. 6, 9, and 10) which may be traced, on each side of the œsophagus, as far as the end of the latter; these nerves were not observed to occur in the proventriculus. The œsophageal nerve supplies the wall of the œsophagus itself, and gives off a branch which can be traced as far as the surface of the muscular appendage.

The eyes, which are of a bright red colour, lie on the dorsal surface of the brain, immediately below the basement-membrane of the skin (fig. 9). Each consists of a double pigmented sac, filled with a clear substance, which no doubt functions as a lens. In surface view (fig. 1) the cavity of the eye is not seen, but it is shown in the horizontal section, fig. 7. Remembering that the plane of the section, fig. 9, is at right angles to that of the section, fig. 7, the difference between the two eyes in the former is readily accounted for by the obliquity of the section.

The ventral part of the head is provided with a pair of small sacs, each of which has an extremely fine lumen opening to the exterior at one side of the anterior portion of the mouth (fig. 9). These bodies are presumably sense-organs, since they are supplied by the above-mentioned œsophageal nerves. Similar organs are described by Repiachoff (12, pl. iv, figs. 1, 3, *y*) in *D. gyrociliatus*, in which species it must be noticed that they occur in addition to lateral, cephalic, ciliated pits.

Body-cavity.—The body-cavity is represented partly by irregular spaces in the loose connective tissue, as described by Weldon in *D. gigas*, and by Repiachoff in *D. gyrociliatus*, partly by more definite spaces, which seem to be specially connected with the internal ends of the nephridia. In males which are sexually mature, by far the greater part of the space between the alimentary canal and the skin is taken up by the very largely developed generative organs (*v.*

fig. 13). The further relations of the body-cavity may be conveniently considered in connection with the excretory and reproductive systems.

Nephridia.—Like *D. gyrociliatus*, as figured by Ed. Meyer (11, and as described, on Meyer's authority, in Lang's Polycladen, p. 678), *D. tæniatus* possesses five pairs of nephridia, whose arrangement is in some respects different from that of the same organs in *D. gyrociliatus*. It may be at once noted that the occurrence, in two species so distinct as *D. gyrociliatus* and *D. tæniatus*, of five pairs of nephridia, raises the question whether the body may not possibly consist of five metameres throughout the genus *Dinophilus*, in spite of variations in the number of the ciliated rings. Thus, according to Korschelt (6), Repiachoff (12)* and Meyer (11), *D. gyrociliatus* is characterised by the possession of seven post-oral ciliated rings (one of which is perianal), in spite of which fact there only five pairs of nephridia. It may, however, be noted that Korschelt figures (pl. xxii, fig. 43) a recently hatched (female) individual, in which the body consists of six segments, sharply marked off from one another, in addition to the tail.

In the female *D. tæniatus* the five pairs of nephridia are all alike, whilst in the male the fifth pair is modified as a part of the generative apparatus. The fifth nephridia of the female occur in the fifth segment of the body, on the ventral side of the intestine (behind the cæcal end of the stomach). The fourth nephridium has exactly the same position with regard to the stomach as the fourth nephridium of the male; it lies behind the posterior ovarian lobe. The third nephridium is situated between the two lobes of the ovary, whilst the second and first nephridia are in the same position as in the male sex.

The following, more detailed description refers entirely to the male, in which the nephridia can be more easily investigated than in the female. The general arrangement of the system may be understood from fig. 15, which illustrates the anatomy of a male *D. tæniatus* as seen from the ventral surface under a compressorium. The figure of course represents the combined results of a long series of observations, but it must be premised that the opacity of the animal was sufficient to prevent any complete elucidation of the structure of the nephridia.

The first four pairs of nephridia may be considered together. Each nephridium opens to the exterior on the ventral side of the body, and probably not far from the longitudinal nerve-cords. The observation of the exact point where the nephridium pierces the skin

* Repiachoff is strongly of opinion that there is no specific difference between Korschelt's *D. apatris* and the earlier described *D. gyrociliatus*.

the above-mentioned pigmented connective-tissue cells.

The internal end of the nephridium is composed of a triangular, ciliated appendage, the apex of which is inserted into the excretory portion of the tube. This insertion, in the case of the second, third, and fourth nephridia, takes place at some little distance from the proximal end of the excretory portion. The appendage is ciliated, the cilia together giving the appearance of a pointed flame-like structure which projects obliquely into the excretory portion of the organ. In certain conditions of the nephridium the ciliated appendage has exactly the appearance of a flame-cell, although as the animal dies and the cilia become more sluggish in their movements, the flame-like appearance is lost. I am inclined to believe, as the result of a long series of observations, that the appendage is provided with a number of cilia, which, working together, produce the optical illusion of a vibratile flame. This is almost certainly true of the portion of the tube described above as the duct, this region being undoubtedly lined by cilia, which, under certain conditions, give rise to a very flame-like effect.

In spite of having devoted a large amount of time to the observation of the ciliated appendages, I am unable to say whether or not

* The form of each nephridium representing the result of one or more actual observations, made at different times.

was extremely difficult, but it may be taken as probable that the external aperture, in each case, is at a level between the two rings of cilia possessed by the segment to which a given nephridium belongs. The inner end of the first nephridium is very slightly behind the principal (second) præoral ring of cilia; this nephridium opens to the exterior on the first body-segment, and may be regarded as the equivalent of the head-kidney of a Trochosphere larva. The second nephridium commences at the anterior end of the stomach, runs at first dorsal to the testis, then bending round to open to the exterior on the ventral surface of the second segment. The third nephridium lies at the level of the middle segment, and, like the second, has its excretory portion situated on the dorsal surface of the testis, its duct curving round to open ventrally on the third segment. The fourth nephridium lies, in the fourth segment, on the ventral surface of the stomach, its internal end occurring close to the aperture from the stomach into the intestine. Its duct, unlike the ducts of the second and third nephridia, runs entirely ventral to the testis.

The internal end of each of the above nephridia lies in a perfectly definite space, which contains an orange fluid and which is probably merely a specialised portion of the general body-cavity. It is almost certainly the case that the spaces which surround the internal ends of the nephridia are continuous with one another, as shown on the right side of fig. 15. In the case of the first three nephridia, the space in question lies on either side of the alimentary canal, and in living specimens was usually most readily distinguishable in the region of the third nephridium, as a distinct cavity, apparently without proper walls, between the stomach and the membrane of the testis. In transverse sections it could usually be seen that this part of the body-cavity extended to the ventral side of the stomach (*v.* fig. 13), whilst in the region of the fourth nephridia, the median portion of the cavity was, in most specimens, observed to pass down ventrally as far as the skin, thus dividing the testis, in this region, into two symmetrical, right and left lobes. In the median space thus formed are situated the internal ends of the fourth nephridia.

The remainder of the general body-cavity consists of a meshwork of spaces, filling up the intervals between the various organs and the skin. These spaces are, like those described by Weldon in *D. gigas*, devoid of an epithelial lining. Many of the cells which bound these lacunæ are large, branching connective-tissue cells, which contain an orange pigment. The pigmented cells are usually more numerous in the male than in the female, their pigment in the female being often markedly paler in colour than in the male, whilst (in the female) their tint tends to be yellow rather than orange. The difference in the colouration of the two sexes, above alluded to in the description of the specific characters, is dependent on the condition of the connective-tissue cells.

Each nephridium (of the first four pairs) consists of three portions: (i) the ciliated appendage; (ii) the excretory portion; (iii) the duct. The entire nephridium is almost certainly composed of a small number of perforated cells, although no nuclei were discovered: it forms a moderately short tube, without convolutions, the curvature of the tube, as actually observed, doubtless depending to some extent on the position of the animal in the compressorium. Thus the differences between the nephridia of the two sides in fig. 15* probably imply nothing more than that the direction of the compression was not the same in all the observations made.

The excretory portion of the nephridium is of a distinct greenish-yellow or orange colour, the walls of this portion of the tube containing numerous colourless vacuoles, and granules of various sizes. One or two of the granules are very frequently large and deep orange in colour. The excretory portion is pear-shaped, the narrow end shading off insensibly, by gradual loss of the vacuoles and granules, into the duct. The first nephridia seem to be usually provided with two swollen portions, whose walls contain excretory granules and vacuoles, instead of with one only, as in the case of the remaining excretory organs. The nephridium is often suspended in a cord of the above-mentioned pigmented connective-tissue cells.

The internal end of the nephridium is composed of a triangular, ciliated appendage, the apex of which is inserted into the excretory portion of the tube. This insertion, in the case of the second, third, and fourth nephridia, takes place at some little distance from the proximal end of the excretory portion. The appendage is ciliated, the cilia together giving the appearance of a pointed flame-like structure which projects obliquely into the excretory portion of the organ. In certain conditions of the nephridium the ciliated appendage has exactly the appearance of a flame-cell, although as the animal dies and the cilia become more sluggish in their movements, the flame-like appearance is lost. I am inclined to believe, as the result of a long series of observations, that the appendage is provided with a number of cilia, which, working together, produce the optical illusion of a vibratile flame. This is almost certainly true of the portion of the tube described above as the duct, this region being undoubtedly lined by cilia, which, under certain conditions, give rise to a very flame-like effect.

In spite of having devoted a large amount of time to the observation of the ciliated appendages, I am unable to say whether or not

* The form of each nephridium representing the result of one or more actual observations, made at different times.

these structures open into the portion of the body-cavity which undoubtedly surrounds them. In some cases the appendage appeared distinctly bifid (fig. 15), whilst in others it had a fimbriated appearance, and seemed to be composed of a large number of minute, elongated, pear-shaped bodies, each attached by its narrow end to the point where the appendage as a whole passed into the excretory portion of the tube. These minute bodies vibrated individually (*i. e.* not in connection with their neighbours) in the body-cavity space in which they were situated. These observations do not appear to favour the view that the ciliated appendage contains a single vibratile flame, nor indeed to render it easy to suppose that the appendage opens into the body-cavity.

At the same time, it must be noted that the ciliated appendages of the first nephridia are somewhat larger than those of the other nephridia, and that several observations were made which seemed to show that the appendage did really open into the body-cavity. In one of these cases I believed that I could see the individual cilia of the appendage projecting into the body-cavity. It is not impossible that the anterior nephridia have attained a somewhat higher degree of differentiation than the remainder.

The proximal end of the excretory portion, into which the cilia of the appendage project, as above described, does not seem to be ciliated, whilst the lumen of this region of the nephridium appears to be often in the condition of a series of isolated vacuoles rather than of a single passage continuous with the cavity of the rest of the organ. Cilia make their appearance towards the end of the pigmented portion, and can be followed uninterruptedly, from that point, as far as the external aperture. The "duct" has extremely delicate, colourless walls, and, as just stated, is richly ciliated internally.

Generative Organs.—A. *Male.*—The testes consist at first (as is shown by the examination of young individuals) of minute, paired, linear cords of cells (fig. 11), lying on the ventral side of the stomach in the general connective-tissue of the body.* It appeared probable that the testicular cells were simply differentiated connective-tissue cells. Owing to an injury to the tail end of the individual from which fig. 11 was drawn, it could not be ascertained whether or not a penis was already developed.

At a slightly later stage the cords of cells which constitute the young testes are found to have become slightly expanded in a lateral

* It is not impossible that this and the next stage described may really be young conditions of the *female* generative organs, and that, for instance, the structure described as the penis may be the unpaired oviduct. I believe, however, that I am right in identifying the animals in question as young males.

direction, so as to form a pair of narrow, horizontally placed plates of cells, still separate from one another. The penis is already developed as a hollow mass of cells attached in its definitive position by a narrow stalk to the ventral ectoderm of the body. There is no connection between the testes and penis, nor could any vesiculæ seminales be identified with certainty in the sections on which the observation of this stage was made. As development proceeds, the lateral extension of the testes goes on increasing, and the two originally separate rudiments fuse from place to place across the middle line. The testis now consists of a solid plate, composed of a few layers of cells, extending along the ventral side of the stomach, and still showing obvious traces of its double origin. The testis next extends laterally round the stomach, still composed of a solid mass of cells. In the final condition, some of these sperm mother-cells are found in groups in various parts of the testis, whilst ripe and half-ripe spermatozoa are found moving about freely in the indefinite cavity which is by this time excavated in the interior of the organ. The testis is separated from the body-cavity by a distinct membrane.

Although, in the adult condition, the testis is constantly continuous across the middle line in its anterior and posterior regions, it is usually divided into two lateral halves, in the region of the aperture from the stomach into the intestine, by a median extension of the body-cavity, which, as already explained, contains the internal ends of the fourth nephridia. The testis, in its most fully-developed form, extends from the region of the muscular appendage of the œsophagus nearly as far as the anus, as shown in fig. 15.

Unripe spermatozoa are found, attached together in sperm-morulæ, in the cavity of the testis. The fully developed spermatozoon (fig. 4) is an extremely long, actively moving, undulating fibre. It hence closely resembles in form the spermatozoon of *D. vorticoides* as described by van Beneden (1) and Mereschkowsky (10) excepting that Mereschkowsky describes and figures a swollen head in the spermatozoon of *D. vorticoides*. I believe that no such structure occurs in *D. tæniatus*, although at the time when fresh material was accessible to me I was not familiar with Mereschkowsky's paper.

Although ripe spermatozoa may be found in any part of the adult testis, they are always present at its posterior end, if they have anywhere reached their mature condition. As has been already explained, the testes are fused together across the middle line in the region of the fifth body-segment, and the ripe spermatozoa which accumulate in this part of the organ are taken into the interior of a pair of vesiculæ seminales (*v.* fig. 15). In their most fully developed condition these structures are much larger than in the figure

that while, for instance, fertilization was being effected near the posterior end of the body, a great mass of spermatozoa (obviously obtained on a previous occasion) was visible at the anterior end of the body. In many cases the females were enormously distended with spermatozoa, which could hardly have been all received at one time.

The common occurrence of great numbers of spermatozoa in the body of the supposed female might suggest that *D. tæniatus* was hermaphrodite. Such a supposition is rendered sufficiently improbable

* Korschelt (6) has probably seen something of this process in *D. gyrociliatus*.

just alluded to (cf. fig. 3), and occupy a large proportion of the cavity of the fifth segment.

The connection between the testis and the vesiculæ seminales is by no means easy to discover in sections, but can be best made out by careful compression of the living animal. Under these conditions, it may be observed that the anterior end of the vesicula seminalis is quite closed, and that the communication with the testis is effected by the agency of a ciliated funnel, which passes forwards from the posterior end of the vesicula, and somewhat from its ventral surface, to open into the posterior median region of the testis (fig. 15). This region is reduced to a narrow space between the two vesiculæ seminales (and therefore ventral to the intestine) during the condition of full distension of these structures by spermatozoa.

The funnel and the adjoining part of the inner wall of the vesicula are ciliated, but I believe that cilia do not occur in all parts of the latter. The vesiculæ seminales never contain unripe spermatozoa, although mature, actively moving spermatozoa are to be found in the cavity of very young and small vesiculæ, even when no such spermatozoa could be seen in the testis itself. This implies that the spermatozoa tend to make their way to the posterior part of the testis as soon as they become ripe.

It is perhaps worth while to mention that the above account of the communication between the testis and the vesicula seminalis has been confirmed, in its general features, by the study of sections.

The fully developed vesiculæ seminales are regularly ovoid in form, with their principal axes parallel to the main axis of the body of the animal. The posterior pole of each vesicula passes into a very obvious duct, which opens laterally into the sheath of the copulatory organ.

The generative pore is a median structure, situated on the ventral side of the base of the tail, a little posterior to the level of the anus (figs. 3, 15). The pore opens into a vestibule, into which projects the extremity of the penis. This organ is embedded anteriorly in a solid glandular mass of cells, and consists of two parts. The first of these is composed of very distinct cells, of a glandular appearance, and staining very deeply with carmine or hæmatoxylin. These cells radiate in a single layer from the internal cavity of the organ. The second part of the penis projects into the generative vestibule, and consists of a series of narrow, spike-like rods (in which nuclei could be distinguished), which, lying side by side, form a truncated cone, open at its extremity, and continuous with the cavity of the penis.

A copulatory organ of the same general character as that above described is well known to occur in the dwarf males of *D. gyrociliatus* (Korschelt, Repiachoff, &c.), whilst from a figure (plate viii, fig. 7) given by M'Intosh (9) of *D. vorticoides* it appears probable that the entire male generative apparatus of this latter species closely resembles that of *D. tæniatus*.

So far as I am aware, copulation has not hitherto been actually proved to take place in any species of *Dinophilus*.* The proof that such a process takes place in *D. tæniatus* is very readily obtained by merely placing a considerable number of individuals of both sexes in a small quantity of sea-water, as in a watch-glass. Under these circumstances, it is noticed, even a very short time after the animals have been placed together, that here and there a male is attached, by means of its penis, to the body of a female. In these cases, the terminal, conical portion of the penis is protruded through the generative pore, and is passed into the skin of the female; spermatozoa are then seen to have passed from the vesiculæ seminales, through the skin of the female, and to be accumulating themselves into a mass immediately beneath the perforation made by the penis.

There seems to be no localisation of the spot at which spermatozoa can be introduced into the female. The penis can obviously be inserted into the skin at any point, as is shown by the fact that, in the cases actually observed, the point selected was sometimes in the region of the neck, in other cases far back in the body of the female, and in other cases near the middle of the body.

The act of copulation has no relation to the maturity of the ova of the female, nor is it prevented by the fact that the female has already received an ample supply of spermatozoa by a preceding operation. It was extremely difficult to discover any female, in which ovaries were recognisably developed, which did not contain large numbers of spermatozoa in its body-cavity. These were observed in almost any part of the body of the animal, their position being probably partly dependent on the manner in which fertilization had been previously effected. The spermatozoa show, however, a great tendency to accumulate into a large compact mass, situated in a space on the ventral side of the stomach (*v.* fig. 14, and description of the female generative organs). In some cases it was observed that the female was receiving spermatozoa simultaneously from two males, in others that while, for instance, fertilization was being effected near the posterior end of the body, a great mass of spermatozoa (obviously obtained on a previous occasion) was visible at the anterior end of the body. In many cases the females were enormously distended with spermatozoa, which could hardly have been all received at one time.

The common occurrence of great numbers of spermatozoa in the body of the supposed female might suggest that *D. tæniatus* was hermaphrodite. Such a supposition is rendered sufficiently improbable

* Korschelt (6) has probably seen something of this process in *D. gyrociliatus*.

by the following considerations: (i) That no other species of *Dinophilus* is known to be hermaphrodite; (ii) that the process of fertilization was frequently observed in *D. tæniatus;* (iii) that the spermatozoa so constantly seen in the female of the same species were, without exception, ripe and actively moving, no trace of spermmorulæ or unripe spermatozoa being discernible. Such stages in the development of the spermatozoa were never missed in any adult male individual.

It will be noticed that the above-described process of copulation in *D. tæniatus* exactly resembles the processes which have been described by Lang (8, p. 231) in certain *Polyclada* (*Anonymus*, &c.)

The morphology of the vesiculæ seminales is one of the most interesting features of *D. tæniatus*, since there is reason to believe that these structures are the modified fifth nephridia of the male. The reasons for this conclusion are two:

(i) Five pairs of ordinary nephridia occur in the female *D. tæniatus* (as in the female *D. gyrociliatus*), whilst the most careful examination, often repeated, of the males of the same animal failed to show any trace, in that sex, of the existence of a fifth pair of undifferentiated nephridia.

(ii) The consideration of young stages of the vesiculæ seminales.

Fig. 5 represents the earliest of these stages which was observed. The vesiculæ seminales were in their definitive position in the fifth body-segment, and their indentification as vesiculæ was rendered sufficiently certain by the fact that they contained ripe spermatozoa. The vesiculæ were arranged in an obliquely transverse position, their outer portions ending blindly at a level between the two ciliated rings of the fifth segment, their inner ends opening into the cavity of the testis. A part of the vesicula immediately succeeding the internal aperture was lined with long cilia; the next part of the tube contained a small mass of spermatozoa. The penis was well developed, and obscure indications of a duct leading from the vesicula to the penis were observed; the existence of this duct was not, however, completely proved. The resemblance of the young vesicula seminalis to an ordinary nephridium was manifested, not only in its shape and position, but still more conspicuously by the fact that its walls contained an orange pigment, exactly resembling that so commonly found in the walls of the excretory tubes.

Stages intermediate between that represented in fig. 5 and the mature form of the vesicula seminalis were frequently observed. The final form is acquired by the gradual distension of the originally subcylindrical tube by spermatozoa, this distension being accompanied by an alteration in the direction of its axis, the result of which processes is that the end which, in the young vesicula, is external, is situated, in the adult condition, in front, the whole organ having now acquired an antero-posterior direction. The funnel, during the above changes, will naturally come to be situated near the posterior end of the organ.

There seems, therefore, fair reason to assume that the young vesicula seminalis shown in fig. 5 is morphologically the fifth nephridium; it must be especially noted that the funnel of the vesicula is in a position corresponding with that of the ciliated appendage of an ordinary nephridium, and that the original external aperture of the modified nephridium was probably (in the phylogenetic history of the organ) at the opposite end of the tube, which ultimately becomes the blind anterior end of the vesicula. The relations of the outer end of the young vesicula to the ciliated rings of the fifth segment further support this conclusion. The connection of the vesicula seminalis with the penis would, in this case, have to be regarded as having been acquired secondarily. Should the above account of the vesiculæ seminales of *D. tæniatus* be confirmed, the structure and mode of origin of these organs might be held to have an important bearing on the question of the phylogeny of the differentiated Chætopod nephridium. The structure of the first four nephridia in the male *D. tæniatus*, or of all five nephridia in the female, is obviously comparable with that of the head-kidney of a Chætopod larva. In this connection the figures given by Ed. Meyer (11) of the larval excretory organs of *Nereis* (Taf. xxvii, figs. 2, 3) and of *Polymnia* (Taf. xxvii, fig. 11) may be especially alluded to. The possibility of the conversion of the internal end of a head-kidney-like nephridium into a ciliated funnel, and of the entire nephridium into a vesicula seminalis, is a fact (if it be a fact) of some morphological interest.

Whilst the excretory nephridia of the male *D. tæniatus* open into a space which has been described above as a part of the body-cavity, the vesiculæ seminales open into the cavity of the testis. In certain other Archiannelids (*Protodrilus, Polygordius*), the space which is partially lined by generative cells, is certainly part of the body-cavity. From the analogy of these forms, it may perhaps be concluded that, in *Dinophilus*, the hardly differentiated space which occurs in the interior of the ripe testis is also a part of the body-cavity. In this case we could assume that whilst the excretory nephridia open into the general body-cavity, the vesiculæ seminales of *D. tæniatus* have acquired an opening into a special generative division of the cavity. Attention may be called to the similarity between the young generative organs shown in fig. 11 and the mesoblastic bands of a Chætopod larva, and also to the similarity between the subsequent history of the testis of *D. tæniatus* and of the body-cavity of the developing Chætopod. Although I make this suggestion with all reserve, it is perhaps possible* that in the connective-tissue lacunæ of the body of *Dinophilus* we have the representative of the so-called "primary body-cavity," whilst in the fully-developed male (fig. 13), the "secondary body-cavity" is represented by the cavity of the testis, with which the funnels of the vesiculæ seminales are connected.

B. *Female.*—The generative organs in the female *D. tæniatus* differ considerably from those of other known species of the genus, in the fact that the ovaries are four-lobed. The general arrangement of the ovaries will be understood by referring to fig. 2, where it will be seen that the ovaries, like the testes, are paired bodies, but that each half is subdivided into two lobes. Each lobe consists partly of small primordial ova and (in a moderately mature condition) partly of larger eggs which have already acquired the orange colour which characterises the ripe eggs. The ovaries are covered by a cellular investment, which is readily seen in fresh specimens to be continuous from lobe to lobe on each side of the body. The ovaries, as in *D. gigas*, are found on the ventral side of the stomach. No ducts could be discovered in the living animal. Spermatozoa, received during the process of copulation, occurred in almost every individual in which the ovaries were at this stage or more highly developed. In specimens in which the ova had become still further developed, the eggs were no longer confined to the four ovaries. As many as fourteen large spherical eggs of a distinct orange colour may, in such cases, occur on the ventral side of the stomach or intestine, and the two ovarian lobes of each side are then usually pushed apart from one another by the occurrence of ripe eggs between them.

Fig. 14 represents a transverse section through the region between the anterior and posterior ovaries of a female with numerous and fully-developed ova. On the ventral side of the stomach is a large space, containing a great mass of ripe spermatozoa, which appears to have no proper wall on its dorsal side at least, being in this region merely roofed in by the stomach. Laterally its walls are formed by the cellular investment of the ovaries, this investment passing across the middle line of the body on the ventral side of the space. In a section which passed through one of the ovaries on each side, the ovarian lobes would simply take the place of the ripe eggs shown in fig. 14. The cellular investment of the ovaries already noticed in fig. 2 would be seen to surround each lobe completely, and to be further continuous across the middle line on the ventral side of the interovarian space, exactly as in fig. 14.

Fig. 12 represents a longitudinal section through the two ovaries

* As has previously been suggested, for other animals, by the Hertwigs.

of the same side at a much earlier stage of development, at a period, indeed, when the entire ovary is composed of a mass of small, uniform, primordial ova. The relations of the investment of the ovaries are further explained by this figure, in which it is seen that the space between the anterior and posterior lobes is, as in the later stage, devoid of any epithelium on its dorsal side. Ventrally, the space is floored by a single layer of cells, separated from the skin by loose connective tissue; the space itself contains (as was occasionally observed in older stages) a few free cells of unknown function.

In the absence of any developmental evidence it is not easy to say what is the nature of the interovarian cavity. From the analogy of the male, as well as from a consideration of the general arrangement of the ovaries, it would appear that the ovaries are primitively paired bodies, and not merely lateral thickenings of a median cavity. The interovarian cavity would thus be a specialised portion of the general body-cavity, which conclusion would be supported by the absence of any proper wall, the space being bounded partly by the investment of the ovaries and partly by the wall of the stomach. The conclusion is further strengthened by distinct evidence obtained from sections, that the internal ends of the fourth nephridia project into the space.

In most females observed in section there was found to be a mass of spermatozoa at the sides of the stomach and dorsal to the ovaries, these masses of spermatozoa usually passing continuously into the large central mass which is nearly always present in the interovarian cavity. The spaces in which these lateral masses of spermatozoa lie appear to be parts of the general body-cavity, which is hence continuous with the interovarian cavity at those points where the spermatozoa enter the latter. This continuity does not necessarily prove that the ventral space is really part of the body-cavity, as, from the method in which the spermatozoa are introduced into the female, they must probably often have to make their way through various obstructions in order to reach the ventral space.

The layer of cells connecting the two ovaries (figs. 12 and 14) across the middle ventral line of the body may thus be provisionally interpreted as resulting from the median fusion of two originally separate organs, and this process probably takes place at an early stage of development, as in the case of the testes of the male.

The interovarian cavity extends along the middle line of the body throughout the whole of the region of the stomach, and therefore occurs, not only between the ovaries themselves, but also behind and in front of the ovaries, which are lateral thickenings of the walls of the cavity, projecting into it. In consequence of this projection, the posterior part of the cavity in fig. 12 is separated (in the particular section in question) from that part which occurs between the anterior and posterior lobes; the posterior part of the cavity is of course continuous with the anterior part. It will be noticed from fig. 12 that the posterior part of the interovarian cavity has an epithelial wall on its dorsal side as well as on its ventral side, and the same is true of the anterior end of the cavity (not involved by the section shown in fig. 12). The complete conversion of the interovarian cavity into a tube which runs backwards below the intestine takes place at the level of the posterior ovarian lobes, and appears to be due to the fusion across the middle line of the investments of the ovaries of opposite sides. The tube thus formed runs backwards, becoming much smaller as it approaches the end of the body. In one specimen examined, the tube was distinguishable almost as far back as the anus, although very minute in the hinder part of its course.

In fig. 14, the eggs which are cut by the section are still outside the interovarian cavity. Most of the large eggs in this individual possessed two nuclei, as shown in one of those figured. They were further provided with a somewhat shrivelled membrane, which is probably the vitelline membrane. In the fresh condition, the only case noticed in which the vitelline membrane was acquired before the eggs reached the exterior was in a dead female, most of the tissues of which were beginning to break up into fragments.

In other sections of the series from which fig. 14 is taken, eggs are found in the interovarian space. The posterior, tubular continuation of this space may probably be regarded as an oviduct, although the process of egg-laying was not directly observed. It does not appear to me probable that the eggs are liberated by the death of the female, as Weldon (13) supposes to be the case in *D. gigas*.

In *D. vorticoides* (van Beneden, No. 1) and in the species described by Korschelt (6) as *D. apatris* (probably identical with *D. gyrociliatus*), the eggs are known to pass to the exterior by means of a minute pore situated on the ventral side of the animal, at the base of the tail. This pore is said not to be recognisable except when the eggs are being laid; the eggs completely lose their shape in passing through the aperture, but regain their spherical form on arriving in the water.

In *Protodrilus*, an animal to which *Dinophilus* is probably allied, the eggs are said by Uljanin and Repiachoff (*v.* Repiachoff, No. 12, p. 29) to escape from the body in the same way as in the above-mentioned species of *Dinophilus*. According to the observations of Uljanin, quoted and confirmed by Repiachoff, the ripe eggs of *Protodrilus* move about freely in the meshes of the network of connective tissue which fills the general body-cavity, passing from segment to segment through apertures which remain between the interlacing muscle-fibres constituting the dissepiments, and finally escape from the body on the ventral side of the last segment.

The above description shows that in *Protodrilus* the eggs fall into the general body-cavity, whilst the same is true of *D. gyrociliatus,* where the body-cavity opens to the exterior by means of a ventral pore situated near the base of the tail. The fact that in *D. tæniatus* the interovarian cavity has been above shown to be continued ventrally almost as far as the anus, taken in conjunction with the admitted difficulty of discovering the actual generative pore except when eggs are being laid, is distinctly in favour of the view that the eggs of *D. tæniatus* are laid in the same manner as that which has been already described in other species of *Dinophilus.* The analogy of *D. gyrociliatus,* in which the eggs undoubtedly fall into the general body-cavity, further suggests that the interovarian cavity, into which the ova fall in *D. tæniatus,* and which is continuous with a passage which leads towards the exterior, is similarly a part of the general body-cavity.

On the Affinities of Dinophilus.—It has been repeatedly pointed out, by Metschnikoff, Lang, Repiachoff, and Korschelt, that *Dinophilus* has affinities with the Annelids, and more particularly with the Archiannelids. Weldon (13) expresses himself even more definitely in favour of the Archiannelid relationships of this form, supporting his conclusions by referring to the muscular œsophageal organ, to the ciliated ventral surface, associated with lateral nerve-cords, and to the character of the excretory organs, as described by Meyer.

The similarities between *Dinophilus* and the admitted Archiannelids are so numerous and so striking that it can hardly be doubted that the above conclusion is amply justified by the facts. It may, however, be worth while to call attention to the special resemblances shown by *D. tæniatus* to admitted Archiannelids, and to one or two considerations which are suggested by the study of this animal.

1. *External ciliation.*—The existence of two rings of cilia on each segment, a feature which appears to be so characteristic of *D. tæniatus* is common to this species and to *Protodrilus Leuckartii* (Hatschek, No. 5). In the latter animal, each segment is provided with two rings, interrupted, as in *Dinophilus,* by the uniform cilia which cover the ventral surface (ventral groove in *Protodrilus*). Two præoral rings of cilia exist in *Protodrilus,* which, however, differs from *Dinophilus* in possessing an elongated "postoral region of the head" (containing the muscular appendage of the œsophagus, and hence probably identical with the first body-segment of *Dinophilus*) which bears five rings of cilia.

2. *Nervous system.*—In *Protodrilus*, as in *Dinophilus*, ventral nerve-cords run along the sides of the ciliated ventral region of the body. In both cases, these cords are connected with the brain by œsophageal commissures running round the sides of the mouth. Further, the œsophageal commissures in *Protodrilus* acquire a relation to the longitudinal muscles which is precisely similar to that which obtains, not only in the same region, but throughout the body, in *Dinophilus*. *Protodrilus* is well known to possess an almost continuous layer of longitudinal muscles, which are separated by small interspaces into two ventral and two dorsal groups. In the region of the head (*v.* Hatschek) the four groups of muscles become widely separated; by referring to Hatschek's fig. 14 (Taf. ii), representing a section passing through the region of the mouth, it will be seen that the ventral longitudinal muscles, in their relative size and in their relations to the œsophageal commissures, are exactly similar to the longitudinal muscles of *Dinophilus*. Still further forwards in *Protodrilus*, the dorsal muscles (which do not seem to be represented in *Dinophilus*) disappear altogether.

The ventral nervous system of *Protodrilus* is not known to be segmented, and Hatschek describes only one transverse commissure between the two cords, occurring at the junction of the "head" and body.

The researches of Foettinger (2) have shown that *Histriobdella* is to be regarded as an Archiannelid. Foettinger re-names this animal *Histriodrilus*, in order to mark its removal from the group of the Leeches to that of the Archiannelids.

In one respect, the nervous system of *Histriodrilus* shows a closer resemblance to that of *Dinophilus tæniatus* than is manifested by that of any other Archiannelid. The ventral nervous system has been shown by Foettinger to be definitely segmented, in correspondence with the external segmentation indicated by metameric constrictions of the skin. *Histriodrilus* possesses about eight ventral ganglia, which, however, differ from those of *Dinophilus* in being continuous across the middle ventral line. In the intersegmental regions alone, the ventral nervous system consists of separated ventro-lateral cords. Paired œsophageal nerves, similar to those of *Dinophilus*, are described and figured by Foettinger (pl. xxv, figs. 10, 11).

3. *Excretory and generative organs.*—The nephridia of *D. tæniatus* closely resemble those of *Protodrilus*, as described by Hatschek. According to this observer, each nephridium of *Protodrilus* commences with a small funnel, opening into the body-cavity, and bearing internally a single, very long cilium. The difficulty of the investigation of nephridia of this type makes it possible that the difference between the funnel in *Protodrilus* and the ciliated appendage in

Dinophilus is really less considerable that would appear from a comparison of Hatschek's figures with my own.

In many of its features, *Polygordius* differs from *Dinophilus* far more than does *Protodrilus*. This is sufficiently obvious by such characters of *Polygordius* as the fusion of the ventral nerve-cords, the absence of a muscular œsophageal appendage, the form of the nephridia, the greater development of the longitudinal muscles, &c. (cf. Fraipont, No. 3). All these facts justify us in concluding that *Polygordius* is less closely related to *Dinophilus* than is *Protodrilus*.

Histriodrilus (*Histriobdella*), on the contrary, is probably more closely related to *Dinophilus* than is *Protodrilus*. The similarity in the nervous systems of the two genera has been already alluded to, and the same general resemblances characterise the excretory and generative systems.

The arrangement of the excretory system in *Histriodrilus* is said to differ in the two sexes. The nephridia are somewhat S-shaped, intracellular tubes (unfortunately not figured by Foettinger in much detail); it is stated that five (or perhaps six) pairs are found in the male, and four pairs in the female; their relations to the segments are shown by means of woodcuts on p. 469 of Foettinger's Memoir. The second nephridium was observed on two occasions to end internally in a ciliated ampulla.

In the existence of structures connected with the generative apparatus, and which may possibly be regarded as modified nephridia, *Histriodrilus* again shows evidences of affinity to *Dinophilus*.

In the female *Histriodrilus* there are two ovaries, which are more or less fused posteriorly (as in *D. gigas*). These ovaries are situated, as in *Dinophilus*, on the ventral side of the alimentary canal. The ripe ova fall into the body-cavity, whence they are taken up by the ciliated funnels of a pair of tubes which open to the exterior laterally. These funnels (woodcut, p. 481 of Foettinger's paper) are large, and open into the body-cavity on the ventral side of the ovaries. The tubes into which the funnels lead possess a dilatation, containing spermatozoa which have been presumably derived from a male individual. The resemblance of these structures to the vesiculæ seminales of the male *D. tæniatus* (in which evidence has been brought forward above to show that the vesicula is a modified nephridium) suggests that they too are possibly modified nephridia.

The male generative organs of *Histriodrilus* appear to be very complicated, and their structure and functions were not thoroughly understood by Foettinger. The testes are placed on the ventral side of the alimentary canal, and are more or less paired in front, whilst they are fused posteriorly. At the posterior end of the generative segment are a pair of vesicles containing spermatozoa (Foettinger, pl. xxix, fig. 3) and obviously comparable with the vesiculæ seminales of *Dinophilus*. As in the latter animal, the vesicles open by ducts into a median organ, supposed by Foettinger to be copulatory, and of very complicated structure. No communication between the vesicles and the body-cavity or testis is described. Anteriorly the generative segment has a pair of lateral eversible penes. The existence of three separate copulatory organs in *Histriodrilus* recalls the condition met with in some Polyclads (*Anonymus, Thysanozoon*), where more than a single penis is found.

The above facts, together with other well-known and striking resemblances between *Dinophilus* on the one hand and *Protodrilus, Polygordius*, or *Histriodrilus* on the other, make it in the highest degree probable that *Dinophilus* is a true Archiannelid, as has been insisted on by so many of the more recent writers on the subject. In the number of segments, in the segmentation of the ventral nervous system, and in the arrangement of the muscular system, of the nephridia, and of the generative organs, *Dinophilus* more nearly approaches *Histriodrilus* than any of the remaining Archiannelids. On the other hand, in the character of the muscular appendage of the œsophagus, in the wide separation of the ventral nerve-cords, and in the method adopted by the female for laying its eggs, *Dinophilus* most closely resembles *Protodrilus*. Although *Dinophilus* seems so clearly an Archiannelid, it is nevertheless possible to hold with Korschelt, Weldon, and others that it gives evidence of having been derived from Platyhelminth-like ancestors.

Weldon (13) has called special attention to the significance of the muscular œsophageal appendage as a representative of the pharynx of a Planarian. The median position of the generative pore, and the method of fertilization adopted by the male *Dinophilus tæniatus*, further support the view of the Platyhelminth origin of the Archiannelids. The median penis of *D. tæniatus* and *D. gyrociliatus* is strictly comparable with the same structure in a Planarian, although it is probably a highly significant fact (if this is really the case) that this organ has entered into relations with a pair of modified nephridia which receive the spermatozoa from the testes.

Korschelt (6) and others have drawn attention to the remarkable fact that, whilst the female of one species of *Dinophilus* differs comparatively little from that of any other species, there are very great differences between the males of the various species. In *D. gyrociliatus* (including *D. apatris*) (and possibly in *D. metameroides*, in which the male is not known), there is very striking sexual dimorphism, the female being many times larger than the male. In *D. vorticoides, D. gigas*, and *D. tæniatus*, on the contrary, the males do not differ appreciably in size from the females. Whilst in *D. gigas* the male is said to have neither penis nor vesiculæ seminales, these structures are found in *D. tæniatus*, which is probably closely allied to *D. gigas*.

I have no observations which explain the disappearance of *D. tæniatus* during the summer. It is, however, important to notice that the eggs develop immediately after being laid. Small individuals were of common occurrence during the early part of April, although I did not succeed in finding the segmenting eggs till April 16th; the termination of my visit to Plymouth occurring a day or two after that date, I have no observations worth recording on the development. The eggs may be easily obtained by looking through mud drawn by means of a siphon from the bottom of a rock-pool which is inhabited by *D. tæniatus*. The general course of the development is apparently similar to that which has been described by Korschelt in *D. gyrociliatus* (*D. apatris*), the embryo, as in this species, acquiring most of its adult characters while still enclosed in its vitelline membrane. The absence of any metamorphosis in *Dinophilus* appears to me a noteworthy fact. It is perhaps a legitimate inference, from the facts known with regard to *Dinophilus*, that a Trochosphere stage is not to be expected in the ontogeny of this animal, since in the persistence of the præoral ring of cilia, and probably of the head-kidneys, and in the general characters of the alimentary canal, the adult *Dinophilus* may be considered to remain in a condition which is practically that of a Trochosphere.

Postscript.—I owe to the kindness of Dr. Norman the opportunity of referring to the description which has been given by G. N. R. Levinsen of *Dinophilus caudatus*, published in a paper which had previously been inaccessible to me (*Bidrag til Kundskab om Grönlands Turbellarienfauna*, Vidensk. Meddel. fra den naturh. Foren. i, Kjöbenhavn, 1879—1880).

D. caudatus is identified by Levinsen with the *Planaria caudata* of Fabricius (Fauna Groenlandica, 1780) and of O. F. Müller (Zool. Danica), and, in the words of Fabricius, "Habitat stupenda multitudine in confervis, et ulvis littoralibus, sæpe illas tegens."

It resembles the species above described as *D. tæniatus* in the division of the body into segments by deep constrictions of the skin, in the form of the testes, and in the existence of a penis and of vesiculæ seminales, but is stated to be so well known that detailed description is unnecessary; it is, moreover, unfortunate that Levinsen has published no figure of the species described by him.

It appears to me quite possible that "*D. tæniatus*" is identical with *D. caudatus*, but as the evidence on this point is quite inconclusive, I do not propose to withdraw, for the present at least, the specific name, which has already been published in the Proceedings of the Cambridge Philosophical Society (vol. vi). According to Levinsen, *D. caudatus* is the species which has been described by other writers as *D. vorticoides ;* its colour is stated to be red, whilst no mention is made of the existence of four-lobed ovaries or of segmental ciliated rings.

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10. Mereschkowsky, C.—*Ueber einige Turbellarien des Weissen Meeres.* Arch. f. Naturg., xlv Jahrg., i Bd., 1879, p. 51 [*Dinophilus vorticoides*].
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DESCRIPTION OF PLATES IX AND X.

Illustrating Mr. S. F. Harmer's paper, "Notes on the Anatomy of Dinophilus."

N.B.—All the figures refer to Dinophilus tæniatus.

Fig. 1.—Dorsal view of a young individual; the mouth, which is ventral, is represented as being visible through the semitransparent tissues of the head.

Fig. 2.—Ventral view of an adult female, somewhat compressed.

Fig. 3.—Longitudinal section of an adult male (combined from several sections). Most of the organs are shown as they appear in a median section; *i. e.* the brain, alimentary canal, testis, penis, and generative pore. The eye, ventral ganglia (the distinctness of which is slightly exaggerated), and vesicula seminalis, being laterally placed, would not

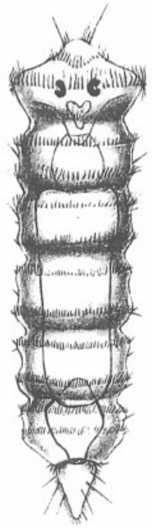

Fig. 1.

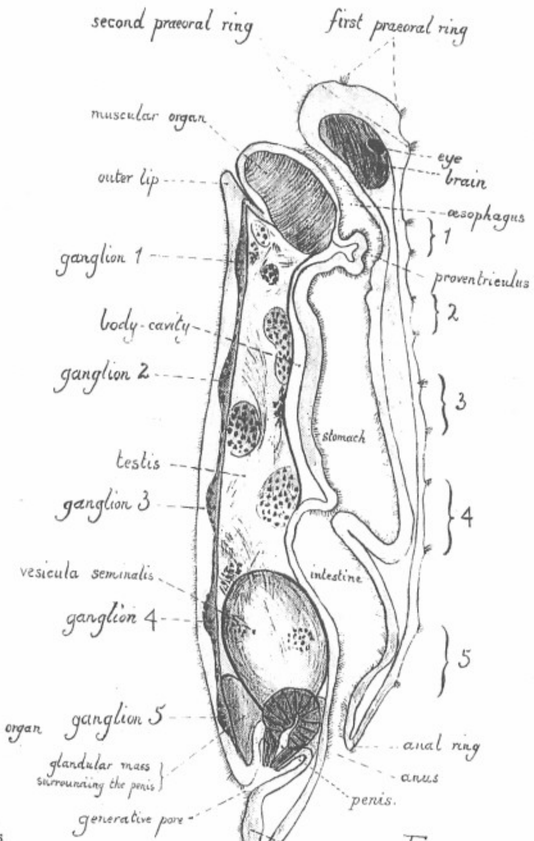

Fig. 3.

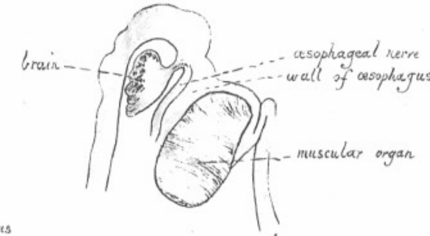

Fig. 6.

Fig. 7.

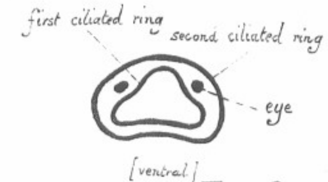

Fig. 8.

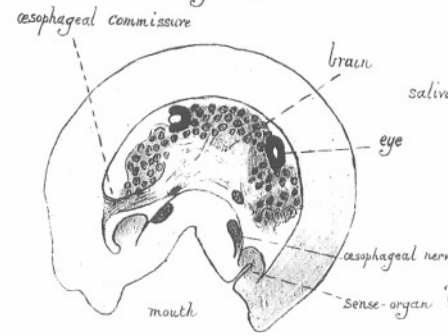

Fig. 9.

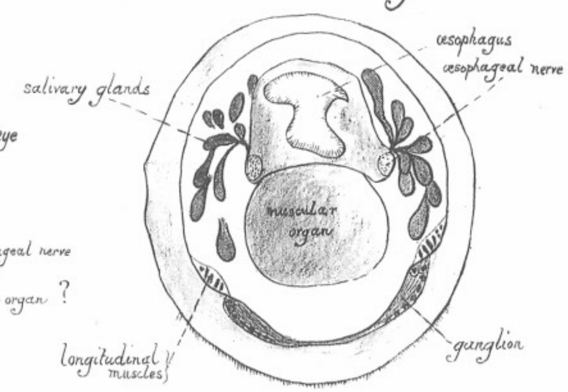

Fig. 10.

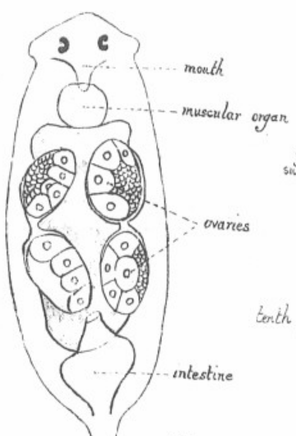

Fig. 2.

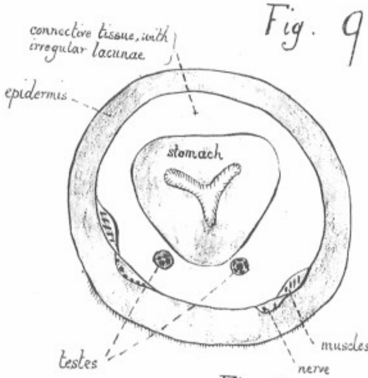

Fig. 11.

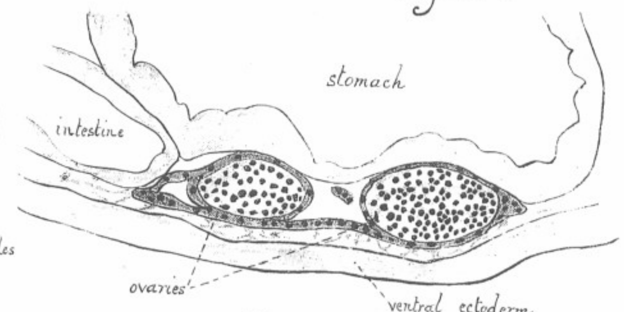

Fig. 12.

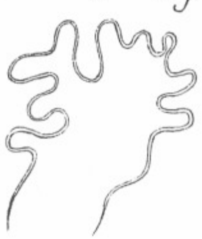

Fig. 4.

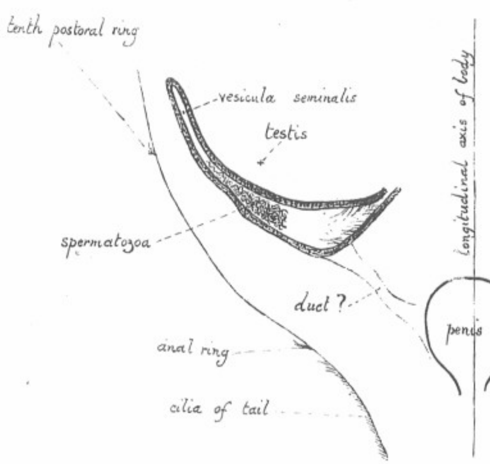

Fig. 5.

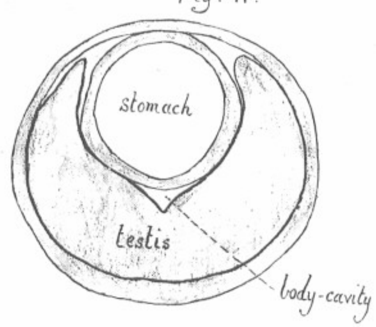

Fig. 13.

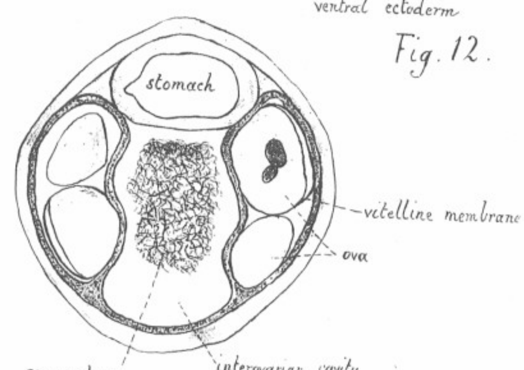

Fig. 14.

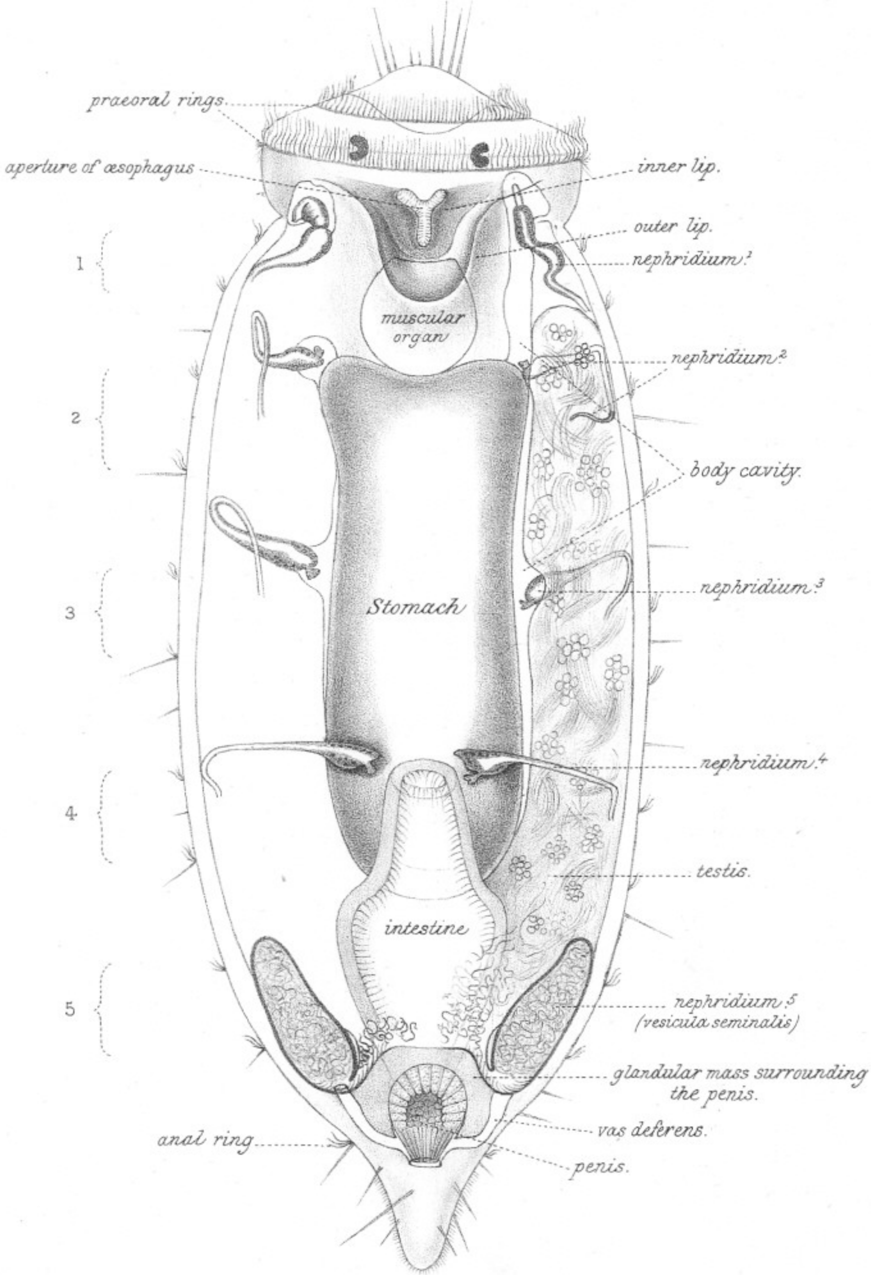

Fig. 15.

S. F. Harmer del. F. Huth, Lithr. Edinr.

appear in a strictly median section. The two ciliated rings of each of the five segments of the body are indicated by one of the brackets to which the numbers 1, 2, 3, 4, 5 refer.

FIG. 4.—Spermatozoon.

FIG. 5.—Ventral view of part of the posterior end of a young male, as seen in a compressorium. The vesicula seminalis is still very young and nephridum-like, opening at its internal end into the cavity of the testis. The existence of the structure marked "duct?" was not established with certainty.

FIG. 6.—Longitudinal section of head, almost median, showing one of the œsophageal nerves.

FIG. 7.—Horizontal section of eye.

FIG. 8.—View, seen from the front, of the surface of the head of an individual killed with hot corrosive sublimate.

FIG. 9.—Transverse section through the head, passing through the origin of one of the œsophageal commissures.

FIG. 10.—Transverse section through the region of the first postoral pair of ganglia.

FIG. 11.—Transverse section through the middle region of the body of a young individual (probably a male).

FIG. 12.—Longitudinal vertical section, not median, passing through the two ovaries of one side of the body, of a young female.

FIG. 13.—Transverse section through the middle region of the body of an adult male.

FIG. 14.—Transverse section through the region of the interval between the anterior and posterior ovaries of an adult female.

FIG. 15.—Ventral view of an adult male, as seen under strong compression in a compressorium. The figure represents the results of a long series of observations. The vesiculæ seminales have been drawn at a rather young stage of development; at their period of maximum development they would appear very much swollen, and would extend forwards as far as the posterior end of the stomach. The double ciliated rings of the five segments are indicated, as in fig. 3, by the numbers 1, 2, 3, 4, 5. The testis is not shown on the left side of the figure.

Report on the Pelagic Copepoda collected at Plymouth in 1888-89.

By

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With Plates XI and XII.

The Copepoda not only form the greatest part of the pelagic life in temperate seas, but are also of the greatest importance in pelagic economy. Feeding on minute organisms and particles of animal and vegetable matter, they are themselves a prey to larger organisms. Some fishes such as the herring, pilchard, and mackerel feed almost exclusively on Copepoda at certain seasons of the year, and experienced fishermen are accustomed to look on the swarms of Copepods which make their appearance in the spring and early summer as the sure precursors of a shoal of fish. The important part played by these minute crustacea in the change of material in the sea has led me to pay particular attention to them amongst the other organisms found swimming free at the surface or at different depths in the open sea. The following is a preliminary account of the species which I have hitherto met with in the surface net collections made during the past year. The systematic work necessarily precedes the more laborious and thorough investigation of the life-history and bionomy of the group which I hope to be able to enter into at a later date, the present work, therefore, pretends to nothing more than an enumeration of the species captured, and an indication of their distribution. The species taken in the surface net amount to sixteen, of which the majority, as might be expected, belong to the Calanidæ. Of the sixteen, nine species belong to this family, two to the Cyclopidæ, three to the Harpactidæ, and two to the Corycæidæ. The majority are well known on British coasts, two species which I have found in abundance, viz. *Paracalanus parvus* and *Euterpe gracilis*, are generally considered rare in this country, and *Pontella wollastoni* is a rare English form which I have found sparingly. One species, *Oncæa mediterranea*, has not hitherto been seen north of the Mediterranean. On the other hand, several well-known species of Calanidæ are altogether absent from my collections, viz. *Metridia armata, Isias clavipes*, and *Centropages hamatus*. The labour of looking through and sorting the large amount of material collected by us during the past year has been very great, but I am satisfied that I have not allowed a species to escape my notice, and the above-mentioned forms must have been absent, during the past year at all events, from the open sea in this neighbourhood.

Having had access to only a limited number of systematic works on the Copepoda I am obliged to confine myself in the descriptive part of this paper to references to the following works. Brady's Monograph of the British Copepoda, three vols. Brady, Report on the Copepoda collected by H.M.S. Challenger, 1883. Claus, Die freilebenden Copepoden, 1863. Ibid, Neue Beitrage zur Kentniss der Copepoden, Arbeit aus dem. zool. Inst. Wien, 1880-81. Giesbrecht, Die freilebenden Copepoden der Kiele Foehrde. Vierter Bericht der Commission zur wiss. Untersuchung der deutschen Meere in Kiel, 1882. Canu, Les Copepodes libres Marins du Boulonnais, 1888. Thompson, Proceedings of the Liverpool Biological Society, vols. i and ii, 1887 and 1888.

Family—CALANIDÆ.

1. CETOCHILUS SEPTENTRIONALIS, *Goodsir*.

CETOCHILUS HELGOLANDICUS, *Claus*. Die freilebenden Copepoden, p. 171, Taf. xxvi.
CALANUS FINMARCHICUS, *Brady*. Monogr., i, p. 38.
— — *Giesbrecht*. Copepod. Kieler Foehrde, p. 156.
— — *I. C. Thompson*. Proc. Liv. Biol. Soc., ii, p. 63.

This genus was found at all seasons of the year in the surface net, though seldom in considerable numbers, apparently it is more abundant towards the end of the autumn, but in the majority of gatherings it is altogether absent.

In adopting the generic name *Cetochilus* in preference to that of *Calanus* I am following the example of Claus, whose arguments in favour of retaining Roussel de Vauzeme's name for the genus appear to me to have more weight than the argument based on the uncertain identity of Müller's *Cyclops longicornis* with Gunner's *Monoculus finmarchicus*. For the discussion of the subject, *vide* Claus Neue Beitrage zur Kent. der Copep., Arb. Zool. Inst. Wien, iii, 3, and Brady, Challenger Reports, loc. cit.

2. PARACALANUS PARVUS, *Claus*. Pl. XI, figs. 1—3.

CALANUS PARVUS, *Claus*. Freilebenden Copepoden, p. 173, Taf. xxvi and xxvii.
PARACALANUS PARVUS, *Claus*. Neue Beitr. zur Kent. der Copep., Arb. Zool. Inst. Wien, iii, 3.
— — *Canu*. Copep. libres Marins du Boulonnais, Bull. Scient. de la France et de la Belg., iii sér., 1 ann., p. 81.

PARACALANUS PARVUS, *I. C. Thompson.* Copep. of Liverpool Bay, Proc. Liv. Biol. Soc., ii, p. 64.

This species appears to have been taken only once before in England, viz. by the Liverpool Marine Biology Committee in 1888. Canu found it in abundance at Wimereux. I cannot consider it as a rare species at Plymouth for I have found it in great abundance in several gatherings and less abundantly in many others. Apparently it is absent from these coasts in the winter, for I could not find a single specimen in gatherings made between September and March. I have not observed the disproportion in the numbers of males and females described by Canu. This species is easily recognised by the form of the first antennæ of the male, by the serration of the external edges of the outer branches of the swimming feet, and their simple spines in both sexes, and by the characteristic shape of the fifth feet in the male and female. The characteristic ensiform and plumose terminal setæ of the second maxillipedes of the male appear to have been overlooked by previous observers, *vide* Pl. XI, fig. 3.

3. CLAUSIA ELONGATA, *Boeck.*

PSEUDOCALANUS ELONGATUS, *Brady.* Monogr., Brit. Copep., i, p. 45, pl. iii.
— — *Giesbrecht.* Freileb. Copep. der Kieler Foehrde, Nachtrag.
— — *I. C. Thompson.* Proc. Liv. Biol. Soc., ii, p. 63.
CLAUSIA ELONGATA, *Claus.* Neue Beitrage zur Kent. der Copep., Arb. Zool. Inst. Wien, iii, 3, p. 16, Taf. iii, figs. 11—15.
LUCULLUS ACUSPES, *Giesbrecht.* Freileb. Copep. der Kieler Foehrde, p. 160.

This is one of the commonest species in the Plymouth district. I have taken it in autumn, winter, and spring in immense numbers. The absence of the fifth pair of feet in the female, and the form of the fifth feet of the male are characteristic features of this species. Young males are frequently very abundant, and as Claus has pointed out (loc. cit.), they differ from the perfect males both in the form of the fifth feet and in other particulars, so that they might easily be mistaken for a distinct species. Giesbrecht in the body of his work, quoted above, refers *Clausia elongata* to a new genus and species, *Lucullus acuspes,* but withdraws this name in an appendix. It is difficult to understand how he can have overlooked the identity of his specimens with *Pseudocalanus elongatus,* Boeck; described by Brady, since the latter's figures of the fifth pair of feet of the male are readily recognisable, defective as his description may be in some particulars. I. C. Thompson in a report of Copepoda collected in Maltese seas, refers to *Lucullus acuspes,* Giesbrecht; and *Pseudo-*

calanus elongatus, Boeck, as distinct genera! ('Proc. Liv. Biol. Soc.,' ii, pp. 140, 142.)

4. DIAS LONGIREMIS, *Lilljeborg*, Pl. XI, figs. 4—6.

DIAS LONGIREMIS, *Brady*. Monogr. Brit. Copep., i, p. 51, pl. v.
— — *Claus*. Freileb. Copepod., p. 193, Taf. xxxiii, figs. 6—14.
— — *Giesbrecht*. Freileb. Copep. der Kieler Foehrde, p. 148.
— — *I. C. Thompson*. Some Copepoda new to Britain, &c., Proc. Liv. Biol. Soc., i, p. 37.

This species is one of the most common near Plymouth. I have taken it in great quantities at all seasons of the year. Giesbrecht remarks that the genus *Dias* is found very sparingly at Kiel during the early spring months, but that it increases in numbers from July to the autumn. At Plymouth the contrary appears to be the case. On February 20th, 21st, and 22nd, 1889, the Calanidæ taken in the tow-net consisted almost exclusively of this species, and it was abundant in gatherings made both before and after these dates.

A close examination of these specimens leaves me in some doubt as to the distinctness of Giesbrecht's three species, *D. longiremis*, Lilljeborg; *D. bifilosus*, and *D. discaudatus*. According to him the remarkable differences (auffallende Merkmale) between *D. longiremis* and *D. bifilosus* are the presence of spines on the last thoracic segment of the former, and their absence in the latter species; the shape of the furca, which is much longer in *D. longiremis* than in *D. bifilosus*, and the presence of frontal setæ in the latter species. *D. discaudatus* is distinguished principally by the swollen furcal segments of the female and the spermatophores of the male, but in addition to these characteristics there are differences in the fifth pair of feet in the male (*vide* Giesbrect, loc. cit., Taf. viii, figs. 30, 31, and 32). In my specimens the spines characteristic of *Dias longiremis* are present, but are not so long as those figured by Giesbrecht; there are no frontal setæ and the feet of the fifth pair are precisely those figured by Giesbrecht for *D. longiremis*. The difference lies in the furcal segments, the proportions of which are those of *D. bifilosus*, Giesbrecht and not of *D. longiremis*. From his drawing of the fifth pair of feet of the male I have no doubt that Brady's figures are taken from *D. longiremis*, Lilljeborg, though he has overlooked the spines of the last thoracic and abdominal segments. Claus' figure of the fifth pair of feet of the male is undoubtedly taken from *D. discaudatus*, Giesbrecht (cf. Claus, Freileb. Copepod., Taf. xxxiii, fig. 14, and Giesbrecht, loc. cit., Taf. viii, fig. 32). At the same time Claus speaks of the frontal setæ characteristic of *D. bifilosus*. Giesbrecht considers that the varieties in the fifth pairs of feet of the males taken by Claus in Heligoland and the Mediterranean point to their being in fact two distinct species, but the facts given above support the conclusion that the characters taken by Giesbrecht as specific are liable to great variation, and that his three species, *D. longiremis, D. bifilosus,* and *D. discaudatus* are, in fact, varieties of one species, viz. *Dias longiremis,* Lilljeborg.

5. TEMORA LONGICORNIS, *O. F. Müller.*

TEMORA FINMARCHICA, *Claus.* Freileb. Copepod., p. 195.
— LONGICORNIS, *Brady.* Monogr. Brit. Copep., i, p. 54.
— — *Canu.* Les Copep. libres marins du Boulonnais, Bull. Sci. de la France et Belg., iii sér., 1 ann., p. 89.
— — *Giesbrecht.* Freileb. Copep. der Kieler Foehrde, Nachtrag.
HALITEMORA LONGICORNIS, *Giesbrecht.* Ibid., p. 149.
— — *I. C. Thompson.* Proc. Liv. Biol. Soc., vol. i, p. 35.

This very common species was found sparingly during the winter months at Plymouth; its numbers increase greatly in April, and appear to reach a maximum in August and September. Thompson, in adopting the generic name *Halitemora,* overlooks Giesbrecht's appendix in which the latter gives way to the priority of Claus' name *Temora* (Claus, Sitz. der Kais. Akad. Wien, lxxiii, 1881.)

6. CENTROPAGES TYPICUS, *Kroyer.*

ICTHYOPHORBA DENTICORNIS, *Claus.* Freileb. Copepod., p. 199, Taf. xxxv, figs. 1, 3—9.
CENTROPAGES TYPICUS, *Brady.* Monogr. Brit. Copep., i, p. 65, pl. viii.
— — *Canu.* Les Copepodes libres, &c., Bull. Sci. de la France et de la Belg., iii sér., 1 ann., p. 96.

Taken in great abundance in summer, autumn, and spring, but it appears to be less abundant in the winter months.

7. PARAPONTELLA BREVICORNIS, *Lubbock.*

PARAPONTELLA BREVICORNIS, *Brady.* Monogr. Brit. Copep., i, p. 69, pl. ix, figs. 1—6.
— — *I. C. Thompson.* Copep. Liv. Bay, Proc. Liv. Biol. Soc., ii, p. 65.

I have only found this species on two occasions, and then in small numbers, viz. on August 31st, 1888, near the Eddystone Lighthouse, and on March 21st, 1889, in the Cattewater.

8. Pontella Wollastoni, *Lubbock.*

Pontella helgolandica, *Claus.* Freileb. Copepod., p. 208, Taf. iii, figs. 5—7; xxxvi, figs. 1—15; xxxvii, fig. 7.
— Wollastoni, *Brady.* Monogr. Brit. Copep., i, p. 73, pl. x *a.*
— — *Canu.* Copep. libr. mar. du Boulonnais, Bull. Sci. de la France et de la Belg., iii sér., 1 ann., p. 100.
— — *J. C. Thompson.* Some Copep. new to Great Brit., Proc. Liv. Biol. Soc., i, p. 37.

I have only found this species twice, on August 31st, 1888, and on October 23rd, 1888, near the Eddystone Lighthouse, in small numbers in each instance. According to Thompson it is not uncommon in Liverpool Bay, and it is one of the commonest species at Wimereux (Canu).

9. Anomalocera Patersonii, *Templeton.*

Irenæus Patersonii, *Claus.* Freileb. Copep., p. 206, Taf. ii, fig. 1; Taf. xxxvii, figs. 1—6.
Anomalocera Patersonii, *Brady.* Monogr. Brit. Copep., i, p. 75, pl. xi, figs. 1—14; pl. x, figs. 13, 14.

This species was abundant at Plymouth in the autumn and late summer but was absent from winter gatherings. I found a few specimens in the contents of the surface net on May 19th, 1889. Sometimes it occurs in immense profusion in the Channel. Mr. Matthias Dunn has sent me a large number of Copepods, dipped with a bucket from Mevagissey Harbour. They consisted almost exclusively of *A. Patersonii.* In the specimens taken on May 19th I noticed that the upaired eye of the male was nearly half as large again as that of the female.

Family—CYCLOPIDÆ.

1. Oithona spinirostris, *Claus.* Pl. XI, figs. 7 and 8.

Oithona helgolandica, *Claus.* Freileb. Copep., p. 105, Taf. xi, figs. 4—9.
— spinirostris, *Claus.* Ibid., p. 105, Taf. xi, figs. 10—12.
— spinifrons, *Brady.* Monogr. Brit. Copep., i, p. 91, pl. xiv, fig. 19; pl. xxiv *a.*
— spinirostris, *Giesbrecht.* Freileb. Copep. der Kieler Foehrde, p. 139.
— — *I. C. Thompson.* Proc. Liv. Biol. Soc., ii, pp. 1, 2.

This species is so rare as to be practically absent from Plymouth seas in the late summer and autumn, but it appears in great profusion in February, March, and April. Giesbrecht states that the same is the case at Kiel. According to the same author the different

European species of *Oithona* are to be considered as varieties of *O. spinirostris*, Claus. The figures of *Oithona* in Brady's Monograph are very unsatisfactory, but those of *O. Challengeri* in the Challenger Report are much better. The only accurate drawings of *Oithona* that I have seen are those of Giesbrecht, whose illustrations never leave anything to be desired. As his work is not always accessible to English naturalists, I give, in Plate XI, figs. 7 and 8, drawings of the mandibles and maxillæ of this species.

2. CYCLOPINA LITTORALIS, *Brady*.

CYCLOPINA LITTORALIS, *Brady*. Monogr. Brit. Copep., i, p. 92, pl. xv, figs. 1—9.
— — *I. C. Thompson*. Copep. Liv. Bay, Proc. Liv. Biol. Soc., ii, p. 65.

A few specimens of this well-marked species were taken in the tow-net in the early days of April, 1889.

Family—HARPACTIDÆ.

1. LONGIPEDIA CORONATA, *Claus*.

LONGIPEDIA CORONATA, *Claus*. Freileb. Copep., p. 111, Taf. xiv, figs. 14—24.
— — *Brady*. Monogr. Brit. Copep., ii, p. 6, pls. xxxiv, xxxv.
— — *Giesbrecht*. Freileb. Copep. der Kieler Foehrde, p. 99.
— — *I. C. Thompson*. Cop. Liv. Bay, Proc. Liv. Biol. Soc., ii, p. 67.

A few specimens were taken in the surface net in March and April, 1889.

2. EUTERPE GRACILIS, *Claus*.

EUTERPE GRACILIS, *Claus*. Freileb. Copep., p. 109, Taf. xiv, figs. 1—13.
— — *Brady*. Monogr. Brit. Copep., ii, p. 22, pl. xl, figs. 1—16.
— — *I. C. Thompson*. Copep. Liv. Bay, Proc. Liv. Biol. Soc., ii, p. 67.

This species, rare in most localities, is very abundant near Plymouth in late winter and spring. I first found it on February 20th, 1889, when the tow-net taken near the Eddystone Lighthouse contained a profusion of females, nearly all carrying ovisacs. Since that date I have taken both males and females, sometimes sparingly, sometimes abundantly, in nearly every gathering up to May 20th.

3. THALESTRIS MYSIS, *Claus*.

THALESTRIS MYSIS, *Claus*. Freileb. Copep., p. 130, Taf. xviii, figs. 12—16.
— — *Brady*. Monogr. Brit. Copep., ii, p. 121, pl. lviii, figs. 1—13.

Three or four specimens were taken in the surface net in the Cattewater on March 21st, 1889.

Family—CORYCÆIDÆ.

1. CORYCÆUS ANGLICUS, *Lubbock*.

CORYCÆUS GERMANUS, *Claus*. Freileb. Copep., p. 156, Taf. ix, figs. 1—4; Taf. xxiv, figs. 5, 6; Taf. xxviii, figs. 1—4.
— ANGLICUS, *Brady*. Monogr. Brit. Copep., iii, p. 34, pl. lxxxi, figs. 16—19; lxxxiii, figs. 11—15; lxxxiv, figs. 10—14.

This species appears to be somewhat rare and locally distributed on British coasts. I first found a few in the tow-net of February 20th, near the Eddystone Lighthouse, and from that date up to May I obtained numerous specimens, scarcely any gathering being without them. It is recorded in my note-book that of the specimens taken February 21st, 22nd, and 23rd, 1889, all the females had ovisacs attached.

2. ONCÆA MEDITERRANEA, *Claus*. Pl. XII, figs. 1—7.

ANTARIA MEDITERRANEA, *Claus*. Freileb. Copep., p. 158, Taf. xxx, figs. 1—7.
ONCÆA OBTUSA (?), *Brady*. Challenger Reports, Zoology, vol. viii, p. 120, pl. li.
— — *I. C. Thompson*. Copep. collected in Maltese Seas, Proc. Liv. Biol. Soc., ii, p. 148.

I have much pleasure in recording this species, which has not before been found north of the Mediterranean. It is very rare at Plymouth. I have only had two specimens, one taken on the 31st August, 1888, the other on April 15th, 1889; both are females.

I am satisfied that my specimens are identical with Claus' *Antaria mediterranea*, but am not quite sure of their identity with *Oncæa obtusa*, Dana. Comparing my specimens with Claus' and Brady's figures, the second joint of the second antenna agrees in my specimens with Claus' drawing and description (zweite Glied der Klammerantennen aufgetrieben, dreieckig, so gross als die dritte), but in Brady's drawing it has not the characteristic swollen three-cornered shape. The furca in Brady's drawing is as long as the three preceding abdominal segments; in Claus' *Antaria mediterranea* and in my specimens it is but little longer than the last abdominal segment. The spines on the first abdominal segment of the male are longer in Claus' figures than in Brady's. From want of specimens I am unable to give an opinion on the specific distinctness of these two forms, but I have preferred to use Claus' specific name for my specimens because of their full agreement with his drawings and description.

PLATES XI AND XII.

Illustrating Mr. G. C. Bourne's paper on *The Pelagic Copepoda collected at Plymouth in* 1888-89.

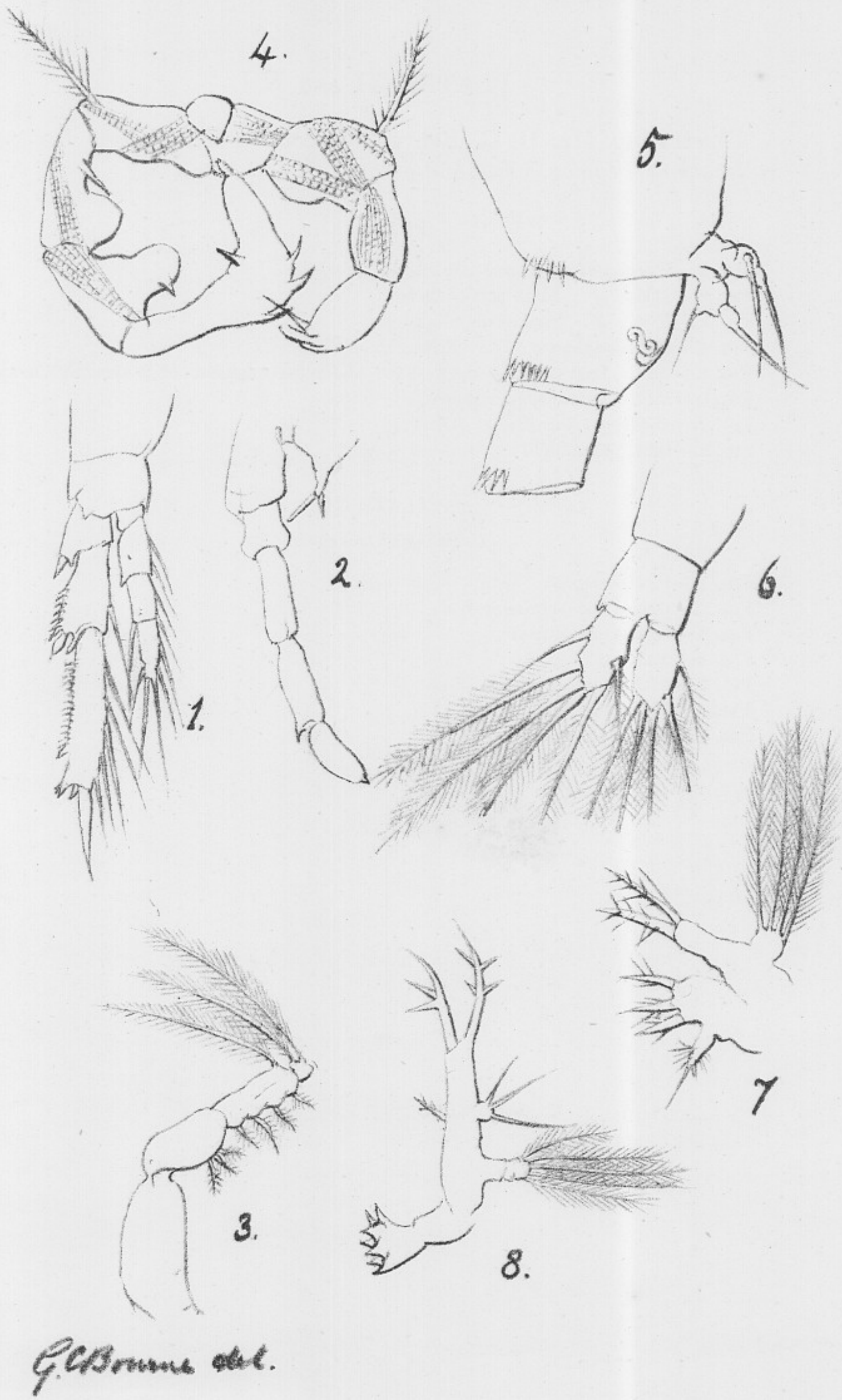
PLATE XI.

FIG. 1.—*Paracalanus parvus*. Third swimming foot.
FIG. 2.—Ibid. ♂. Fifth pair of feet.
FIG. 3.—Ibid. ♂. Second maxillipedes.
FIG. 4.—*Dias longiremis*. ♂. Fifth pair of feet.
FIG. 5.—Ibid. Last thoracic and first two abdominal segments of ♀ showing the spines.
FIG. 6.—Ibid. Furcal segments of ♂.
FIG. 7.—*Oithona spinirostris*. Maxilla.
FIG. 8.—Ibid. Mandible.

PLATE XII.

Oncæa Mediterranea. ♀.

FIG. 1.—First antenna.
FIG. 2.—One of the swimming feet.
FIG. 3.—Second maxillipede.
FIG. 4.—Maxilla.
FIG. 5.—Abdominal segments.
FIG. 6.—First maxillipede.
FIG. 7.—Second antenna.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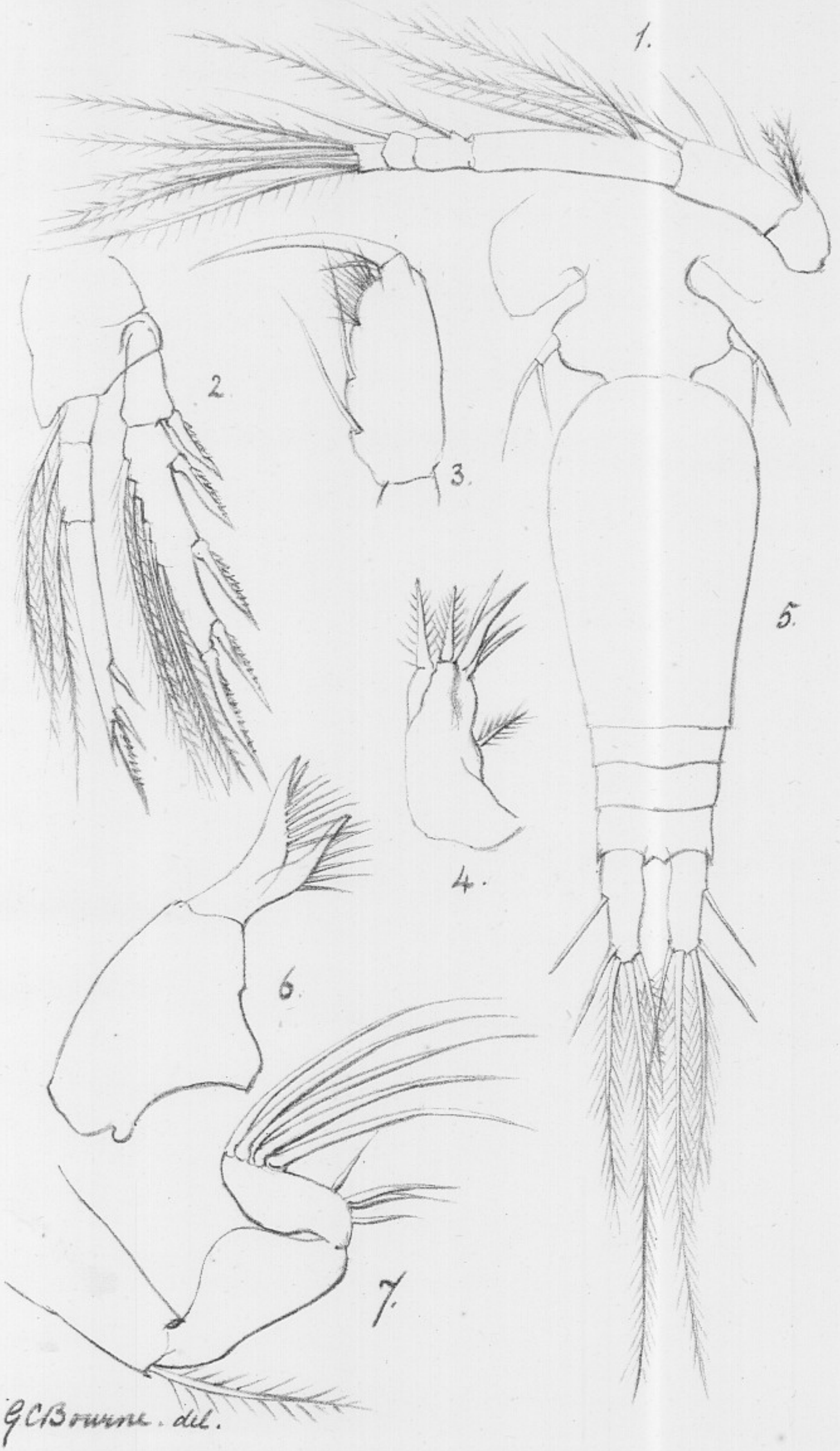
G. C. Bourne del.



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Destruction of Immature Fish.

By

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Among the questions on sea fishing which are periodically and pertinaciously brought forward by some people, there is none which is more persistently paraded before the public than the wholesale destruction by trawling and other means of immature food-fishes. When questions of this kind are brought forward they are invariably accompanied with demands for legislative interference, and in this instance it is demanded by some that beam trawling should be prohibited within the three-mile limit; by others that it should be prohibited altogether at certain seasons; by others, again, that shrimp trawling should be forbidden; and a fourth party, with some show of reason, requires that certain specified areas should be closed against trawling for a number of years. It is unnecessary to say that if any of these prohibitive measures were adopted an important branch of the fishing industry would be seriously affected, and it is well, before any credence is given to the statements of those who agitate in this matter, that the whole subject should be put clearly before the public, that the extent and the deficiency of our knowledge should be made known, and that accurate observations should be placed alongside of and compared with the more random statements of the would-be legislators.

In point of fact, very few observations of scientific accuracy have been made. By far the most important contribution to the subject is the report of Prof. McIntosh, published in the Appendix to the Report of the Royal Commissioners on Trawling in 1885. In addition to this, observations are being made by the officers of the Fishery Board for Scotland, and some few have been made by the Marine Biological Association, of which it is proposed to give an account here.

Before proceeding further with the subject, it is well to clear up an ambiguity arising from the misuse of the word "immature." Strictly speaking, an immature fish is a young fish which has never developed ripe roe or milt. If it could be proved that great quantities of such fish were destroyed it might be conceivable that great damage is being done to sea fisheries, for young fish of all kinds have a great many enemies to contend with, and it is quite possible that man, by employing more numerous and more powerful engines for their destruction, might so diminish the number of breeding fish as to cause the young brood to be unable to cope with the numerous destructive agencies which beset them on their road to maturity. However this may be, and the case admits of much argument on both sides, the first question is whether such immature fish are in fact destroyed in vast numbers. It is just for this reason that a precise meaning should be attached to the expression "immature fish." An arbitrary standard of size is no criterion of the immaturity of different species of fish; a turbot of ten inches length may be immature when a plaice or sole of the same length is filled with ripe ova, and there are some species of fish commonly used for food which seldom exceed ten inches in length, and in such cases many adult, that is to say, sexually mature specimens, fall below the arbitrary standard and are classed as "immature" or sometimes "undersized" fish. In making inquiries on this subject it is necessary that, by comparison of very many specimens, a minimum of size should be determined for the adults of each species of fish, so that it can be affirmed with tolerable certainty in each case that every fish below a certain size is really immature. Obvious as this may seem, it is necessary to insist upon it, for hitherto size and not sexual maturity has been the test of observers; and even Prof. McIntosh's report, admirable in all other respects, leaves one in complete doubt as to whether the fish classed by him as immature were really sexually immature or merely undersized fish. It must be remembered, however, that the Professor had a very limited time in which to carry out his investigations, and that it would require long observation and experience to obtain the necessary data for determining at what average size different species of fish may be expected to come to maturity.

The importance of precision in definition will readily be understood after examination of Prof. McIntosh's report. In ninety-three hauls of the trawl 81,854 fish were taken, of which 11,613—a large proportion numerically—were classed as immature fish. But of these no less than 2956 were long rough dabs (*Hippoglossoides limandoides*), 6314 were common dabs (*Pleuronectes limanda*), and 1072 were combined common and long rough dabs. These two species of flat-fish are often small, never exceeding thirteen inches in length, and generally they are much smaller. It is probable that a large proportion of those taken by Prof. McIntosh were really mature, but small or undersized fish. But in any case the number of long rough and common dabs taken, whether mature or immature, is of no great importance. Neither species is valuable, and though eaten they are only sold at a very low price to the poorer classes of certain districts. Thus, of the whole number of 11,613 fish classed as immature, as many as 10,342 belonged to nearly worthless species.

Prof. McIntosh's observations were carried out on trawlers working in the ordinary course of business in the following localities: St. Andrews Bay, Aberdeen Bay, off Smith Bank, the Firth of Forth, off Scarborough.

Similarly Mr. Cunningham, the Naturalist of the Marine Biological Association, has made frequent observations on trawlers engaged in their business off Plymouth and westward to Mount's Bay. His experiences in all seasons and in all weathers coincide very closely with those of Prof. McIntosh. Very young flat-fishes are not captured in the large beam trawls working in depths of thirty to forty fathoms. Flat-fishes somewhat less than six inches in length are not uncommon, but they invariably belong to worthless or nearly worthless species, and of these no specimen under three inches long has been noticed.

The more valuable species of flat-fish taken by Plymouth trawlers are the sole (*Solea vulgaris*), turbot (*Rhombus maximus*), brill (*Rhombus lævis*), merrysole (*Pleuronectes microcephalus*), megrim (*Arnoglossus megastoma*), plaice (*Pleuronectes platessa*). Mr. Cunningham has never seen any of these species less than six inches in length brought up in the beam trawl. But there are several smaller species of little marketable value of which numbers of small specimens are commonly caught; these are flounders (*Pleuronectes flesus*), dabs (*Pleuronectes limanda*), thickbacks (*Solea variegata*), and scald-fish (*Arnoglossus laterna*). As the staff of the Marine Biological Association has been engaged on other problems, these fish have not been regularly counted and measured, but in the matter of flat-fish it is obvious that there is no difference between the north-east coast of England and Scotland and the channel near Plymouth. In both cases large numbers of undersized flat-fish are caught, and in both cases they are composed nearly exclusively of worthless species. The long rough dab (*Hippoglossoides limandoides*) is an exceedingly rare fish on the south-west coast of England, and its presence in the one and its absence in the other case forms the principal difference between Prof. McIntosh's results and those of the Marine Biological Association. In Prof. McIntosh's experiments 596 immature plaice were captured, and these principally in St. Andrews Bay, in depths varying between four and a half and twenty fathoms. It has been seen that very few small plaice are caught in the beam trawl at Plymouth, but quantities are caught by other means, as will appear later.

Of immature round fish Prof. McIntosh captured an altogether insignificant number, the largest number being gurnards. Mr. Cunningham reports that small specimens of various species (whiting, pollack, pouting, hake, ling, doreys, and sea breams) are not uncommon in the contents of the large trawls, but he does not remember to have seen a specimen less than six inches in length. But the numbers of these small marketable fishes are altogether insignificant when compared to the cuckoo or boar fish (*Capros aper*), of which small species (it is less than six inches in length when full grown) vast numbers are sometimes caught. It is important to observe that round and flat fishes under six inches in length are caught in the large-meshed trawl, as it has often been maintained that soles and other fish of that size escape through the meshes. The conclusion with regard to flat fishes is that the young forms are not generally found in deep water, and that the large trawls do not and cannot destroy immature flat-fish. As for round fish it is known that when young they frequent rocky bottoms where the trawl cannot work, and their rarity in the trawl proves that they are not destroyed by it.

In fact no case has been made out against beam trawling. First it was attacked on the grounds that it was destructive of spawn, and this was speedily disproved; lately it has been attacked on the ground that it is destructive of immature fish, and this was disproved by the Royal Commissioners of 1883, whose conclusions have been confirmed at Plymouth; the last possible grounds of attack were equally disposed of by the Royal Commissioners, and it would be well if agitators would now let beam trawling alone. The complaints made of the destruction of very young fish in bays and estuaries appear, however, to have more foundation in fact, though more knowledge is sadly required. It is well known that in summer in certain localities millions of very small fish are to be seen along the margin of the shore, and that they often perish in vast numbers through the drying up of tidal pools by the sun. They are also eaten by gulls and by other fishes. A certain proportion escape destruction, and, according to their species, seek different habitats during their adolescence. It is an open question whether man can possibly destroy such a quantity of very young fish as to make any difference to the number of those that come to maturity. Often as it has been insisted upon, the public does not appear to realise that every female fish that comes to maturity lays a prodigious number of eggs; that if millions of these perish before hatching, or before they come to maturity after they are hatched, there will still be as many or even more adults left as the parents from which they had their origin, and that in spite of the seemingly enormous waste, the number of the species is kept up. That this is the case is familiar to all students of natural history, but it would seem to be hardly understood by the majority of well-informed people who are not naturalists.

The Royal Commissioners of 1863, 1878, and 1883 have all come to the conclusion that the destruction of very young fry by man is so very small relatively to its prodigious destruction by other agencies that it can make not the slightest difference to the total number of fish that survive. In point of fact, however, very little is known as to the numerical relation between fry killed by man and those destroyed by other agencies, and until accurate estimates are made in several localities, it is not possible to lay down a law on the subject.

Minute flat-fishes are not found on the rocky shores of Plymouth Sound, but there are several localities on the south coast where the conditions are favorable to the life of young fishes; such are Tor Bay, Whitsand Bay, and Mevagissey Harbour. The want of a suitable steamboat has prevented the staff of the Marine Biological Association from making the long and numerous expeditions to distant places necessary to the prosecution of this line of research, but with the help of Mr. Matthias Dunn they have gained a good deal of information about Mevagissey Harbour. Mr. Dunn sent some two dozen young flat-fish, about as large as a man's thumbnail, to the Laboratory in April, and since then Mr. Cunningham has visited Mevagissey and received several consignments of young fish. His experiences are given in his own words.

"On May 15th I paid a visit to Mevagissey to see Mr. Dunn and examine the young flat-fishes which he had informed me were to be seen in large numbers in the harbour at low tide. The old harbour of Mevagissey is almost completely empty of water at low spring tides and it was in this condition when I was there; the bottom consists of soft mud or harder muddy sand, and in the inequalities of the surface were left pools of water and running streamlets. In these were myriads of young flat-fishes, most of them completely metamorphosed and of a dark colour, but a few transparent and still having an eye on each side of the head. Among them I found a few soles. The little fish were in constant motion, rising to the surface of the water and then going again to bottom and lying on or in the sand. They could be caught without difficulty by the hand or with a cup or with a muslin net. I found all except the soles were of one species, namely, the flounder (*Pleuronectes flesus*); the individuals of this species varied from 10 mm. to 18 mm. in length (three eighths to three quarters of an inch). The young soles were scarce, I caught only three specimens the day I was there, but Mr. Dunn sent me up fifteen more the next day; these were all about 14 mm. in length (half an inch).

"On May 31st Mr. Dunn sent up about a hundred more *Pleuro-*

nectes flesus, and one small sole caught in the harbour at low tide as before. The sole was 18 mm. long, the flounders 15 to 19 mm. The difference represents the growth which had taken place in the fortnight elapsed. From the fact that after two or three days' search during these spring tides Mr. Dunn was only able to find a single young sole, it may be inferred that after reaching the size of 18 mm. the small soles move into somewhat deeper water, and are no longer to be found within the low-water mark of spring tides.

"I searched the shores of Sutton Pool and the mouth of the Plym estuary at Plymouth, and found no specimens of young flounders such as were so plentiful at Mevagissey; but some boys brought me two specimens of *Pleuronectes flesus* on May 31st, 10 mm. long, taken at low water on the muddy shore of Sutton Pool."

There are three points of particular interest in this Report, first the preponderance of the comparatively worthless flounder over the valuable sole; secondly, the indication given of the rate of growth of both sole and flounder; thirdly, the inference as to the change of habits of the young sole. Much more information is required on the last two heads. Undoubtedly the minute fish migrate from the beach to deeper water in search of food, but next to nothing is known of their history and movements at this time. It is known that small flat-fish, between three and six inches in length, are commonly caught by shrimp trawls working in one to three fathoms of water, and by seine nets hauled inshore. It has already been pointed out that when undersized flat-fish are captured by large beam trawls, they almost invariably belong to small and valueless species; and it is important to note that the same rule holds good, though in a lesser degree, for shrimp trawls,—at any rate it is so in Plymouth Sound.

The shrimp trawls used at Plymouth have an iron beam from nine to twelve feet long, and the mesh of the net is about half an inch square at the cod end. Whilst working at the life-history of the sole during the last twelve months, Mr. Cunningham engaged the shrimp trawlers of Plymouth to bring him all the small soles caught by them in the Sound. The number brought in was not large, never more than three or four in a day, and as a rule they were not brought in on more than one or two days in a week. Thus the take of undersized soles in Plymouth Sound is not large, and as the shrimpers at once throw overboard all the soles which are too small to be of market value, no destruction is done. On several occasions the fisherman of the Marine Biological Association has trawled in Cawsand Bay and elsewhere with the express purpose of getting very young soles. The results of his fishing are instructive, and the following cases may be regarded as typical. On August 15th, 1888, the trawl was shot several times in Cawsand Bay, where it was reported the shrimpers were catching and destroying "vast numbers" of small soles. Only one small sole, three inches in length, was taken, but with it were numbers of young scaldfish (*Arnoglossus laterna*), which may easily be mistaken for young soles on cursory examination. On May 8th of this year in the same locality several hauls of the trawl brought up, besides worthless gobies and dragonets, two specimens of *Solea minuta*, two and a half and three inches long, two dabs (*Pleuronectes limanda*) two or three inches long, and one scaldfish two inches long. *Solea minuta* is a distinct and absolutely worthless species, which never exceeds five inches in length; it is commonly mistaken for a young sole. On May 9th the fisherman caught two marketable soles (seven inches and thirteen and a half inches long) below Plymouth citadel, and numbers of small dabs two inches long and upwards. On May 10th, trawling in the Cattewater, he took six *Solea vulgaris*, six and three quarter to seven and three quarter inches in length, and twenty-two dabs, one and three quarters to six inches in length. In August, 1888, the fisherman was instructed several days in succession to bring up to the Laboratory undersized flat-fish brought in by the trawlers. They all proved to be scaldfish (*Arnoglossus laterna*). At the time it was being reported that an immense number of young soles were being destroyed.

It seems to be clearly established that plaice under six inches in length congregate in large numbers in particular places, often referred to as "nurseries." They are caught in numbers at all depths less than twenty fathoms. Such a nursery has recently been discovered and described in Nature by the Fishery Board for Scotland, and it is remarkable that nearly the whole of the 596 undersized plaice taken by Professor McIntosh during his experimental trawling were captured in St. Andrews Bay. The largest number taken by him in one haul was 122 in four and a half fathoms of water, but the next largest numbers, 65 and 64, were taken in twelve and twenty fathoms respectively. The only "nursery" practically known by the Marine Biological Association is the estuary of the Plym, called the Cattewater. The fishing in the upper part of this estuary, from Oreston to Laira Bridge and upwards, is the private property of the Earl of Morley.

Fishing with seine nets last autumn, the lessee of the fishing, Mr. Henry Clark, Q.C., in seven hauls captured some 200 plaice less than seven inches long, together with others of larger size. All the small fish were returned alive into the water, and this is always done in this private water, but below Oreston, where the fishing is public, the small plaice are destroyed wilfully or through negligence. On the 16th of May Mr. Cunningham saw large numbers of young plaice (*Pleuronectes platessa*), herring (*Clupea harengus*), and pollack (*Gadus *pollachius*) caught by the seine in the Cattewater. The plaice were about four and three quarter inches, the herring five and one eighth inches, long. They were about one year old, except the herring, which were probably hatched in the January previous, and all were taken away, none returned to the water. In the following week the fisherman of the Marine Biological Association was fishing with a seine in the same place, and, as before, a numerically large proportion of undersized plaice were captured, but were returned to the water. It is beyond question that large numbers of undersized fish are destroyed by seines every year in the Cattewater, and from information received it appears that this is the case in many other localities. But it would be necessary to make continuous and careful observations before it could be asserted that such fishing is injurious and ought to be prohibited.

It appears from what has been said above that the Marine Biological Association is not acquainted with any "nursery" of young soles. It is stated that such nurseries do exist on various parts of the English and French coasts. Investigation should be made, and if such nurseries can be proved to exist on the English coast it would doubtless be proper to prohibit fishing there, since soles require protection more than any other fish. It is strongly suspected that quantities of young soles are destroyed every year in certain creeks in the estuary of the Thames. Faversham Creek is an example, but scientific evidence is required before any steps are taken, as these "young soles" may prove to be thickbacks (*Solea variegata*) or other species.

Young turbots and brill (*Rhombus maximus* and *R. lævis*), three quarters to an inch in length, are found floating at the surface of the sea. Mr. Cunningham has examined several such in the early part of June, and Mr. Dunn, of Mevagissey, finds them floating at the surface every year. Mr. Cunningham considers that these fish are little more than a month old, and that their pelagic habit is due to the fact that they possess a large air bladder. It is unnecessary to say that their habit at this age protects them from trawling in any form.

A consideration of this report will lead to the inference that the destruction of immature fish has been greatly exaggerated by persons interested in some particular branch of fishing. Destruction doubtless does occur, but in the case of very small fry it is an open question whether it is injurious. The destruction of plaice must be determined before it can be asserted that it is injurious, and the destruction of very small soles is not proven. But it is evident that in spite of the work already done an immense quantity of accurate information is still needed, and this the Marine Biological Association hopes, in the course of its work, to supply. During the past year they have been unable to gather more than scattered and often chance pieces of information, but as soon as they are equipped with the means necessary to so extended an investigation, no effort will be spared to obtain data of the highest possible accuracy.

The Cœlom and Nephridia of Palæmon serratus.

By

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With Plates XIII—XV.

The accepted accounts of the excretory organs of the Decapod Crustacea are based chiefly upon the investigations of those numerous observers who have studied *Astacus fluviatilis;* the only recent memoir which attempts to deal with the arrangement of this system of organs in any other genus being the well-known work of Grobben.*

Dr. Grobben gives a short description of the nephridium of *Palæmon Treillianus,* which may be summarised as follows:

The whole organ he believes to consist of a single tube, beset with numerous cæcal diverticula, and arranged for the most part in a compact coiled mass, which forms the glandular portion of the kidney. The outer end of this tube dilates into a large bladder, which leads by a short and delicate ureter to the exterior; while its inner extremity terminates in a curious enlargement, the "end-sac," the walls of which are richly supplied with blood-vessels.

This account of the structure of a Decapod green gland is very attractive, because of its complete agreement with the descriptions given by Claus, Grobben, Hoek, and others of the shell-gland of the Entomostraca, and it has naturally received much attention from morphologists. Lankester† has compared the "end-sac" of the Crustacea with the space into which the nephridium opens in an embryo Limulus, and has suggested that in each case the vesicle which receives the termination of the renal tubule is a reduced representative of the cœlom; and Sedgwick has demonstrated that the similarly circumscribed space into which each nephridium of Peripatus is the remnant of an embryonic cœlomic pouch.‡

* Grobben, *Die Antennendrüse der Crustaceen,* Arb. Zool. Inst. Wien, Bd. iii, 1880. The references to the earlier works are so fully given in this paper that they will not be repeated here.

† Quart. Journ. Micr. Sci., vol. xxv, 1885, p. 516.

‡ Sedgwick, *A Monograph of the Development of the Genus Peripatus,* Studies from

The considerations here shortly summarised have led to the conclusion that the Arthropods must be regarded as a group of animals in which a cœlom, comparable with that of Chætopods, Molluscs, &c., has either permanently retained, or has secondarily acquired the condition of existence as a mere appendage of the nephridium, the functional body-cavity being a space of an entirely different nature.

Observations recently made in the Laboratory of the Marine Biological Association at Plymouth have led me to believe that the cœlom of Palæmon, at least, is much more highly developed than is generally supposed; and to take a view of the structure of the nephridium which differs considerably from that enunciated by Grobben.

The observations referred to were made upon the common English *P. serratus* (Fabr.), and were suggested by an attempt to repeat the experiments on excretion recently described by Kowalewsky,* who has shown that the renal tubules of *P. Treillianus* send branches into the thorax,—branches which extend back as far as the pericardium (l. c., p. 37).

Kowalewsky's observations were made by injecting various colouring matters into the tissues of the prawn; and these colouring matters, being absorbed by the renal tissues, stained such tissues deeply, and so made them easy of observation.

If a small quantity of a 1 per cent. solution of indigo-carmine be injected into the tissues of a healthy *P. serratus*, the colouring matter passes quickly into the venous sinuses, and in this way the gills speedily acquire a blue colour. Kowalewsky has demonstrated the presence in the gills of *P. Treillianus* of certain cells which take up colouring matters, and which have an acid reaction; so that a neutral or alkaline solution of litmus, passing from the body into the branchiæ, becomes reddened on absorption by these cells. I have been unable to satisfy myself of the existence of these cells in *P. serratus*, in which the blue colouration observed after injections of indigo-carmine seems to be due simply to the presence of colouring matter in the blood passing through the vascular and transparent lamellæ of the branchial plumes.

Be this as it may, however, the colouring matter, after appearing in the gills, gradually leaves these organs and is more and more completely taken up by the cœlomic and nephridial cells. Some hours after an injection the prawn is seen to have lost all colour, except in the region of the kidneys and in the median dorsal portion

the Morphological Laboratory in the University of Cambridge, vol. iv, pt. i, and Quart. Journ. Micr. Sci., vol. xxvii, 1887, pp. 533, *et seq.*

* Kowalewsky, A., *Ein Beitrag zur Kenntniss der Exkretionsorgane*, Biologische Centralblatt, Bd. ix, Nr. 2, March, 1889.

of the cephalothorax; these portions of the body being after an injection of suitable strength intensely blue. The colouring matter remains in these regions for some time, presumably until its final excretion through the nephridia

If a prawn, in which indigo-carmine has been absorbed in the manner just described, be dissected in strong alcohol, it will be seen that the blue area of the thorax communicates by a deeply stained band of tissue with each nephridium; and if the blue structures be carefully dissected out and removed from the body they will present the appearance which is shown in fig. 1. The cephalothorax is then seen to contain a large delicate sac (*cœ.*), whose walls consist of a flat pavement epithelium with a slight investment of connective tissue. This sac extends from the front of the head, immediately behind the rostrum, to the anterior extremity of the generative gland, to which it is closely attached (fig. 1, *ov.*). Dorsally the sac is covered only by the integument, from which, however, it is separated in the middle line by the ophthalmic artery (*a. o.*).

The walls of the cephalothoracic sac have the power of absorbing indigo-carmine in considerable quantities; and it is this property which causes the appearance of a dark blue patch in the cephalothorax after injection. The cavity of the sac is filled with a clear fluid, which is not blood, and which does not, at least for some time after the injection of indigo-carmine into the tissues, become coloured blue.

At its anterior extremity the cephalothoracic sac gives off a pair of tubular processes, one on each side, each of which dips downwards and passes between the œsophageal nerve-commissure and the great antennary muscles to open into the urinary bladder of its own side (figs. 1 and 8). A perfect communication is thus established between the nephridia and the cephalothoracic sac.

It is evident that, if the observations here recorded are correct, we have a sac in close contact at one extremity with the generative gland and in communication at the other with the nephridial tubes, and so with the exterior. This sac is further devoid of any communication with the system of blood-spaces. That is to say, we have a sac precisely similar in all its relations to the cœlomic sac of a Mollusc—especially to that of such a form as *Octopus*.*

The connection of the cœlom with the generative gland is so close as to render it perfectly probable that the cavity of the gonad and of its ducts may at an earlier stage in ontogeny be continuous with that of the cœlomic sac.

The junction between cœlom and nephridia is effected, as has

* Compare the account of the renal and cœlomic organs of this form given by Grobben, Arb. Zool. Inst. Wien, Bd. v, 1884.

already been seen, by means of a rather long, narrow tube, which is beset with small cæca, and which from about its middle point gives off a long branched tube, which ramifies about among the tissues of the base of the eye-stalks and of the first antennæ. Similar tubules are given off from the bladder, running from this organ into the second antenna. All these cæcal appendages of the cœlomic system are lined throughout by an epithelium, which is perfectly characteristic, and by which they are easily to be recognised in sections of the eye-stalks or antennæ.

In a paper read at the meeting of the British Association at Manchester, in 1887, an abstract of which was subsequently published in Nature (vol. xxxvii, No. 960, March 22nd, 1888, p. 498), Lankester has described certain spaces in the limbs of *Astacus* which appear to be lined by an epithelium and to be distinct from the blood-vascular system of spaces. It seems possible that these spaces, which Professor Lankester considers to be cœlomic in nature, are derived from processes of the nephridio-cœlomic apparatus of the same nature as those just described in *Palæmon.*

The external appearance of the nephridium itself has been accurately described by Grobben, except for the omission of the cœlomic canal which enters the bladder at the postero-internal angle, and which was entirely overlooked by this author, whose mistake in this point is probably due to his method of dissection, for he begins his account of the kidney with the words, "Präparirt man die (hintere) Antenne los," in which case one could certainly not expect a communication between the nephridium and any structure in the trunk to remain unbroken.

The nephridium communicates with the exterior by a short, delicate ureter, opening in the ordinary position at the base of the first antenna, and which opens by its proximal extremity into the antero-internal angle of the bladder.

The bladder itself is large, and its outer wall is invaginated by the glandular portion of the kidney and by the "end-sac;" these last-named structures being therefore partially invested by the epithelium of the bladder, in the manner described by Grobben in *P. Treillianus.* The layer of epithelium thus investing a part of the kidney is shown in fig. 8.

The epithelium of the bladder varies in character in various regions. That portion of the wall which forms the investment of the end-sac and of the glandular tubules consists of a layer of flattened cells, the nuclei of which stain deeply with hæmatoxylin, and appear nearly homogeneous, the protoplasm of the cells being granular, and also staining deeply (fig. 7). In the free portions, fig. 3, the epithelium is less flattened, and the cells exhibit traces of striation, especially towards their peripheral extremities; the nuclei in this region also staining deeply, and presenting a more or less homogeneous appearance. In all parts of the bladder the nuclei frequently appear, in preserved specimens, to project more or less beyond the cell-protoplasm into the lumen of the organ.

Grobben is of opinion that the bladder of *P. Treillianus* receives only a single nephridial tubule, which by its convolutions builds up the whole glandular substance of the kidney. In *P. serratus* a continuous series of sections shows that several tubules open into the bladder. In the series from which the drawings figs. 2 *a*, *b*, *c* were made, one such tubule is seen to open into the bladder in the section *a*, while ten sections below this point, in fig. 2 *b*, no communication between the bladder and the renal tubules is visible. Going still farther back, however, the section fig. 2 *c* shows a second opening, receiving a tubule which itself receives a number of branches. These figures suffice to demonstrate the existence of two openings into the bladder, and in the series from which the drawings are taken, five such communications could be recognised.

The course of the tubules in the substance of the gland is exceedingly hard to follow. All the tubes except one seem for a short distance after their exit from the bladder to run parallel with the surface of the gland, and then to bend inwards and upwards toward the end-sac. During their course they give off numerous cæca branches in the manner described by Grobben. One tube runs from the bladder along the posterior edge of the gland, and passes for some distance beyond the others; it then turns upon itself and passes into the substance of the gland, giving rise to a projecting process, attached to the postero-external angle of the organ (see fig. 1.)

Immediately after leaving the bladder, the lumen of the tubules is large; they are lined by an epithelium exhibiting the characteristic striation, and provided with a delicate cuticle. The nuclei of the epithelial cells are coarsely granular in stained sections, the granules staining fairly deeply. As it passes inwards, the lumen of each tubule becomes smaller, and the nuclei become clearer, and less distinctly granular. The two kinds of epithelium are shown in figs. 4 and 5.

The tubules are packed tightly together in the body of the kidney, the small spaces between them being filled with branched connective-tissue cells.

On reaching the dorsal surface of the organ, the renal tubules open into the "end-sac," which has been already referred to.* In fig.

* A quite similar case, in which communication between the end-sac and the body of a

7 the entry of three such tubules, α, β, and γ, is represented. The end-sac itself is a kidney-shaped structure, receiving in its concavity a large blood-vessel. It contains in its interior a considerable cavity, into which project a number of radial septa. These septa, together with the external wall of the organ, are made up of a dense connective tissue, which is deeply stained by hæmatoxylin, and in which run numbers of blood-vessels (fig. 7, *b. v.*). These blood-spaces are not, however, so numerous as those figured by Grobben in the corresponding septa of *P. Treillianus*; and there is a further difference between the blood-spaces of Grobben's figure and those seen by myself, inasmuch as the latter are always bounded by a distinct epithelium. I do not wish, however, to throw doubt on the accuracy of Grobben's figure without having had an opportunity of investigating the species described by him.

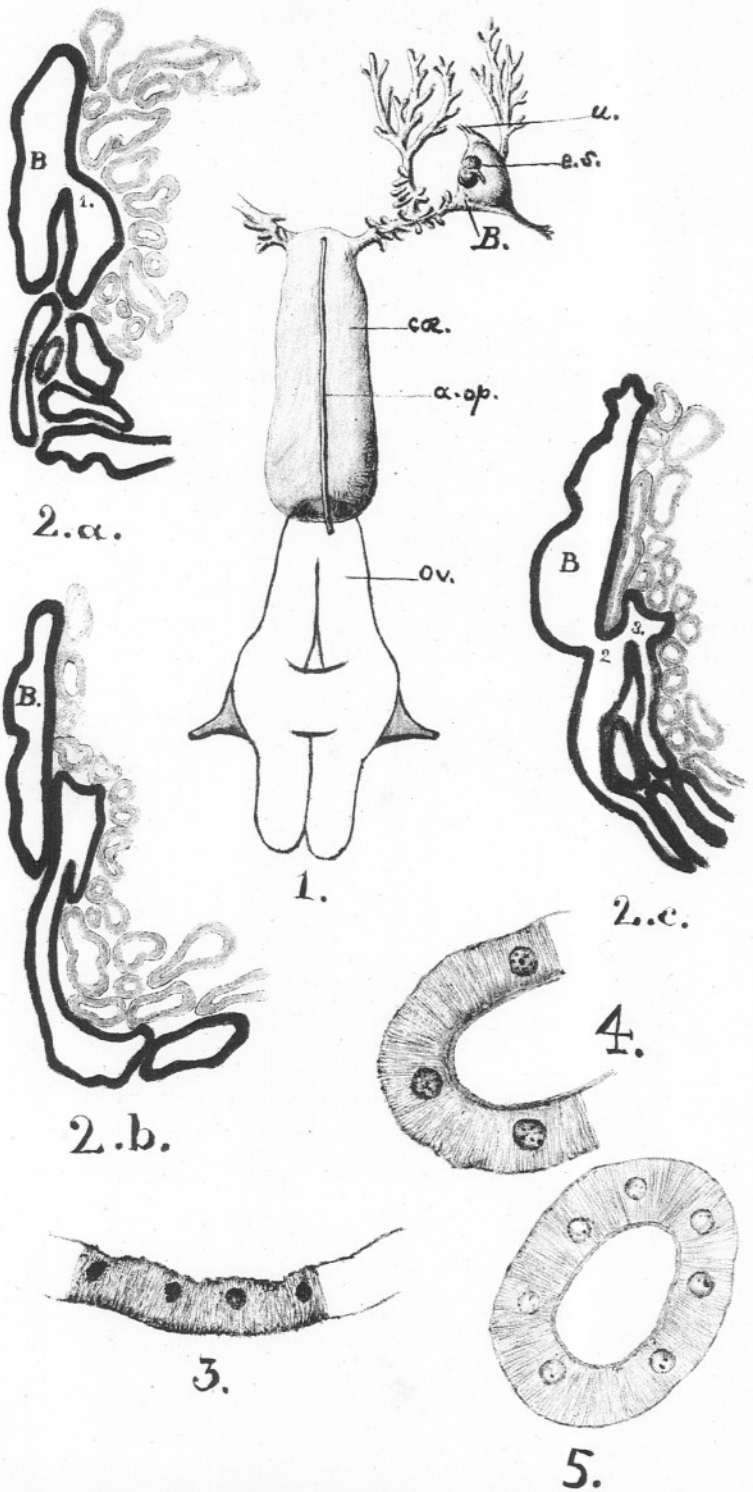
The cavity of the end-sac is lined by a curious epithelium, composed of large, pale, finely granular cells, with rounded nuclei (see fig. 7, *Ge. ep.*). In none of my preparations have I been able to see an arrangement of the epithelium so regular as that figured by Grobben (l. c., pl. i, fig. 8). In many of my sections, also, patches occur on which the epithelium is absent,—apparently from some cause independent of the methods of manipulation.

The cavity of the "end-sac," and to some extent also the lumen of the nephridial tubes, is filled with an irregular, finely granular clot. For the sake of clearness, this clot has only been inserted in the upper half of fig. 7.

The arrangement, of which a description has here been attempted, will be made clear by an inspection of the diagram fig. 6, in which it will be evident that the comparison so often made (by Claus, Grobben, and others) between the glomerulus of the Vertebrate kidney and the end-sac of the Crustacean green gland is abundantly justified, each glomerulus being the termination of a cæcal outgrowth from a bent nephridial tube, which communicates on the one hand with the body-cavity and on the other either directly or indirectly with the exterior.

In a future paper I hope to describe the modifications of this arrangement in other genera. I may here say that I have found in *Pandalus annulicornis* a cœlomic sac which is similar in its relations to the sac just described, but that in this genus the glandular part of the kidney is formed entirely by the glomerulus,—this structure being formed by a folded invagination of the wall of the nephridial tube, containing large numbers of blood-capillaries.

nephridium is established by more than one tube, occurs in the young coxal gland of *Limulus* (cf. Gulland, Quart. Journ. Micr. Sci., vol. xxv, pl. xxxvi, fig. 2).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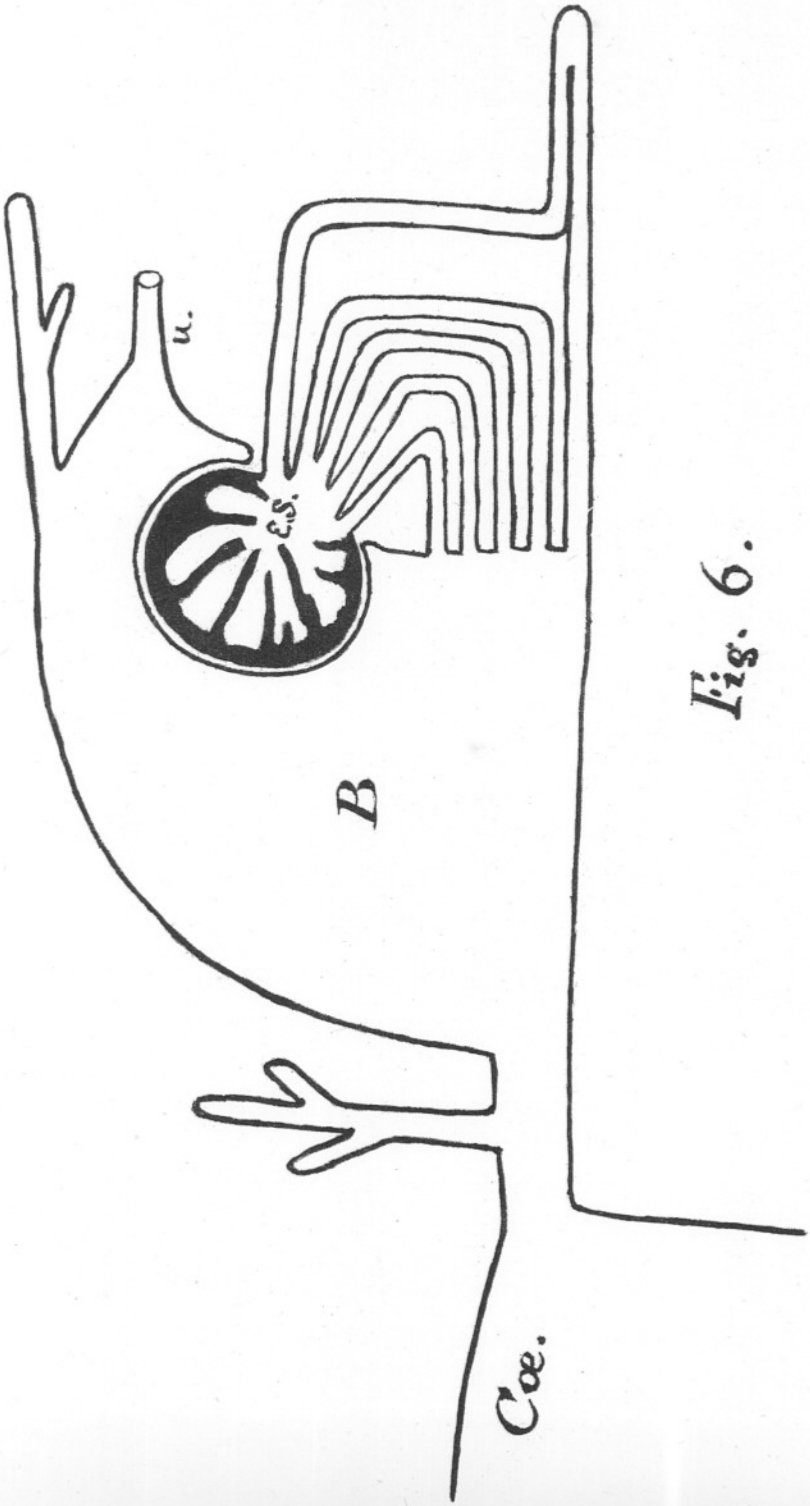
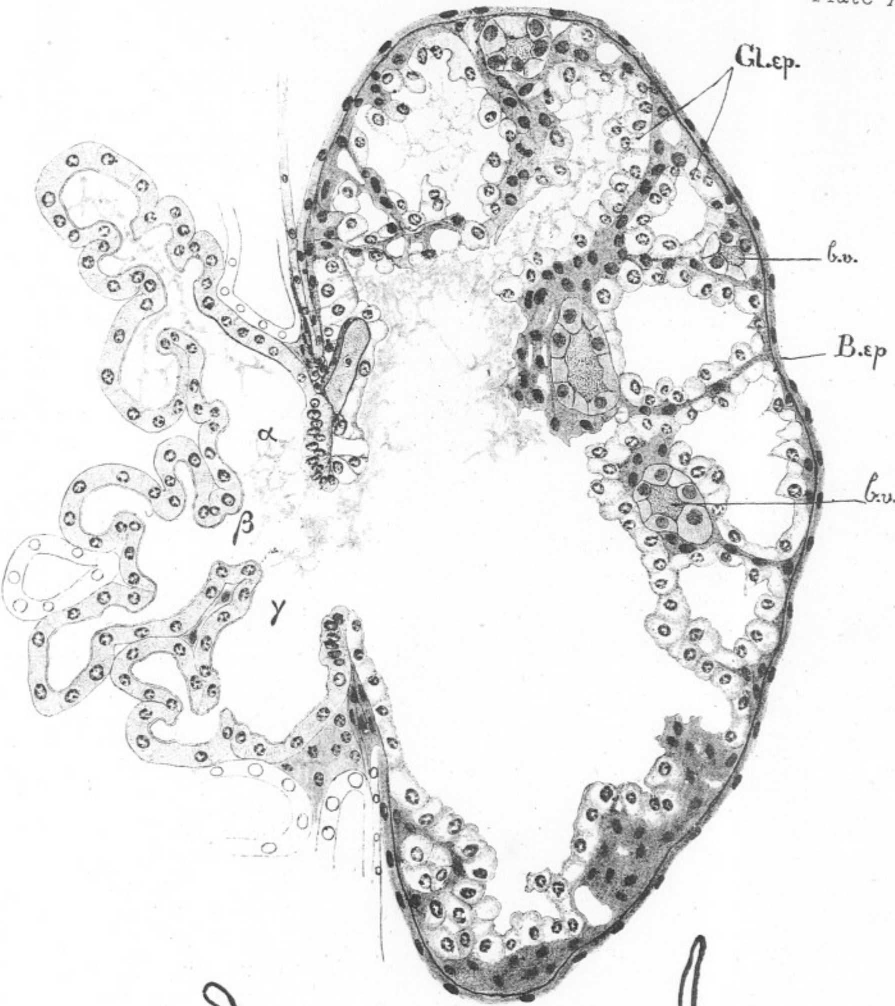


Fig. 6.

Plate XV.



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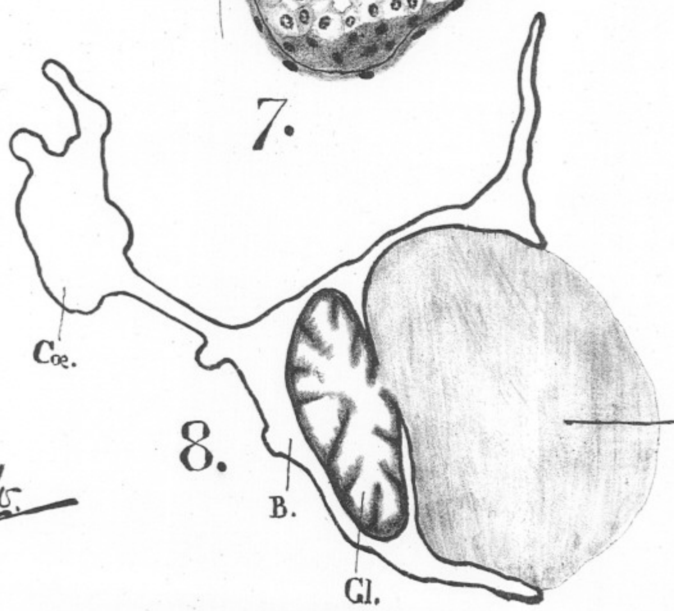

8.

Note on the Function of the Spines of the Crustacean Zoœa.

By

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With Plate XVI.

Anyone who has examined the so-called "protective" spines of the various Zoæa larvæ must have been struck by their great tendency to develop in one straight line, parallel to the long axis of the body. Among the *Macrura* this is the case in the Zoœa of *Peneus,* in the larva attributed by Claus to *Hippolyte,* and in the Galatheidæ. In the *Brachyura* the same result is attained in a slightly different way.

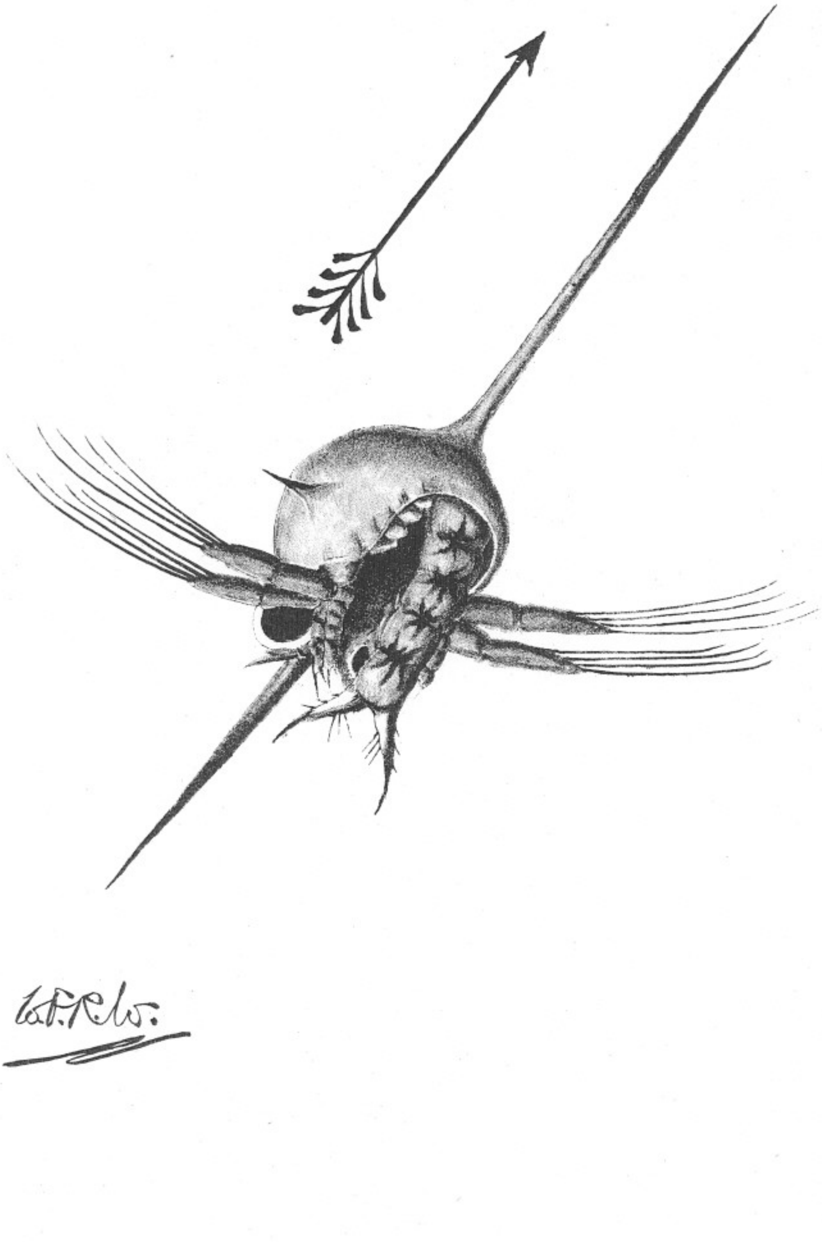
A comparison between the behaviour of those forms which are provided with long spines and those which are devoid of them, will show clearly that these structures have at least one function which has not, I believe, been hitherto recognised.

The accompanying drawing was taken from a Portunid larva, seen obliquely from above while in the act of swimming. The larva is seen to lie upon its back, and to swim in the direction of the arrow by rowing itself along with its maxillipeds, exactly in the manner of two men sculling a narrow racing boat. Steering is effected by means of the tail.

The great majority of the Brachyurous larvæ which I have observed swim in this manner, though some of them do not lie upon their backs.

If a number of Decapod larvæ be placed together in a large glass vessel, the effect of these spines upon their swimming capacities is very manifest. Such a larva as the Portunid of the figure will swim in an absolutely straight line towards the light, moving with great rapidity, and neither changing his direction nor losing his equilibrium during a journey of several feet. Those larvæ without spines, on the other hand, such as *Crangon* or *Palæmon,* will make their journey their journey towards the light in a very different manner. Their progress will be in a succession of ill-directed spirals, and it will be accompanied by that peculiar rotation about the long axis of the body which is seen in larvæ whose locomotion is effected by means of ciliated girdles. And not only will all forward movement be thus indirect, but it will be impeded by frequent and apparently involuntary somersaults, after which each Zoœa will hang for a moment vertically in the water, as if to recover its sense of direction.

It is hard to avoid the supposition that this power of rapid and direct motion which accompanies the possession of long spines must be an advantage to its possessor; but if this be the case, it is difficult to imagine the causes which have led to the abolition of such spines during the passage from the *Peneus* group to such forms as *Crangon, Palæmon,* &c., which are numerous and widely spread, while their larvæ are devoid of spines and incapable of executing the rapid and skilful movements in question.



On the Structure of the Thallus of Delesseria sanguinea. *Lamour.*

By

M. C. Potter, M.A., F.L.S.

With Plates XVII and XVIII.

The Delesserias, a genus of red seaweeds, six species of which inhabit the shores of the British Isles, have the thallus differentiated into a well-marked foliar expansion and a cylindrical portion; these we may respectively term the leaf and the stalk. Descriptions of this thallus are given in all books on seaweeds, for instance, in Harvey's (Phycologia Britannica), or Hauck's (Die Meeresalgen), but as far as I am aware no detailed account has been given of these structures. Agardh* and Wille† briefly describe their histology, but pay no special attention to them. The leaf is generally a fairly broad expansion (Pl. XVIII, fig. 1), with a definite midrib which gives off laterally a number of veins, these again giving off other veins and so on; the veins taper and become gradually finer till they end in being unicellular (fig. 2). This arrangement of veins exactly resembles the distribution of the fibro-vascular bundles in the leaf of an ordinary Dicotyledon and we shall see that they perform nearly the same functions in the two cases. By cutting transverse sections of the leaf we find that it is a plate of cells one cell thick (fig. 3, A, *a*) with here and there masses of cells, the veins. The cells of the leaf seen in surface view are polygonal with their protoplasm continuous‡ from cell to cell (fig. 4). While the leaf is small and is still growing the veïns are developed by the cells of the leaf dividing into three (fig. 3, B); the cells on each side may divide similarly and thus the vein become broader (fig. 3, C); the cells also above and below (fig. 3, A, *b*) the central ones may cut off segments and thus the vein becomes thicker. In this way we can trace the development of a vein from its unicellular ending to its largest part where it joins the midrib or another large vein. The midrib is developed in exactly the same way. The central cells first formed (fig. 3, C) elongate considerably as the young leaf grows; the cells formed by the divisions of the outer ones do not become so long as the central cell; thus the cells in the centre of each vein are longer than those external to them. The cells of

* *Florideernes Morphologi*, Kongl. Svenska Vetenskaps Akademiens Handlingar, 1879.

† *Bidrag til Algernes Physiologiske Anatomi*, Kgl. Svenska Vetensk. Akad., 1885.

‡ *On the Continuity of the Protoplasm in the Florideæ*, see Gardiner, in Proc. Camb. Phil. Soc., vol. v, p. 104, and Hick, in Journal of Botany, vol. xxii.

the vein, with the exception of the most external layer, are much longer than broad and have their protoplasm continuous with each other and with those cells which touch them (fig. 5).

As regards the stalk we find that the outer layer is made up of small squarish cells, while scattered irregularly in the centre are very large cells between which smaller cells are packed (fig. 6). Fig. 7 shows that the large cells are conducting cells, and that their protoplasm is continuous at their ends and also with the neighbouring cells at the sides.

We now come to consider the physiological importance of these structures, and at the outset we can clearly distinguish between an assimilating tissue, viz. the parts of the leaf where it is only one cell thick and the outermost cells covering the veins, and a conducting tissue, namely, the veins in the leaves and large cells in the stalk. The cell wall is thick, gelatinous, and pitted, and by means of these pits the protoplasm is continuous from cell to cell. The assimilated substances can easily be passed through a few cells to the veins; here they find an easy passage to various parts of the plant, some being stored up in the stalk which serves for a reservoir of reserve material as well as for an organ of attachment. Comparing the Delesseria leaf with that of a Dicotyledon, in both cases we have conducting tissue, but in the Delesseria there is only one conducting tissue required to take the assimilated substances to parts of the plant where they are wanted, and since the plant lives entirely submerged there is no need of a tissue to conduct water to the leaf; and we see too that in Delesseria, coupled with morphological differentiation into stalk and leaf, there is also physiological differentiation into assimilating and conducting tissue.

The above remarks apply especially to *D. sanguinea*, and judging from Harvey's pictures we conclude that in the main all the species are alike in possessing assimilating and conducting tissue.

DESCRIPTION OF PLATES XVII AND XVIII.

Illustrating Mr. M. C. Potter's paper "On the Structure of the Thallus of *Delesseria sanguinea*."

FIG. 1.—Part of thallus of *Delesseria sanguinea*.

FIG. 2.—Portion of leaf magnified. *a.* The midrib. *b.* Lateral veins given off from it. *c.* Fine veins.

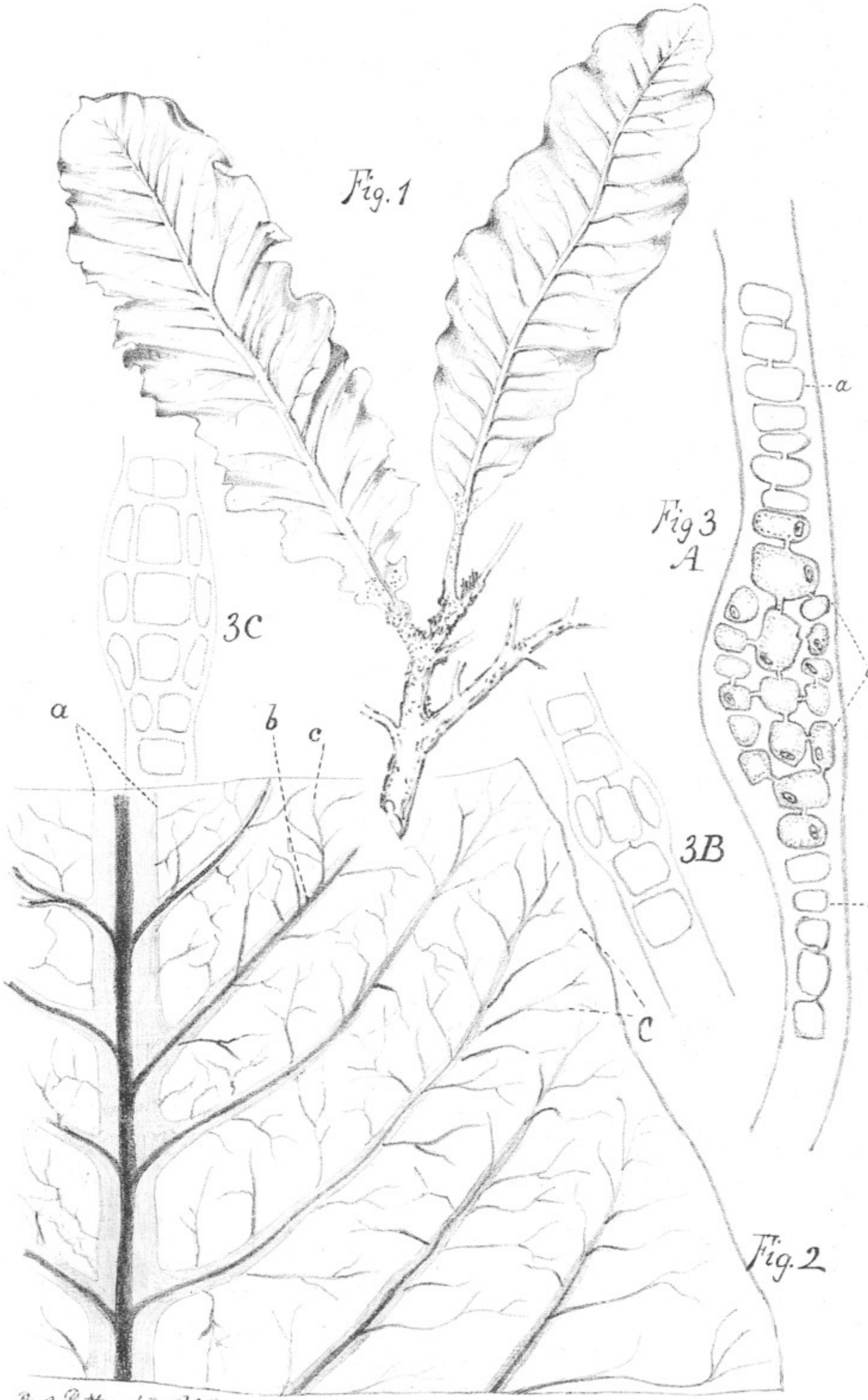
FIG. 3.—Transverse section of leaf. A. Section showing the unicellular part (*a*) and a small vein (*b*). B and C. Section showing the development of a vein.

FIG. 4.—Portion of a leaf seen in surface view.

FIG. 5.—Cells from a fine vein.

FIG. 6.—Transverse section of portion of stalk, the shaded portions (*a*) indicating the pits where the cells are continuous at their ends.

FIG. 6.—Longitudinal section of stalk, showing a large conducting cell.



M.C. Potter del. G.C.B. reprod.

Fig. 4

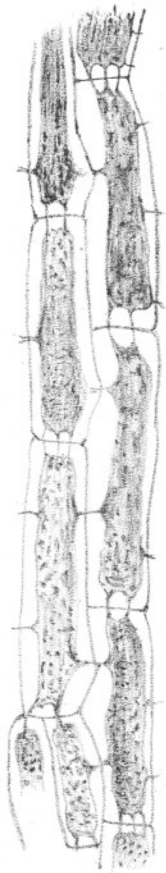


Fig. 5

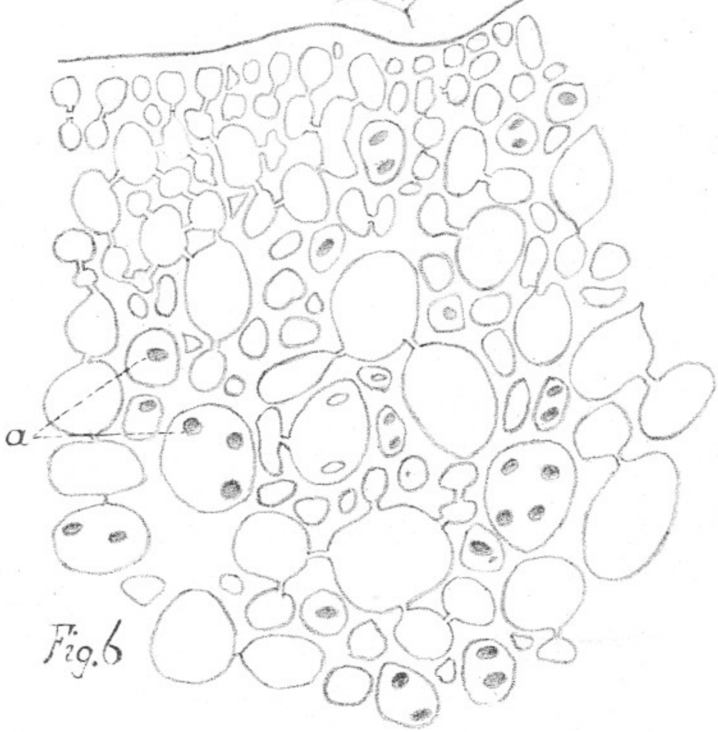
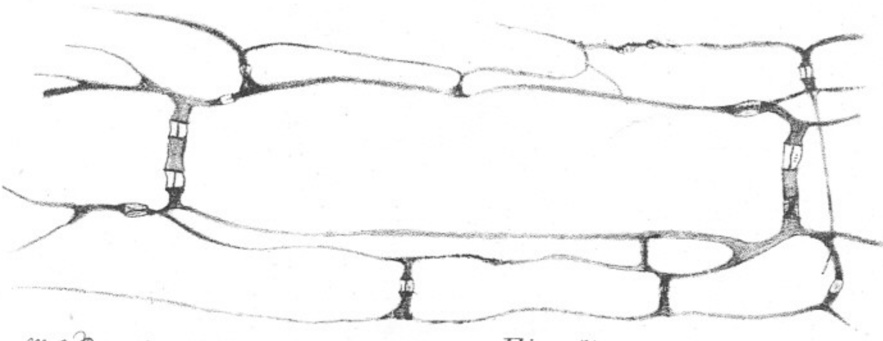


Fig. 6



M. C. Potter del. G. C. B. reprod. Fig. 7.

Report on the Nudibranchiate Mollusca of Plymouth Sound.

By

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The species included in the present report have all, with one exception, been taken since the opening of the Laboratory in June, 1888. Twenty-four genera and thirty-six species will be found recorded, and these afford a considerable addition to the previously known Nudibranchiate Fauna of the Sound.* Many of the specimens have been obtained north of the breakwater by personally searching under the stones and examining the rock-pools between tide-marks, but the majority have been procured by means of the dredge, the best grounds for this being near the Duke Rock Buoy and around the Mewstone, a fine conical rock which marks the entrance to the Sound on the east.

That the Fauna of the Sound has deteriorated during the last fifteen or twenty years seems undoubted, the cause being the continued increase in the amount of outfall of waste and commercial products from the Three Towns.† Vayssière in his account of the Opisthobranchiate Mollusca of the Gulf of Marseilles reports similar impoverishment of the Fauna due to similar causes. At a part of the coast, he says (25, p. 7), where *Haminea cornea*, *Philine aperta*, *Aplysia punctata*, *Doris virescens*, *Polycera quadrilineata*, and numerous Eolids used to be found in abundance, "dans ces deux dernières années il nous a été impossible de rencontrer plusieurs de ces mollusques et ceux qui ont resisté deviennent rares."‡ From what I have heard of the zoological condition of other bays along the Devon and Cornish coasts, I have no doubt that, especially among the Nudibranchiata, there are many species to be found in the neighbourhood which have not been taken by us inside the Sound or in the adjacent waters.

Notwithstanding this, some very valuable captures have been made, notably two examples of *Idalia aspersa* and three specimens of *Lomanotus*. The latter especially have proved of great interest, and their characters afford a very valuable addition to our knowledge of the genus in British seas. One species of *Eolis* appears to be new. Moreover, I have throughout tried to make this report not merely a list of species, but as far as possible a contribution to

* Cf. this Journal, No. II, First Series, p. 185.

† See the Director's Report, this Journal, New Series, No. I, p. 5.

‡ Cf. also some remarks by Thompson of Weymouth (24).

science. The *Zeit-geist* is in many quarters making for a re-examination of the very foundations of the theory of Natural Selection, and I trust that the observations here recorded on the subjects of variation, reproduction, rate of growth, colour, and habits of life may be of some service in furnishing facts as regards the life-conditions of this particular group of animals. I further trust that it may not be difficult for others to separate my own theoretical opinions or conclusions from the facts themselves.

During the past year a considerable advance in our knowledge of the value of colour in this group has been made. Darwin* himself seems to have been very doubtful whether the bright tints of Nudibranchs, and especially of the *Eolididæ,* really served as a protection, except in a few cases; but evidence is accumulating rapidly to prove that in this group colour, whether conspicuous or dull, has a very important value for the individual and species. Giard (6) and Herdman (13) have simultaneously noticed that the colouring of the common *Archidoris tuberculata* affords a means of rendering it inconspicuous in the localities and positions in which it is usually found. This species feeds usually upon *Halichondria panicea,* a common spreading shore-sponge, and the colours of the two are very similar. I may point out that this mimetic resemblance is increased by the possession by the Mollusc of a layer of dermal spicules; an enemy, knowing by inherited instinct, or far more probably by actual experiment and consequent education, the unpalateableness of the sponge, would be doubly deceived as regards the Nudibranch, both by its resemblance to the sponge in appearance and colour, and also by its similar *feel.* The case of this *Archidoris* is, however, somewhat complicated; individuals are often found with patches of green or violet colour on the back, and these add to the general inconspicuousness by being the tints of overhanging or surrounding weeds. Indeed, these colours are often seen in the sponge itself. Herdman does not appear to have noticed the mimicry between the Nudibranch and sponge, but he has a very interesting case in which the colour of the former perfectly simulated that of the surrounding rock, Nullipores and *Spirorbis* tubes.

A case more closely approaching one of true mimicry I came across on the shore at Drake's Island in the early spring of this year. It was that of a small *Archidoris Johnstoni* fixed on the side of an upright rock between tide-marks, and so exactly resembling a small piece of *Halichondria panicea* (var. *papillaris*) that at first I was quite deceived by it. It was situated with the head above and the anus below, the gill-plumes being (as Alder and Hancock state to be usual in the species) half retracted and forming a perforated cone perfectly resembling one of the protruding oscula of the sponge.

* Descent of Man, 2nd ed., pp. 261, 262, 264.

Several instances of pure "protective resemblance" to a fairly fixed surrounding may be found in Giard, and also one which seems to me to be a case of "mimicry" proper, namely, the resemblance of *Eolis papillosa* to a contracted *Sagartia parasitica*, the dorsal papillæ of the former corresponding to the tentacles of the latter. I have placed my remarks upon this most interesting case in my notice of the species (*infra*). Giard has made a mistake in regarding these cases of protective colouring as instances of a special mimicry existing between the Nudibranchs *and the particular species which they affect for prey;* but emphasis ought not to be laid upon this point, for (*e. g.*) *Eolis papillosa* not only preys upon *Sagartia parasitica*, but attacks anemones generally.

To what extent the colours of the smaller Eolids are explicable as instances of this mimicry of Actinians, I do not feel prepared to say at present. Wallace* thinks it probable that in some cases at least they are "warning colours as a sign of inedibility."

My own opinion is that the bright colours of the papillæ of Eolids in the majority of cases are serviceable in two ways. Their main purpose is no doubt to warn enemies of the presence of disagreeable qualities (*e. g.* nematocysts). But from the bright colours being generally confined to the papillæ, which are well known to be detached from the body with the greatest ease, and to be reformed to their full size in two or three days, I think this arrangement must be serviceable in directing the experimental attacks of young and inexperienced enemies to the non-vital papillæ, and away from the vital, inconspicuously coloured parts of the body. The enormous mortality of Nudibranchs† shows what would be the value in the struggle for life of such a means of facilitating the education of enemies, while giving the individuals themselves an additional chance of escape. That butterflies often escape from the attacks of birds owing to the conspicuousness and prominence of their wings, is shown by the many captures of individuals with mutilated wings which have been recorded; but in the case of Eolids such attacks of enemies (fishes chiefly) at the same time give them the needful experience of the unpalatable nature of their intended prey.‡ I have, however, experiments in progress for the verification of these and other ideas as to the value of colour in Nudibranchs and other groups of marine animals.

The ways in which colour probably serves as a protection through-

* Darwinism, London, 1889, p. 266.

† Cf. Darwin, Voyage of Beagle, 2nd edit., p. 245, *note*.

‡ Since the above was in type Mr. Poulton has drawn my attention to his account of the defensive value of "tussocks" in the larva of *Orgyia* (Trans. Ent. Soc., 1888, p. 589), which I had quite overlooked. The analogy is remarkably striking.

out the group are certainly very various, just as they are in *Lepidoptera*. One case especially is worthy of a moment's notice, viz. that of the tiny Dorid, *Ægirus punctilucens*. I have only met with one example of this form as yet, but in the conditions in which I met with it (see notice of species, *infra*) its general colour, form and size were highly protective in the way of rendering it inconspicuous. On a closer view, however, the sparkling blue-green spots which are so characteristic of the species became evident and conspicuous. The idea at once struck me that these spots must be serviceable in some way when the general protective colouring has failed to conceal the animal from its enemy, but of this, from lack of individuals for experiments, I can adduce no proof. Further, the habits of the Nudibranch itself are not at all satisfactorily known; D'Orbigny states it to live upon small species of *Ulva*, but though I can give no conclusive evidence I am almost sure that the habit which D'Orbigny observed is by no mean normal. Another case which appears to me to be similar is that of *Elysia viridis*, which is coloured bright-green and lives among green weeds. On its back, however, are a number of pearly spots in regular rows, very conspicuous upon a close view. I cannot help comparing them with the spots on the back of *Ægirus punctilucens*. In *Elysia* these spots appear to mark the positions of " pouch-like mucous follicles,"* a fact which adds to the interest of the case. I hope shortly to give an account of their structure and function, and of the value to the species of the markings which indicate their presence.

I desire here to express my great indebtedness to my friend and former tutor, Mr. E. B. Poulton, M.A., F.R.S.,† for his constant kindness and encouragement; also to Mr. W. Hatchett Jackson, M.A., F.L.S., for the equal value of his friendship and advice; and to Mr. G. C. Bourne, M.A., F.L.S., the Director of the Laboratory, for the time and facilities which he has readily granted me. I must also thank Canon A. M. Norman, M.A., D.C.L., F.L.S., for the help of his experience on several points, and Professor Charles Stewart, M.A., F.L.S., for information about the Fauna of Plymouth Sound in previous years.

In the report I have refrained from discussing anatomical characters, since I have not been able to consult the original papers and monographs of Bergh (with one or two exceptions) and Trinchese. To the same cause I should wish to be attributed whatever imperfections may be found in my classification.

* See Macalister, Introduction to Animal Morphology, part i, 1876, p. 280.

† I need hardly refer to the great suggestive value of Mr. Poulton's numerous papers on the colour, markings, and habits of lepidopterous larvæ and pupæ.

NUDIBRANCHIATA

(= OPISTHOBRANCHIA NON-PALLIATA, Lankester).

Sub-order 1.—PYGOBRANCHIA, Gray.

Family—DORIDIDÆ, *Leach.*

Sub-family—DORIDIDÆ CRYPTOBRANCHIATÆ, *Bergh.*

1. ARCHIDORIS, *Bergh.*

1. A. TUBERCULATA, *Cuvier.*

Common among the rocks between tide-marks. As many as thirty specimens were obtained on May 31st at Bovisand, north of the pier. Spawn this year most abundant in March and April, but on account of the mildness of the winter and warmth of the spring, marine animals generally have been breeding earlier than usual. On May 29th half-a-dozen specimens were obtained from the shore at Batten, of which one was only three quarters of an inch long, and several others were less than an inch and a half in length. The spawning is prolonged throughout the summer. On August 2nd a young individual was dredged in twenty fathoms off Rame Head, one inch in length. Several large specimens have been met with at various times; the finest, which was five inches in length, was obtained from the mouth of the Yealm on January 21st. It was seen in a fathom of water from the boat's side by W. Roach, our fisherman, and would have been in two feet of water at extreme ebb.

This species usually feeds upon *Halichondria panicea*, a very common littoral sponge, and* Giard (6) has noticed the general resemblance it bears in form and colour to its prey. It would be more correct to say that it is protectively coloured in relation to its *surroundings*; see Herdman (13) for a very good case and for his remarks upon it. Professor Stewart tells me that he once obtained on the shore at Cremyll four or five individuals, apparently of this species and at least two inches long, from a mass of *Hymeniacidon sanguinea* upon which they were feeding, and that, remarkably enough, they were all bright red in colour. Possibly they were examples of Alder and Hancock's species *Archidoris flammea*, though more than twice the size of their specimens.

2. A. JOHNSTONI, *A. and H.*

I have only seen one individual of this species, though Professor Stewart tells me that in former days it was very plentiful. I obtained

* More than fifteen years ago Giard remarked upon the deceptive appearance of this species "au milieu des masses rougeâtres des Amarouques qui couvrent le fond" (Arch. Zool. Exp., i, 1872, pp. 553, 558.)

our specimen from a rock between tide-marks at the east end of Drake's Island in the spring of this year. As I have mentioned in the introduction, this individual had most perfectly the appearance of a young *Halichondria panicea*, the "blossom-like cup" (A. and H.) formed by the branchiæ simulating the osculum of the Sponge. It was about one inch in length when extended fully, but was very changeable in shape. In appearance it was of a very pale, creamy white colour.

The branchiæ in this individual were twelve in number, but Alder and Hancock state the normal number to be fifteen. I notice that Hancock's figures represent only twelve.*

3. A. COCCINEA, *Forbes*.

Between tide-marks on the rocks below the Laboratory, May 14th, one specimen, three eighths of an inch long. One was also obtained in the autumn of last year. Mr. Heape found one on the shore at Ram's Cliff in November, 1886, and again in August, 1887, and also trawled one between the Duke Rock and Drake's Island in November, 1886.

4. A. PLANATA, *A. and H.*

One specimen, three eighths of an inch long, of a reddish flesh-colour, was obtained with the dredge from near the Duke Rock Buoy May 22nd, 1889. Mr. Heape also obtained one on ground between the Duke and New Grounds' Buoys in November, 1886, between the Duke Buoy and Drake's Island in the same month, and again in Barn Pool January 19th, 1888.

Sub-family.—DORIDIDÆ PHANEROBRANCHIATÆ, *Bergh*.

Section A. GONIODORINÆ (=GONIODORIDÆ, *Bergh*).

2. ACANTHODORIS, *Gray*.

5. A. PILOSA, *Müller*.

One fine specimen, an inch and a half long when not completely expanded, from the estuary of the Yealm, opposite the coastguard station, May 25th, 1889. It would come under Alder's third colour-variety (1), being very black in colour. We have obtained five or six other specimens also, but the record of their capture has been lost. They are quite colourless in spirit, and are not so large as the first-mentioned specimen.

* I have since (Sept. 11th) obtained another specimen from Drake's Island, and in this the branchial plumes are fifteen in number.

3. Lamellidoris, *Alder and Hancock.*

6. L. bilamellata, *Linneus.*

Thirty or forty specimens were obtained from the mouth of the Yealm, October 20th, 1888. Occurs also inside the Sound at Batten and Jennycliff. Seven or eight obtained with the dredge from off the Duke Rock, January 23rd this year.

7. L. sparsa, *A. and H.*

Two specimens of this rare species were obtained with the dredge in fifteen fathoms water off Stoke Point, January 17th, 1889. Each was just a quarter of an inch in length, ovate in form, and nearly equally rounded at both ends. One was of a brownish-pink colour, deepening just behind the tentacles and within the branchial circle, the other was of the same general hue but very pale and slightly purplish in the middle of the back. A character which was marked in each of these specimens, but which Alder and Hancock have not mentioned in the account of their specimen, is that the spiculose tubercles on the back were each surrounded by a ring of blackish pigment, and generally contained a black spot in their centres. Hancock's drawing (Monograph, fig. 3) represents these markings, although there is no mention of them in the text. The tentacles were yellowish white with brown spots or patches; the tubercles on the margins of the tentacular cavities were white with a black spot in the centre of each; but the "obtuse point behind," mentioned and figured in Alder and Hancock's Monograph, was not well marked in either of these individuals. These specimens also did not show the "few distant reddish-brown freckles or spots" on the back which were strongly marked in their example. I believe the branchial plumes were ten in number, but they were very small, not expanded, and hard to make out. The two were kept alive for several days, but were very torpid and remained constantly on the bottom or sides of the dish, never being seen to float on the surface of the water.

8. L. aspera, *A. and H.*

A young individual of this species was dredged between the Mallard and Cobbler Buoys on July 25th of this year. The contents of the dredge were chiefly large quantities of Polyzoa (*Bowerbankia imbricata, Bugula flabellata* and *avicularia*), and it was apparently from among these that the Nudibranch emerged after being placed for some time in a dish. It was only one tenth of an inch in length, but the dorsal tubercles were so characteristically flattened that there could be no mistake in the identification.

4. GONIODORIS, *Forbes*.

9. G. NODOSA, *Montagu*.

Common on rocks between tide-marks in the Sound. In October of last year it was obtained at the following localities—off Ram's Cliff, north of Batten breakwater, at the east end of Drake's Island, one mile west of the Mewstone, and in the estuary of the Yealm. This species, like many other Nudibranchs, comes to the shore in the spring to spawn. Very many large ones were found on the rocks below the Laboratory, near the ladies' bathing place, as early as February this year, and the spawn was abundant in March, April, and May. Young ones were being obtained frequently with the dredge in July.

10. G. CASTANEA, *A. and H.*

One example, just an inch long, was obtained from the shore at Bovisand, north of the pier, on May 31st of this year. Near it was some spawn which corresponded *generally* with that described and figured in Alder and Hancock, but the coil was larger and curiously recurved so as to form a sort of figure 8. After finishing the third round in one direction, the animal had begun again on the opposite tack, depositing two coils. It was all in one piece, and probably was deposited by this individual.

5. IDALIA, *Leuckart*.

11. I. ASPERSA, *A. and H.*

We have obtained two specimens of this rare species. The first was dredged in the estuary of the Yealm on October 20th, 1888. It is rather more than three sixteenths of an inch long in alcohol and corresponds with Forbes's description of I. *inæqualis* in having the back " circumscribed, elevated, with steep sides," a character which may be exhibited by other individuals of this species *aspersa* (see Alder and Hancock). It is colourless in spirit, has no median tubercles or filaments on the back, and has the anterior gill-plume and the posterior pair of filaments bifurcated.

The second example was dredged off Penlee Point on June 29th of this year. It was just over half an inch in length and its colour was a mottled rosy brown with yellow spots. This colour has largely persisted in alcohol. The two tentacular appendages on each side were as long as, or longer than, the tentacles proper, as Alder and Hancock have represented them, and they were constantly waving about while the animal was alive. The branchiæ were ten in number, but the anterior plume was deeply bifurcated as usual, thus forming eleven points. The posterior plume was not bifid. The lateral filaments were four on each side, the anterior ones very small, the posterior pair very broad at their bases and bifid.

These dorso-lateral rows of filaments are plainly homologous with the ridges found in the genera *Polycera, Goniodoris,* &c., and these also with the "epipodial folds" (Lankester, after Huxley) of *Archidoris,* so that a term to convey this idea would be of service. The "pallial ridges" of Alder and Hancock ought therefore to be termed "epipodial ridges." These structures are of considerable morphological importance and exist to a greater or less extent in every British species (at least) of the family *Dorididæ,* though often represented by very specialised vestiges (*e. g.* the branchial appendages of *Thecacera*); and I believe their homologues are to be seen in *Tritonia* and *Lomanotus,* becoming strangely modified in the Eolididæ. Additional ridges are sometimes developed, viz. a median, and a pair of sublateral (cf. *Goniodoris, Polycera, Idalia elegans* and *Leachii*).

In view of the variability of the branchiæ and epipodial filaments in this genus I think it must be regarded as certain that Forbes's two specimens of *Idalia inæqualis* are in reality varieties of *I. aspersa* (cf. Alder and Hancock's Monograph, Appendix, p. v). They were obtained together in thirty-five fathoms in St. Magnus' Bay, Zetland. The habit of associating in couples seems to be very common among Nudibranchs (cf. Giard, p. 502), and I have noticed it in species which are usually found in large groups (*e. g. Goniodoris nodosa*). If I should prove to be right in regarding the Zetland *Idalias* as varieties of *I. aspersa,* the Scarborough *Tritonias* (*lineata,* A. and H.) as varieties of *T. plebeia,* and the various British forms of *Lomanotus* as all of one species, then we should apparently have three instances of selective association between similar varieties in so low a group as the *Mollusca.*

6. Ancula, *Lovén.*

12. A. cristata, *Alder.*

In March of this year Mr. W. B. Hardy took a fine individual of this species from a tide pool below the ladies' bathing place. It was an inch in length when fully extended. I obtained another specimen between tide-marks near the same place in April.

Section B.—POLYCERINÆ (= POLYCERIDÆ, *Bergh*).

7. ÆGIRUS, *Lovén*.

13. Æ. PUNCTILUCENS, *D'Orbigny*.

On March 6th of this year we obtained one of these remarkable little creatures from near the Duke Buoy. Some of the contents of the dredge, consisting chiefly of Hydroids and Polyzoa, had been placed in a dish of sea-water, and after some time I found this Nudibranch to have emerged and made its way to the side of the vessel.

The epipodial ridges are represented in this species by a row of tubercles on each side, somewhat more definitely marked than the rest.

The usual habitat of this species appears to be under stones at low-water mark (see Alder and Hancock, 1). Balfour obtained it in shallow water in the Firth of Forth (16), and M'Intosh (17) states it to be "not uncommon under stones in rock-pools between tide-marks" at St. Andrews.

For some remarks on the colouration see the Introduction (*supra*).

8. TRIOPA, *Johnston*.

14. T. CLAVIGER, *Müller*.

One specimen of this species was obtained on March 29th with the dredge off the Mewstone. The lateral gill-plumes were considerably smaller than the median one. The orange pigment-spots on the back were confined to a median row.

9. THECACERA, *Fleming*.

15. T. PENNIGERA, *Montagu*.

One example of this rare species was obtained on August 3rd of this year in twenty fathoms off Rame Head. Giard states it to be not uncommon on the coast near the laboratory at Wimereux, and that it is particularly an autumn species, feeding upon Bryozoans of the genus *Bugula*.

10. POLYCERA, *Cuvier*.

16. P. QUADRILINEATA, *Müller*.

This species is not uncommon. It has been found in Jennycliff

Bay, in the Cattewater, on the north side of Drake's Island, and on the rocks near the ladies' bathing place, and has been obtained several times with the dredge off the Mewstone and in the estuary of the Yealm. Mr. Heape trawled it several times in Wembury Bay. It is subject to considerable variation, as Alder and Hancock state. In August, 1888, an individual was taken from the north side of Drake's Island which was irregularly spotted with black on a white ground. There were minute yellow tubercles on the body. The velar processes were two, with indication of a third, on the right side, and three on the left. The branchial prominences of the epipodial ridges were normal.

In May of this year a fine specimen from the Cattewater measured just over one inch in length.

On June 5th, from one and three quarter miles south of the Mewstone, was taken an individual of the variety mentioned in the Monograph as possessing no tubercles on the back. There were eight velar filaments, pigmented orange, and there was no pigment elsewhere. The gills and tentacles were normal; indeed, as yet I have seen no marked variation in the structure of these organs in this species, though such variation occurs, according to Alder and Hancock.

Another specimen of this variety was obtained on June 11th from three miles south of the Mewstone.

Young ones were obtained in tide-pools below the ladies' bathing place in July last year.

17. P. OCELLATA, *A. and H.*

On March 6th was obtained one small specimen of this species from near the Duke Rock Buoy, with the dredge.

Late in June I found three individuals under a stone between tide-marks on the shore under Mount Edgcumbe Park near the "Bridge." On the same small flat stone was some spawn, one and a half times coiled.

Sub-order 2.—CERATONOTA, Lankester.

Family—TRITONIIDÆ, *Johnston.*

11. TRITONIA, *Cuvier.*

18. T. HOMBERGII, *Cuvier.*

Not uncommon in deep water off the Eddystone, where it is brought up in the trawl. A specimen was taken in April, 1888, forty miles north of the Longships lighthouse. Early in May of this year a mass of Molluscan spawn was brought to us by a trawler which I think must have been deposited by one of these fine Nudibranchs. It was in the form of an exceedingly long and narrow ribbon, greatly convoluted, and was of a salmon-pink colour as nearly as I can remember. I unfortunately did not appreciate its importance at the time and took no notes of it, but I am now almost sure that it must have been the spawn of this *Tritonia*. On August 25th, 1887, Cunningham dredged a young specimen an inch and a quarter long, in nineteen fathoms' water, one mile south of the Mewstone.

19. T. PLEBEIA, *Johnston.*

This species is taken somewhat frequently. In September of last year I found two specimens in a piece of rock bored by *Saxicava*, one of them being only half an inch in length. This stone had been brought up with the dredge from south of the Mewstone, and other captures show the species to be fairly common there. One obtained on May 21st showed somewhat peculiar characters. The colour was entirely salmon-pink, deeper on the back from the colour of the liver appearing through the integument. The oral veil was entire, semicircular, and not produced into tentacular prominences, but with a tendency to form four obtuse angles, two on each side. There were five pairs of branchiæ (the anterior pair much the largest) and no small intermediate ones. The edges of the tentacular sheaths were entire, but not so regular as in Hancock's figures in the Monograph. Around each of the branchiæ and around the tentacular sheaths was an area of white pigment, opaque. Length just over half an inch.

This species is also occasionally obtained inside the Sound. One specimen was taken from the Cattewater on November 20th, 1888, and on the next day another was obtained from east of the Mallard Buoy. These, however, had *probably* been thrown overboard with the rest of the "scruff" from trawlers on their way to Sutton Pool. They were probably at the time fixed to pieces of *Alcyonium digitatum* upon which they feed, and in relation to which, as Giard has pointed out, their colour and form are evidently serviceable as affording a protective resemblance to their surroundings. On the day of its capture the individual from the Cattewater spawned on a frond of *Fucus serratus* in a dish; the coil had six perfectly regular turns, attached at short intervals to the weed. The specimen from the Mallard had only four tentacular prominences on the oral veil;

it was very pale in colour and possessed intermediate branchiæ, differing in these respects from the other individual. The edges of the tentacular sheaths, I noticed, were capable of undulation, though they formed no fixed wavy outline. Several of the characteristics of this individual are thus seen to afford an approach to Alder's species *T. lineata*, of which he found two specimens at Scarborough. Indeed, I think the distinctness of this species is open to considerable doubt.

Family.—DENDRONOTIDÆ, *Alder and Hancock.*

12. Dendronotus, *Alder and Hancock.*

20. D. arborescens, *Müller.*

Only one small specimen of this species has been obtained since June, 1888. It was brought up with the dredge from a depth of about twenty-five fathoms south of Penlee Point, in November. It was half an inch in length and had five pairs of branchial appendages, the tufts forming the two last pairs being arranged alternately, not opposite each other. The markings were of a brown-pink hue, with yellow tubercles and colouration here and there (cf. Alder and Hancock's variety, *pulchella*).

A larger specimen, just over seven eighths of an inch in length was dredged in twenty-three fathoms, about three miles south of the breakwater, on February 9th of last year (1888).

Though so rare here, Herdman (12 and 14) reports this species to be abundant at Hilbre Island during the winter months. It is abundant at Wimereux, and has a protective resemblance to the red-brown much-branched weeds of the genus *Callithamnion* (Giard, 6.)

13. Lomanotus, *Verany.*

21. L. varians, *mihi.*

On June 11th of this year three Nudibranchs were included in the results of the day's dredging at about three miles south of the Mewstone which I found with pleasure to belong to this rare genus *Lomanotus* (*Eumenis*, A. and H.). It was not so easy, however, to assign them to any of the specific divisions which have been founded for the reception of the five hitherto known British examples, and after a careful examination I have come to the conclusion that I must either institute two new species for the specimens which we have dredged or unite the four previously described British species and the three specimens which we have dredged into a single species.

Reasons drawn from a study of the amount of variation which is exhibited among Nudibranchs generally have led me to take the latter course, although it is not without some diffidence that I do so.

The history of the genus in British waters is, so far as I know, as follows: Forty-five years ago Alder dredged a single example near Berry Head, Torbay, for which he created a new genus (*Eumenis*) and specifically named *Eumenis marmorata*. At the time he was not aware that Verany had already published the description of a genus which was identical (as Alder and Hancock subsequently stated in their Monograph) and which had been named *Lomanotus* by him. In Lamlash Bay, Isle of Arran, another example was dredged by him, for which he created a new species, *Lomanotus flavidus*. In Weymouth Bay, also, Thompson (24) dredged two specimens, one in December, 1855, the other in December, 1856, which agreed apparently in all the points by which they differed from the two previous examples, and for which Thompson (adopting Alder's view) founded a new species which he named *portlandicus*. Lastly, Dr. Norman (19) dredging off Berry Head, Torbay (the spot whence Alder obtained his first example), in June, 1875, obtained another fine specimen for which he founded the species *Lomanotus Hancocki*.

Of the three specimens which we obtained on June 11th two were very closely alike both in size, structure, and colour, and the other was rather larger and much paler in colour and showed certain structural differences. I will describe this one first. In length it was just over five eighths of an inch. It was of a fawn colour, slightly reddish on parts of the back, with numerous small white spots, but without any dark spots or patches. The veil was produced into two tentacular prominences on the right, one on the left. The foot was as usual produced into a curved process at each corner anteriorly, and it was fairly broad as in *L. marmoratus* and *flavidus* (and probably in *L. portlandicus* and *L. Hancocki* also, since no peculiarity in this respect was noticed). The epipodial ridges formed on each side an almost upright waved expansion undulating into four lobes beset with small papillæ of irregular form, the median one in each lobe being somewhat longer than the rest. This condition is almost exactly the same as that described for *L. marmoratus*, but in our specimen the four *inward* undulations of the ridge were considerably more conspicuous than the outward from possessing larger papillæ, these papillæ increasing in size towards the centre of each of the (inwardly-directed) lobes. The waved ridges, indeed, might be said to be broken into four semicircular lobes, whose convexities are directed towards the median dorsal line of the animal. (Compare the definition of the species *marmoratus*, A. and H., in the

Monograph, Synopsis, p. 47, "branchiæ forming a *nearly* continuous waved line of papillæ on each side.") The dorsal tentacles had the same form as in *L. marmoratus* and were completely retractile within their sheaths. Each sheath was long, stout, *and produced at the margin into five or six blunt prominences or tubercles.* It is thus seen that this animal differs from Alder and Hancock's *marmoratus* almost exclusively in the form of the tentacular sheaths and in the colouring; and the doubt arises whether Alder's view of specific characters in this genus can be any longer regarded as correct, since upon it a new species ought to be created for the reception of the iudividual just described.

As was apparently the case with the Weymouth examples, our two other specimens agreed so closely that a single description will serve for both. Length half an inch. Colour much darker than in the preceding specimen, being of a rich, dark, velvety brown, spotted profusely with yellowish white. Veil with four blunt but prominent processes, thicker than in the preceding. Epipodial ridges on each side well marked, thick, fleshy, and foliaceous, undulating four times (four in, four out), the margins beset with bulbous papillæ of which the median ones of the inward undulations were longer than the rest. The outward undulations were as well marked as the inward. Tentacular sheaths spacious and fleshy, each with five projections on the margin. Foot exceedingly narrow and slender, to some extent at least from contraction. On the morning of June 12th each of these individuals had a couple of pieces of spawn upon its back behind the tentacles. Each piece was in the form of an incomplete coil, thickened at the commencement, and in shape much resembling a comma (ɔ), the tail being taken, however, rather closer round the head. The two pieces were placed with the "heads" close together and "tails" approaching each other, one of the commas being reversed (ɑɔ), and were guarded in this position by the first pair of inward undulations of the epipodial ridges which approached above so as to touch each other in the mid-dorsal line (cf. *L. portlandicus*). The chief peculiarities common to these two specimens were the dark brown colour, the thick fleshy character of the papillæ (which reminded me of the condition in *Ægirus punctilucens*), and the very slender foot. The fact that these two individuals should present such a close agreement in almost every point (in alcohol one has not quite so much brown pigment as the other) and that the differences between them and the other described British examples of the genus are comparatively considerable, would have been quite sufficient reason for the creation of a new species if I had not paid some amount of attention to the question of variation in the group generally.

In my notice of *Tritonia plebeia* (*supra*) I described one or two instances of considerable peculiarities of structure in individuals of the species. I showed that the edges of the tentacular sheaths which are usually "entire-edged" may occasionally be somewhat undulate in outline; and one specimen exhibiting this character, in addition to a general paleness of colour and the possession of only four velar tentacles, was seen to bring us very close to Alder and Hancock's species *Tritonia lineata*, one of the distinguishing characters of which is the possession of "undulating margins" to the tentacular sheaths. Of this "species" only two specimens were (or have been, so far as I am aware) obtained, under stones at Scarborough. Now, the genera *Tritonia* and *Lomanotus* are nearly allied, and though they have diverged in certain points of internal structure yet they still retain a great similarity in the structure and form of the dorsum generally and of the epipodial ridges and tentacular sheaths in particular. The undulating ridges of *Lomanotus* are to be seen in *Tritonia Hombergii*, although the papillæ of the former have grown into the branchial plumes of the latter, the larger plumes being simply developments of the larger papillæ on the inward undulations in *Lomanotus*. Therefore having established variations from the usual type of entire-edged tentacular sheaths in a species of *Tritonia*, I would adduce this as an argument for the probability of variation in the corresponding structures in any given true species of *Lomanotus*.

Alder founded his species *marmoratus* because of the entire-edged sheaths and the irregular character of the epipodial papillæ (added to some peculiarities of colour) in his specimen. He judged his specimen *flavidus* to be specifically distinct because of its possession of tuberculated sheaths and better differentiated papillæ on the epipodial ridges. So also in describing Thomson's specimens from Weymouth, he concluded them to be types of a new species for which he suggested the name *fimbriata* because of the filamentary character of the processes on the edges of the tentacular sheaths and epipodial expansions. Dr. Norman also founded the species *Hancocki* partly because of the small size of the dorsal tentacles in his specimen from Torbay, but considerably because the edges of the sheaths were produced into "leaflet-like points" and the papillæ of the lateral expansions were of "flat triangular" form. Norman, however, adds a valuable observation. He says significantly, "The papillæ . . . are capable of contraction and dilatation, and are constantly changing their apparent dimensions while the animal is in motion." Very probably the "leaflet-like points" of the tentacular sheaths possessed the same contractility of tissue, for the edges of the sheaths and of the epipodial ridges generally possess the same characters.

It is most instructive also to compare the sizes of the different specimens of *Lomanotus* described. Norman's example was two and a quarter inches long and Thomson's specimens were upwards of one and three quarters inches in length. Alder's *marmoratus* from Torbay was rather more than half an inch, as also was our largest specimen. Our two other specimens were just half an inch, and Alder's *flavidus* from Lamlash Bay was a quarter of an inch in length. Thus on the theory that they are all of one species we find that the oldest examples (as judged by size) have the greatest differentiation of the margins of the sheaths and of the epipodial ridges, that those nearest together in age are closely alike, and that the youngest individual (*flavidus*) has the simplest characters.

Altogether the conclusion seems inevitable that all the British specimens so far taken are members of the same species. The main difficulties to my mind are the apparent similarity of Thomson's two specimens (taken at different times in Weymouth Bay) and the close similarity of two of ours. But the difficulties are not sufficient to outweigh the evidence for the conclusion which I have just expressed; variation in Nudibranchs frequently takes place in definite directions (cf. *Cavolina Farrani*, No. 31, *infra*), and the Weymouth examples and our two similar individuals may well represent two fixed varieties of the species. It ought to be noted that these two individuals had apparently been copulating, on account of their depositing eggs at the same time. So far as the evidence goes, therefore, we have here a species of Nudibranch producing offspring of very variable external structure, the individuals apparently showing a tendency to unite rather with those of their own variety than with those unlike themselves.

I have to add that I regret to have been unable to consult Verany's account of his species *Genei*. In all probability it will be found that he has not limited its characters to so extreme a degree as Alder has done with regard to *L. marmoratus*, *flavidus*, and *portlandicus*, and in this case our specimens would probably be referred to *L. Genei*, Verany. In the meantime I have thought it well to adopt a new name, *Lomanotus varians*, for the single British species, since to employ any one of Alder's names would lead to confusion.

There is an observation which I omitted to add in its proper place above, viz. that the first described individual was seen by me occasionally to swim vigorously through the water in the dish in which I had placed it, by lashing its body from side to side, much as it is described by Lowe for a Nudibranch from Madeira of the genus *Peplidia* (*vide* Alder and Hancock's Monograph, p. 22). The two other individuals were torpid in their movements, and would not expand sufficiently for me to be able to make out the exact dimensions of the foot.

Family—MELIBEIDÆ, *Alder and Hancock.*

14. Doto, *Oken.*

22. D. coronata, *Gmelin.*

This species is common on *Plumularia.* Early in April a small specimen was dredged one mile south of the Mewstone, and another small one from the same locality on May 27th. In the latter the last branchia was very slender and simple in structure, not tuberculated; forwards from it there was a regular gradation to those with extensile tubercles. Cf. Herdman and Club, 14, p. 232.

In the collection of preserved specimens there is no undoubted example of *D. pinnatifida.* Mr. Heape has left a record of having found a variety of *D. coronata,* " or new species," in considerable numbers on Sertularians trawled in thirty-five fathoms, five miles south of the Eddystone.

23. D. fragilis, *Forbes.*

Commonly found here on *Antennularia ramosa,* sometimes on other Hydroids, *e. g. Halecium.* The habit, so noticeable in this group of Molluscs, of individuals of a species going about in couples, is very prevalent in the genus *Doto.* The two species mentioned above are usually obtained in pairs near the " roots " of Hydroid-stocks.

Family—PROCTONOTIDÆ, *Gray.*

15. Antiopa, *Alder and Hancock.*

24. A. cristata, *Della Chiage.*

One specimen of this species was dredged west of the Mewstone on June 7th of this year. It was one and a quarter inches in length. In colour it was very pale, the usual yellowish colour being confined to the laminæ of the dorsal tentacles and the median crest between them. There were opaque white markings along the back in the form of a pair of discontinuous lines, one on each side, from the front of the head to the tentacles and from the tentacles to just behind the heart, where they joined to form a single median discontinuous line running to the tip of the tail.

Family—EOLIDIDÆ, *Gray.*

16. Eolis (= Eolidia in the restricted sense of Gray).

25. E. papillosa, *Linneus.*

This well-known species is by no means common here now, though it is obtained occasionally between tide-marks and in shallow water. Prof. Stewart tells me that it used to be abundant at Cremyll.

Giard has pointed out the great resemblance which an individual of this species bears to a contracted *Sagartia troglodytes*. It is very probable that we have here a case approaching one of true mimicry, for Actinians are, as a rule, carefully avoided by shore-fish on account of their nematocysts, which, as I have several times tested, are very irritating to the lining membranes of the mouths of fishes. The fish are additionally deceived because of the possession by the Nudibranch of nematocysts at the tips of the papillæ. Some of the shore-fish which frequent rock-pools I have noticed to *touch* their intended prey, before eating it, with the fleshy margins of the mouth; and the usefulness of the possession of a certain number of irritating thread-cells is at once obvious. Further, the habit, which has been so often noticed in this and other Eolids, of erecting the papillæ when disturbed seems to me to be correlated with this function of the thread-cells, for by the bristling up of the papillæ the nematocysts at their tips are placed in the most advantageous position for the assault.

It is very interesting to note that in the two British species of *Hermæa*, which are inconspicuously coloured with respect to their surroundings, nematocysts appear to be absent. *Hermæa bifida* lives among red weeds of the genus *Griffithsia*; the body and papillæ generally are very transparent and of indefinite outline, *but the lateral hepatic canals of the body and the branches to the papillæ are highly developed and very conspicuous, having the form and colour of the branches of the weed.* The protective resemblance is here very perfect, though there still seems to be another resource for the animal when discovered, viz. the ejection, when touched, of a fetid, colourless fluid (see Alder and Hancock, 2).

Hermæa dendritica is coloured bright green, with dendritic markings, and lives upon the green weed *Codium tomentosum*.

For description of another possible species of this genus see No. 32.

17. Facelina, *Alder and Hancock.*

26. F. coronata, *Forbes.*

Late in March of this year a specimen of this species, one and a quarter inches in length, was dredged off the Mewstone. On May 11th six magnificent specimens were dredged off the same ground, with a mass of *Syncoryne*. Some spawn was brought up as well, and a young individual was only three eighths of an inch long.

For the carnivorous habits of this beautiful Nudibranch see Alder and Hancock (2) and Gosse (7).

18. Flabellina, *Cuvier*.

27. F. punctata, *A. and H.*

On May 11th one specimen was dredged, just over an inch in length, from one mile south of the Mewstone. The rose colour of the head and back was much deeper in this than in Alder's individual from Torbay. The dorsal tentacles were coloured dark brown along the middle third of their length, especially at the sides on the lamellæ; the upper third of the tentacles was pale in colour.

19. Coryphella, *Gray*.

28. C. rufibranchialis, *Johnston.*

Examples of this species were obtained by Mr. Heape in twenty to twenty-five fathoms off Whitsand Bay and ten miles south-east of Plymouth, in May, 1887. We dredged two splendid specimens along with a number of other Eolids on May 11th this year, one mile south of the Mewstone. Three more were dredged on June 11th in twenty fathoms, three miles south of the same rock.

29. C. Landsburgii, *A. and H.*

I took a small example of this rare and beautiful species from an *Antennularia*-stock dredged near the Duke Rock, in January last. It was only three sixteenths of an inch long. The colour was a beautiful, very transparent, pale violet, deepest on the lower part of the tentacles. The hepatic cæca of the dorsal papillæ were orange red in colour, with numbers of small, dark brown spots. The papillæ were arranged in four or five clusters, very ill-defined after the first set. They were very long in comparison with the size of the body, the largest being as long as the oral tentacles. They were not so stout as in Alder and Hancock's individual, and were capable of considerable flexion and extension. The opaque white ring near the tip of the papillæ was well marked. The dorsal tentacles were set well apart at the base.

This individual was kept alive for some weeks; the heart could easily be seen beating between the first and second clusters of papillæ.

Haddon (11) and Herdman (12) report the capture of individuals, probably of this species, of much larger size.

20. Cavolina, *Cuvier*.

30. C. olivacea, *A. and H.*

One specimen, dredged on May 11th, one mile south of the Mewstone. It was three eighths of an inch in length. The two pairs of lateral streaks of rose colour on the head were very well marked.

31. C. Farrani, *A. and H.*

Two examples of this species were obtained at different times during October, 1888, from the Cattewater. The dorsal tentacles were short and rather thick. The oral tentacles were thicker and longer than the dorsal, entirely orange in colour, and constricted at the bases. One of them deposited some spawn, attached by the edge and coiled two and a half times.

On November 1st a number of Eolids were found on the blades of some *Laminaria saccharina* from the Cattewater (under Queen Anne's Battery), on which extensive stocks of *Obelia geniculata* were growing. I described and classified them at the time as follows:

" A. *Cavolina Farrani.*—White in colour, with orange-tipped branchiæ. Seven or eight.

" B. *Cavolina*, sp.—Length half an inch or more. Dorsal tentacles rather longer than the oral but more slender. Body transparent, whitish, *marked on the back with large patches of orange red.* Branchial papillæ inflated or elliptical; in six, seven, or eight rows, three papillæ on each side; *of olive-green colour, orange at tips.* Dorsal and oral tentacles coloured like the branchiæ. Large oval patch of yellow pigment behind the dorsal tentacles. Back of head olive brown, merging into orange red below (*i. e.* in front of the bases of) the dorsal tentacles.

" In the larger specimens the colours of the branchiæ and back were much intensified, *the branchiæ being of a deep purplish black,* and the back being mottled with deep orange red. The upper large branchiæ had whitish, not orange, tips. The oral tentacles were almost entirely orange in colour; the dorsal tentacles were long and cylindrical. Five or six specimens."

The examples of *Eolis Farrani* which Mr. Murray obtained on the coast of Elgin were mainly of a purplish or umber tint, and the colour of the tips of the branchial papillæ was "generally whitish, with only a slight tinge of orange" (see Alder and Hancock's Monograph, Appendix, pp. xi, xii). M'Intosh also has obtained "fine purple varieties" at St. Andrews, and his figure shows the presence of deep orange-red pigment (17, plate ii, fig. 13), therefore I think there can be little doubt that our specimens were varieties of the same species, *Cavolina Farrani*. Compare also M'Intosh's *Eolis Andreapolis* (18), probably a variety of *C. Farrani*, not a distinct species.

"C. *Cavolina*, sp.—Same generally as B, but the tips of the branchiæ are of an opaque white, instead of orange, and very conspicuous. The patches of colour on the back are crimson rather than orange, and the integument has the appearance of velvet. One specimen."

Probably also a variety of *C. Farrani*.

"D. *Cavolina*, sp.—Half an inch in length. Body slender. Branchiæ numerous. Entirely white in colour. Two specimens."

No doubt another variety of *C. Farrani*.

"E. *Cavolina*, sp.—Half an inch in length. Body slender. Entirely orange in colour. Tentacles equal in size. Branchiæ inflated, in six or seven rows of three papillæ on each side. Central gland much sacculated. Papillæ with specks of opaque orange; no specks on the tentacles. Radula as figured and described by Alder and Hancock for *Eolis Farrani*. One specimen."

Certainly a variety of the same species. Compare also M'Intosh's *Eolis Robertianæ* (18).

All these Eolids were feeding upon *Obelia geniculata*, and were obtained from the same blades of *Laminaria*. As they all agreed so far as structure is concerned (except as to slight variations in the length of the tentacles), there can be hardly any doubt that they are members of the same species *Cavolina Farrani*, A. and H.; and in trying to estimate the value of colour in the *Eolididæ* it is certainly very puzzling to find almost equal numbers of two very different colour-varieties (A and B) of a species living under exactly the same conditions. I am not quite sure yet of the reason for this dimorphism.

With the above-described examples of *Cavolina Farrani* taken from the Laminaria on November 1st there was another Eolid which for convenience' sake I will describe here, although its structure does not admit of its being placed in the same genus.

32. *Eolis?* sp.

Body half an inch in length. Foot produced at the corners anteriorly. Dorsal tentacles wrinkled with regular annuli, not laminated; set considerably apart at their bases. Branchial papillæ in fourteen or fifteen rows, four papillæ on each side; papillæ slender in form. Oral tentacles longer than the dorsal. Colour of body transparent white; glands of branchiæ yellowish. Opaque white spots at tips of branchiæ in the form not of complete rings but of semilunar or crescentic patches on their anterior faces. Very characteristic was a beautiful opalescent pale blue colouring on the back of the head between the oral and dorsal tentacles, on the inner faces of the oral tentacles, and on the anterior faces of the larger branchial papillæ. On the posterior faces of the branchiæ this colour became more pink than blue. It was also made out slightly along the back and markedly on the back of the foot or "tail." Here at the very extremity it merged into a patch of the ordinary opaque white spots. The individual lived very well in a dish for several days, but an accident very unfortunately prevented me from examining the radula.

I know of no species to which this remarkable little Eolid can be referred; if it should prove to be new I would suggest for the species the name *Eolis Huxleyi*, in honour of the President of our Association.

21. GALVINA, *Alder and Hancock.*

33. G. CINGULATA, *A. and H.*

We have obtained this species on two occasions. On June 11th one specimen was dredged in twenty fathoms three miles south of the Mewstone. It was not quite three eighths of an inch long and *possessed nine rows of branchiæ.* The lateral lines of olive-brown between the bases of the papillæ were broad and well marked. The tentacles were pale in colour, and there was no patch of pigment behind. The animal was very active and restless.

On August 7th another specimen was obtained from the estuary of the Yealm. When fully extended it was very slender and measured just over three eighths of an inch, but it *possessed only five rows of papillæ.* The olive-brown pigment was diffuse at the sides and did not form distinctly marked lateral lines. The ring of bright red colour on each of the tentacles shown in Hancock's figures was represented by a band of reddish brown in this individual. The papillæ often assumed a contracted and tuberculated state, such as is persistent in the genus *Doto.*

22. TERGIPES, *Cuvier.*

34. T. DESPECTA, *Johnston.*

Large numbers of these minute Eolids were found crawling about on the hydrosomes of extensive colonies of *Obelia geniculata* growing on *Laminaria saccharina* from off the Mewstone on March 28th of this year. The majority were transparent and quite colourless, having simply an opaque white mass at the tip of each papilla. The dorsal tentacles were constantly long and slender, while the oral tentacles in some individuals could barely be made out at all. The papillæ were slender and not very club-shaped; they were, as usual, pointed at the tips. There was considerable variability in the arrangement of the papillæ, mainly due, however, to the animals being in different stages of growth. In the majority of individuals there was a pair in front, set opposite each other, and then two or three other papillæ behind them, arranged alternately, of which the first-*formed* one seems always to be on the left side. The heart was situated behind the first pair. In the largest individual, which was only one eighth of an inch in length, there were five *pairs* of papillæ, the second and fourth being the largest, with a single papilla on the left side behind the last pair. The heart was situated between the second and third pairs. The first pair was *double*, having two papillæ on each side, the outer ones being very small. In this large individual there was some faint brownish-yellow or slightly olivaceous pigment scattered over the body and on both pairs of tentacles. The "glands" of the papillæ were somewhat sacculate and of a faint yellowish-brown colour. The usual opaque white at the tips was yellowish at the extremity and faintly bluish in an ill-defined ring just below.

In one individual examined, which possessed remarkably long and slender dorsal tentacles, the left tentacle showed an abnormality in the form of a linear and slender outgrowth close to its base, directed backwards and outwards, and larger than either of the oral tentacles. M'Intosh figures a somewhat similar abnormality in the same tentacle of a *Doto coronata* (17, plate ii, fig. 14).

The spawn of this variety of *Tergipes despecta* was abundant on the stems of the Hydroid. The masses were not so reniform as they are represented by Alder and Hancock; they are more or less spherical in shape, slightly compressed from side to side and flat or very slightly concave along one edge (the *hilum*), from the centre of which proceeded a short gelatinous stalk for attachment. This stalk was constantly present, although I do not find it described for either *Tergipes despecta* or *exigua*. The spawn-masses varied in size, some containing only a quarter the number of ova found in the majority. The size of the spawn-masses was never so large as indicated in Alder and Hancock for *T. despecta*, and their shape was never so oblong and reniform as figured for *T. exigua*. The eggs were contained each in a separate capsule, and the larvæ possessed very long cilia on the edges of the velar lobes.

These little Eolids appeared to me to feed not upon the Hydroid itself but upon the minute Algæ which accumulate on its stems and branches.

Giard thinks the egg-masses of this genus to be of such form and colour, and to be so arranged upon the stems, as to imitate the gonosomes of the Hydroids upon which they are found.

Sub-order 3.—HAPLOMORPHA, Lankester.

Family—ELYSIADÆ, *Alder and Hancock.*

23. ELYSIA, *Risso.*

35. E. VIRIDIS, *Montagu.*

This interesting species was dredged in the estuary of the Yealm in some numbers on October 20th, 1888, and was again obtained there early in August of this year. This animal lives among green weeds (*Codium tomentosum, Zostera marina*) and its general bright green colour is certainly protective. The value of the "lustrous specks" of blue or rose colour I have not been able to prove as yet. Whatever their meaning, they will probably be found to have the same value as the spots of sparkling blue on the back of *Ægirus punctilucens.* See some remarks in the Introduction.

Family—LIMAPONTIADÆ, *Gray.*

24. LIMAPONTIA, *Johnston.*

36. L. NIGRA, *Johnston.*

Found by Mr. Heape on the Reny Rocks, February 6th, 1888.

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The Fish Pot of the Caribbean Sea.

By

Edward M. Earle, Jamaica, W.I.

This method of taking the fish alive is, I believe, peculiar to this sea and its neighbouring waters. Indigenous or non-indigenous matters but little in that which follows; it is sufficient to state that pot-fishing forms about the only mode of capture practised in these regions for supplying the people with fresh fish.

I say *about* the only mode of capture practised, but there are some exceptions. Of nets, here and there, a seine, a turtle, and a mullet will occasionally be found, but a drift, a trammel, and a trawl will be searched for in vain. Hand-lining is only occasionally practised, and whiffing only under exceptional circumstances, as the canoe travels from land to the pot, between the pots, and back to land; and during the king fish season a kind of bulter or trot may now and then be met with under the local name *palanca* or *palanque*—most probably derived from the Indian—but it is very rare, and these go to make up the auxiliaries.

While the fish are never taken from the pots in an offensive condition, they are more frequently than not in an unfit condition for food ere they reach the consumer, a state of things not very creditable to a country not more than one generation behind the rest of the world. But we look and hope for a change in these our fishy matters ere long.

It will perhaps be advisable if mention were made here that in writing of the fish pot of the Caribbean Sea I refer more particularly to those around the coast of this island and immediate waters; and although slight differences may exist in construction and working, in and around some of the other islands and the mainland, these differences are of so slight a nature as to call for no special mention.

It is to be regretted that in a country like this, consuming millions of pounds weight yearly of imported dry and wet cured fish, having a sea teeming with myriads of fine edible fish, the waters subject to no or very rarely to meteorological disturbances, where as a rule boats may fish and work for months together without interference from the elements, the people should remain content to depend upon outside energy and capital, and the feeble, very feeble, labours of a handful of fishermen—so-called—working but four or five hours out of the twenty-four, and employing a system of capture—not altogether devoid of some merit—that existed three hundred years ago, for so important a factor of daily life and universal economy. And yet it is so not only here but all through the beautiful islands in our seas.

The fish pots of the Caribbean Sea are made of various shapes and sizes, an individual idea monopolising their construction. They are made principally of the bamboo (*Bambusa vulgaris*) and occasionally of the wild cane, but wherever the former plant is ubiquitous, and the growth of the latter partial—growing on the banks of streams and in the vicinity of water, but loving best the running water—nine tenths, or more, are made of bamboo. But those made from the calamus are much preferred, for besides, lasting nearly double the time they are exempt from the ravages of the sea maggot or worm, which plays sad havoc in the spring months with the bambusa.

Fish pots are made of various shapes as well as sizes, for some are square, some oblong, but generally they are shaped zig-zag like the frame of Coleman's agricultural harrow. They are usually made of three sizes, and the size is denoted by the number of entrances or funnels, such as one funnel (smallest size), two funnels, and three funnels (the largest).

In building a pot the maker first of all proceeds, with the aid of a matchette and strong sharp knife, to split the long canes into strips of from one half to three quarters of an inch wide, and then thins them down to one eighth or one twelfth of an inch thick, according to the size of the pot to be made. When a sufficient number of these long pliable laths are prepared the plaiting commences and is performed in a rapid manner on a level piece of ground, the plaits usually resting on one knee. The width of the pot is determined by the number of meshes forming the first row, and these being completed the work proceeds rapidly, the mesh being hexagonal and from three quarters to one inch from angle to angle. The plaiting invariably takes place on the spot where the bamboo grows, under the shelter of an adjacent clump, or a neighbouring mango or other tree. When the three or more sections of which the future pot is to be composed—the top, the bottom, and the sides—are completed, they are rolled into a somewhat large cylindrical parcel, and conveyed on the head to the beach of the fishing village, where they are spread out out on the sand to straighten and lose the curve the temporary rolling has produced. When quite flat and the bend or curve gone the building of the pot commences. This is conducted in the following manner:—First of all the long side piece or pieces are placed on edge so as to assume somewhat the shape the pot is intended to take. Upon this upstanding trellis the future top of the pot is placed, and its edges firmly laced to the upper edge of the side piece by the branches of a strong and durable withe locally known as the vine or bine pear (*Cereus triangularis*). When this lacing has been completed all round the incomplete structure is turned completely over, the top, or already laced section, now lying on the ground. The bottom piece is now placed in position, as was the first, or top, and similarly laced all round. The plaited funnels, or entrance mouths, already introduced into the pot's interior, are now placed in position between the top and bottom sections, and these are also lashed firmly by pieces of the same withe. When all the lacing and tying has been completed, a straight stick of from one and a quarter to one and a half inches in diameter and some six inches longer than the pot's depth, is placed in each corner of the pot, passing through the extreme corner meshes of both top and bottom sections, and these are firmly lashed in position.

The pot lying on the flat surface of the sand causes these upright pieces, or posts, to project or extend upwards, about four or five inches, through the upper or bottom section, and these form four legs or supports, biting the rock, grass, or sand upon which the pot is eventually set. To these four posts are first lashed and then nailed two long, round poles which cross each other in the centre of the pot, and they are firmly lashed along their entire length, giving to the structure stability and strength.

The bottom or under side of the pot now being complete, the structure is turned over, and two other poles are placed in similar positions over and along the top, lashed and nailed to the four corners upright.

The curved or bent heads or mouths of the funnels are now brought up against the top and firmly secured in position by lashing. When thus fastened these funnels have their inner ends raised against the top side of the pot, their mouths, which are pear-shaped, turning downwards. The next thing is the introduction of four stones, the size and weight depending upon dimensions of the pot, and these are lashed, one in each corner at the bottom, to act as sinkers and subsequently weights, when the pot is set and lying in position.

The finishing stroke now only remains, and this is done by attaching the cable to the two cross-poles at the point of intersection, which should be as nearly as possible over the centre of the pot. To this cable are attached withe stays which are run from the cross-poles, and these prevent the pot turning or swaying from side to side. The engine is now ready to be taken to sea and deposited as a submarine trap for fish, many of whom enter the funnels and having passed through the pear-shaped mouths find themselves in a cul-de-sac and unable to get out.

The cables used for fish pots an usually of two kinds; either the large and strong pliable stems of curtain withes, or a two-ply rope made from the shredded leaves of the silver thatch (*Thrinax argentia*). Of the withes those generally used are the velvet (*Cissampelos pareiva*) and the large milk (*Melastelma parviflorum*), and, when they can be procured, the Iron and Old Tom withes. As may be supposed, it is not always possible to obtain these withes of the requisite size and strength for the larger pots, and when this is the case the cable is formed by twisting two or more together into a rough rope. These withes are of great value to the sea-fisherman, for with the silver thatch they form not only cables but cordage, and it is seldom that a yard of imported manufactured rope is seen in a fishing village or on the canoes. The withes and thatch above enumerated are not only strong but very durable, outlasting the pots, and under favorable circumstances, with care, a cable will serve two sets of pots. These withes are found and collected in the woods, suspended from large trees, or like tendrils encircling trunks and branches.

There is no more useful and valuable plant to the fisherman of these seas than the silver thatch, which on rocky soils and in droughty districts grows in great abundance. This small thatch plays an important part in the fisherman's economy as from its leaves he manufactures all his cordage and much of his cables.

The leaf is fan-shaped, the upper surface a bright glazed green, the under-leaf a silvery-grey and velvety, growing to a diameter of from two to three feet. The plant is usually found only a few feet in height, but will grow if undisurbed to a height of ten to twelve and fifteen feet. The leaves when required for twisting are shredded off the centre stalk which runs along its whole length, and these shreds are then twisted into a two-ply rope for cordage, a three-ply with thicker strands being used as cables. These ropes and cordage are exceedingly strong, their tensile strength being considerable, and the action of the salt water has very little effect upon their durability. The fishermen and fisherboys are adepts at twisting this thatch, and I have watched and known a boy of twelve or thirteen years get through his twenty-five fathoms in a day, not of continuous but spasmodic work, every now and again leaving off to spend ten or twenty minutes at a time in the waves as they roll up the sandy beach.

The pot now being ready for use is taken out to sea and lowered at some desirable spot, the locality and depth being selected to suit the idiosyncrasies of the owner. If snappers (*Messoprion uninotatus, and M. chrysurus*) are wanted the pot will be deposited in from ten to twenty-five fathoms; if other and mixed fish then the depth will vary and run down to fifty and sixty fathoms according to the nature of the bottom and the principal fish sought. They are almost invariably set without bait of any kind, but in some localities some bait, such as dead sprats, viscera, and salted herrings (enclosed in fine netting), are attached to some part of the inner pot.

The cables to which the pots are attached are arranged as follows. Should the depth of water be thirty fathoms the cable is made to measure one fourth more, or forty fathoms. Two thirds of the depth, above the pot, a matured piece of bamboo, about six feet long, is securely fastened and floats suspended in mid-water, and this buoy keeps the lower portion of the cable continually taut. The upper end of the cable is attached to a similar piece of bamboo, and this is allowed to swing and play about, serving for a mark to identify and recover the pot when it is visited for the purpose of examination.

Under favorable conditions a pot will last for months, appearing bi-weekly or tri-weekly, as shall be required, at the surface, to have its contents transferred to the bottom of the dug-out; but—and it sometimes happens—a storm may carry away the upper and identifying bamboo and the pot is lost for ever, for the fisherman seldom tries to recover except in shallow water. An unusually strong current will perhaps carry the whole structure away, and in this case it is sometimes recovered. Should the pot not be visited for a week or more, its finny contents accumulating the while, some member of the shark family may utterly destroy its wicker sides to feast upon the enclosed captives, or a devil-fish will sever the bamboo buoys and leave the pot below unconnected and irrecoverable.

When set the fish pot is visited usually every other day, sometimes twice, occasionally only once a week. When this longer interval occurs some reason may be assigned for the delay. If the pots were visited daily they would yield a larger harvest, but then the Carib fisher believes in "letting to-morrow take care of itself," and carries out his belief. A pot made of matured bamboo will withstand the action of the salt water and the worm, and remain serviceable for from six to eight months and in some cases a month longer; one made from the wild cane four to six months longer than the bamboo. The silver-thatch cable, like the withes, will in-invariably outlast the pot.

When a pot is *hauled*, as it is termed, it is brought to the surface by means of the cable, and when alongside the canoe it is turned on end, the fish shaken into one corner from which they are extracted by the hand, through a small gate or gap left purposely for that purpose. When all are transferred to the canoe the gate is closed, refastened, and the pot returned to its watery home. It is rarely a pot is lifted without containing fish; frequently great numbers, eight, ten and twelve dollars' value, are taken in the large deepset pots at a single haul.

In isolated cases where a fisherman can command the services of a large canoe, thirty feet or so in length, pots of extra large size are set in deep water down to 100, 120 and more fathoms, and when these are so set they more than repay for extra energy. These deep-sea pots require to be made of extra strength, and as it is only here and there a canoe can be found large enough to work them, they are very few and very far between.

The fishing canoe is a splendid boat, buoyant as a cork and as staunch as a lifeboat. They are made from the single trunk of the silk cotton tree, the *Bombax cieba* of botanists, shaped and dug out by adze and axe, and when properly shaped and thoroughly fitted, which they seldom are, no faster or safer boat exists.

Tealia tuberculata (Cocks).—A Study in Synonymy.

By

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Naturalist to the Association.

With Plate XIX.

In the Report of the Cornwall Polytechnic Society for 1851 Mr. W. P. Cocks described a species of sea-anemone under the name of *Actinia tuberculata*. He gave a small figure in illustration, but this was somewhat indefinite. His description is as follows:—"Body globular, light brown, densely covered with large greyish-white tubercles, the apex of each tubercle depressed; disc white; mouth large, lips thick, corrugated, and everted; tentacula numerous, large, obtuse, some bifurcated, others trifurcated. Diameter three and a half inches when contracted."

P. H. Gosse in his British Sea Anemones and Corals, 1860, quotes the above description, and adds that he had privately received further particulars from Mr. Cocks, namely, that the anemone was obtained thirteen miles south-west from Falmouth, attached to a valve of *Pecten maximus*, that it lived with Mr. Cocks for some months, that it was "bulky, rather loose in texture, when fully expanded covering the bottom of a large pan,—it had the appearance of a mammoth *Bellis*. It appeared to be extremely irritable, and upon the slightest provocation would throw off from its body a large quantity of thick glaire, which if allowed to remain produced a disagreeable smell. When contracted it had the appearance of a half-boiled sago pudding."

Gosse says he ventured to suggest that it might have been a large colourless deep-water specimen of *Tealia crassicornis*, but Mr. Cocks repudiated the identification while admitting the relationship; Gosse concludes that it *may* be distinct.

A species of anemone which is extremely common in deep water in the neighbourhood of Plymouth, off the south coast of Devon and Cornwall, and numbers of which have been brought to the Laboratory of the Association, is without doubt the species described by Cocks. Cocks' description is not as precise and detailed as the zoological definition of a species ought to be, but there are points in it which apply so perfectly to the form I refer to that it is certain that my specimens belong to the same species as the specimen examined by Cocks. These points are (1) that the column is "densely covered with large greyish-white tubercles, the apex of each tubercle depressed;" (2) that the tentacles are "large, numerous, obtuse, some bifurcated, others trifurcated." This division of the tentacles does not occur in all specimens, and when it does occur is present only in two or three tentacles out of the whole number; it is confined to the extremity of the tentacle, which divides into two or three terminal portions, or bears a secondary tentacle growing from it almost at right angles. This branching of the tentacles is not therefore a constant character, and does not occur always on particular tentacles, but it is a kind of abnormal growth which has, so far as I know, only been observed to occur in this species. (3) Mr. Cocks' specimen was attached to a valve of *Pecten maximus*, and all the specimens I have received were attached to the surface (usually the inner) of single valves of large Lamellibranchs, most frequently valves of *Cyprina islandica* or *Pinna pectinata*.

Description of the species.—The size is large, ranging from 8 to 13 cm. in diameter of base and 2 to 5 cm. in height in the expanded condition. The tentacles are usually short and blunt with transverse stripes of colour. The disc is reddish or brownish in the centre round the mouth. The walls of the stomodæum are yellowish, wrinkled with longitudinal folds, and tumid. The directive or œsophageal grooves are very conspicuous, their surfaces are smooth and white, but at the upper end of each there is a slight projection of the oral disc which is distinguished by being more brightly coloured than the rest of the disc. The external part of the disc is of a light yellowish tint, but radiating striæ of red pass from the central coloured part to the bases of the tentacles, the base of each tentacle being enclosed by two such coloured striæ. The extent of the red-brown central area of the disc varies considerably,—sometimes it is absent altogether, sometimes it extends almost to the origin of the internal cycle of tentacles. This coloured area always disappears in specimens kept for some months in our aquarium, the whole disc becoming of a pale drab colour. The primary tentacles are distinguished by two milk-white bands, which lie within the red striæ enclosing the base of each, and which extend outwards from each primary tentacle to the most exterior cycle of tentacles, where they pass on to the adjacent sides of two tentacles belonging to this cycle. The tentacles are translucent with transverse rings of faint colour; the base is white; above this is a band of very faint red, then comes another band of white, then another band of red much more pronounced, and finally the tip is white. The tip of each tentacle is perforated, and when a specimen is taken out of water and contracts forcibly, water is forced out of the terminal pores of the tentacles in streams with some force.

The column is of a yellowish-grey colour with scattered patches of red. It is closely beset with large bladder-like warts, which are arranged in vertical rows in close proximity to one another. The largest of these warts are on the margin of the column, while near the base they get smaller and gradually disappear. Each wart has from two to four white patches which are probably glandular. The warts have the power, probably due to these glandular patches, of attaching pebbles or sand to themselves, and to such objects they adhere with considerable tenacity, but this property is not often exercised in the natural condition, the surface of the column being almost always bare.

The base is usually expanded considerably beyond the column when there is room for it; when an animal on a somewhat small shell is left undisturbed in an aquarium the base soon extends on to neighbouring surfaces.

The tentacles are strongly retractile, that is, they can be contracted to a very small size towards their bases, and the margin of the column can be contracted so as completely to cover the tentacles and disc. When the animal is much irritated after the tentacles and disc have been retracted and covered by the column, the animal continues to contract and expel water from its interior until it becomes quite flat so that the walls of the column form a disc almost parallel to the base.

The principal peculiarities of the species consist in the number and arrangement of the tentacles. The primary tentacles, which as already mentioned are conspicuously distinguished from the rest by white bands enclosing their bases, are ten in number. These probably consist of two cycles of five, but there is nothing in the adult to indicate this. Having recognised these primary tentacles it is not difficult in the living animal to ascertain the arrangement of the other tentacles, in the space between any two of the primaries. It is found that in any specimen some of the intervals between two primaries possess a regular normal arrangement of other tentacles; this normal arrangement is seen in all the intervals on the right hand side in fig. 1. The normal arrangement consists in the successive subdivision of the space by tentacles, first into two halves, then into four parts, then into eight, then into sixteen. That is to say between the two primaries there is a tentacle of the second cycle with a pair of mesenteries corresponding to it; then on each side of this tentacle, *b*, there is a tentacle, *c*, of the third cycle, with a pair of mesenteries; then in the four spaces thus separated there are four tentacles, *d*, of the fourth cycle each with a pair of mesenteries; and finally, there are eight tentacles, *e*, which have no mesenteries corresponding to them, but are between the pairs of mesenteries belonging to the other tentacles. Thus if this regular arrangement existed throughout the tentacular system the numbers would be 10, 10, 20, 40, 80, or 5, 5, 10, 20, 40, 80, in the successive cycles, and the total number would be 160. But in every specimen that I have examined the number and arrangement of the tentacles was abnormal in some of the spaces between the primaries. I have given diagrams showing the arrangement found in two specimens. In the specimen represented by fig. 1 the arrangement of the tentacles was normal in eight out of the ten spaces between the primaries. Two of the primaries opposite to each other can of course be distinguished as directives by their position opposite to the directive œsophageal grooves; and these two are further distinguished, as seen on dissection, by the fact that the muscles of their mesenteries are on the outer sides of the latter. In the diagram fig. 1, the two inter-primary spaces on the left of the upper directive tentacle have an abnormal number of tentacles. In each space there are two tentacles wanting; the deficiency is probably in the outer cycle (interseptal cycle). Thus the total number of tentacles in this specimen was 156 arranged thus: 10, 10, 20, 40, 76.

In the other specimen represented in fig. 2 the abnormality was much greater. Here only four of the spaces between the primaries possessed the normal number of tentacles. If we number the spaces from the upper directive tentacle round to the right, we find that in the first the arrangement is 1, 2, 3, 5; in the second 1, 2, 3, 7; the third is normal, 1, 2, 4, 8; in the fourth the arrangement is 1, 2, 3, 7; the fifth is normal; in the sixth the arrangement is 2, 3, 5, 9. Thus in this space there are four tentacles too many, the usual arrangement being altered from the beginning by the occurrence of two tentacles of the second cycle between the two primaries, instead of one. The seventh and eighth spaces are normal; in the ninth space the arrangement is 1, 2, 2, 4, a deficiency of six; in the tenth space the arrangement is 1, 2, 4, 6, a deficiency of two.

I have not examined the internal anatomy very minutely, but I have ascertained that in the existence of a very strong circular muscle, and in the large number of complete mesenteries this form agrees with *Tealia crassicornis*.

Synonymy.—It seems clear that this anemone is, on the one hand, not of the same species as *Tealia crassicornis*, and, on the other, that it is closely allied to that form. Gosse, as I have already mentioned, was inclined to consider Cocks' specimen as really belonging to *T. crassicornis*, and Andres, in his Monograph of the Actiniæ, therefore places the names *Actinia tuberculata*, Cocks, and *Tealia tuberculata*, Gosse, among the synonyms of *T. crassicornis*. This he was scarcely justified in doing, as he had never examined a specimen.

But Professor Haddon* has done something much more surprising. He places, with a note of interrogation, *Tealia tuberculata* (Cocks), Gosse, as a synonymn of *Actinauge Richardi*, Marion. This species is one of the sub-family Chondractininæ, of Sagartian Actiniæ; Sagartian Actiniæ, according to Haddon's definition, being those which possess acontia, while the Chondractininæ are distinguished by emitting the acontia by the mouth only. All the Chondractininæ have six primary mesenteries. It is thus sufficiently evident that *T. tuberculata* does not belong to the Chondractininæ, and is not, therefore, identical with *Actinauge Richardi*. But it must also be pointed out that there are sufficient indications even in Cocks' original description and Gosse's remarks that Cocks' species was quite different from *Actinauge Richardi*. In the latter species, Haddon states that the pedal disc is usually bent round ventrally so as to form a cup-shaped concavity which is filled with sand. Cocks states that his specimen was attached to a valve of *Pecten maximus*. In *A. Richardi* Haddon states that the tentacles of the inner cyles have a well-marked swelling at their bases, and thinks that a misinterpretation of this character was the cause of Cocks' description of some of the tentacles in his specimen as bifurcated or trifurcated. This certainly shows very little respect for Mr. Cocks' powers of observation, and it is to be hoped that Professor Haddon will receive better treatment at the hands of his successors. Mr. Cocks describes the tentacles of his specimens as obtuse, those of *Actinauge Richardi* taper towards the extremity. The diameter of the latter species is 3 cm., that of Cocks' specimen three and a half inches.

The classification of the Actiniæ is still very uncertain and unsatisfactory. Gosse's definition of the genus Tealia, which is practically adopted by Hertwig in his Challenger Report, applies to the species here under consideration in all respects but one,—the tubercles of the column in *T. tuberculata* are arranged in vertical rows, not irregularly scattered; but these rows are not so widely separated nor so distinctly marked as in Bunodes. Andres adopts Gosse's definition, with the addition of the clause: Tentacles in decimal cycles, not duodecimal. In this I agree with Andres. For the present, therefore, I think that we may define the genus Tealia as follows: Tentacles numerous, in decimal cycles, short, or of moderate length, very contractile; margin completely covering the disc in contraction; a fossa between the margin and the outer tentacles,

* *Revision of the British Actiniæ*, see Trans. Roy. Dub. Soc., vol. iv, ser. ii.

column closely beset with numerous large, adhesive warts, which are largest on the margin; base extending beyond the column, no acontia or cinclides; size large, diameter exceeding the height; numerous complete mesenteries, circular muscle very thick and strong.

Of this genus there seem to be three species known: *T. crassicornis* (Müller), distinguished provisionally by the number of tentacles, 5, 5, 10, 20, 40; *T. tuberculata* (Cocks), distinguished by the ideal number of tentacles—5, 5, 10, 20, 40, 80, and by the irregularity of the tentacles in number and in shape; *T. bunodiformis* (Hertwig), decribed in the Challenger Report. *Tealia digitata* has been removed from the genus; it is a Chondractinia, one of the Sagartian genera.

There is one other described species which requires consideration in connection with the Genus Tealia, namely, *Bolocera eques*, Gosse. It is certain, I think, that *Bolocera eques* does not belong to the genus Bolocera; its characters, as described by Gosse (British Sea Anemones and Corals, 1860), are quite inconsistent with Gosse's own definition of Bolocera. The specific characters are, tentacles wholly retractile, white, encircled with a red ring; in these respects the tentacles agree with those of the genus Tealia. Gosse's figure gives only a few scattered warts, but his description says the column is "studded on the upper two thirds with numerous minute warts increasing in number to the margin; these are either prominent or level at the pleasure of the animal, and they have the power of attaching fragments of entraneous matter, which, however, seems rarely exercised." All this applies perfectly to *Tealia tuberculata* (Cocks); all the rest of Gosse's description applies equally to *Tealia tuberculata*, except the formula of the tentacles, which is given as 6, 6, 12, 24, 48, 48 = 144. If the tentacles are really thus arranged of course the form must be distinct from *T. tuberculata*, but considering the peculiar irregularity of the tentacles in the latter species and the unusual equality of the two outer cycles in Gosse's formula, it is possible that he made an error in the enumeration. I have little doubt myself that *Bolocera eques* is a synonym of *Tealia tuberculata*, and until someone has identified a specimen of *Bolocera eques* I shall hold this opinion. No one has yet identified *Bolocera eques*, except Gosse himself, who only saw two specimens, one from twenty-eight fathoms off the mouth of the Tees, the other from Banff.

Tealia tuberculata occurs most commonly in this neighbourhood, in about thirty fathoms, to the west of the Eddystone; it is especially common on the shelly ground off the Dodman Point. It is frequently taken in the Cattewater, but it owes its presence there to the fact that the trawlers often carry their "scruff" to the Cattewater and throw it overboard after they have anchored.

Fig. 1.

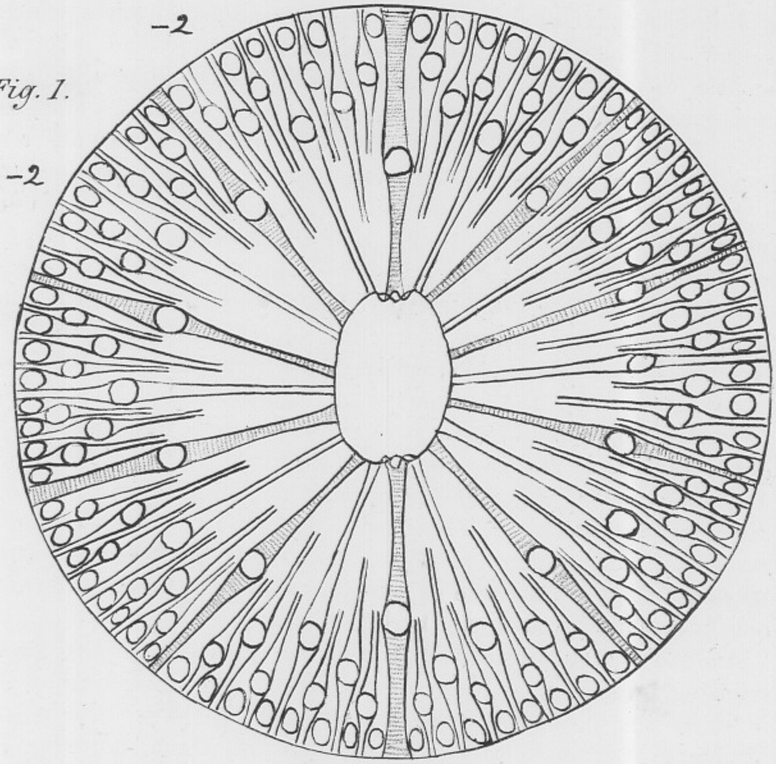
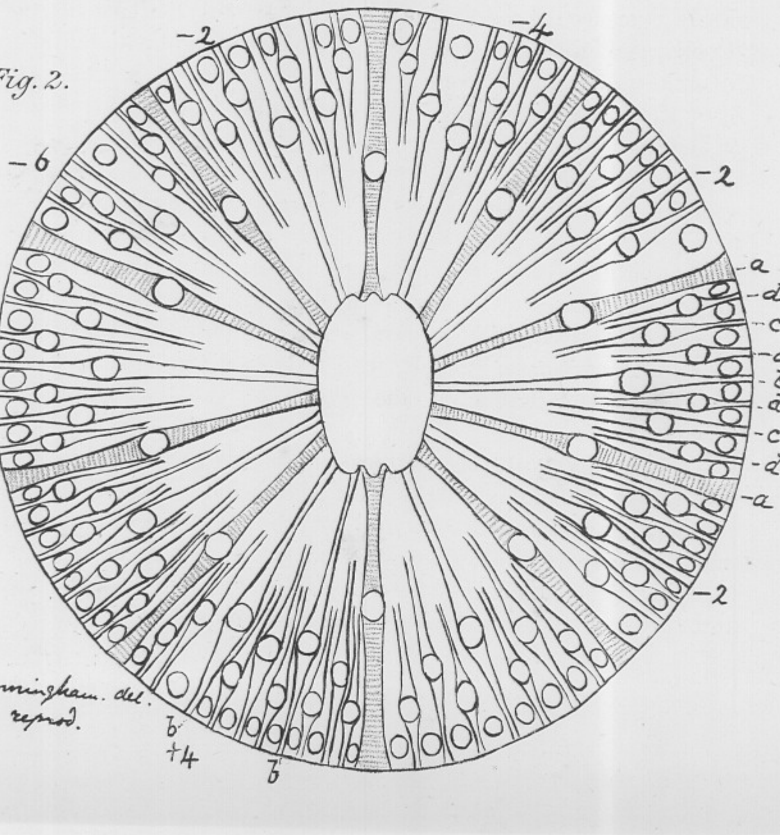


Fig. 2.



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NOTES AND MEMORANDA.

Notes on the Senses and Habits of some Crustacea.—In the course of investigations as to the perceptions of fishes, some interesting facts in the natural history of Crustacea have come under my notice. All the Crustacea in the tanks, except *Carcinus mœnas* and *Portunus depurator* are more active by night than by day. Prawns, *Pandalus*, *Stenorhynchus* and *Inachus* generally remain stationary during the day, but will leave their places to hunt for food if any be put in; but *Ebalia*, *Portunus pusillus*, *Porcellana longicornis*, *Galathea andrewsii*, *Virbius varians* and shrimps are rarely visible until night falls, and hardly ever come out by day even to feed. *Eurynome aspera*, though not hidden away like these, being naturally almost indistinguishable from the broken shells, &c., amongst which it lives, seems also never to feed by day. Excepting the shrimps, nearly each individual of the above-mentioned forms has its own place to which it retires when morning comes, and in which it remains during the whole day. One prawn has occupied the same hole for some weeks, and another, which had lived a fortnight in one corner, left it when some mussels were put in, and now sits on the mussels during the day. The distinction then between day and night is of importance to these animals. Such an animal as a shrimp is in fact certain to be caught by keen-sighted fishes if it uncovers itself by day. If shrimps are thrown by day among pollock, they are always eaten unless they reach the bottom of the tank, but there they are safe even if unburied, for the pollock seems unable to see them when on the bottom, and at once gives up the chase. This may or may not be due to their protective colouration. Pollock very rarely take anything off the bottom, and worms and even glistening things like pieces of mackerel are generally left by them if they are not eaten whilst sinking.* Moreover, the bottom of the pollocks' tank is made of yellow gravel brought from the Chesil Beach, which in no wise resembles a shrimp.

Wrasses, however, which are especially fond of shrimps, can not only catch them as they sink in the water, but pursue them on the bottom. The sight of the wrasse is particularly keen, and I have often seen a large wrasse search the sand for shrimps, turning sideways and looking with either eye independently like a chamæleon. Its vision is so good that it can see a shrimp with certainty when the

* This can only be true of small pollock, for large pollock are frequently taken with ground baits.

whole body is buried in grey sand, excepting the antennæ and antenna-plates. It should be borne in mind that if the sand be fine, a shrimp will bury itself absolutely; digging with its swimmerets, kicking the sand forwards with its chelæ, finally raking the sand over its back and gently levelling it with its antennæ, but if the least bit be exposed, the wrasses will find it, in spite of its protective colouration. Shrimps put into the wrasses' tank at night escaped for some days, hence they must retire to the sand before daylight is strong enough for the wrasse to see them. The knowledge of night and day is therefore of paramount importance to a shrimp, as it is not safe for it to hunt until darkness has come. Strangely enough, it seems that this knowledge is not obtained through the eyes, or at all events not entirely through them, for if the eyes be extirpated, the shrimps will bury themselves during the day, getting up in the twilight and careering about at night just like uninjured shrimps. On one occasion (7 p.m., August 4th) I noticed that the blind shrimps in a tub were lifting themselves out of the sand exactly at the same time as the normal shrimps in another vessel were doing so. If, however, food be thrown in by day, the blind shrimps will get up and hunt for it while the normal shrimps very rarely take any notice. Similarly, a blind prawn will remain in his place all day unless food be thrown in, but comes out and wanders at night. It is a singular fact that a prawn, though blind will often find his way back to his proper place, and stay in it.

Both prawns, shrimps, *Stenorhynchus*, &c., find their food almost exclusively by scent, and when blind find pieces of food quite as quickly as uninjured ones. If a piece of worm be put into a small glass sphere with a hole in it, and the sphere is then sunk in the tank, the prawns, &c., will come out of their holes and find it. They do not seem to have any very accurate knowledge of the direction of a scent, but on perceiving it they begin rushing vaguely about, feeling the ground all the way with their chelæ. On finding the glass, the first comer will feel inside, pull out the worm, and skip with it to some high place. I have noticed that those which come after generally find the glass in which the worm has been as easily as the worm itself, and they will continue feeling inside in a puzzled way for some time, showing that the scent remains after the worm is gone. (Conger, soles, and rockling, which all feed by smell and touch, will all do the same thing.)

Shrimps are much quicker at finding food than prawns. They hunt with their faces down on the ground like hounds questing, while the prawn hunts with his head held up as usual. If a piece of worm be just buried in sand, a shrimp will dig it out at once, whether blind or not. I have also seen a prawn, after much hesitation, plunge its two arms resolutely into an anemone (*Anthea*) and pull out a worm which the anemone had closed over. In like manner a blind *Stenorhynchus* or *Inachus* will perceive a piece of worm when it has been in the water a few minutes, and will then set out and find it. I have seen them hunting about when worms have been put into another tank from which water was flowing into their own vessel. There can then be no doubt that these animals find their food by scent, and it becomes difficult to determine what sort of objects they can see. It is not even certain that they can see each other. If a prawn is eating a piece of worm and another prawn finds it and takes it away, the first prawn will again begin to quest wildly as at first, and does not make for the prawn with the worm, though it may be only a few inches off. Nevertheless, it is certain that prawns at all events can perceive more than mere difference between light and darkness, for they notice a hand or even a thin stick placed between them and the light, putting out their antennæ towards it. *Stenorhynchus* also will put up its anterior pair of walking legs when a fish swims close over its head. It would appear that the eyes of these creatures are particularly sensitive to shadows. If a worm is hung by a thread in the water about eight inches from the bottom, the prawns will first hunt on the bottom as usual, and will then begin swimming about in quest, but on coming a few inches below the worm they will rise to it directly.

Though it seems probable that the sense of smell is obtained through the antennules, in shrimps at all events it is not exclusively so derived, for a shrimp with no antennules will hunt if a piece of worm is put very near it. On the other hand, the antennæ, of a prawn at least, appear to have no such power, as prawns when eagerly seeking food may be seen to touch it with their antennæ and still be unable to find it.

As is well known, certain crabs, as *Stenorhynchus, Inachus, Pisa,* and *Maia,* have the habit of fastening pieces of weed, &c., on their backs and appendages until they are almost indistinguishable from the surrounding weeds if there are any. In the case of *Stenorhynchus* and *Inachus* I have often watched this process. The crab takes a piece of weed in his two chelæ, and neither snatching nor biting it, deliberately tears it across as a man tears paper with his hands. He then puts one end of it into his mouth, and, after chewing it up, presumably to soften it, takes it out in the chelæ and rubs it firmly on his head or legs until it is caught by the peculiar curved hairs which cover them. If the piece of weed is not caught by the hairs, the crab puts it back in his mouth and chews it up again. The whole proceeding is most human and purposeful. Many substances as hydroids, sponges, Polyzoa, and weeds of many kinds and colours are thus used, but these various substances are nearly always symmetrically placed on corresponding parts of the body, and particularly long plume-like pieces are fixed on the head, sticking up from it. It may be supposed that these actions are of use for purposes of concealment, and hence it might be expected that they should be dependent on the power of vision, but not only are all these complicated processes gone through at night as well as by day, but a *Stenorhynchus* if cleaned and deprived of sight will *immediately* begin to clothe itself again with the same care and precision as before. It may be mentioned that there is certainly no disposition on the part of a *Stenorhynchus* dressed in any colour, say green, to take up a position amongst green weed or indeed amongst weed at all, and so on, while some individuals which have taken up their station among weeds do not dress themselves at all.

Sense of Touch in the Rockling (*Motella*).—Both the large three-bearded rockling and the small five-bearded form flourish in the tanks. They are nocturnal in their habits, and lie still all day. If a worm be thrown in by day, the small species will sometimes swim straight up and take it, having to some extent the power of seeing objects, but the large species never does this. Generally, both the animals take no notice of food thrown in until it has lain in the water some minutes, when they start off in search of it. The rockling searches by setting its filamentous pelvic fins at right angles to the body, and then swimming about feeling with them. If the fins touch a piece of fish or other soft body, the rockling turns its head round and snaps it up with great quickness. It will even turn round and examine uneatable substances, as glass, &c., which come in contact with its fins, and which presumably seem to it to require explanation. The rocklings have great powers of scent and will set off in search of meat hidden in a bottle sunk in the water. Moreover, a blind rockling will hunt for its food and find it as easily as an uninjured one.

The barbels of the rocklings bear sense organs having the structure of taste-bulbs, but the sensitive rays of the pelvic fins do not, having an epithelium made of tall, thin cells, somewhat like that upon the fingers of a gurnard.

Sudden Colour Changes in Conger.—During the months of May, June, and July I occasionally saw the conger living in the tanks more or less covered with bright, white spots. These spots come and go suddenly, and their size varies from that of small shot to that of a threepenny-piece. Sometimes the head, both sides of the pectoral and dorsal fins, and anterior end are thus covered, while sometimes it is the posterior end or the middle of the body which is affected. I have seen these spots vanish suddenly, but sometimes they remain for several hours. It does not seem that these appearances are of the nature of secondary sexual characters, for they appear on conger of all sizes. These spots are, of course, caused by contraction of the chromatophores in the skin, but they do not appear to be connected with light, for they not only are occasional in their occurrence but once they appeared on a blind conger also. They do not appear to indicate any special emotion or diseased state, as frequently the animals thus affected are seen to feed like the rest.

Contractility of the Iris in Fishes and Cephalopods.—While in warm-blooded animals the size of the pupil is regulated by the accommodatory mechanism of the iris, this power appears to be wanting amongst Teleostean fishes in general. I have examined the eyes of conger, soles, mullet, wrasse, pollock, &c., and have never seen any alteration in the width of the pupil either by day or night or in twilight, neither do they contract when a strong light is flashed on them by night. On the other hand, all the Elasmobranchs living in the tanks are provided with a means of altering the size of the pupil. In the skate this takes the form of the well-known fern-shaped process from the upper edge of the iris which by day covers the whole pupil. This structure has often been described, but I have found no mention of the fact that it is gradually drawn up in twilight and completely so at night, leaving the pupil clear. If a bull's-eye lantern be turned on to one eye, this process very slowly descends again, and in about fifteen or twenty minutes it will reach down over half the pupil. Probably if the exposure to light were continued it would fall into the position which it occupies by day, but the skate always swam off after about twenty minutes. When the animal turned round, it could be seen that the process of the eye on the dark side had also descended to the same degree as on the light side.

In the dog-fish, nurse and angel-fish, the pupil is almost completely closed during the day by the iris, the edges of which nearly meet along a slit-shaped opening which extends more or less diagonally from the upper posterior edge to the lower anterior one. This slit gradually opens as twilight comes on and in the night the whole of the pupil is exposed. When the light of the lantern was turned into one eye of a dog-fish or nurse, the iris very slowly contracted until the edges met as by day. When the animal turned round the other pupil was seen to be still open widely as before.

The turbot* is the only bony fish in which any great change in size of the pupil was seen. This fish has by day a downward pro-

* I have since seen the same changes in the pupil of the brill.

cess of the iris, which covers the upper half of the pupil but which is drawn up at night. This process gradually returns to its position if an artificial light be shown. I have, however, also seen that the pupil of the gurnard (*Trigla cuculus*) which is almost diamond-shaped by day, enlarges somewhat and becomes circular at night.

It is difficult to correlate this power of contracting the iris among fishes with any special feature in the powers of vision or even with nocturnal habits. The skate and dog-fish in the tanks move very little by day and seem to find find their food entirely by touch and smell, while the angels remain completely buried until night.

On the other hand, in such typically nocturnal fish as conger and soles there is no such mechanism of accommodation. It may be mentioned that the turbot sees very well by day and will rise to catch food falling in the water.

The eyes of the Elasmobranchs glow in the light of the lantern like a cat's eye, but the eyes of the other fishes in the tanks do not.

The iris of Cephalopods (*Eledone* and *Sepiola*) contracts for light like that of a warm-blooded animal, leaving a slit-like pupil. The size of the pupil in *Eledone* varies also with the emotions of the animal. I found that it contracted more for green light than for yellow and least of all for red. In the tanks the Sepiolas sit on the ground with their eyes closed by the lower lids throughout the day.

Modes in which Fish are affected by Artificial Light.—If the fish in the tanks are looked at by night with a lantern several somewhat interesting phenomena may be seen. Fish are differently affected according as they are day or night feeders. Soles and rockling stop swimming if a light is shown, and the former bury themselves almost at once. Bass, pollock, mullet, and bream generally get quickly away at first, but if they can be induced to look steadily at the light with both eyes they gradually sink to the bottom of the tank, and on touching the bottom commonly swim away. Sometimes the fish will lie close to the glass, turning one eye only to the light; in this case the animal never lies horizontally, but always with that side of the head depressed which is turned towards the light. In this connection I may mention that I have seen a whiting which had lost one eye by disease which always swam with the blind side higher than the normal one. In the case of mullet effects apparently of a mesmeric character sometimes occur, for a mullet which has sunk to the bottom as described will sometimes lie there quite still for a considerable time. At other times it will slowly rise in the water until it floats with its dorsal fin out of the water, as though paralysed. I once saw one which remained in this odd position for some minutes after the light had been turned off it. I could not get the mullet to attend to the lamp if the room was generally lit up. The red gurnard and the bass will sometimes swim up to and lie by the light for a time, but they were never seen to take any other notice of it. Turbot, on the contrary, are occasionally greatly affected by the light of a lantern. When the light is first shown they generally take no notice of it, but after about a quarter of an hour I have three times seen a turbot swim up, and lie looking into the lamp steadily. It then seemed to be seized with an irresistible impulse like that of a moth to a candle, and throws itself open-mouthed at the lamp. On one occasion a turbot continued to dash itself with such violence at the lamp that it wore the skin of its chin through till it bled. When the light was moved to another part of the glass the turbot soon followed and began again.

Sound heard by a Lamellibranch (*Anomia*).—In the course of an attempt to find out what class of sounds are generally transmitted to animals living in water I found that Anomia if open can be made to shut its shell by smearing the finger on the glass of the tank so as to make a creaking sound. The animals shut themselves thus when the object on which they were fixed was hung in the water by a thread. It is therefore clear that the action perceived was not communicated merely by the jarring of the solid framework of the tank. The noise made by the finger had to be of a particular pitch, for neither mere rubbing on the glass nor the exceedingly high note made by squeezing the edge of a wet cork along the glass produced any effect. It is remarkable that the Anomia took no apparent notice of the sound made by creaking the antenna of a crayfish under water. Instances of real sounds being perceived by aquatic animals are so rare that this fact seemed worth recording. —W. BATESON.

The Fisheries and Fishing Industries of the United States.—The United States Fish Commission has recently published the third, fourth, and fifth sections of the treatise on the Fisheries and Fishing Industries of the United States which is being jointly produced by them and the United States Census Bureau. The three sections above mentioned comprise four quarto volumes, the first of which contains Sections III and IV, devoted to the Fishing Grounds of North America and the Fishermen of the United States respectively. The section on the History and Methods of the Fisheries extends over two volumes of text and a volume containing two hundred and fifty-five plates illustrating the methods of catching and curing fish and other marine products. It is no disparagement of the excellent works published by private individuals in England to say that no such complete treatise upon the fisheries of a single country has ever yet been attempted or so successfully carried out. Mr. Holdsworth's excellent book upon deep-sea fishing is the most complete work of its kind published on the English Fisheries, but it could not be expected that an individual could include within the compass of a single octavo volume such a varied mass of information as is presented by the United States Commission. The editing of these volumes has been in the hands of Mr. Brown Goode, who has had the help of nineteen associates, many of them well known from their scientific and practical researches.

Members of the Marine Biological Association who would learn how much practical benefit can be conferred on a national fishing industry by such a body as the United States Fish Commission should obtain and read these volumes; they are not only instructive but interesting. It would be difficult to over-estimate the importance of the information given in Section III. Not only are all the areas frequented by United States fishermen described in the text, with an account of the fishes caught in each and the seasons at which they are to be found, but their exact localities are mapped out in a number of excellent charts which embrace the whole of the eastern coast of the North American Continent. No less valuable are the charts showing the annual variations of sea temperatures at various points on the same coast. The fact that the migrations of fish are largely dependent on the temperature of the sea has long been known in a general way, but hitherto no observations have been made of extent and accuracy sufficient to allow a judgment to be formed on the subject. The following paragraph, taken from Mr. Richard Rathbun's report, is instructive:—"During the winter months the water temperatures on the ocean plateau outside of the capes is higher than that of Chesapeake Bay or the Potomac River. The latter part of February or early in March the temperature of the bay waters rises above that of the ocean waters outside. Coincident with this the shad make their appearance in the Chesapeake and are taken in the pounds which are set in salt water along the shores of the bay. About the 1st of April the temperature of the water in the Potomac river rises above the temperature of the water in the bay. Coincident with this is the beginning of the shad fishing in the river."

The section on the fishermen is interesting reading. Some of the American fishermen appear to live as exclusive a life as the fishermen of Europe, and in Maine, for example, they are dependent on the middlemen, and get but small returns for their labour, 175 dollars, little more than £45 per annum. The fishermen of New England, of which the chief port is Gloucester, Massachusetts, are a very different class of men; they are well educated, do not form a class by themselves, and are withal admirable sailors and fishermen. They earn as much as £200 per annum, and a skipper who is part owner of a schooner has been known to make £3000 in a single year.

The section on history and methods may prove rather puzzling to English readers. There is no beam trawling in America, and the flat-fish which are held in so much esteem and command so high a price in this country, the sole, the turbot, and the brill, are unknown on the other side of the Atlantic. On the other hand, many names unfamiliar to us are to be found, such as tautog, menhaden, squeteague, skulpin. The different methods of catching fish are well explained in this section. It is noticeable that the Americans use larger ships than Englishmen, they set their lines in a different manner, they use nets such as the purse seine which are scarcely known and rarely, if ever, used in this country, and they do a great deal of their curing on board ship. Undoubtedly they are ahead of Europeans in their methods of fishing, as in many other things; the fishermen are certainly advanced in this, that they are not prejudiced in favour of old methods, but are one and all ready to try novelties in gear and boats, and to adopt them if successful, to listen to advice and to learn all that they can about marine life and the habits and characteristics of the fish they catch. They assist the Fisheries Commissioners in their researches, and in return receive many benefits from the Commission.

In comparing the work on Fisheries done by the United States Fish Commission with what has been attempted in other countries it must not be forgotten that they possess an income out of all proportion with that bestowed on other fishery departments or commissioners. But when they can produce such a work as this in addition to their scientific and practical researches, no one can assert that the income is not well spent.—G. C. B.

C. Spence Bate, Esq., F.R.S.

The Association has lost one of its ablest and most energetic members in Mr. C. Spence Bate, F.R.S., who died, after a painful illness, at his residence, The Rock, South Brent, Devon, on the 29th of July.

It is hardly necessary here to dwell on Mr. Spence Bate's scientific attainments; as a carcinologist he was distinguished throughout Europe, and his works on the British Amphipoda (in conjunction with Professor Westwood) and the Macrurous Crustacea of the Challenger expedition are testimony to his acute powers of observation and his patience in study.

From the date of its foundation Mr. Spence Bate took the keenest interest in the Marine Biological Association. He was elected a member of Council soon after its formation, and was among those who urged the advantages of Plymouth as a site for a Marine Laboratory. On Plymouth being chosen Mr. Spence Bate took an active part in the early arrangements necessary for acquiring the site and erecting the buildings; his influence was instrumental in securing for the Association that local support which has been so freely given by the authorities and inhabitants of Plymouth, and he personally took a large share in watching the progress of the building and arranging the details of its interior. Lately Mr. Spence Bate was a frequent visitor to the Laboratory, was ever ready to assist younger naturalists with his stores of knowledge on Crustacea, and was most helpful in lending from his own library scientific memoirs not in the possession of the Association.

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 on 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 MARINE BIOLOGICAL 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.

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NOTICE.

Persons desirous of joining the M. B. A. can do so on application to the Director, The Laboratory, Citadel Hill, Plymouth. Members pay One Guinea annually, or a Composition Fee of Fifteen Guineas for Life Membership. Founders pay £100. Governors (Life-Members of Council) £500. 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 letters and other correspondence should be addressed to the Director, the Laboratory, Citadel Hill, Plymouth.

For a statement of the objects and organization of the Association, see page 3 of the wrapper.