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PROCEEDINGS

AND

TRANSACTIONS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

VOL. V.

SESSION 1890—91.

LIVERPOOL:
PRINTED BY T. DOBB & CO., 229, BROWNLOW HILL.

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ERRATA.

Page 28, line 18 from foot, delete *Sertularella tenella.*

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Page 47, line 4 from foot, delete *Chiton discrepans.*

Plate III. reprinted from the Journ. Linn. Soc. has not been re-lettered and bears it original number, Pl. 34.

Page 112, footnote: for Vol. part 33, read Vol. xxviii, part 33.

Page 130, fifth line from the top; for 29, read 22. Sixth line from the bottom; for 42, read 45.

Page 132, sixth line from top; for 39 read 40.

Page 140, fourteenth line from bottom; for 90 read 89.

Explanation of Plate V. add

Fig. 10. Isolated central cell. × 450.

Fig. 11. Striation on walls of intercellular canal. × 450.

PROCEEDINGS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

OFFICE-BEARERS AND COUNCIL

FOR SESSION V., 1890—91.

President:

T. J. MOORE, C.M.Z.S., Lond.

Vice-Presidents:

J. DRYSDALE, M.D., F.R.M.S.

Professor W. A. HERDMAN, D.Sc., F.L.S., F.R.S.E.

Hon. Treasurer:

ISAAC C. THOMPSON, F.L.S., F.R.M.S.

Hon. Librarian:

R. HANITSCH, Ph.D.

Hon. Secretary:

R. J. HARVEY GIBSON, M.A., F.L.S., F.R.S.E.

Council:

H. C. BEASLEY.
N. CAINE.
Prof. CATON, M.D., F.R.C.P.
W. J. HALLS.
C. H. HURST, Ph.D.
ALFRED LEICESTER.
J. LOMAS, Assoc. N.S.S.
F. C. LARKIN, F.R.C.S.
G. H. MORTON, F.G.S.
W. NARRAMORE, F.L.S.
THOS. C. RYLEY.
A. O. WALKER, F.L.S.

REPORT of COUNCIL.

During the Session 1890—91 there have been eight ordinary monthly meetings of the Society, held as heretofore at University College, and one field meeting at Hilbre Island in June, 1891.

As on former occasions the Society has been favoured with addresses from some distinguished Biologists from other centres, viz., Dr. H. C. Sorby, F.R.S, and Mr. G. Murray, F.L.S., whose papers were much appreciated.

The communications made to the Society have been representative of almost all branches of Biology, whilst not a few interesting exhibits have been submitted at the meetings.

The society may congratulate itself on the excellent condition of the Library as shewn by the Librarian's Report which follows.

The Treasurer's usual statement and Balance Sheet are appended.

No alterations have been made in the laws of the Society during the past session.

The members at present on the roll are as follows:—

Honorary Members.....	5
Ordinary Members.....	66
Student Members.....	25
Total.....	96

SUMMARY of PROCEEDINGS at the MEETINGS.

The first meeting of the fifth session was held at University College on Friday, 10th October, 1890, Mr. T. J. Moore, President, in the chair.

1. The Report of the Council on the Session 1889-90 (see "Proceedings," Vol. IV., p. viii.) was read and adopted.
2. The Treasurer's Balance Sheet for the Session 1889-90 (see "Proceedings," Vol. IV., p. xxxi.) was submitted and approved.
3. The Report of the Librarian (see "Proceedings," Vol. IV., p. xxviii.) was submitted and approved.
4. The following Office-bearers and Council for the ensuing session were elected:—Vice-Presidents, J. Drysdale, M.D., F.R.M.S., Professor W. A. Herdman, D.Sc., F.L.S., F.R.S.E.; Treasurer, Isaac C. Thompson, F.L.S., F.R.M.S.; Librarian, R. Hanitsch, Ph.D.; Secretary, R. J. Harvey Gibson, M.A., F.L.S., F.R.S.E.; Council, H. C. Beasley, N. Caine, Prof. Caton, M.D., F.R.C.P., W. J. Halls, C. H. Hurst, Ph.D., Alfred Leicester, J. Lomas, Assoc. N.S.S., F. C. Larkin, F.R.C.S., G. H. Morton, F.G.S., W. Narramore, F.L.S., Thos. C. Ryley, A. O. Walker, F.L.S.
5. Miss A. E. Warham, B.Sc., exhibited some specimens of the rare fresh-water worm *Pteridonais*.

   This rare worm was first found by Mr. T. Shepheard, F.R.M.S., of Chester, in a canal in that neighbourhood, about August, 1882. It was exhib-

ited and described by Professor Ray Lankester at the meeting of the British Association at Southport in 1883. It is one of the Oligochæta, and obtains its name from the presence of three pairs of bunches of long setæ placed on the segments behind the head. It forms a delicate tube, in which it lives, attached to *Cordylophora* and water-weeds, and which it can leave at will. Asexual reproduction takes place by gemmation. The specimens exhibited were sent to Professor Herdman by Mr. Shepheard a few days before (October 3rd, 1890). They were found in the Chester canal, where the animal had not been seen for six years previously.

6. The President read his opening address "on the History of the Living Zoological Collection at Knowsley" (see "Transactions," this volume, p. 1). The address was illustrated by many specimens from the Derby Museum, Pictures, Books, &c.

A vote of thanks to the President was proposed by Dr. Newton and seconded by Mr. Morton and carried unanimously.

The second meeting of the Society was held at University College on Friday, November 14th, 1890, Mr. T. J. Moore, President, in the chair.

1. Mr. H. C. Beasley exhibited and made some remarks on a specimen of *Lithostrotion junceum*. A discussion followed.
2. A paper on the Foraminifera of Aigburth was read by Mr. I. C. Thompson for Mr. E. Burgess. (See Transactions, p. 73.)
3. Prof. W. A. Herdman, D.Sc., read the Fourth Annual Report on the Puffin Island Biological Station and

the L.M.B.C. Dredging Expeditions. The Report was illustrated by lantern slides and specimens. Mr. F. Archer, Mr. Leicester, and Mr. Harvey Gibson afterwards exhibited with remarks some of the chief finds made in their special groups. (See Transactions, p. 19.)

The third meeting of the Society was held at University College on Friday, December, 12th, 1890, Mr. T. J. Moore, President, in the chair.

1. Mr. G. H. Morton, F.G.S., exhibited a series of specimens of *Syringopora* and made remarks on the genus.
2. A short paper by Mr. H. C. Chadwick on *Cucumaria planci* was communicated. (See Transactions, p. 81).
3. On the genus *Ecteinascidia*, &c., by Professor W. A. Herdman, D.Sc. (See Transactions, p. 144.)
4. Mr. Harvey Gibson gave an account of the Marine Algæ collected in the District during the past two years, and illustrated his remarks by specimens and lantern views. (See Transactions, p. 83.)

The fourth meeting of the Society was held in University College on January 23rd, 1891, Mr. T. J. Moore, President, in the chair.

1. Mr. G. H. Morton, F.G.S., exhibited with remarks some old Catalogues of the Liverpool Museum.
2. Mr. F. Archer, B.A., communicated some notes on the occurrence of seals in Anglesea.
3. Mr. H. C. Beasley exhibited a sandstone slab from Runcorn shewing foot prints and tracks of animals. A long discussion followed in which Messrs. Lomas, Morton, Herdman, Moore, Archer and others took part.

4. Mr. J. Lomas, exhibited a Calamite from St. Helens.
5. Dr. Hanitsch gave an address, illustrated by lantern views, on the structure of British Sponges.
6. Mr. A. J. Ewart gave an account of an expedition undertaken by himself, Mr. Henderson, and Mr. Harvey Gibson, during the first week of the year, to Port Erin, I. of Man, the object of the expedition being the collection of Algæ. The results arrived at are given in Mr. Harvey Gibson's paper on the Marine Algæ of the District. (See Transactions, p. 83.)

The fifth meeting of the Society was held at University College on Friday, February 13th, Mr. T. J. Moore, President, in the chair.

1. Mr. A. O. Walker, F.L.S., read a report on the Higher Crustacea collected in the L.M.B.C. District during 1890.
2. Prof. Herdman gave an account of the Biological results of the cruise of Mr. A. Holt's S.Y. "Argo" round the W. Coast of Ireland during August, 1890. The paper was illustrated by specimens and lantern views. (See Transactions, p. 181.)
3. Mr. George Murray, F.L.S., Botanical Department, British Museum, delivered an address on the Distribution of Algæ in Space and Time. (See Transactions, p. 164.)

   A vote of thanks was proposed to Mr. Murray by the Secretary, seconded by Dr. Herdman and carried unanimously.

The sixth meeting of the Society was held at University College on Friday, March 13th, Prof. W. A. Herdman, Vice-President, in the chair.

1. Mr. I. C. Thompson read a letter from Mr. W. S. McMillan giving some details of his biological work in the West Indies.
2. Mr. E. Archer drew attention to the appointment of a Superintendent to the new Sea-Fishery Board under the Lancashire County Council. On the motion of Prof. Herdman, seconded by Mr. Archer, the Secretary was instructed to inform the chairman of the County Council "that the Liverpool Biological Society learn with pleasure of the establishment of a Sea-Fishery Board under the County Council of Lancashire and of the election of a Superintendent, to whom they will be pleased to afford all possible assistance in the prosecution of his labours."
3. Mr. I. C. Thompson exhibited with remarks an abnormal egg.
4. Prof. Herdman exhibited with remarks a supposed mummy kitten from Egypt.
5. Mr. J. Hornell read a Report on the Polychætous Annelids of the L.M.B.C. District. (See Transactions, p. 223.)

The seventh meeting of the Society was held at University College on Friday, April 10th, Mr. T. J. Moore, President, in the chair.

1. The Secretary read a communication from Dr. Hurst suggesting certain experiments on peas, with the view of testing the results obtained by Mr. Francis Galton.
2. Prof. Herdman made some observations on the results of a recent visit of some members of the Society to Hilbre Island. The animals collected on that occasion were exhibited.

3. Dr. H. C. Sorby, F.R.S., gave an account of his method of mounting animals for exhibition by means of the lantern, and illustrated his address by a large series of slides prepared by himself. A discussion followed. (See Transactions, p. 269).
4. Mr. W. Narramore, F.L.S., communicated a paper on the Fresh Water Algæ of the District, with critical remarks on species. The paper was illustrated by specimens and lantern views. (See Transactions, p. 272.)

The eighth meeting of the Society was held at University College on Friday, May 8th, Mr. T. J. Moore, President, in the chair.

1. The Secretary read a letter from the Chairman of the Fishery Board of the Lancashire County Council, acknowledging the promised aid of the Society in the work of the Fishery Board.
2. Dr. C. H. Hurst read a paper on "Heredity and Variation." A long discussion followed.
3. Dr. J. Ellis, F.E.S., read a paper on "Secondary Sexual Characters of British Coleoptera." A discussion followed.

The ninth and last meeting of the Society for the fifth session took the form of an excursion to Hibre Island on June 6th. Prof. W. A. Herdman, Vice-President, took the chair at the business meeting held subsequently, when on the motion of the Chairman, seconded by Mr. I. C. Thompson, Mr. T. J. Moore was re-elected President for the ensuing session.

LAWS of the LIVERPOOL BIOLOGICAL SOCIETY.

I.—The name of the Society shall be the "LIVERPOOL BIOLOGICAL SOCIETY," and its object the advancement of Biological Science.

II.—The Ordinary Meetings of the Society shall be held at University College, at Seven o'clock, during the six Winter months, on the second Friday evening in every month, or at such other place or time as the Council may appoint.

III.—The business of the Society shall be conducted by a President, two Vice-Presidents, a Treasurer, a Secretary, a Librarian, and twelve other Members, who shall form a Council; four to constitute a quorum.

IV.—The President, Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be elected annually, by ballot, in the manner hereinafter mentioned.

V.—The President shall be elected by the Council (subject to the approval of the Society) at the last Meeting of the Session, and take office at the ensuing Annual Meeting.

VI.—The mode of election of the Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be in form and manner following:—It shall be the duty of the retiring Council at their final meeting to suggest the names of Members to fill the offices of Vice-Presidents, Treasurer, Secretary, Librarian, and of four Members who were not

on the last Council to be on the Council for the ensuing session, and formally to submit to the Society, for election at the Annual Meeting, the names so suggested. The Secretary shall make out and send to each Member of the Society, with the circular convening the Annual Meeting, a printed list of the retiring Council, stating the date of the election of each Member, and the number of his attendances at the Council Meetings during the past session; and another containing the names of the Members suggested for election, by which lists, and no others, the votes shall be taken. It shall, however, be open to any Member to substitute any other names in place of those upon the lists, sufficient space being left for that purpose. Should any list when delivered to the President contain other than the proper number of names, that list and the votes thereby given shall be absolutely void. Every list must be handed in personally by the Member at the time of voting. Vacancies occurring otherwise than by regular annual retirement shall be filled by the Council.

VII.—Every Candidate for Membership shall be proposed by three or more Members, one of the proposers from personal knowledge. The nomination shall be read from the Chair at any Ordinary Meeting, and the Candidate therein recommended shall be balloted for at the succeeding Ordinary Meeting. Ten black balls shall exclude.

VIII.—When a person has been elected a Member, the Secretary shall inform him thereof, by letter, and shall at the same time forward him a copy of the Laws of the Society.

IX.—Every person so elected shall within one calendar month after the date of such election pay an Entrance Fee of Half a Guinea and an Annual Subscription of One

Guinea (except in the case of Student Members); but the Council shall have the power in exceptional cases, of extending the period for such payment. No Entrance Fee shall be paid on re-election by any Member who has paid such fee.

X.—The Subscription (except in the case of Student Members) shall be One Guinea per annum, payable in advance, on the day of the Annual Meeting in October.

XI.—Members may compound for their Annual Subscriptions by a single payment of Ten Guineas.

XII.—There shall also be a class of Student Members, paying an Entrance fee of Two Shillings and Sixpence, and a Subscription of Five Shillings per annum.

XIII.—All nominations of Student Members shall be passed by the Council previous to nomination at an Ordinary Meeting. When elected, Student Members shall be entitled to all the privileges of Ordinary Members, except that they shall not receive the publications of the Society, nor vote at the Meetings, nor serve on the Council.

XIV.—Resignation of Membership shall be signified *in writing* to the Secretary, but the Member so resigning shall be liable for the payment of his Annual Subscription, and all arrears up to the date of his resignation.

XV.—The Annual Meeting shall be held on the second Friday in October, or such other convenient day in the month as the Council may appoint, when a Report of the Council on the affairs of the Society, and a Balance Sheet, duly signed by the Auditors previously appointed by the Council, shall be read.

XVI.—Any person (not resident within ten miles of Liverpool) eminent in Biological Science, or who may have rendered valuable services to the Society, shall be eligible

as an Honorary Member; but the number of such Members shall not exceed fifteen at any one time.

XVII.—Captains of vessels and others contributing objects of interest shall be admissible as Associates for a period of three years, subject to re-election at the end of that time.

XVIII.—Such Honorary Members and Associates shall be nominated by the Council, elected by a majority at an Ordinary Meeting, and have the privilege of attending and taking part in the Meetings of the Society, but not voting.

XIX.—Should there appear cause in the opinion of the Council for the expulsion from the Society of any Member, a Special General Meeting of the Society shall be called by the Council for that purpose; and if two-thirds of those voting agree that such Member be expelled, the Chairman shall declare this decision, and the name of such Member shall be erased from the books.

XX.—Every Member shall have the privilege of introducing one visitor at each Ordinary Meeting. The same person shall not be admissible more than twice during the same session.

XXI.—Notices of all Ordinary or Special Meetings shall be issued to each Member by the Secretary, at least three days before such Meeting.

XXII.—The President, Council, or any ten Members can convene a Special General Meeting, to be called within fourteen days, by giving notice in writing to the Secretary, and Stating the object of the desired Meeting. The Circular convening the Meeting must state the purpose thereof.

XXIII.—Votes in all elections shall be taken by ballot, and in other cases by show of hands, unless a ballot be first demanded.

XXIV.—No alteration shall be made in these Laws, except at an Annual Meeting, or a Special Meeting called for that purpose; and notice in writing of any proposed alteration shall be given to the Council, and read at the Ordinary Meeting, at least a month previous to the meeting at which such alteration is to be considered, and the proposed alteration shall also be printed in the Circular convening such meeting: but the council shall have the power of enacting such Bye-laws as may be deemed necessary, which Bye-laws shall have the full power of Laws until the ensuing Annual Meeting, or a Special Meeting convened for their consideration.

BYE-LAW.

Student Members of the Society may be admitted as Ordinary Members without re-election upon payment of the Ordinary Member's Subscription; and they shall be exempt from the Ordinary Member's entrance fee.

LIST of MEMBERS of the LIVERPOOL BIOLOGICAL SOCIETY.

SESSION 1890-91.

A. Ordinary Members.

(Life Members are marked with an asterick.)

ELECTED.

1890 Archer, F., B.A., 21, Mulgrave-street
1890 Assheton, R., M.A., Owens College, Manchester
1888 Atkin, Hope T., Egerton House, Egerton Park, Rock Ferry
1886 Banks, Prof. W. Mitchell, M.D., F.R.C.S., 28, Rodney-street
1890 Batters, E. A. L., B.A., LL.B., F.L.S., The Laurels, Wormley, Herts
1886 Barron, Prof. Alexander, M.B., M.R.C.S., 31, Rodney-street
1888 Beasley, Henry C., Prince Albert-road, Wavertree
1889 Brown, Prof. J. Campbell, 27, Abercromby-square
1889 Buchanan, J. R. M., M.D., 23, St. Albans-road, Bootle
1887 Caine, Nathaniel, 10, Orange-court, Castle-street
1886 Caton, R., M.D., F.R.C.P., Lea Hall, Gateacre
1886 Chisholm, J. M., M.D., White House, Woolton
1890 Clubb, J. A., University College
1891 Coombe, Miss L. M., Blackburn House, Hope-street
1890 Davies, D., 55, Berkley-street
1890 Davies, T. H., F.I.C., 85, Chestnut-grove, Marsh-lane

1890 Dawson, R. A., Glengarry, Lytham
1886 Dillcock, T., 8, Church-street, Egremont
1886 Drysdale, John, M.D., VICE-PRESIDENT, 36A, Rodney-street
1889 Dwerryhouse, A. R., Church-end Farm, Hale
1886 Edmonds, William, 69, Albany, Oldhall-street
1886 Ellis, J. W., M.B. (Vic.), F.E.S., Howard Place, Stoke-on-Trent
1890 Ewart, A. J., University College, Liverpool
1886 Glynn, Prof. T. R., M.D., F.R.C.P., 62, Rodney-street
1886 Gibson, R. J. Harvey, M.A., F.L.S., SECRETARY, University College
1886 Halhed, W. B., Sunnyside, Prince's Park
1886 Halls, W. J., 35, Lord-street
1887 Hanitsch, R., Ph.D., Zoological Laboratory, University College
1887 Healey, George F., Oakfield, Gateacre
1886 Herdman, Prof. W. A., D.Sc., F.L.S., F.R.S.E., VICE-PRESIDENT, University College
1887 Higgin, T., F.L.S., Ethersall, Mossley Hill
1890 Hornell, J., 27, Church-street, Egremont
1888 Hurst, C. H., Ph.D., Owens College, Manchester
1886 Jones, Charles W., Field House, Prince Alfred-road, Wavertree
1886 Larkin, F. C., F.R.C.S., 54, Rodney-street
1886 Leicester, Alfred, Priory Gardens, Birkdale
1890 Lowndes, W., 173, Lodge-lane
1886 Lomas, J., Assoc.N.S.S., 23, Avondale-street, Smithdown-road
1888 Melly, W. R., 90, Chatham-street
1886 McMillan, William S., F.L.S., Brook-road, Maghull
1886 McClelland, Joseph, M.D., 7, Sefton-drive, Sefton Park

1886 Moore, Thomas J., C.M.Z.S., PRESIDENT, Free Museum
1886 Moore, G. F., 15, Kremlin-drive, Tuebrook
1886 Morton, G. H., F.G.S., 209, Edge-lane, E.
1887 Narramore, W., F.L.S., 5, Geneva-road, Elm Park
1888 Newton, John, M.R.C.S., 44, Rodney-street
1889 Ogle, John J., Museum, Bootle
1888 Phillips, Prof. Reg. W., M.A., University College, Bangor
1890 Phillips, T. R., 7, Wright Street, Egremont
1886 *Poole, Sir James, J.P., Abercromby Square
1890 Rathbone, Miss May, Backwood, Neston
1890 Roberts, Leslie, M.B., 31, Rodney-street
1887 Robertson, Helenus R., Glendaragh, Livingstone-drive
1887 Rowlands, W. Ellison, 28, Green-lane, Stoneycroft
1887 Ryley, Thomas C., 10, Waverley-road
1886 Smith, Andrew T., Jun., 13, Bentley-road, Prince's Park
1889 Stewart, W. J., B.A., 26, Lord-street
1886 Tate, A. Norman, F.I.C., 9, Hackins-hey
1886 Thompson, Isaac C., F.L.S., F.R.M.S., TREASURER, Woodstock, Waverley-road
1889 Thornely, Miss L. R., Baycliff, Woolton Hill
1889 Thurston, Edgar, Gov. Central Museum, Egmont, Madras, India
1888 Toll, J. M., 340, Walton Breck-road
1886 Vicars, John, 8, St. Albans-square, Bootle
1886 Walker, Alfred O., J.P., F.L.S., Colwyn Bay
1889 White, P. H., M.B., University College, Bangor
1889 Williams, Miss Leonora, 55, Rocky-lane

B. Student Members.

Armstrong Miss A., 26, Trinity-road, Bootle
Armstrong, H., Stainsland, Spital, Cheshire
Bell, R. G., 121, Kirkdale Road
Buckley, Miss L., B.Sc., University College, Liverpool
Christophers, S. R., 10, Lily-road, Fairfield
Dickinson, T., 3, Clark-street, Prince's Park
Dumergue, A. F., 79, Salisbury-road, Wavertree
Earnshaw, W. H., Leavy Greave, Rudgrave-place, Egremont
Fowler, Miss C., High School, Belvidere-road
Gould, Joseph, Littledale-road, Egremont
Hannah, J. H. W., 4, Adderley-street, Edge-lane
Harding, Miss M., Kremlin-drive, West Derby
Henderson, W. S., 2, Holly-road, Fairfield
McMillan, R., 20, Aubrey-street
Nixon, H. T., 27, Anfield-road
Nixon, J. P., 27, Anfield-road
Paden, R., Free Museum
Palethorpe, Miss F., 14, Sandon-street
Palmer, C. J. L., 24, Rock Park, Rock Ferry
Ross, S. J., 18, Lawrence-road, Wavertree
Quinn, J. C., Gateacre House, Gateacre
Waterhouse, W. J., 269, Lord-street, Southport
Warham, Miss A., B.Sc., Girls' High School, Pendleton
Williams, Henry, Jun., 57, Balliol-road, Bootle
Wilmer, Miss, Fernleigh, Westbourne-road, Birkenhead

C. Honorary Members.

H.H. Albert I., Prince of Monaco
Claus, Prof. Carl, University, Vienna
Fritsch, Prof. Anton, Prague, Bohemia
Giard, Prof. Alfred, Sorbonne, Paris
Marshall, Prof. A. Milnes, D.Sc., M.D., F.R.S., Owens College, Manchester

REPORT of the LIBRARIAN.

Our Society has arranged an exchange of publications with seven additional Societies since the last Report, making in all fifty-eight Societies. In July, 1890, the Library contained 828 volumes and pamphlets. It now numbers 1194, an increase of 366 in the year. The following list gives the titles of the exchanges and donations received during this session :—

1. Archives Néerlandaises des Sciences exactes et naturelles. Tome xxiv., Nos. 4—5, xxv., No. 1.
2. The Australian Museum, Sydney. Report of the Trustees for 1889. Records, Vol. i., Nos. 4—6. Catalogue of the Australian Birds, Part iii., Psittaci.
3. Berichte über die Senckenbergische naturforschende Gesellschaft in Frankfurt a. M. 1890. Katalog der Vogelsammlung im Senckenbergischen Museum, Frankfurt a. M., 1891.
4. Berichte der Königl. Sächs. Gesellschaft der Wissenschaften zu Leipzig. 1890. 1891, i.
5. Bulletin de la Société Imperiale des Naturalistes de Moscou. 1890.
6. Bulletin of the Museum of Comparative Zoology, at Harvard College. Vol. xvi., No. 9, xx., 2, 3, 5—8 ; xxi., 1—4.
7. Bulletin of the United States Commission of Fish and Fisheries. Vol. viii. (1888).
8. Bulletin Scientifique de la France et de la Belgique. Tome xxii., 2. xxiii, 1.
9. Fishery Board for Scotland. Eighth Annual Report. 3 parts.
10. Journal of the Marine Biological Association. N.S. Vol i., No. 4, Vol. ii., No. 1.
11. Math. u. naturw. Mittheilungen aus d. Sitzungsber. d. königl. preuss. Akademie der Wissenschaften zu Berlin. Mai, 1890—April, 1891.

11a. Sitzungsberichte d. königl. preuss. Akademie etc., 1891, Nos. i—xxiv.

12. Mémoires de la Société de Physique et d' Histoire Naturelle de Genève. Tome xxxi., 1re partie.
13. Mémoires de la Société Zoologique de France. Tome iii., Nos. 2—4 ; Bulletins : Tome xv., 3—6.

14. Proceedings of the Academy of Natural Sciences of Philadelphia, 1889, part 4 ; 1890 ; 1891, part 1.
15. Proceedings of the Birmingham Philosophical Society. Vol. vii., part 1.
16. Proceedings of the Canadian Institute. Ser 3, Vol. vii., No. 2. Fourth Annual Report. Transactions, Vol. i., Nos. 1 and 2. Time Reckoning for the Twentieth Century. By S. Fleming.
17. Proceedings of the Royal Physical Society, Edinburgh. Session 1889-90.
18. Scientific Proceedings of the Royal Dublin Society. Vol. vi. (N.S.), Nos. 7—9.
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27. Studies from the Biological Laboratories of the Owens College. Vol. ii.
28. (*a*) Annual Reports of the Smithsonian Institution. 1888.
    (*b*) Proceedings of the United States National Museum. Nos. 782, 794, 799—809, 811—830.
    (*c*) Bulletin of the United States National Museum. No. 38.
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32. (*a*) Kgl. danske Vidensk. Selskabs Skrifter, 6 te Raekke, naturvidenskabelig og mathematisk Afd. V, 3.
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34. Transactions of the Royal Society of Victoria. Vol. i.—Proceedings, Vol. ii, (N.S.).
35. Berichte d. Kommission zur wissenschaftlichen Untersuchung d. deutschen Meere in Kiel. Vols. i—vi.—Ergebnisse d. Beobachtungsstationen an d. deutschen Küsten. 1873—89.—Atlas der Meeresalgen.—Fische der Ostsee.—Mittheilungen.
36. Annual Reports of the Fishery Board for Scotland. Vols. i—v.
37. Bergens Museum, Aarsberetning, 1886—89.—Turbellarier ved Norges Vestkyst.—Nye Alcyonider, Gorgonider og Pennatulider.—Myzostomernes anatomi og histologi.
38. Laboratory Reports of the Royal College of Physicians, Edinburgh. Vols. i, ii and iii.
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41. Studies from the Morphological Laboratory in the University of Cambridge. Vol, i, part 2. Vols. ii, iii, iv. Vol. v, part 1.
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43. Bolletino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino. Vols. i.—v. Vol. vi, Nos. 94—103.
44. Nachrichten von der königl. Gesellschaft der Wissenschaften zu Göttingen. 1889. 1890.
45. On *Pherusa fucicola*, L. By Alfred O. Walker, F.L.S. Presented by the author.
46. On the development of the Sporangia in *Rhodochorton rothii*, N., and *R. floridulum*, N., and on a new species of that genus. By R. J. Harvey Gibson, M.A., F.L.S. Presented by the author.

As an increase of the book-case accommodation could not be postponed any longer and as there were no special funds available, it was suggested that the members might be asked for a voluntary subscription of five shillings each towards the purchase of a book case, the cost of which was estimated at about £14. Circulars were sent out, and the Librarian wishes to express his thanks to those members who have answered. The donations

already received amount to £11, and it is hoped that the balance will be subscribed in the near future. Special thanks are due to Dr. Drysdale who generously subscribed the sum of £5 for this purpose.

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TRANSACTIONS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

OPENING ADDRESS

ON THE

HISTORY OF THE LIVING COLLECTIONS AT KNOWSLEY.

By T. J. Moore, Corr. M.Z.S. Lond., President.

Part I.

When the Society did me the honour to elect me to the office of President, and I was asked what subject I would take for my Presidential address, I suggested the History of the Living Collections formerly existing at Knowsley, and known far and wide for many years, but now a matter of memory only to a few people well on in life. The suggestion having been favourably received, I now proceed to redeem my promise.

The collection was a notable one, formed for a very worthy object, very successfully carried out, and the only records ever made are now quite unattainable, viz., the "Catalogue of the Menagerie and Aviary at Knowsley formed by the 13th Earl of Derby, K.G., President of the Zoological Society of London, August, 1851 (Liverpool: published by Joshua Walmsley, 50 Lord Street)." The catalogue was the only one ever prepared, and was written by myself for the purely business purpose of selling the living collection by auction on the premises by Mr. J. C. Stevens, of King Street, Covent Garden, London, the old-established natural history auctioneer. This was speedily out of print. The other record was prepared for private circulation and presentation by the Earl of Derby, edited by Dr. John Edward Gray, of the

British Museum, printed in folio in 1850, and illustrated by 59 chromolithographs of hoofed quadrupeds from drawings made from the living objects by Mr. B. Waterhouse Hawkins, the well-known zoological artist, who subsequently modelled the restorations in the grounds of the Crystal Palace, Sydenham, of the huge Saurian and other extinct animals, which models are still to be seen there. A preliminary volume contains similar illustrations of animals and birds, by Edward Lear.

Edward Geoffrey Smith Stanley, thirteenth Earl of Derby, succeeded to the title and estates of his father, the twelfth Earl, in 1834, whose taste for side issues of natural history was devoted for many years to the breeding and training of fighting cocks, long since dropped by the world of fashion, and to the training of racehorses and the founding of the Derby and Oaks races at Epsom, to which he annually migrated with a large retinue, and which still maintain their hold in undiminished force upon all classes of the British public. The thirteenth Earl's tastes were of a different kind: though still bent upon natural and living objects, they were quiet and unobtrusive, being devoted to the study of birds and beasts preserved in his museum at Knowsley Hall, and bequeathed at his decease to the borough of Liverpool, and to the collecting and breeding of such beasts as would be likely to be ornamental or useful if successfully naturalized in this country. In the pursuit of this object, unselfish and patriotic in the extreme, he spared neither time, labour, nor expense. Restrained, however, during the lifetime of his father, when he came into power he threw himself heart and soul into improving his estate and the laying out of roads extending far and wide; and whereas his previous efforts in relation to his living collections were limited to the modifying and adapting of

grounds and structures already to hand, he now planned and erected a grand "New Aviary" of large extent and laid out for great distances all around it large fenced paddocks and rustic sheds for deer and cattle, and extensive accommodation for water-fowl. His tastes were inborn, and his devotion thereto culminated in his election to the Presidency of the Linnean Society, and subsequently to that of its offshoot, the Zoological Society of London, originated in 1824 under the auspices of Sir Thomas Stamford Raffles, late Governor of Sumatra. The Society began with unlimited aims, as regarded its living collection, in the Regent's Park, and shortly after established a farm at Kingston in the hope that its larger space and greater privacy might prove more suitable for objects akin to Lord Derby's—that of breeding creatures useful or ornamental. However, after a few years (in 1834), while Lord Derby was extending his labours, the Society contracted theirs by giving up the farm on account of expense.

The accommodation devoted to the living collection at Knowsley was roughly estimated at 100 acres for all purposes, including old and new aviaries, paddocks, plantations, coppices, &c., the general term "Aviary" finding acceptance and use with the inhabitants and people generally, but a line was drawn at Menagerie as being unmanageable and altogether foreign. Some thirty names of attendants were down on the pay lists. The Superintendent and ruling spirit in all things was Mr. John Thompson, a man of suitable genius and of great vigour and energy, selected from the staff of the Zoological Society.

My own appearance at Knowsley, from the staff of the Zoological Society, in May, 1843, as his assistant and amanuensis, was due to his kindly recommendation to the Earl, and continued to the close in 1851, when the four-

teenth Earl recommended me and Mr. Dyson (a Conchologist, &c., who had collected in Central America), to the Town Council, who appointed me in January, 1852, Keeper of the Derby Museum, on its removal to Liverpool.

Lord Derby was not the only great landed proprietor with zoological proclivities. Earl Fitzwilliam, of Wentworth House, Yorkshire, had the next largest collecton to that at Knowsley; and Sir Robert Heron, of Stubton, a Lincolnshire Baronet, ranked next. At Windsor, under George IV., and at Buckingham Palace, under the Queen, similar tastes were indulged. George IV. received from the Pasha of Egypt the first living Giraffe imported into England, and this brought John Gould to light. The son of a gardener, he had acquired sufficient skill to be entrusted with the stuffing of this giraffe, which was so meritoriously done that both he and the giraffe were transferred to the Zoological Society's Museum, where the genius of Gould (a great and not even yet fully appreciated genius), discovered itself to the Society and to the Ornithological world.

The Queen had a small aviary at Buckingham Palace, and sent some living Angora goats from Windsor to Knowsley, and other interchanges of living specimens likewise took place. Finally Lord Derby, in his will, gave directions that the Queen first and the Zoological Society next, should each have the choice of all the specimens from any one species from Knowsley that might be living at his death. The Queen chose the Impeyan pheasants, being the first pair imported into Europe, and three young birds bred from them at Knowsley, which, by the way, were reared by myself. The Zoological Society chose the Eland antelopes, five in number, and valued at £1000. These also were the first imported to Europe and bred at Knowsley.

The living collection was never in a more flourishing condition than at its dispersion: long cherished plans were yielding their result, and the extension of steam to mercantile shipping was beginning greatly to facilitate the transport of living specimens from India and the Cape, and would in a very few years have greatly added to the collections. As it was it seemed a pity to disperse what had been gathered together at so much labour and cost. But it was the wisest course; to let it droop and gradually die away would have been melancholy in the extreme, whereas the living collection, then in its prime, was a memory to all who were familiar with it. Alas! now but few.

Its richness may be gathered from the following summary appended to the Catalogue, which will be given more in detail further on after some particulars as to how the Collection had been got together.

			Of which are Knowsley-Bred.	
	Species.	Individuals.	Species.	Individuals.
Total number of Mammalia	94	345	39	207
Total number of Birds, exclusive of Poultry	318	1272	45	549
Total	412	1617	84	756

At the time of his death, Lord Derby was in correspondence with some 30 agents in the Old World and the New.

He had sent out an Expedition consisting of Mr. Burke and two other men from Knowsley Gardens to South Africa. and supported them there for three years collecting plants and animals. He sent Mr. Whitfield, a retired Surgeon, annually for many years in succession to the

West Coast of Africa for Antelopes, Ostriches, &c. He sent Mr. Bates on two expeditions to Honduras for Ocellated Turkeys, also Mr. David Dyson. He sent Mr. Burke to collect in the Hudson Bay Territories; and sent his Superintendent for several years in succession for Bustards specially reared for him in Germany, and more than once to Norway and Sweden for Reindeer and Capercaillie.

All this activity resulted in the acquisition of many museum specimens, the British Museum and Zoological Society receiving all the larger objects, as Giraffes, Rhinoceroses and other large game to the ultimate loss of Liverpool. Over and above all this resulted the discovery of some important beasts and birds altogether new to science, e.g., the Striped Eland or Jing-e-Jonga, *Oreas Derbianus*, from West Africa; the Water Musk Antelope, *Hyomoschus aquaticus*, from Sierra Leone, Gambia, and Senegal, remarkable for being the only ruminant having the third and fourth metacarpals distinct through life, so that the manus scarcely differs from that of the Boars; the Derbian Screamer, *Chauna Derbiana*, Gray, from the northern coast of Columbia; the Derby Mountain-Pheasant, *Oreophasis Derbianus*, G. R. Gray, from the Forests of the Mountain Volcan de Fuego, or Volcano of fire, Guatemala original or type specimen. This last remarkable bird, the first specimen of its kind ever taken, was presented by C. Klee, Esq., of Guatemala, and brought to England in 1843 by Mr. Bates, a collector sent to that country by his Lordship expressly to procure Natural History specimens. Very few specimens have since been obtained. The bird being confined, so far as is yet known, to a single mountain, is exceedingly rare, and very difficult to procure. Mr. O. Salvin, whose hunter had brought him three specimens, made three or four expeditions without seeing more than traces of it. He states

that they feed on the fruit of the Palo careta, a forest tree itself rare, of the genus *Prunus*, that in the morning they frequent its upper branches, they then descend to the underwood where they remain all day basking and scratching among the leaves, and that it is known to the Indians as the Khannandy, and to the half breeds as Faisan. Mr. Bates called it Gallina de Monte. The remarkable protuberance on the head is attached to the skull and is very hollow, being filled with a kind of cellular tissue as in the bill of the Toucan, and is very fragile. The female differs from the male only by being smaller, and having a shorter and more tapering horn. The habits of this species, and the form of the horn show its affinity to the Curassows. (See O. Salvin, in the "Ibis" for 1860, p. 248.)

In person Lord Derby was tall and of very active habits, fond of walking and of his gun, but very deaf. He became paralized on his left side soon after attaining his title. He took daily carriage exercise, and took great interest in laying out the new roads through the park. Those across the moss presented many difficulties. He commenced and carried on to completion a high and well built stone wall round the whole of the park, measuring 10 or 12 miles in length with numerous tastefully built stone lodges.

The old Aviary measured some 380 feet by 385 feet, was walled in, and comprised an ornamental piece of water with an island and breeding boxes on poles for British and foreign water fowl, of which Eider Ducks with their musical morning call, and Whistling Ducks with their cheerful cry of "*Teakettle-tea kettle-tea*" at all times of the day; the songs of Virginian Nightingales, Cardinals and other Grosbeaks, various tuneful Finches, in aviaries close by, and gently cooing Doves did indeed so merrily pass the day; the cries of the Whistling Eagles, Caracara Vultures and other numerous Birds of Prey; the shrill clarion of

Cranes, on the lawn, the ventriloquistic double notes of Trumpeters and the call of Cariama perched on the tall posterns of the gates, made life lively and cheerful. I at least enjoyed it vastly, as did those few individuals who were so fortunate as to obtain orders of admission, strictly limited to two parties of half a dozen a day, under special guide and guard. The Stanley Cranes were often allowed to disport themselves here, dancing in stately minuet fashion, dignified, yes, very dignified, and slyly watching the movements of every visitor withal, and pecking a sharp and forcible peck on the hands and knuckles in spite of the vigilance of the attendant.

The Birds of Prey, over 50 in number, were kept in wire or net enclosures near by, and to prevent undue obesity and sluggishness, were condemned to two involuntary fasting days in each week; yet notwithstanding this limitation, and without the help of any, or scarcely any carnivorous mammals, a contract for a dead horse or dead cow was a weekly necessity. On one occasion an injured carriage horse, fat and in tempting condition, and killed on the premises, caused just a little surreptitious experimenting on the qualities of rump steaks from a horse by the boldest and youngest hands on the staff: the examples of Parisians being at that time much discussed in the papers and therefore having some degree of responsibility: the verdict was not unfavourable though I was not myself a juror.

Besides Cranes other creatures were turned out on the old aviary lawn for exercise: notably some newly imported Ostriches, immature but full sized; and such is the power of these birds that one of the biggest men about the establishment, a blacksmith full six feet high, was twice felled to the ground by one of these birds before he could beat a safe retreat; the upward lifting of the foot, the rear-

ing of the bird to an alarming height, and the sudden descent of the foot, two-toed and "nothing more," on the man's breast is a sufficient explanation of the fall of the poor blacksmith, for the Ostrich was privileged but the blacksmith was *not:* give and take being necessarily prohibited among the living specimens. Some time before this the adult male Ostrich in our museum (the finest stuffed one I have ever seen) came to an untimely end at Knowsley, suspicion supposing he had not had the full benefit of his privileges. This happened more than forty years ago, but only came to my knowledge a few days since, when comparing notes with Edward Prescott, one of the staff, and who alone beside myself now lives to bear personal testimony respecting the Aviary at Knowsley. This bird was seemingly all right when shut up at night and was found dead in the morning, but without external injury.

The new Aviary was directly planned and constructed for its special purpose. It occupied a plot of ground protected by a wall and embankment all round it, thickly planted with shrubs and trees, and bearing a girdle of stout hurdles to prevent the intrusion of strangers. A carriage drive passed through this, and the ground was divided into spacious hurdle paddocks, with substantial buildings annexed, in which the Ostriches, Zebras, Antelopes and other precious denizens were housed. The most notable feature however was a huge wire Aviary in several compartments, masking the dwelling house of the Superintendent, in the rear of which were a series of houses with glass roofs and fronts protected with wirework, in which were kept in great freedom, amid dwarf shrubs and trees, the Impeyan and Argus Pheasants, the first ever imported, and other choice birds, such as Curassows, Crowned Pigeons, and other smaller and rare species.

My own sleeping room looked directly into this arrangement, and through my window I witnessed, at five o'clock on spring and summer mornings, the first imported Argus Pheasant display himself by curving his huge wings over his head like a triumphal arch, as he would have done had he had a mate, which unfortunately was not the case.

Here also I witnessed the superb Impeyan Pheasant court his mate and display his gorgeous metallic tints with staid but grotesque demeanour. These also were the first pair seen alive, and they and their progeny were subsequently housed in Royal accommodation, as they ultimately went to the Queen. In a neighbouring compartment lived a bachelor Brush Turkey, *Tallegalla Lathami* or Mound Bird from Australia. His occupation for several weeks was to scrape together, all the leaves and loose vegetation I could supply him with, scraping doubtless in fond anticipation of the dawn of some Queen Talegalla upon his solitude: unhappily it was a case of "love's labour lost," although the scene has been faithfully set forth by the skilled hands of Mr. Henry Reynolds, the lamented Taxidermist, to the Museum, lately deceased, where other examples may be seen, of how various mound making birds prepare for the hatching of their eggs by the heat evolved from the decomposition of vegetable matter.

Time fails me to dwell upon other inmates of this Aviary: of Tree Pigeons which refused the most enticing dove-like food, when it was placed before them on the ground where all the other species condescended to feed, and like spoiled children would not eat till placed according to their accustomed habits, viz., on a level with the tree boughs several feet from the ground: of the beautiful Australian Pigeon, *Ocyphaps lophotes*, or the corpulent Wonga-wonga and Nicobar, or the bronze wings, with

beautiful metallic reflections; all Ground Pigeons, and all from Australia; as also the Crowned Pigeons of the Nicobars.

Beyond these, and domiciled in one of the houses were African Ostriches, the finest in the country, the accommodation being unequalled elsewhere. Here the Ostriches were let out for air and exercise daily in spacious paddocks, with choice herbage; here they had space to indulge to some extent in their very erratic style of running; somewhat in the manner of their relations the Rheas, or so-called American Ostriches, the strong point of which is their frequent and sudden turning at right angles when at full speed, thus out-manœuvering a horse, which necessarily shoots on ahead. The African Ostrich does this in a fashion, but he has a habit peculiar to himself: he sits down upon his haunches, draws his neck in and downwards, and blushes till his neck looks like a huge and limp German sausage. This he sways from side to side of his body, with heavy blows and grotesque noises. I have seen at Antwerp Gardens a living male Somali Ostrich not long known, having a well coloured neck and steel-blue leggings, who gave his mind during our interview wholly and solely to "going in" for me any way whatever, though fortunately perhaps for me, no way could he discover.

The following notes on the Llama tribe, the Red Deer or Stag, and the Stanley Crag, by Lord Derby, are extracted from the "Gleanings" already referred to.

"Specimens of the four kinds of the *Llama* tribe of animals, namely, the *Llama*, *Alpaca*, *Guanaco*, and *Vicuna*, have for several years been kept in life at Knowsley.

"Of the four kinds the Alpaca is the most important, at

bearing the wool now so extensively used for articles of dress, on which account numerous attempts have been made to naturalize the species in Great Britain, which its reputed hardihood seemed to point out as an easy achievement, but which attempts have not hitherto been attended with as much success as was anticipated. The length of the voyage, added to unskilful treatment, so much impairs the health of those that survive, that they seldom live for any length of time after their arrival; otherwise they could, with judicious treatment, in all probability be naturalised, and after a few generations would, as in the case of some other exotics, become perfectly inured to our climate. The four kinds are perfectly distinct, yet have such a general appearance, that one kind may easily be mistaken for another: the distinctions however are very evident to a practised eye, and are as follows:—

"The Guanaco approaches the Llama very nearly, both in its size and the texture of its wool, but is a much stronger and more vigorous animal. It is clean and well-made, light and active, and always of a light buff or fawn colour on the upper surface, and white beneath and on the inner side of the limbs; the face is greyish-black. There is less wool on the head, neck and upper part of the limbs, and that on the body is shorter and more sparingly furnished than in the Llama, and is mixed with coarse hair of greater length than the wool. The male is vicious, active, watchful and restless, and nearly or quite untameable; this is the invariable character of the species. In confinement it is constantly trying to seize any person that approaches it: it endeavours to throw down its opponent by springing against him with all its force, and then bites viciously. The spirit of the *adult* animal is such, that it will never allow itself to be conquered otherwise than by sheer strength. The female, though

milder and of more quiet habits, is of a fiery disposition and ready to avenge any affront.

"The Vicuna is the smallest of the four kinds, measuring 2 feet 10 inches at the withers. The neck is long, the ears moderately so. The wool is shortest on the neck and limbs: on the body it is three inches in length; and along the lower part of the sides numerous hairs of double that length are intermixed with the wool, and wave lightly over the undercovering, to which they form a sort of fringe. The colour is always buff or fawn and, as in the Guanaco, never varies. The Vicuna is a very timid animal, always wandering to the furthest limits of its enclosure, seeking further liberty: it is very nimble, light and active, fond of solitude, and perfectly harmless. The wool is of the finest texture, greatly surpassing even that of the Alpaca, and has lately been used as a substitute for the fur of the beaver.

"The Llama is the largest and strongest built of the four kinds, standing about 3 feet 9 inches high at the shoulder. The colour varies so considerably in different individuals, that the five living examples now at Knowsley are *each* of a different colour; but the variations, though so great, are generally merely variations of one colour, *brown;* in some specimens there is more or less of pure white on different parts of the animal. The wool is coarse, unfit for finer fabrics, and seldom more than 12 inches long: it covers the lower part of the neck and the whole of the body, leaving the head and legs clothed with only a short fur. The ears are longer in proportion than those of the Alpaca, and rather more curved towards each other. Its temper is always mild and gentle.

"The Alpaca is much smaller than the Llama, and more slenderly built, standing about 3 feet 2 inches high at the shoulder. The colour varies, but not so much as in the

Llama: some are pure white, with one or two patches of black: some are entirely black: while others are dark brown; but black is the predominant colour. The wool is thick-set and extremely fine and soft, and covers the whole head, neck, body and legs, leaving only the face bare. The wool reaches in some instances to 17 inches in length, and sometimes exceeds even that, which is perhaps rather more than the average, which is attained in about two years after shearing. The full-fleeced Alpaca is so thickly clothed with wool from head to foot, that he may at once be known from the rest of the group; his long neck appears of great bulk from the quantity of its clothing; indeed, no animal could be provided with a warmer dress, which in some cases almost touches the ground. The Alpaca is perfectly harmless and inoffensive.

"As the question of the age of the Stag or Red Deer (*Cervus elaphus*) has been very much *quæstio vexata*, and there are but few instances in which it can be spoken of with any degree of accuracy, I am inclined to think it might be of some use to state what is known here relative to one of our Stags, and who has latterly been honoured with a place in the National collection at the British Museum. 'Old Billy,' by which name he was well-known to all in this neighbourhood, was bred in the park at Knowsley in 1819, and at the usual age of three years was caught and sent up (1822) for the supply of the hunting paddocks kept by my late father for that sport at the Oaks, Surrey, and after being regularly hunted during some years without any injury being sustained by him, had the singular good fortune of returning to his native haunts in this park, where for many seasons he continued the acknowledged head of all the Deer, though he was not without a frequent struggle for the dominion with some of

his aspiring younger rivals. In one of these combats it is supposed that he received a wound which made him for a time rather lame; in consequence of which the keeper, he thinks in 1830, enticed him into the yard behind his house, and there doctored him until his recovery, upon which in a few months he was restored again to the full range of the park. From that period, however, he never forgot the benefits he had received in the keeper's yard, and in subsequent severe seasons would often make his way into it and go to the bin from which the keeper had been accustomed to give acorns, &c., during his illness; and if he could contrive to open, would proceed to help himself. Even at other times, if the keeper met him in the park and called to him by his name, he would stop and stand still, look round him, and on recognising his friend would leave his hairy comrades and meet the caresses of his benefactor. On the keeper naming this once to Lord Stanley while walking in the park, and Billy in sight, the keeper called to him, and Lord Stanley, in the man's company, went up to him, spoke to, and patted him. From that time Lord Stanley shared also in the influence the keeper had over him, so as even to be able to introduce other persons to Billy's acquaintance,—among them myself; but I have never ventured to exercise the same familiarity with him as my son or the keeper, though whenever I have met him in the park, and called him by name, he would stop, recognise it, and advance towards me, even if I was in a carriage, though he would not then come very near up to it. He did not seem to care even if his friends had a gun in their hands; but a dog, especially a strange one, he had a great dislike to. Some dogs that the keeper kept in his back yard, Billy was very good friends with there, but if he met them loose in the park they were as strangers to him.

"Thinking, both as a fine animal, and also on account of the singular circumstances attending him that it would be worth while to retain a picture of him, Billy, in the year 1842, stood for his portrait to a well-known talented artist of Liverpool in the line of animals, Mr. Richard Ansdell, who was at that time taking likenesses of several of the animals then in the Menagerie here, which picture now hangs opposite to the entrance door in the hall at Knowsley. For the two or three last years of his life poor Billy had become very infirm, and so evidently declining, that it was clear he could not longer resist his competitors unaided. The keeper therefore adopted the plan of placing him in a small clump of oldish trees, fenced in from the general park during the winter months, and in that shelter he died in March, 1845, having evinced for some time the infirmities of his advanced age. I do not however, think that there had been *much* alteration in his horns for the last few years, though what alteration there *was*, was for the worse; and at the last his horns were so *very* indifferent, that when Thompson sent up the body to the British Museum, he did not send the last horns with which he died, but a somewhat earlier and rather better pair, as the last were injured and broken in the animal's last struggles. Shaw tells me it was the last three winters that he was kept up in the plantation, from whence he would often lead him across the front green into his old quarters in the yard, and when there, if he could find an opportunity by the door being open, he would often enter the kitchen and lie down like a dog before the fire."

Lord Derby, in his Notes on Stanley Cranes (*Scops Paradisea.*), observes in his "Gleanings from the Menagerie and Aviary":—

"I possessed for some years several individuals of that

species of the genus *Anthropoides* which my late friend Dr. Latham had done me the honour to distinguish by my name, in consequence of my having the good fortune first to draw his attention to the bird, which I had seen in the Tower of London, then under the care of Mr. Cops; but not one of them had ever shewn any chance of a sign of breeding, until, in the year 1843, my Superintendent, Thompson, thought he saw in two of them an inclination to pair, and he immediately determined to separate them from all others of the same kind, in a small paddock behind his own house, in which were the Elands and some large fowls. The plan succeeded, for in the next year, (1844) the hen had seven eggs, but scattered about in different parts of the paddock, without any appearance of a nest. From this circumstance I entertained little, if any, expectation of any good being derived from them, but we decided to put them into the hatching-machine, and the result was, that while six out of the seven proved barren, the seventh produced a chicken, which however was always delicate and lived but a very short time, not above two or three days.

"The system of seclusion was continued, and in the spring of 1845 she laid five eggs, which Thompson placed at first under a turkey, but not considering her a sufficiently good nurse, when the period of hatching drew near, he took them from her and put them under a large hen, of a somewhat Indian breed. Two of the five proved addled; the other three had birds in them, of which the third died in the shell; but two were hatched, and far from shewing any disposition to remain in the nest and be fed, they from the first took to their legs, and followed the example of so many chickens or partridges, actively running about and picking up the food thrown to them, and even taking from the hand. They ap-

peared to go on very well for some short time; but in about a week or ten days, I think, one of them was found one morning to be suffering apparently from cramp, for it could not stand on its legs, though it fed very well; but though every attention was paid to it, it never recovered its powers. . . . The other continued strong and healthy, and grew very rapidly in size, and I trusted we might have succeeded in finally rearing that one; but at last, a short time before its companion's death, it also became ill, and survived its fellow but very little. I had them both preserved, and all three now form portions of my Museum. The same attempt will be continued with the same pair next season, and a second pair are already separated after the same plan, when I trust, with one or the other, we may be more fortunate than we have yet been, especially if the next season should be more favourable than the two last have been."

Ultimately one bird when arrived nearly at maturity soared to a considerable height from the paddock, but in descending snapped its legs in a hurdle and died in consequence; so serious and unexpected are the risks and accidents to which animal life is subject in confinement.

NOTE.—A further paper dealing with some of the more interesting animals kept at Knowsley will be laid before the Society later in the Session, and printed in due course.

FOURTH ANNUAL REPORT of the LIVERPOOL MARINE BIOLOGICAL STATION on PUFFIN ISLAND.

By W. A. Herdman, D.Sc., F.L.S., F.R.S.E.,

DERBY PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, LIVERPOOL; CHAIRMAN OF THE LIVERPOOL MARINE BIOLOGY COMMITTEE, AND DIRECTOR OF THE STATION.

[Read 14th November, 1890.]

The Year.

The past year, although rather an uneventful one, can show its fair share of work done both at Puffin Island and also by means of dredging expeditions in Liverpool Bay. In accordance with the decision of the Committee expressed at the end of last year's report, the Puffin Island Biological Station was closed from the beginning of November till the middle of March, but although it seemed best to do this under the special circumstances of the time, the Committee hope that they may never require to close the station again. The interruption to work and the disorganization of arrangements was considerable, extra trouble and fresh expense were caused at the re-opening in spring; and although the former keeper, who had obtained a temporary situation in Liverpool during the winter, came back to the Station and was in charge most of the summer, he had evidently become unsettled and no longer displayed that single-minded devotion to Biology which is essential in such a situation. Later in the summer he became engrossed in other matters which occupied his time and energies to an extent quite incompatible with any further tenure of the Puffin Island post,

and consequently he had to leave the employ of the Committee. He has been succeeded as keeper by Thomas Jarrett, who was at one time an assistant at the Biological Station and left, of his own accord, for the purpose of getting married—after which he went to sea.

Jarrett and his wife have now been in charge of the Station for some weeks, and are carrying on the work of taking observations and making collections very satisfactorily. Only a few days ago, by taking a tow-netting off Puffin Island in the very early morning before it was light, he obtained a number of specimens of the interesting phosphorescent Schizopod *Nyctiphanes norvegica*, which had never been found before in our district.

Station Record.

The following Naturalists have been working at the Biological Station for longer or shorter periods during the present summer:—

DATE. 1890.	NAME.	WORK.
April.	I. C. Thompson, F.L.S., Liverpool	Copepoda.
—	R. J. Harvey Gibson, F.L.S., University College, Liverpool	Algæ.
—	G. A. Burrow, Botanical Assistant, Liverpool	Algæ.
May.	I. C. Thompson, F.L.S.	Copepoda.
—	George Brook, F.L.S., University of Edinburgh	Embryos of Molluscs.
—	W. A. Herdman, University College, Liverpool.	Nudibranchs and Tunicata.
—	R. J. H. Gibson, F.L.S.	Algæ.
—	Nath. Caine, Liverpool	General.
—	A. J. Ewart, University College, Liverpool...	Algæ.
—	J. Hornell, Liverpool	Polychæta.
—	J. Lomas, Liverpool...	Polyzoa.
—	Percy F. Kendall, Manchester	Mollusca.
	[A number of others forming the dredging party on the "Hyæna" expedition of May 23rd paid a passing visit to the Station.]	

June.	J. Hornell, Liverpool	Polychæta.
—	R. J. Harvey Gibson, F.L.S.	Algæ.
—	George Murray, F.L.S., British Museum ...	Algæ.
—	L. N. Boodle, R. Coll. of Sci., London... ...	Algæ.
—	E. A. L. Batters, F.L.S., London...	Algæ.
—	H. C. Chadwick, Manchester...	Echinoderms.
August.	J. Vicars, Bootle	Land Plants.
—	J. A. Clubb, University College, Liverpool...	Nudibranchs.
—	E. Briscoe, Liverpool	General.
—	A. Butchart, Liverpool	General.
—	A. T. Watson, Sheffield	General.
Sept.	Miss L. R. Thornely, Liverpool	Hydroida.
—	Miss J. H. Willmer, Birkenhead	Polyzoa.
—	Miss M. Beaumont, Liverpool	General.
—	W. Thornely, Liverpool	General.
October.	I. C. Thompson, F.L.S.	Copepoda.
—	R. J. Harvey Gibson, F.L.S.	Algæ.
—	W. A. Herdman.	Tunicata and Nudibranchs.
—	Alfred Leicester, Southport	Land Mollusca.

This list happens to contain exactly the same number of entries as the corresponding one for 1889, but in the present year the Station was not open for work until April. The absence of any workers during July may be partly accounted for by the general bad weather during that month, and by the specially bad weather on July 12th when several of the Committee who intended to work for some time at the Station started with a dredging expedition in the steamer "Spindrift" but could not be landed at Puffin Island and were brought back in the evening to Liverpool.

The sailing boat "Bonnie Doon", the black rowing boat "Ascidian" and the small blue punt are still in serviceable condition and have been in constant use during the season. The fixed work-table and shelving in front of the window in the room opening off the kitchen, and the sleeping bunks in the inner room, were put up early in the

year and have proved useful additions to the somewhat meagre accommodation at the Station.

Publications.

Since the last Report no new volume of the "Fauna"* has been issued, but several L.M.B.C. papers have been communicated in the usual way to the Biological Society and published in the Transactions. Extra copies of these in sheets have been printed off for the purpose of being included in the third volume of the "Fauna" which will probably be ready some time in 1892. These papers are:—(1.) a third report by Dr. R. Hanitsch, on the Sponges of the district, a lengthy paper illustrated by six plates, adding twelve species to our record and three species new to science, containing a re-description of the remarkable *Seiriola compacta* from the caves on Puffin Island, and giving an account of the enormous masses of *Cliona celata* obtained off Rhoscolyn, on the west coast of Anglesey, during the "Hyæna" cruise of May, 1890; (2.) a list of the land Mollusca of Puffin Island, by Mr. Alfred Leicester; (3) a report (one plate) by Mr. Alfred O. Walker on the Higher Crustacea collected during 1889, containing some notes on Cumacea, and a description for the first time of the adult male of the Amphipod *Podocerus isopus*; (4) a paper by Mr. I. C. Thompson, on the remarkable Copepod genus *Monstrilla* and the family Cymbasomatidæ; and (5) the third report on the Nudibranchiata, by Professor Herdman and Mr. J. A. Clubb, with four plates, and containing some further investiga-

* Volume I. of the Fauna of Liverpool Bay, price 8/6, was published in 1886. It contains 372 pp. and 12 plates. Vol. II., price 7/6, and containing 240 pp. and 12 plates, was issued in July, 1889. Copies of these may be obtained on application to the Liverpool Marine Biology Committee, University College, Liverpool.

tions into the structure and functions of the cerata or dorsal papillæ, a discussion of the condition of the epipodia in various genera, and an account of some experiments made at the Liverpool Aquarium in feeding fishes with certain Nudibranchs.

A number of additional L.M.B.C. reports are well advanced and will be laid before the Biological Society in the course of the present session. Amongst these may be mentioned,—an extensive report by Mr. Harvey Gibson on the Algæ, in the preparation of which Mr. Gibson has been fortunate enough to secure the assistance of Mr. E. A. L. Batters, Mr. George Murray and other celebrated algologists; and a report upon the Polychæta, on which Mr. J. Hornell has been engaged for a couple of years, and in which upwards of 70 species will be discussed, at least half of which are additions to the Fauna. The long expected report upon the Fishes of the district, by Mr. Moore, will, it is hoped, be soon completed; and we welcome as new recruits Dr. C. Herbert Hurst, of Owens College, who has taken charge of the Pycnogonida, and Mr. F. Archer, who has been a valued friend and critic and a member of our Committee from the beginning, and who is now responsible for the Testaceous Mollusca and has already added considerably to the records published by Mr. Darbishire in our first volume of "The Fauna."

Surface Organisms.

The weekly records filled up by the keeper show that the gelatinous surface Algæ referred to in last year's report have again been present in abundance. This condition of the sea was first noticed on June 6th, and continued with intermissions until September 6th, when it finally disappeared. According to Mr. A. W. Bennett, to whom it has been

submitted, the brown gelatinous matter is a Diatom allied to *Rhizosolenia*, but in a peculiar condition being without its siliceous covering. Mr. Thompson noticed the abundance of small drum-shaped greenish-brown Algæ in the tow-nettings which he examined from June 7th onwards. Ctenophora have been present in profusion on the surface throughout the summer. Mr. T. Comber, F.L.S., has examined some of this year's surface gatherings for Diatoms, and finds by far the most prevalent form in the samples he received is *Biddulphia baylii* (96 per cent. in gatherings taken in May). However, his further observations are reserved until more material has passed through his hands. The surface Dinoflagellata (*Ceratium tripos* and allied forms) which are sometimes present in great abundance are now being investigated by Mr. I. C. Thompson.

The Puffins (*Fratercula arctica*) are still abundant. They came to the island this year in the last week of April, and left about the middle of August.

The Sea-weeds of the District.

Investigations on the Algæ of Puffin Island and the neighbourhood are now being carried on very actively by Mr. Harvey Gibson, who tells me that he has on record 275 species in all, of which 70 are additional to his former report. Early in April Mr. Thompson, Mr. Gibson and the Botanical Laboratory Assistant, Geo. Burrow, went to the Island for the Easter holidays. Mr. Thompson worked the surface successfully, taking gatherings by moonlight round the Island (when *Zaus spinatus* and other forms were taken), and also leaving a tow-net out all night attached by a rope 20 feet long to the "D. B." or Dinmor buoy, about one mile out to sea from Dinmor Point, Anglesey. This net was found when examined 24 hours after to have caught an enormous

quantity of surface organisms, the greater number being Copepoda, and these chiefly *Temora longicornis*, *Centropages hamatus*, *Pseudocalanus elongatus* and *Calanus finmarchicus;* with these were a quantity of *Peltidium depressum*, a littoral species usually found attached to *Laminaria*, but apparently swimming on the surface during the early morning hours. A large number of Cumacea (3 species) were also in the tow-net and several Schizopoda, Amphipoda (5 species) and some *Sagitta*. The net, although kept extended near the surface by the strong tide, probably sank at the slack tide near to the bottom so as to have taken Cumacea and such a feebly-swimming Amphipod as *Dulichia porrecta*.

Mr. Gibson occupied himself with the Algæ, examining especially the Beacon rocks, the Sponge caves and shelving rocks on the north side of the Island, the caves at Dinmor Point and the D. B. buoy, where he was fortunate enough to find, along with many common forms, over 20 of the rarer species, including *Lyngbya gracilis*, *Dermocarpa prasina*, *Entocladia wittrocki*, *Epicladia flustræ*, *Pringsheimia scutata*, *Calliblepharis jubata*, and *Ahnfeltia plicata*, new to our district, and one, *Rhodochorton seiriolanum*, new to science. Mr. Gibson again visited the Island towards the end of May along with Mr. Ewart, and made further collections of Algæ from the rocks, chiefly of the North side and N.E. Spit, including *Callithamnion corymbosum*, *Ceramium acanthonotum*, *Griffithsia setacea*, *Ralfsia verrucosa*, *Hildenbrandtia rosea*, and *Polyides rotundus*.

Later on (June 21st), an important party of Botanists, consisting of Mr. George Murray, F.L.S., of the British Museum; Mr. L. N. Boodle, Demonstrator of Botany at the Royal College of Science, London; Mr. E. A. Batters, F.L.S.; and Mr. Harvey Gibson, visited the station with the object of prosecuting further researches on the Algal flora of the Island. As this was the first occasion on which the

marine plants had received the attention of an algologist so skilled as Mr. Batters, it was to be expected that many rarities would be collected and many additions made to the preliminary list already published. The party utilised every low tide occurring during their stay, and although the tides were by no means very favourable, yet at least 150 species were collected, including:—*Ascocyclus reptans, Isthmoplea sphærophora, Symploca harveyi, Ectocarpus terminalis, Laminaria hyperborea, Lithophyllum lenormandi, Punctaria tenuissima Chantransia secundata, Phyllophora traillii, Callithamnion gracillimum* and *Dictyota dichotoma*, var. *intricata*. A form hitherto undescribed and forming the type of a new genus was discovered by Mr. Batters encrusting the stems of *Cladophora pellucida*, and will be described by Bornet and Batters under the name of *Schmitziella endoplœa*, n.sp. and n. gen. One of the richest localities on the island is undoubtedly the deep gully on the north-east side, and there, and in the deep rock pools on the east Spit, the best finds were made. Altogether the two days' work was productive of no less than 27 species new to the district, of which one is new to science. Mr. Gibson and Mr. Batters visited Hilbre Island in July and examined the rocky parts of the Island. Their chief finds were:—*Sphacelaria radicans, Litosiphon pusillus, Prasiola stipitata*, and several species of Cyanophyceæ.

Mr. J. Vicars visited Puffin Island again this year for the purpose of collecting land plants (see Appendix A. to last year's report, p. 43). He chose his time so as to be a couple of months later in the year than on his previous visit, but was not able to make any additions to the list.

In a final visit to Puffin Island at the end of October, Mr. Gibson found on the S.W. Spit, *Rhodochorton membranaceum, Rhodymenia palmata, Prasiola stipitata*, and many species already noted from Hilbre Island, and elsewhere,

but new to this locality. On this occasion also the cystocarps of *Catenella opuntia*, which have been seldom seen before, were found in abundance.

Zoophytes, Annelids, &c.

Before the "Hyæna" dredging expedition in May, a party of eight members of the Committee and others, including Mr. George Brook, F.L.S., Lecturer on Embryology in the University of Edinburgh, worked at the station; and a week later Mr. J. Hornell, who had been on the "Hyæna" trip, left the rest of the party at Bangor and then devoted some time to the investigation of the Annelids first of the mud flats about Garth, where he found several species new to the district, and secondly at Puffin Island. Amongst the most notable forms collected on this occasion by Mr. Hornell were *Dasychone lucullana*, *Serpula reversa*, *Sigalion boa*, *Trophonia plumosa*, *Phyllodoce laminosa*, *Flabelligera affinis*, *Scoloplos armiger* and a specimen of the curious and aberrant *Sphærodorum flavum*. The most abundant Polychæta on the shore at Puffin are *Eulalia viridis*, *Nereis pelagica*, *Polynoe lagisca*, and a *Cirratulus*. The Gephyrean worm *Phascolosoma vulgare* also occurs in mud under stones on the south Spit (October 26th, 1890).

Mr. Chadwick collected at Beaumaris and at Puffin Island towards the end of June, and had a couple of days dredging from the Turbot Hole upwards to the straits; and Mr. J. A. Clubb and others did some work at the station in August. Mr. Chadwick dredged a fine *Chalina oculata*, eight inches in height, four examples of *Pilumnus hirtellus* each ensconced within a separate whelk shell, many *Clavelina lepadiformis*, which is very abundant near Beaumaris, and some *Cucumaria planci* which have since reproduced by transverse fission in captivity, three of them

having now become seven in number (see Trans. L'pool Biol. Soc., vol. V., 1890-91).

Early in September, three lady students of University College, Liverpool, Miss L. R. Thornely, Miss J. H. Willmer, and Miss M. Beaumont, accompanied by Mr. W. Thornely, spent a week at the Station chiefly in collecting and preserving material and in examining the Hydroids and the Polyzoa, at which Miss Thornely and Miss Willmer had been working for some time previously.

Miss Thornely has examined and identified nearly all the collections of Hydroid Zoophytes and Polyzoa made in the various expeditions during the year, and reports to me that we have now found 71 species of Hydroids in the L.M.B.C. district, and of these 34 have been found on the shores of Puffin Island. Among the rarer forms found recently may be mentioned: *Hydranthea margarica, Sertularella tenella, Campanularia hincksii, Gonothyræa gracilis, Aglaophenia tubulifera,* and *Plumularia echinulata.* During her work at Puffin Island Miss Thornely found the following four species of Polyzoa which had not been previously recorded, viz., *Lepralia pallasiana, Cellepora avicularis, Pedicellina cernua,* and *P. gracilis.* Miss Thornely has also identified 25 species of Polyzoa found by Mr. F. Archer at Bull Bay.

In April, Dr. Hanitsch, Mr. Hornell, and Mr. C. H. H. Walker spent some time in collecting at Port Erin, Isle of Man, where they succeeded in getting some remarkably fine specimens of *Puchymatisma johnstoni* and other species of sponges, including two new to the district, viz., *Reniera ingalli,* B., and *Chalina montagui,* J., the latter an extremely fine specimen, equal to if not surpassing in size any specimen of the species ever recorded. In fact Dr. Hanitsch considers that in sponges this year has been remarkable rather for the number of fine specimens obtained than for

additions to the list of species. Those collected during the "Hyæna" expedition will be referred to further on.

Protective Colouring.

The important and now popular subject of the relations existing between the forms and colours of animals and their environment has received a good deal of attention at Puffin Island, and various instances of protective and warning colours have been noted in the reports. There are two additional cases of "procryptic" colouring (according to Poulton's excellent system of nomenclature) which seem worthy of record, viz., the small flat-clawed crab *Porcellana platycheles* and the Annelid *Eulalia viridis*.

P. platycheles is very common on the shores of Puffin Island and is generally found on the under surfaces of irregular fragments of carboniferous limestone. A dozen or more specimens may be exposed on turning over a large stone, but until one is aware of the concealment, the crabs are so inconspicuous that they usually escape notice. They place their flat bodies in slight depressions on the stone, and the dirty greyish-brown colour of the carapace corresponds exactly with the muddy surface of the decaying limestone, while to still further aid this protective resemblance, the strong hairs with which the limbs are fringed entangle mud particles and other foreign bodies and so help in grading off the body of the crab into the surrounding stone. And then the habits of the animal come in: *P. platycheles* is a peculiarly sluggish crab, and certainly in many cases its salvation must depend upon lying quiet. When the stone is turned over the crabs usually "sham dead" or rather, in this case, "sham rock," and so long as they remain motionless are very inconspicuous indeed. It is obvious that in such a case the more sluggish the animal is in time of danger the greater

is its chance of escape, and very probably the habit of lying quiet has been acquired for this purpose by the action of natural selection. The ventral surface of the crab is white, in marked contrast to the dark coloured back, and this I believe is also protective. When stones are turned over or shaken a certain number of crabs lose their hold and fall on their backs. They then lie still with the white ventral surface exposed and are readily mistaken for the white worn fragments of shells and chips of rock found imbedded in the mud under such stones.

Eulalia viridis is a Phyllodocean worm of a brilliant green colour which is very common on the shore at Puffin Island in the crevices of rocks and in the holes made by *Saxicava rugosa*, and is often seen hanging in a loose coil or festoon from an overhanging ledge or from the under surface of a stone. It is of course, when seen by itself or when attention has been drawn to it, a conspicuous object on account of its colour, but when lying upon green seaweeds it is very effectually concealed. Very frequently, however, the worm occurs amongst red and reddish-brown seaweeds where it naturally forms a contrast with its surroundings. In such cases it bears considerable resemblance to the tufts of the green filamentous Alga *Cladophora rupestris* which are seen scattered about amongst the red seaweeds. You may look at a tangled green bunch which seems to be an Alga and wonder what it is that is slightly unusual it its appearance, when perhaps one of the coils will slowly move and the apparent seaweed resolves itself before your eyes into a specimen of *Eulalia*. It is wonderful how easily even the practised eye of a naturalist may be deceived by these resemblances, and I have no doubt it is the same with the eye of the careless fish or other passing enemy.

Nudibranchiata.

Mr. Clubb and I have been carrying on our observations on Nudibranchs during the last year whenever opportunity offered. We went to Hilbre Island on February 20th, to attend the 20-foot tide. Although low water was not till 6 p.m. when it was rather cold and dark, we succeeded in finding the following species:—*Eolis papillosa* (spawning), *Acanthopsole coronata*, *Coryphella rufibranchialis*, *Cuthona nana* (?), *Galvina picta* (two distinct colours), *Dendronotus arborescens* (many of all sizes), *Ancula cristata* (very abundant, and spawning) and *Doris bilamellata* (spawning).

In regard to the other animals noticed on this occasion it may be mentioned that the spawn masses of *Arenicola* and of *Scoloplos* were abundant in pools on the sand. The Hydroid Zoophyte *Garveia nutans* was also abundant. This form is certainly spreading in the district and has been found twice this year at Puffin Island, by Mr. Thompson on April 4th, and by myself on October 26th. The masses of *Sabellaria alveolata* at Hilbre were found to be spreading and to cover a large area. Many young colonies of *Alcyonium digitatum* were observed, and many small specimens of *Sabella*. The starfishes which are usually so very abundant were almost entirely absent on this occasion. No young mussels, and no specimens of *Hydrobia* were found.

A month later, in March, we made a second trip to Hilbre at a very low ebb, accompanied by Dr. Hanitsch, and again succeeded in obtaining a number of Nudibranchs. We found several specimens of the rare *Coryphella landsburgi*. This is apparently the first time this species has been found in our district since the two original specimens recorded by Dr. Byerley in 1849 and 1853. These new specimens afforded us the opportunity of re-describing the

living animal and of observing the condition of the cnida or stinging cells. We also found *Galvina picta* again, and Mr. Walker has sent us specimens dredged at Colwyn Bay during the same month. There can be no doubt that this species is becoming more abundant in the neighbourhood.

We were much impressed on both the February and March visits to Hilbre with the effective protection afforded to *Doris bilamellata* by its rich yellow and brown tints which, although rendering it conspicuous in a white dish or a vessel of clear water, harmonize completely with the animal's natural surroundings, the dark purple-brown rocks spotted with patches of adhering mud, sand, small Algæ and Zoophytes. A reef of rock which we were exploring on the March visit had a number of specimens of this Nudibranch scattered over it which were not at first noticed because of the perfect manner in which their colours blended with those of the environment.

Ancula cristata was again present in extraordinary profusion at Hilbre in March. On one reef of rocks a little way above low water mark, there must have been many thousands of specimens present. For yards it was impossible to walk without treading on them, and handfuls were readily collected by scraping the specimens together from the mud-covered rocks. Many of these we brought to Liverpool alive and used for the experiments with fishes in the Museum Aquarium, which were described in our Third Report on the Nudibranchiata, and in "Nature" for 26th June, 1890. This Nudibranch anchors itself to the rock by a string of mucus attached to its tapering tail, and this habit enables it to live as it does on exposed rocks in the wash of the tide. I have several times watched specimens of *Ancula* in a few inches of water when there was a strong tide running past the rocks and waves dashing on them,

and noticed that they were swayed backwards and forwards in the water, but remained securely anchored by their tails.

Ancula is not protectively coloured; and as it has no cnidophorous sacs with stinging cells, like those of *Eolis*, its bright white and yellow colouring and conspicuous appearance on dark rocks seems at first inexplicable. From experiments made at the Aquarium last spring I came to the conclusion that it is distasteful to fishes, and possibly it is the secretion of certain large compound glands at the apices of the cerata or dorsal processes which is of an offensive nature.

Doto coronata, when it is found at Hilbre Island, generally occurs on colonies of the Zoophyte *Clava multicornis*; but Dr. Sibley Hicks tells me that he has found it in our district, on the sides of the body of the sea-anemone *Anthea cereus*, lying in cavities which it had apparently eaten out for itself. Another rare Nudibranch which we found at Hilbre in March was *Cratena viridis*, of which only two specimens had been found before in our district, one at the Isle of Man and the other at Puffin Island. A fourth was dredged later in the summer in Rhoscolyn Bay, Anglesea, during the cruise of the "Hyæna."

Altogether we have now recorded forty-three species of Nudibranchs in our district, of which thirty-one have been found at Hilbre Island and seventeen at Puffin Island. Besides affording opportunities for investigations into the condition of the stinging organs in various species of Eolids, and into the relation of the colouring to the environment in other forms of Nudibranchs, these specimens have enabled us to make a comparison of the epipodial structures throughout a series of genera, from which we have arrived at the conclusion that all the dorsolateral projections, or cerata, of Nudibranchs, often the

most conspicuous and brightly coloured parts of the body, are to be regarded as outgrowths of an epipodial ridge.

The experiments with fishes referred to above, and which I announced my intention of undertaking in last year's L.M.B.C. report, have been fully described since in the third report on the Nudibranchiata. They showed that the order of edibility of the forms which were offered to the fishes was :—*Dendronotus*, *Doris*, *Ancula*, and *Eolis*; *Eolis* being the most distasteful form, *Ancula* next, *Doris* less so, and *Dendronotus* edible, but from its size offering difficulties to the rather small fishes which we tried.* These results are of importance in connection with the explanation of the colours of the various Nudibranchs. It is obvious that if an animal is not thoroughly objectionable, from taste or otherwise, and has not yet become conspicuous with warning colours, it will be an advantage for it to be protectively coloured. *Eolis* is a most distasteful form, and has conspicuous colours of a warning nature. *Ancula* is also distasteful and is conspicuously coloured. *Doris* is less distasteful and is still protectively coloured; while *Dendronotus*, which I regard as edible, is very effectually concealed amongst the seaweeds it lives on, by its large branched cerata and red-brown colours.

The "Hyæna" Expedition.

The Liverpool Salvage Association having once more kindly placed their s.s. "Hyæna" at the disposal of the L.M.B.C., a four days' dredging cruise was arranged and successfully carried out at Whitsuntide. The old gunboat left the Mersey on Friday, May 23rd, and steamed to the Menai Straits. Some of the party spent the afternoon and evening collecting on the shore at Puffin Island, near which the "Hyæna" was anchored for the night. On the

* For further details see Trans. Biol. Soc., Liverpool, Vol. IV., p. 150.

following morning (after landing some beds, chairs, dredges, and other supplies for the Biological Station), the various sections of the party were gathered from Puffin Island, Beaumaris, and Bangor in time for breakfast on board the steamer. There were nearly thirty biologists in all (the largest number we have yet had on one of these cruises), including Mr. N. Rundell, Secretary of the Salvage Association, Captain Young, who had been with us on several previous "Hyæna" trips, representatives from Owens' College, Manchester; University College, Liverpool; the Manchester Museum; Edinburgh University; University College, Bangor; Firth College, Sheffield; and other naturalists from Liverpool, Manchester, Chester, Sheffield, and Southport.

It had been proposed to explore the northern coast of Anglesea, but the weather was so bad and the sea so rough in the direction of Point Lynas that, after a few hauls of the dredge off the north side of the South Spit, Puffin Island, the plans were altered and a start was made in the opposite direction. In passing up the Straits some dredging was done off Lleiniog, between Penmon Point and Beaumaris, depth six fathoms, where several specimens of the rare Nudibranch *Cratena concinna* were obtained, along with a single very small specimen (2·5 mm. long) of *Dendronotus arborescens*. The latter is interesting in connection with our attempt (see the second of these Reports, p. 7) to introduce this species at Puffin Island. We cannot of course be sure that this small specimen is the offspring of any of the *Dendronotus* which we set free in September, 1888, only about a mile away, but, at any rate, this is the first specimen of this species which we have found in that neighbourhood.

The next haul was off Port Dinorwic, where the dredge came up filled with sand, stones, and broken shells, on

which many animals were attached, including large numbers of the small red Ascidian *Styela grossularia*. The "Hyæna" then passed on into Carnarvon Bay and commenced working along the southern coast of Anglesea. The dredges and various kinds of tow-nets, surface and bottom, were used at intervals. A very large midwater net, attached to a triangular wooden frame was used for the first time and worked satisfactorily, but did not catch much, probably on account of the large size of mesh of the strong material of which it was made.

Mr. W. E. Hoyle's deep-water closing net has now been modified in the direction indicated in last year's report, so that it can be opened and closed not by the agency of sliding weights, but by an electric current. The "Hyæna," with its powerful dynamo, affords special facilities for experiment with this novel form of tow-net, which was used frequently during the cruise, not so much with the object of collecting specimens as for the purpose of detecting and remedying any possible defects in the construction, and of guarding against conditions which might interfere with the proper action of the apparatus. On the whole the net worked satisfactorily, the causes of occasional failures were discovered, and when an improved form of frame, made according to the design advocated by Professor Hensen, of Kiel, has been incorporated, the apparatus will, no doubt, be a most useful addition to the implements of the marine biologist. The mechanical details for working this tow-net may be described as follows :*—

The mode of opening and closing the net by the successive detachment of two cords, or links, has been retained ; but these are now looped round the shorter arms of two bell-crank levers, the longer extremities of which

* See Report of Committee on this Tow-net, laid before Section D of the British Association, at the Leeds Meeting in September, 1890,

rest upon two studs projecting laterally from the sector of an escapement wheel near its circumference. The lengths of the levers are so adjusted that when the first tooth of the escapement is liberated one of them falls, whilst the second is retained until the third tooth has been liberated. The escapement sector is actuated by a spring, and its movements are controlled by an electro-magnet, whose armature is attached to, or rather made solid with, the escapement itself. The current passes to the magnet down a wire in the rope by which the net is towed, and when the net is let down closed the circuit is open. As soon as the desired depth has been reached contact is made, the movement of the armature releases the first tooth of the escapement, and the net opens. When the circuit is broken the second tooth of the sector is caught by the escapement, and held until a second contact sets free the other lever and closes the net.

A further contemplated improvement is the combination of this electric opening and closing tow-net with the electric illuminated tow-net which we have now used during several successive cruises of the "Hyæna." A small incandescent lamp will be placed in the mouth of the net, and the same current will be used for causing the movements of the net and for supplying the light.

Several hauls of the dredge were taken during the afternoon in Carnarvon Bay on a sandy bottom, at depths of 12 to 20 fms., in which, amongst other things, *Ascidia plebeia*, a Holothurian, *Leda pernula*, *Astarte sulcata*, *Acmæa testudinalis*, and *Pandora inæquivalvis* were obtained. The "Hyæna" anchored for the second night in a small rocky bay, Porth Dafarch, on the south side of Holyhead Island (close to where the s.s. "Missouri" was wrecked a few years ago), and about half the party were landed to sleep on shore. After dark, those who remained on board com-

menced tow-netting by electric light, and repeated, with some modifications, the experiments which had been made during the last two cruises of the "Hyæna" at the Isle of Man in 1888 and 1889, and which were fully described in the L.M.B.C. reports for these years.

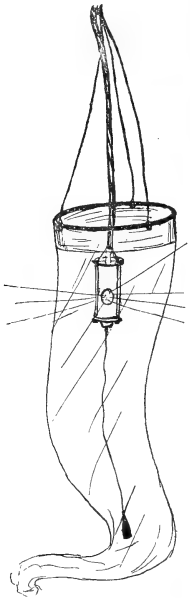

Fig. 1.—Tow-net with electric light.

On the present occasion the large arc lamp was hoisted over the side of the ship so as to throw a strong glare on the water, and Edison-Swan incandescent lamps were sent down to the bottom in tow-nets, which were hauled up at intervals. Comparatively few Cumacea, Amphipoda and Schizopoda were obtained this time, but shrimps and young

fishes were, for the first time in our experience, attracted by the light to the surface, and some of them were caught and preserved. The fishes proved to be young of *Ammodytes lancea* and *Gadus virens*.

One of the ship's boats was kept in the area illuminated by the arc lamp, and by leaning over her side the small objects in the surface-layer of water could be most distinctly seen, and particular animals picked out and captured with a hand-net as they darted about in the neighbourhood of the light. Mr. Leicester and Mr. Hornell were indefatigable in this work and rendered good service. Dr. Hurst and I arranged to be awakened by the sailor on watch at three a.m., when we got up and took a surface tow-netting about dawn, which was afterwards found by Mr. Thompson to contain a much greater number of Copepoda, and more variety than any of the other tow-nettings, either day or electric-light, surface or bottom. Amongst other interesting things it contained a large number of specimens of *Peltidium depressum* which had not been taken at all during the day, and only in very small numbers with the electric-light bottom-net. This same species was taken shortly before near Puffin Island by Mr. Thompson in the tow-net which he left out all night attached to the Dinmor buoy. This Copepod is usually found sticking on *Laminaria* in the day-time, but evidently comes to the surface in abundance late at night or early in the morning. It is evident that this plan of taking surface gatherings at 2 or 3 a.m. will have to be further developed in our future cruises. Probably the best way will be for the biologists to keep watches like the sailors and have the tow-nets going all night long.

The following day was spent in steaming slowly about off the southern coast of Anglesea, dredging and tow-netting at frequent intervals. The surface life was found to be

very poor, comparatively few Copepoda and almost no representatives of other free-swimming groups being obtained; but Mr. Thompson noticed the relative abundance in all the tow-nettings, both surface and bottom, during the day, and also with the electric light at night and at dawn, of unusually large specimens of *Dias longiremis*, and also the prevalence of the somewhat uncommon *Isias clavipes* in all the surface gatherings, though none were taken in the bottom ones.

Mr. Walker reports that as regards the higher Crustacea the results were rather poor. A few novelties, however, were the Cumacean *Eudorella truncatula*, Bate, taken close to Puffin Island with a small canvas dredge on the previous day, a new species of *Podocerus* from near Lleiniog, and *Leptocheirus hirsutimanus*, Bate, taken in the Straits, and also off Towyn.

The dredging results during this day were good. The following localities were explored:—(1) Porth Dafarch, (2) Penrhos Bay, (3) two miles off Towyn Lodge, (4) between Towyn and Rhoscolyn Head, and (5) off Rhoscolyn Beacon, where we had six hauls. Some very fine Sponges were obtained, and Ascidians (six species) were plentiful. One patch of rich ground was discovered near Rhoscolyn Beacon, where *Antedon rosacea*, in the "pentacrinoid" and also in the adult state, was brought up in abundance, along with various Tunicata (*Ascidia virginea*, and *A. venosa*), Holothurians, Nudibranchs (*Cratena viridis* and *Doto fragilis*), Zoophytes, Polyzoa, and especially large Sponges. Altogether this expedition was, probably, more prolific in regard to Sponges than in any other group.

Dr. Hanitsch tells me that, in addition to a number of commoner species, we obtained in that one day (May 25th), in the dredgings in Penrhos Bay, off Towyn, and off Rhoscolyn Beacon, specimens of *Raspailia ventilabrum*, *Poly-*

mastia mammillaris, *P. robusta*, *Tethya lyncurium* (budding), and magnificent examples of the massive form of *Cliona celata*, the largest specimen, from near Rhoscolyn Beacon, measuring 31 cm. by 20 cm. horizontally, and 12 cm. vertically, and being probably not exceeded in size by any sponge ever collected on the British coasts.

Miss L. R. Thornely, who has carefully examined all the material we brought back from this expedition, informs me that we obtained 26 species of Hydroid Zoophytes, including *Halecium tenellum*, *Diphasia attenuata*, *Plumularia echinulata*, *Eudendrium capillare*, and *Garveia nutans*. Miss Thornely has also given me a list of the Polyzoa which she has identified from this cruise, comprising 38 species, six of which have not previously been recorded from that region (Anglesea) of our district, viz., *Scrupocellaria scrupea*, *Membranipora pilosa* form *dentata*, *Smittia reticulata*, *Cellepora avicularis*, *Bowerbankia caudata*, and *Pedicellina cernua* form *glabra*. In a collection made by Mr. F. Archer at Bull Bay, on the north coast of Anglesea, later in the summer, Miss Thornely finds 25 species, including several of the rarer ones mentioned above, and *Cellepora ramulosa*.

Mr. Hornell tells me that this cruise gave for the first time to our local fauna the Annelids *Spinther oniscoides*, *Nicomache lumbricalis*, *Sabellaria spinulosa*, large numbers of *Polynoe scolopendrina*, and one example of *Nychia cirrosa*, which, curiously, was first described as British by the Swedish naturalist, Malmgren, from a wrongly named specimen of *Polynoe* in the British Museum, labelled as hailing from Beaumaris.

On the third night we again anchored in Porth Dafarch, and after dark the electric lights were again used for a couple of hours. This time the large arc lamp was taken to the stern and suspended close to the surface of the

water, but as it was not working steadily one of the incandescent submarine lamps was lowered over the side and kept a few inches under water, and this proved most effective in attracting animals to a stationary tow-net or a hand net beside it.

Some samples of the mud and other deposits brought up by the dredge from several localities during this cruise, and that of the "Spindrift" on September 27th, have been carefully examined by Mr. F. G. Pearcey, of the Manchester Museum, for Foraminifera. Mr. Pearcey has kindly supplied me with a list of the 71 species found, which I append to this Report (see Appendix A, p. 58). It will be noticed that this list of Foraminifera adds 8 species to those previously recorded in our district, and of these one, *Ammodiscus spectabilis*, is new to British seas. Mr. E. Halkyard, F.R.M.S., informs me that he has found at Southport the two unrecorded species *Polymorphina sororia* and *P. myristiformis;* while further additions to our list have been made from material collected by Mr. Thompson from the Mersey at Aigburth, and examined by Mr. E. Burgess, and which will form the subject of a separate paper in the Transactions of the Liverpool Biological Society, Vol. V., p. 73.

On the fourth day the "Hyæna" returned through the Menai Straits to Liverpool. As usual the specimens collected were distributed to our specialists, and are now in process of being worked out. I have only been able to give a meagre preliminary account of the results, and I have no doubt we shall hear more in future L.M.B.C. Reports of the "Hyæna" expedition of 1890.

Other Dredging Expeditions.

Through the kindness of Mr. J. Herbert Lewis a small tug, the "Albert," belonging to Messrs. Coppach, Carter and Co., of Connah's Quay, was lent to the Committee for

an afternoon's dredging at the mouth of the Dee, on July 5th. Mr. Carter accompanied the vessel from Mostyn, and picked up the party from Liverpool at Hoylake about one p.m. Unfortunately the sea was rough, and although a number of hauls of the dredge were taken, both in Hilbre Swash and in the Welshman Gut, they were rather unproductive. Late in the afternoon the beam trawl was tried with more success, bringing up quantities of Zoophytes, Sponges, &c., along with some fish. The dredging party landed on Hilbre Island in the evening for the low tide, and were joined there by some of the other members of the Liverpool Biological Society, it being the occasion of the annual field meeting for the presidential election.

The tow-nets had been worked as usual with great success during the afternoon, and Mr. Thompson has furnished me with a list of Copepoda, &c., from Hilbre Swash, in which the following occur, besides many of the usual commoner forms:—*Dias discaudatus, Cyclopina gracilis, Laophonte lamellifera, Lichomolgus (?)*, and *Euterpe gracilis*, along with several Cumacea, *Appendicularia* and the Cladoceran *Podon intermedius* which, although not uncommon, appears not to have been before recorded from British seas. Some good Copepoda were taken in the tow-net at Puffin Island on August 27th, including one specimen of *Monstrilla rigida*, and a larval *Lernæa*.

A most welcome grant of £50 from the Government Grant Committee of the Royal Society, to be applied to the further exploration of Liverpool Bay, has enabled us to hire seaworthy tugs on a couple of occasions for single day trips to the "central area" of Liverpool Bay. This region, which lies N.W. and W. of the bar lightship and onwards towards the Isle of Man, we regard as being still comparatively virgin ground, and as on each occasion when we have visited any part of it, notwithstanding very

adverse weather and want of sufficient time, we have been encouraged by finds which gave promise of rich ground

Fig. 2.—Map of the L.M.B.C. District.

and abundant spoil, we feel that more of our efforts in the future must be directed towards the exploration of this region outside the bar.

On July 12th we hired the tug "Spindrift," belonging to the Liverpool Steam Tug Company, for a day's work, and a party of fourteen of us started from the Landing Stage for a long day at sea. We steamed to a point about 25 miles N.W. of the bar lightship, where, at depths of about twenty fathoms, we had a dozen hauls of large and small dredges, besides tow-netting work. The bottom, as a rule, was composed of sand and broken shells, covered in places with enormous quantities of Ophiuroids—mostly *Ophiothrix pentaphyllum*. *Spatangus purpureus* was also obtained in abundance and of large size. Mr. Walker tells me that a very large *Iphimedia obesa* and two *Euonyx*

chelata were picked off an *Echinus*. During the "Hyæna" expedition another similar case of Amphipoda living on an Echinoderm had been met with when a number of females and young males of *Melita obtusata* were found on *Asterias rubens*.

The following Annelids were obtained in this "Spindrift" expedition :—*Lumbrinereis fragilis, Sthenelais limicola, Malmgrenia castanea, Syllis tubifex, Sphærodorum flavum, Eunice* sp., *Hermadion pellucidum*, and *H. assimile*. It is worthy of remark that the two species of *Hermadion* were in all cases discovered as commensals with Echinoderms. One specimen of *H. pellucidum* was picked off a *Solaster*, another off an *Astropecten*, and a third off an Ophiurid, while *H. assimile* was taken from *Echinus sphæra*.

On September 12th, Mr. Walker saw two very fine living specimens of *Palinurus vulgaris*, the spiny lobster, which had been caught at Valley in Anglesea. This is believed to be the first record of its occurrence in Wales.

Another expedition to the "central area" in the "Spindrift" took place on September 27th. We hoped on this occasion to be able to reach the ground where the very large specimens of *Fusus antiquus*, brought into market by the Fleetwood trawlers, live, and for that purpose Mr. R. D. Darbishire brought with him a Fleetwood trawler as a guide ; but some time was spent in dredging on the way, and although we eventually reached the proper region, we were evidently not on the exact ground, as our dredges and trawl failed to bring up any of the desired whelks.

We tried on this occasion a new trawl, made on the pattern of those recommended by Prof. A. Agassiz and by the Prince of Monaco. The runners are double, and both sides of the net are weighted, so that it is a matter of indifference which side the instrument falls on, and the wooden beam is replaced by two iron bars, which can be

unshipped so as to allow of easy transport. This instrument worked well on every occasion on which it has been tried.

We obtained, at about 15 miles N.W. of the bar, a number of specimens of *Philine aperta*, several of the beautiful large Nudibranch, *Eolis tricolor*, some Holothurians (*Cucumaria hyndmanni*) and Ascidians, and also dozens of the strange scabbard-like tubes of *Onuphis conchylega*. Amongst the other worms obtained and since identified by Mr. Hornell, are :—*Owenia filiformis, Nicolea venustula, Lumbrinereis fragilis, Serpula reversa, Thelepus cincinnatus, Sthenelais limicola, Malmgrenia castanea* (on every specimen of *Spatangus purpureus*) and *Hermadion pellucidum*.

On this expedition, and on the previous "Spindrift" trip in July to the same region, Mr. F. Archer took special charge of the testaceous Mollusca, and passed large quantities of the sand and gravel brought up by the dredges through his sieves, in search of the more minute forms. He has now found ten species which were not recorded in the Report on the Mollusca in the first volume of our Fauna, including :—*Pandora inæquivalvis, Venus chione, Puncturella noachina*, and *Adeorbis subcarinatus*.

The mud dredged on this trip has been examined for Foraminifera by Mr. F. G. Pearcey and Mr. G. W. Chaster, and has yielded 63 species (see Appendix A, p. 58.) The Zoophytes of this expedition, and of the "Albert" trip on July 5th, have been examined partly by Miss Thornely and partly in the Zoological Laboratory of University College by Mr. W. J. Halls. The "Spindrift" forms include the following additions to our list :—*Hydranthea margarica, Bimeria vestita, Campanularia hincksii, Gonothyræa gracilis* and *Aglaophenia tubulifera*. The surface life on this occasion (Sept. 27th) was very abundant, the tow-nets bringing up great quantities of Copepoda, &c. Amongst these

Mr. Thompson has found several of the rarer forms, *e.g.*, *Euterpe gracilis*, *Pontella wollastoni*, and *Parapontella brevicornis*.

Mr. A. Chopin, of Manchester, spent a week at the end of August in collecting Invertebrata round the southern end of the Isle of Man, and was singularly successful in some groups. He has kindly submitted all his lists, and some of the specimens, to me, and I note that he obtained:—

Sponges, eight species.

Hydroida, twenty-seven species, including *Syncoryne eximia* (dredged off Spanish Head), and *Lafoea fruticosa* (on *Sertularia abietina*), not previously found in our district. Some members of the Manchester Microscopical Society also obtained in June, *Corymorpha nutans*, (near Shagg Rock, 12 fathoms), and *Coryne pusilla* (Fleshwick Bay), both rare species.

Actiniaria, eighteen species and recognised varieties, including *Sagartia nivea* and its variety *immaculata*, not previously recorded.

Echinodermata, eight species.

Polychæta, five species.

Rotifera, *Synchæta baltica*, Ehr., not previously recorded.

Arachnida, *Halacarus rhodostigma*, Gosse (always on *Bowerbankia imbricata*), not previously recorded.

Polyzoa, twenty species.

Crustacea, twenty species, including *Portunus corrugatus*, not previously recorded.

Mollusca, thirteen species, including *Chiton discrepans*, new to the district.

Mr. Chopin collected at Hilbre Island, in September, the following Sea-Anemones:—*Sagartia viduata*, varieties

ælurops and *melanops*, and *Sagartia troglodytes*, varieties *scolopacina* and *candida*.

The Shrimp Enquiry.

At the February Meeting of the Biological Society, last Session (see "Proceedings," p. xiv.), I announced my intention of trying to collect statistics during the coming year that would aid in giving us more exact knowledge of the life-history and habits of the common shrimp (*Crangon vulgaris*) in this neighbourhood. It is well known that we are here in the centre of a considerable shrimping industry, and large numbers of shrimps come into the Liverpool market from various points on the adjacent coasts of Lancashire and Cheshire, both in the fresh condition and also potted in butter.

I prepared a circular, asking a few simple questions, such as a fisherman or shrimper would be perfectly well able to answer, and despatched a set of questions with blank spaces for answers, one for each month of the year, to five centres in the district, where I was fortunate enough to find gentlemen who kindly undertook to get the forms filled up by fishermen and returned to me. Mr. T. Comber, F.L.S., undertook Parkgate; Mr. R. L. Ascroft, Lytham; Mr. A. Leicester, Southport; Mr. A. G. Haywood, Crosby; and Mr. Henry Isaacs, Hoylake. Unfortunately I have not received anything like complete returns for the year from all of these fishing centres, but two of them, Lytham and Parkgate, have continued to send me reports during the whole year with the greatest regularity. I have now reduced these reports to a tabular form, which is annexed. I have also received some interesting information from Mr. W. B. Halhed, obtained from Parkgate fishermen. I wish to express my acknowledgments to all these gentlemen for their hearty co-operation,

SHRIMP REPORTS FOR 1890.

QUESTIONS.	JANUARY.				FEBRUARY.					MARCH.				APRIL.			MAY.	JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		DECEMBER.	
	Parkg'te	Lytham	South'pt	Crosby	P'gate	L'th'm	S'port	Crosby	H'lake	Parkg'te	Lytham	Southp't	Crosby	Parkg'te	Lytham	Southp't	Lytham	Parkg'te	Lytham	Parkg'te	Lytham	Parkg'te	Lytham	Parkg'te	Lytham	Parkg'te	Lytham	Parkg'te	Lytham	Parkg'te	Lytham
1.—Have Shrimps been plentiful this month, and what was the average catch?	No, a few qts. occas'n'ly	No. 40 qts.	No, very scarce, 20 qts.	No, very scarce, not a qt.	No.	No, 15 qts.	No, 12 qts.	No, 2 qts.	No, very scarce	No, 4 qts.	No, 10 qts.	No, 3—4 qts.	No, 1 pt.	No, 1—2 qts,	No, 10 qts.	No, 3—4 qts.	No, 4 qts.	Yes, fairly, 12 qts.	Yes, 20 qts.	No, not very.	No, 6 qts.	Yes, good catches.	Yes, 50 qts.	Yes, 12—18 qts.	Yes, 60—100 qts.	Yes 30—50 qts.	Yes, 100 qts.	Yes, 30 qts.	Yes, 80—100 qts.	No, almost none.	Fairly, 50 qts.
2.—Were they of large size?	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Half large.	Medium.	Yes.	Yes.	Yes, all.	Half large.	Yes.	Yes.	Yes.	Yes.	Yes.	Some.	Mixed.	Yes.	Average.	No, very small.	Not very large.	No.	Fairly large; mixture.	No.	A mixture.	Not very large.	...	Not very large.
3.—Were any young or immature ones seen?	No.	Yes.	Very few.	No.	No.	Few.	Few.	No.	No.	No.	Few.	No.	Yes, some. Small escape.	No.	Yes, a good many.	No.	No.	Yes.	Yes, and fry.	Some.	Yes, plenty.	Some.	All young and immature.	Good many small.	Great many young and immature.	Some.	Many young and immature.	Some.	Many young and immature.	...	A great many young and immature.
4.—Had any of them eggs?	Yes.	Yes, most.	Yes, about half.	Yes, some.	Yes.	Yes, all.	Yes.	Yes.	Yes.	Yes, full.	Yes, all.	Yes, full.	Yes, large heavy.	Yes, full.	A few.	Yes, full.	Few.	Yes.	Not many.	A few still in spawn.	Large, had eggs.	None noticed.	No.	Hardly any.	Few.	No spawn at all.	Not many.	...	A good many.	...	A great many.
5.—In what locality were they caught?	Off Point of Ayr and Hilbre.	Blackpool Pier to Nelston Buoy.	Formby to end of Southport Pier,	Bootle Dock Wall to Formby Point.	As before.	As before.	As before.	As before.	Outside the Banks.	Off Point of Ayr.	Blackpool Pier to the Gut Buoy.	As before.	As before.	As before.	As before.	As before.	Blackpool to Southport.	On the sand banks.	As before.	Near N.W. Light Ship.	As before.	Near N.W. Light Ship.	Lytham Pier to buoy 2 in Gut.	Off Point of Ayr.	As before.	Off Point of Ayr.	As before.	Off Hilbre Island & Point of Ayr.	As before.	As before.	As before.
6.—In what depth of water, and on what bottom?	10—12 feet, sand.	2—4 fathoms, sand and mud.	1—3 fathoms, sand.	3 feet, sand.	Do.	Do.	Do.	Do.	4—5 fms.. sand and mud.	3 fms. on "Sand Pipes."	4—12 feet, sand.	Do.	Do.	1 fathom sand.	Do.	Do.	1—4 fms. mud.	15 fms. sand.	Do.	8—10 fms. sand.	Do.	Shallower than last.	3—8 feet, sand.	10— fm slut an ston	Do.	8—10 fms. slutch and stones.	Do.	Sand.	1—5 fms. on mud.	As before.	1—6 fms.
7.—What were the Shrimps feeding on?	Small, thin lug worms.	Don't know.	Green worms.	Shore worms and refuse.	Do.	Don't know.	Dead crabs.	Do.	Shell fish.	Small lug worms in sand pipes.	Don't know.	Small worms and dead matter.	Shore worms.	Don't know.	Don't know.	Small worms, etc.	Don't know.	...	Don't know.	...	Don't know.	Can't say.	Don't know.		Don't know.	Can't say.	Don't know.	...	Don't know.	...	Don't know.
8.—Did you see anything eating the Shrimps?	Cod and crabs.	Whiting.	Codling and† Whiting.	Whiting and Flukes.	Do.	Whiting and young Codling.	Codling.	Do.	Small whiting and Codling.	Codling.	Marble blebs.†	Codlings	As before.	No.	Marble blebs, stingers† and white crabs.‡	Codlings	Marble blebs, white crabs. and ray patches†.	Yes, crabs.	Marble blebs, white crabs, and ray patches.	...	Marble blebs and white crabs.	Can't say.	No.		No.	No.	No.	...	No.	...	A great many whiting.
9.—What has been the general weather and state of the sea this month?	Very rough.	Rough.	Very rough.	Very rough.	Cold.	Very rough.	Rough	Fogs and cold.	Rough and fine.	Fine and rough.	Very rough.	Rough and cold.	If mild should be many in April.	Fine.	Fine, calm.	Variable	Very rough for May.	...	Fine then rough.	Unsettled.	Very rough.	Good.	Not very good.	Fai	Fine then rough.	Fair, some gales.	Very rough.	Fine then frost.	Very rough.	Severe frost.	Weather thick and sea calm.
10.—Have you any other remarks to make?	In cold weather Shrimps bury in sand.	...	+ Shrimps found in the fishes' stomachs.	Shrimps bury in sand in rough weather.	Many raked out of sand.	...	If dry in March and April should be many young.	Dearer in L'pool market than ever known	...	Small Shrimps in 'gutters,' in 2 feet water.	+ *Pleurobrachia.*	...	Rake up Shrimps from sand 1 foot deep.	Very scarce year, so small prawns taken.	†† + *Weever fish. Polybius henslowii.*	Bad season altogether.	+ Young skate.	Nothing but shrimps, salmon very scarce.	Some covered with "weeds" (Zoophytes).	Not as plentiful as usual in July.	...	...	...	...	...	Very bad spring but good autumn for shrimps.	...	Shrimps went when frost came.	...	Shrimps buried in sand.	...

I have in many cases simplified the wording of the answers, and have left out some irrelevant remarks. The Crosby fishermen complain bitterly of the prejudicial effect of the Liverpool refuse boats upon their industry, and declare that these boats discharge their rubbish much nearer the shore than they are permitted by law.

It will be noticed from the answers * to the first question that the shrimps are more plentiful on the fishing grounds in summer and autumn than in winter and spring, and there seems to be abundance of evidence that they are directly affected by the weather. In cold or very stormy weather they are said to bury themselves deep in the sand, and several of my correspondents mention having disinterred them when raking for cockles at a depth of more than a foot in the sand. The prawns also disappear in cold weather, but whether they burrow is doubtful as they live on "hard" ground.

There seems to be a general belief that shrimps spawn all the year round, and I have no doubt that out of a great many shrimps some few may be found with spawn at any time, but from the answers to question 4 in the table it is evident that late winter and spring are the spawning times in this neighbourhood. Then nearly all the specimens taken are large and full of spawn, while in summer and autumn "fry" and immature forms make their appearance in quantity, and individuals with spawn are few or absent.

Many of the answers in regard to the food and the enemies of the shrimp were "don't know" and "cannot tell." The greater part of the positive evidence is that they feed upon "shore worms" in "sand pipes" (or their

* The standard of a good catch appears to vary somewhat with the locality and the time. What is considered "plentiful" at one time is returned as scarcity in another month.

excreta?), which I take to mean *Sabellaria alveolata;* while their enemies are generally said to be cod, whiting, flukes, small thornbacks, weevers, and crabs (especially "white crabs," *Polybius henslowi*). *Pleurobrachia* ("marble blebs"), which is sometimes put down as an enemy, would be very unlikely to be able to injure a shrimp.

It may be of interest perhaps to record a typical week-end visit to Puffin Island in rather wintry weather. Near the end of October four of us (Mr. Thompson, Mr. Gibson, Mr. Leicester, and myself) arrived at the Island on a Saturday, after a spinning sail down from Garth, in the "Bonnie Doon," and found that the new keeper, Thomas Jarrett and his wife, had been busy for some days white-washing and cleaning the station within and without, and had introduced several much-needed improvements in the household arrangements.

This particular expedition to the Island was made partly for the purpose of collecting certain special animals and sea-weeds, and partly in order to establish the new keeper in his place, and give him full directions for making collections and taking observations during the winter. Certainly the biologists have never before been so comfortably housed at Puffin. The arrangements in regard to board and lodging were as satisfactory as could well be in such a delightfully isolated spot, where everything, from a sack of coals to a pat of butter, has to be brought from Bangor, if not further, landed when possible on the rocks or the shingle, and conveyed on one's own back, or the donkey's—usually the former—up a cliff, and over half a mile of island top, consisting chiefly of long grass, limestone rocks, and awkwardly placed rabbit holes, before it reaches the biological station. The new sleeping bunks, fixed in three tiers of

two each against the wall of one of the rooms, (II. in fig. 3) are found to be a great improvement on the camp beds, especially in cold weather; and a long fixed work-table, with some shelving, has converted another room (III.) into a most useful indoors laboratory, where work can be carried on at night and on very cold days, when the outside laboratory, with its stone floor and many windows, is too uncomfortable, even for the enthusiast.

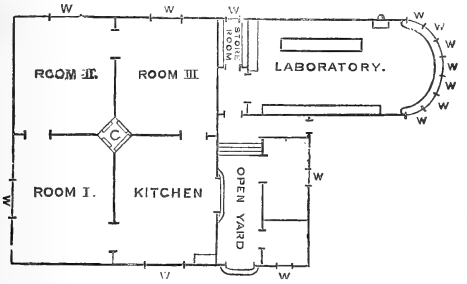

Fig. 3.—Plan of the Biological Station. W.W., windows; C, chimney.

Saturday was bright but showery all day. The afternoon was spent by the whole party on the long south spit at low tide, and the animals and plants collected were arranged, identified, and preserved in the laboratory during the evening. At night the wind rose and blew with great force against the north side of the house, and squalls of hail rattled against the windows at intervals. In the morning we were up at half-past seven, and found a heavy sea rolling in, a keen north wind blowing, and the mountains behind Penmaenmawr and Llanfairfechan white with snow. Mr. I. C. Thompson, with characteristic energy, at once conveyed me off to the cliffs for a morning plunge in the breakers in the middle of a shower of mingled sleet and driven sea foam; while our more sensible com-

panions superintended Mrs. Jarrett's efforts to fry our ham and eggs in the station frying pan, which was found to have a considerable perforation in its centre.

Immediately after eight o'clock breakfast the biological work began, and lasted till dark. Mr. Alfred Leicester explored the Island, high and low, for land mollusca, and succeeded in finding three snails (*Zonites alliarius*, *Z. nitidulus*, and *Helix virgata*) previously unrecorded. Mr. Harvey Gibson followed the retreating tide downwards foot by foot as he searched the shore for Algæ. Mr. Thompson and I initiated the keeper into the mysteries of tow-netting for the purpose of making collections of surface life. We went out in the punt with our nets and bottles, and coasted as far as we dared venture in that frail craft along the lee side of the Island, getting abundant gatherings as we went, and storing up the Copepoda and Diatoms in tubes (duly labelled), which will give many an hour of hard work at the microscope to our specialists before the results are known, and the lists printed in our reports. Later on we all assembled on the reefs opposite

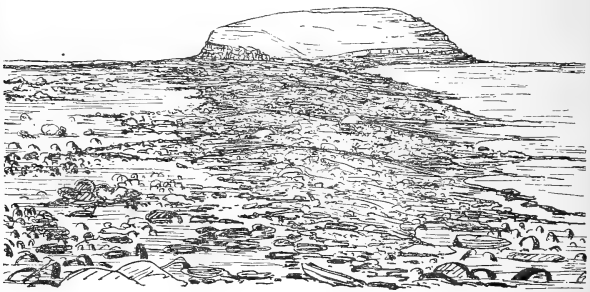

Fig. 4.—View of Puffin Island from the end of the South Spit at low tide. The best collecting ground is amongst the *Laminaria* and boulders shown in the front of the figure.

the Beacon rocks for the last of the ebb, and worked downwards with the tide, trying literally to leave not a stone unturned, for in such a spot the biologist finds his choicest specimens in the sheltered nooks and crevices underneath the boulders and ledges of rock, which have to be turned over—sometimes by the united strength of the party—in order that the treasures beneath may be revealed.

Under one such stone as it rolled back I caught sight of a large cuttlefish, *Eledone cirrhosa*, closely related to the octopus. There it sat in a shallow pool, something like a large yellowish toad, blinking its brilliant eyes, changing, chameleon-like, the colour of its skin, puffing out its fat round body, and squirting water at me with its funnel. I carried it home from Puffin Island next day in a large jar of sea-water, and it was before me on my study table as I wrote these lines, climbing about the jar by means of its eight long tapering arms provided with powerful sucking discs, stretching itself up to the surface of the water, and extending its arms out in all directions like radii—suggesting the appearance of some monstrous spider in which the web is part of the animal's body—and then suddenly collapsing and dropping all in a heap to the bottom.

We found besides many Ascidians, and a few Nudibranchs; Sponges, Zoophytes, and Polyzoa, were in profusion, and of the new Algæ, which fell to Mr. Gibson's share, there was almost no end. Altogether we were in luck, and when we had followed the tide down to its lowest, and a little beyond, and were driven up the shore by the advancing waves and the approaching darkness, saturated to our knees and elbows, and ordinarily wet over most of the remainder of our bodies, but laden with spoil, we tramped across the Island to our snug little station,

where Mrs. Jarrett was boiling the kettle and frying the fresh herrings for tea, agreeing as we went that there was no place like Puffin, and no pursuit so delightful as marine biology. It is not, as some think, only in the height of summer that the biologist can carry on his field work.

We brought back collections of various groups which have been distributed to our specialists. A small bag of matted algæ and mud from low-water mark has yielded Mr. Archer 16 species of the smaller mollusca, including *Pecten similis*, *Rissoa parva* var. *interrupta*, *Rissoa semistriata* (new to the district), *Chemnitzia elegantissima*, *Jeffreysia opalina*, and *Phasianella pullus*.

It is perhaps worthy of record here that we have found, half hidden in the soil on the S.W. corner of the Island, a slab of stone marking the grave of a sailor who was buried there a century and a quarter ago. The inscription is now only partially legible, but Mr. Thompson found in the Linnean Society's Library a copy of an old work giving an account of excursions in this part of Wales, made in 1798 and 1801 by the Rev. W. Bingley, F.L.S., in which occur the following passages about Puffin Island:—"Tradition respecting Priestholme says that when the now Lavan Sands formed a habitable part of Carnarvonshire a bridge communicated across the channel, and they yet pretend to show the remains of an ancient causeway from there to Penmaenbach, near Conway, for convenience of devotees who made pilgrimages to the Island;" and "On the Island I found an upright stone with the inscription—

Barᵉ. Stout,
belonging to the
Salley, died in
the small pox
Nov. ye 3rd, 1767.
N.B.—The ship was cast
away here."

The present condition of the inscription is this :—

Bar . . .
belo . . .
Sal . . . .
. . . . . .
. . . . . .
. . . . . .
a w . .

We are to have neighbours on Puffin Island in future. The rabbitting, &c., on the Island has been let by Sir Richard Bulkeley to Jeremiah Griffiths, from Bangor—the use of the house, &c., for scientific purposes, being reserved as before for our Committee, as I am courteously informed by Mr. Preston, the agent for the estate. The ruined cottage at St. Seiriol's old church on the top of the Island is now being repaired as a habitation for Jeremiah Griffiths, and as he and his sons propose to carry on fishing operations of various kinds all the year round in the neighbourhood of the Island, the biologists may regard this industrial invasion with equanimity, and even satisfaction. I am sure that the scientific and the economic exploration of the "Turbot Hole" will go on peacefully side by side, and prove mutually beneficial.

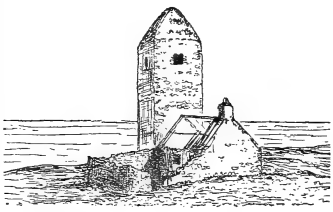

Fig. 5.—St. Seiriol's Church tower and old cottage on Puffin Island. (From a "Kodak" photograph).

Appended to this report will be found :—

(A.) A list of the Foraminifera identified by Mr. Pearcey from the deposits obtained during the "Hyæna" and "Spindrift" expeditions.

(B.) A list of the papers on the Fauna and Flora of Liverpool Bay, published since 1886, as the result of the L.M.B.C. investigations.

(C.) The Hon. Treasurer's usual statement, containing the list of Subscriptions and Donations to the L.M.B.C. funds, and the Balance Sheet for the year.

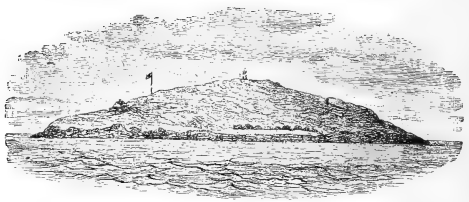

Fig. 6.—Puffin Island from the north.

Applications to be allowed to work at the Biological Station, or for specimens (living or preserved) for Museums, Laboratory work, and Aquaria should be addressed to Professor Herdman, University College, Liverpool.

Subscriptions and Donations should be sent to Mr. I. C. Thompson, F.L.S., 19, Waverley Road, Liverpool.

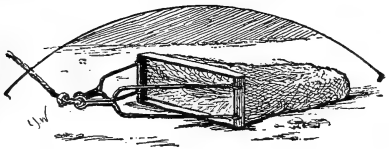

Fig. 7.—The Naturalist's Dredge.

Appendix A.

NOTES on the FORAMINIFERA dredged by the L.M.B.C. in LIVERPOOL BAY during 1890.

By F. G. Pearcey, Manchester.

In June of this year Professor Herdman was good enough to leave with me to examine for Foraminifera four samples of the residues from bottles containing animals which had been collected from various localities in Liverpool Bay during the cruise of the "Hyæna" in May; and since that I have received through Mr. Standen a further supply of deposit dredged during the "Spindrift" excursion on the 27th of September in the same district. Mr. G. W. Chaster also preserved some samples of deposits from the "Spindrift" expedition, and picked out and identified the Foraminifera. He has, on Professor Herdman's suggestion, submitted the rarer and more critical species to me for confirmation, and his results are now included in my lists. This last is the richest sample I have yet had an opportunity of examining from Liverpool Bay. It is not to be expected that with such a small supply from so large an area, anything very remarkable would be made out; especially after the long continued researches on this particular group of organisms in the same district by Mr. J. D. Siddall of Chester, whose admirable report on the Foraminifera of Liverpool Bay was published in the first volume of reports of the Liverpool Marine Biology Committee in 1886. In that report several representative deep-sea forms are recorded, and therefore I was anxious to have the opportunity of examining some of the deposits from this district.

In accordance with Professor Herdman's request I herewith append the result of my investigation, which although small is sufficient to show that there are a number of interesting forms to be found in the district marked out for exploration by the L.M.B. Committee; and I venture to point out to any Rhizopodists resident in the locality, who may have time to spare, that, from the nature of the deposits which have so far come under my observation, they should search well for the following forms, which I believe may yet be taken, viz., *Astrorhiza limicola*, *Pelosina variabilis*, *Hyperammina arborescens* and *Hyperammina vagans*, more especially if carefully looked for along the seaward boundary. Perhaps a word or two here on the method of collecting may not be out of place. Whenever an opportunity occurs a good quantity of the deposit should be carefully washed through sieves in a tub of

sea-water on the spot, especially in cases where a muddy deposit is found. The siftings so collected should be carefully preserved in bottles with spirit, and labelled (inside) with a good B.B. pencil, while a part should be kept as long as possible in sea-water and examined in the fresh state. The water remaining in the tub in which the material has been washed, should be poured through a fine muslin bag or net, made for the purpose, and the contents of this net should also be carefully preserved for future examination, as in this way some of the rarer forms are often taken.

Notwithstanding the small amount of material examined by me, I have been able to add eight new species to the locality, one of which is new to British seas; these are as follows:—*Miliolina pulchella*, d'Orb.; *Haplophragmium agglutinans*, d'Orb.; *Ammodiscus spectabilis*, Brady; *Textularia trochus*, d'Orb.; *Lagena globosa*, Mont.; *L. clava'a*, d'Orb.; *L. lævigata*, Reuss; and *Globigerina bulloides*, var. *triloba*, Reuss. Two of these are worthy of further note, viz.,

Miliolina pulchella, d'Orb. (sp).

Mr. H. B. Brady, in his Challenger Report, pl. iii, figs. 10—13, and M. Terquem in his memoir on the Foraminifera of the Upper Pliocene beds of the island of Rhodes, figure this form. Mr. Brady says, *Miliolina pulchella* is not uncommon amongst the larger Miliolæ of comparatively shallow water at depths of less than 100 fathoms. It occurs on the northern portion of our own coast, and occasionally elsewhere in the North Atlantic, in the Mediterranean, and more rarely amongst the East Indian Islands. It is therefore of considerable interest to have met with it in Liverpool Bay.

Ammodiscus spectabilis, Brady.

One perfect and one broken specimen of this species were obtained amongst the material dredged off Penrhos, which answer in detail to those described and figured by Mr. Brady (Report on the Challenger Foraminifera, vol ix., pl. xxxviii., figs. 20—22) with the exception merely that those taken off Penrhos are much smaller. This form is only known to have been taken from two other localities, viz., North Atlantic, and off the East Coast of Buenos Ayres in 1900 fathoms. It is therefore now added for the first time to the British Fauna.

It is interesting to find that many of the Foraminifera which we know as inhabitants of the great ocean basins, also occur in the shallow seas round our own coast; and this is of great importance in discussing the Geographical and Bathymetrical distribution of these forms.

I now give a list of the species found in 1890, with the localities, No. 5 being the only one from which what could be called a good sample of a rich deposit was obtained.

GENERA, SPECIES, AND VARIETIES OF FORAMINIFERA.		1. Lleiniog Menai Straits.	2. Port Dinorwic.	3. Carnarvon Bay.	4. Off Penrhos	5. 20 Miles N.W. of Bar Light Ship.
Biloculina	*depressa*, d'Orb.....	...	...	...	...	×
B.	*ringens*, Faulk.....	...	...	...	...	×
B.	*elongata*, d'Orb.....	...	...	...	...	×
Spiroloculina	*excavata*, d'Orb	...	...	...	...	×
S.	*limbata*, d'Orb.....	...	...	...	...	×
S.	*planulata*, d'Orb.....	...	...	...	...	×
Miliolina	*subrotunda*, Mont.	×	×	×	×	×
M.	*bicornis*, W. & J.	...	...	...	×	×
M.	*seminulum*, Linn.	...	×	×	×	×
M.	*agglutinans*, d'Orb.....	...	...	×	...	×
* *M.*	*pulchella*, d'Orb.....	...	...	...	×	×
M.	*oblonga*, Mont.....	×	...	...	...	×
M.	*trigonula*, Lamk.....	...	...	...	...	×
Ophthalmidium	*inconstans*, Brady	...	...	...	...	×
Cornuspira	*involvens*, Reuss.....	...	×	×	×	...
Dendrophrya	*erecta*, Str. Wright.....	...	×	×	×	...
Psammosphæra	*fusca*, Schulze	...	...	×	...	×
Haliphysema	*tumanowiczii*, Bow.....	...	×	×	×	...
Reophax	*difflugiformis*, Brady...	×	...	...	×	...
R.	*scoopiurus*, Mont.	...	...	×	...	×
R.	*fusiformis*, Will.....	...	...	...	...	×
R.	*moniliforme*, (?) Siddall	...	...	...	...	×
Haplophragmium	*canariense*, d'Orb. ...	...	×	×	×	×
* *H.*	*agglutinans*, d'Orb	...	...	×	...	×
Placopsilina	*bulla*, Brady	...	×	×	×	...
P.	*varians*, Carter	...	...	×	×	...
**Ammodiscus*	*spectabilis*, Brady	...	...	...	×	...
Trochammina	*inflata*, Mont.....	...	...	...	...	×
Textularia	*sagittula*, Defrance ...	...	...	...	...	×
* *T.*	*trochus*, d'Orb	...	...	...	...	×
T.	*variabilis*, Will.....	...	...	...	...	×
Verneuilina	*polystropha*, Reuss.....	...	...	×	...	×
Bulimina	*elongata*, d'Orb.....	...	...	...	...	×
B.	*elegans*, d'Orb.	...	...	...	...	×
Bolivina	*punctata*, d'Orb	...	...	...	×	×
Cassidulina	*lævigata*, d'Orb.....	...	...	...	...	×
**Lagena*	*globosa*, Montagu	...	...	...	...	×
* *L.*	*clavata*, d'Orb	...	...	...	...	×
* *L.*	*lævigata*, Reuss	...	...	...	...	×

L.	*sulcata*, W. & J.....	..	×	×	×	×
L.	*sulcata*, var. *interrupta*, Will.	...	...	...	...	×
L.	*costata*, Will.....	...	...	...	...	×
L.	*williamsoni*, Alcock.....	...	...	...	...	×
L.	*squamosa*, Mont.....	...	...	...	×	...
L.	*lævis*, Mont.	×	...	×	...	×
L.	*semistriata*, Will.	...	...	...	...	×
L.	*hexagona*, Will.	...	...	×	...	×
Nodosaria	*communis*, d'Orb.	...	...	×	...	×
N.	*pyrula*, d'Orb.....	...	...	...	...	×
Cristellaria	*rotulata*, Lamk	...	...	...	...	×
C.	*crepidula*, F. & M.....	...	...	...	...	×
Polymorphina	*gibba*, d'Orb.....	...	×	...	...	×
P.	*compressa*, d'Orb.	...	...	×	...	×
P.	*concava*, Will.....	...	...	...	...	×
P.	*lactea*, W. &. J.....	...	...	...	...	×
Globigerina	*bulloides*, d'Orb..... ..	...	...	...	...	×
* *G.*	*bulloides*, var. *triloba*, Reuss	...	...	...	...	×
Discorbina	*rosacea*, d'Orb.	×	×	...	×	×
D.	*globularis*, d'Orb.	...	×	×	...	×
D.	*orbicularis*, Terq.	×	×	...	×	×
Planorbulina	*mediterranensis*, d'Orb.	...	...	...	×	×
Truncatulina	*lobatula*, W. & J.	...	...	×	...	×
T.	*refulgens*, Mont.....	...	...	...	...	×
T.	*ungeriana*, d'Orb.	...	...	×	...	×
Rotalia	*beccarii*, Linn.	×	×	×	×	×
R.	*nitida*, Will.	...	...	...	...	×
Gypsina	*inhœrens*, Schultze ...	...	...	...	×	×
Nonionina	*depressula*, W. & J. ...	...	...	...	×	×
N.	*scapha*, F. & M.....	...	...	...	...	×
Polystomella	*crispa*, Linn.....	...	×	×	...	×
P.	*striatopunctata*, F. & M.	×	×	×	×	×

Those marked with an * are additions to the former lists of Foraminifera found in the L.M.B.C. district.

Appendix B.

LIST of PAPERS on the FAUNA and FLORA of LIVERPOOL BAY published since 1886 as a result of the L.M.B.C. investigations.

1886.

1. Introduction to Vol. I. of "Fauna," by Professor W. A. Herdman D.Sc., F.R.S.E., F.L.S. (Fauna of Liverpool Bay, vol. i., 1886, pp. 1—15, and chart.)
2. Pioneers in local Biology, by Rev. H. H. Higgins, M.A. (Fauna, vol. i., pp. 16—31.)
3. On Shallow-water Faunas, by Professor A. Milnes Marshall, M.A., M.D., D.Sc., F.R.S. (Fauna, vol. i., pp. 32—41.)
4. Report upon the Foraminifera of the L.M.B.C. district, by John D. Siddall, Chester. (Fauna, vol. i., pp. 42—71, and pl. i.)
5. Report upon the Porifera of the L.M.B.C. district, by Thos. Higgin, F.L.S. ; with description of a new species of *Aphroceras*, by H J. Carter, F.R.S. (Fauna, vol. i., pp. 72—94.)
6. Report on the Hydroida of the L.M.B.C. district, by W. R. Melly, J. Sibley Hicks, L.R.C.P., F.L.S., and Prof. Herdman, D.Sc. (Fauna, vol. i., pp. 95—113.)
7. List of the Medusæ and Ctenophora of the L.M.B.C. district, by J. A. Clubb. (Fauna, vol. i., pp. 114—119.)
8. Report on the Alcyonaria of the L.M.B.C. district, by Prof. Herdman, D.Sc. (Fauna, vol. i., pp. 120—122, and pl. ii.)
9. Report on the Actiniaria of the L.M.B.C. district, by John W. Ellis, L.R.C.P., F.E.S. (Fauna, vol. i., pp. 123—130, and pl. ii.)
10. Report upon the Crinoidea. Asteroidea, Echinoidea, and Holothuroidea of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc. (Fauna, vol. i., pp. 131—139.)
11. Report on the Ophiuroidea of the L.M.B.C. district, by Herbert C. Chadwick, Manchester. (Fauna, vol. i., pp. 140—143.)
12. Report on the Vermes of the L.M.B.C. district, by R. J. Harvey Gibson, M.A., F.R.S.E., F.R.M.S. (Fauna, vol. i., pp. 144—160.)
13. Report on the Polyzoa of the L.M.B.C. district, by Joseph Lomas, Assoc. N.S.Sc. (Fauna, vol. i., pp. 161—200, and pl. iii.)
14. Report on the Copepoda of the L.M.B.C. district, by Isaac C.

Thompson, F.R.M.S. (Fauna, vol. i., pp. 201—208, and pl. iv.)

15. Notes on the Cirripedia of the L.M.B.C. district, by F. P. Marrat, Liverpool Museum. (Fauna, vol. i., pp. 209—211.)
16. List of the Amphipoda of the L.M.B.C. district, by G. Herbert Fowler, B.A., Owens College; with list of the recorded Isopoda, compiled by Prof. Herdman. (Fauna, vol. i., pp. 212—220, and pl. iv.)
17. Report on the Podophthalmata of the L.M.B.C. district, by Alfred O. Walker, F.L.S., Chester. (Fauna, vol. i., pp. 221—226.)
18. Report on the Pycnogonida of the L.M.B.C. district, by W. B. Halhed, Liverpool. (Fauna, vol. i., pp. 227—231.)
19. Report on the Testaceous Mollusca of the L.M.B.C. district, by R. D. Darbishire, Manchester. (Fauna, vol. i., pp. 232—266.)
20. Report on the Nudibranchiata of the L.M.B C. district, by Prof. W. A. Herdman, D.Sc., F.L.S. (Fauna, vol. i., pp. 267—277.)
21. Notes on the Cephalopoda collected by the L.M.B.C. during the summer of 1885, by W. E. Hoyle, M.A., M.R.C.S., F.R.S.E. (Fauna, vol. i., pp. 278—280.)
22. Report on the Tunicata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., F.L.S. (Fauna, vol. i., pp. 281—311, and pls. v., vi.)
23. Preliminary list of the Algæ of the L.M.B.C. district, by Alfred Leicester, Southport. (Fauna, vol. i., pp. 312—314.)
24. First Report on the Marine Fauna in the neighbourhood of Penmaenmawr, by Isaac C. Thompson, F.R.M.S. (Fauna, vol. i., pp. 315—317.)
25. Notes on the Marine Invertebrata of the South End of the Isle of Man, by Prof. W. A. Herdman, D.Sc. (Fauna, vol. i., pp. 318—341, chart.)
26. Notes on some of the Polychæta collected by the L.M.B.C., by R. J. Harvey Gibson, M.A., F.R.S.E., F.R.M.S. (Fauna, vol. i., pp. 342—353, and pls. vii. and viii.)
27. Notes on Variation in the Tunicata, by Prof. W. A. Herdman, D.Sc., F.L.S. (Fauna, vol. i., pp. 354—364, and pl. ix.)
28. On a new species of *Sycandra*, by R. J. Harvey Gibson, M.A., F.R.S.E., F.R.M.S. (Fauna, vol. i., pp. 365—367, and pl. x.)
29. Note on the possible naturalization of the American Clam, *Venus mercenaria*, on the coasts of Lancashire and Cheshire, by Thomas J. Moore, Liverpool Museum. (Fauna, vol. i., pp. 368—370.)

[The preceding papers, 1—29, form Volume I. of the Reports on the Fauna of Liverpool Bay, published by the Liverpool Marine Biology Committee.]

1887.

30. The Liverpool Marine Biology Station on Puffin Island, by Prof. W. A. Herdman. (Nature, vol. xxxvi., pp. 275—277, with cuts, July 21st, 1887.)

31. On *Ascopodaria nodosa*, n.sp., by Joseph Lomas, Assoc. N.S.S. (Proc. Lit. and Phil. Soc., L'pool, vol. xli., p. xlvi.)
32. Notes on the Mysidæ of Liverpool Bay, by A. O. Walker, F.L.S. (Proc. L'pool Biol. Soc., vol. i., pp. 26—28, with cuts.)
33. Notes on the structure of *Alcyonidium gelatinosum*, by Joseph Lomas, Assoc. N.S.S. (Proc. L'pool Biol. Soc., vol. i., pp. 29—33, and pl. iii.)
34. On some Copepoda, new to Britain, found in Liverpool Bay, by Isaac C. Thompson, F.L.S. (Proc. L'pool Biol. Soc., vol. i., pp. 34—39, and pls. iv.—vi.)
35. The Exploration of Liverpool Bay and the neighbouring parts of the Irish Sea by the Liverpool Marine Biology Committee, by Prof. W. A. Herdman, D.Sc., F.L.S. (British Association Report, Manchester, 1887, p. 733.)
36. On some Copepoda, new to Britain, found in Liverpool Bay, by Isaac C. Thompson, F.R.M.S. (British Association Report, Manchester, 1887, p. 734.)
37. The Reproductive Organs of *Alcyonidium gelatinosum*, by Prof. W. A. Herdman. (Nature, vol. xxxvii., p. 213, Dec. 29th, 1887.)

1888.

38. The Foundation and First Season's Work of the Liverpool Marine Biological Station on Puffin Island, by Prof. W. A. Herdman, D.Sc. (Proc. L'pool Biol. Soc., vol. ii., pp. 38—62, with cuts.)
39. Second Report on the Copepoda of Liverpool Bay, by I. C. Thompson, F.L.S. (Proc. L'pool Biol. Soc., vol. ii., pp. 63—71, and pls. i and ii.)
40. *Cyclista coccinea*, Müll., an Actiniarian new to Liverpool Bay, by John W. Ellis, L.R.C.P., &c. (Proc. L'pool Biol. Soc., vol. ii., pp. 72—73.)
41. Report on the Polyzoa of Puffin Island, by Joseph Lomas, Assoc. N.S S. (Proc. L'pool Biol. Soc., vol. ii., pp. 74—77.)
42. The Geology of Puffin Island, by J. W. Gregory, F.G.S., British Museum. (Proc. L'pool Biol. Soc., vol. ii., pp. 78—94.)
43. Contributions to the Anatomy and Histology of *Limax agrestis*, by Richard Hanitsch, Ph.D. (Proc. L'pool Biol. Soc., vol. ii., pp. 152—170, and pls. x—xii.)
44. Report on the Crustacea of Liverpool Bay 1886-87, by A. O. Walker, F.L.S. (Proc. L'pool Biol. Soc., vol. ii., pp. 171—181, and pl. xiii.)
45. Marine Biology and the Electric Light, by Prof. W. A. Herdman. (Nature, vol. xxxviii., pp. 130—131, June 7th, 1888.)
46. The Utility of Specific Characters, by Prof. W. A. Herdman. (Nature, vol. xxxix., pp. 200—201, Dec. 27th, 1888.)

1889.

47. Second Annual Report of the Liverpool Marine Biological Station on Puffin Island, by Prof. W. A. Herdman, D.Sc. (Proc. L'pool Biol. Soc., vol. iii., pp. 23—45, with chart and cuts.)
48. Report on the Marine Diatomaceæ of the L.M.B.C. district, by Dr. H. Stolterfoth, M.A., Chester. (Proc. L'pool Biol. Soc., vol. iii., pp. 117—127.)
49. Report on the Marine Algæ of the L.M.B.C. district, by R. J. Harvey Gibson, M.A., F.L.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 128—154.)
50. Second Report on the Porifera of the L.M.B.C. district, by Richard Hanitsch, Ph.D. (Proc. L'pool Biol. Soc., vol. iii., pp. 155—173, and pls. v.—vii.)
51. Second Report on the Echinodermata of the L.M.B.C. district, by Herbert C. Chadwick. (Proc. L'pool Biol. Soc., vol. iii., pp. 174—180.)
52. Third Report on the Copepoda of Liverpool Bay (L.M.B.C. district), by Isaac C. Thompson, F.L.S., F.R.M.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 181—191, and pl. viii.)
53. Appendix to Third Report on the Copepoda of Liverpool Bay (L.M.B.C. district), by Isaac C. Thompson, F.L.S., F.R.M.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 192—194, and pl. ix.)
54. Third Report on the Higher Crustacea of the L.M.B.C. district, by Alfred O. Walker, F.L.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 195—213, and pls. x. and xi.)
55. Second Report on the Polyzoa of the L.M.B.C. district, by Joseph Lomas, Assoc. N.S.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 214—224, with cuts.)
56. Second Report on the Nudibranchiata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., F.L.S., F.R.S.E., and J. A. Clubb. (Proc. L'pool Biol. Soc., vol. iii., pp. 225—239, and pl. xii.)
57. Second Report on the Tunicata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., F.L.S., F.R.S.E. (Proc. L'pool Biol. Soc., vol. iii., pp. 240—260, and pl. xiii.)
58. Report on the Seals and Whales (Pinnipedia and Cetacea) of the L.M.B.C. district, by Thomas J. Moore, Corr. Memb. Zool. Soc. Lond. (Proc. L'pool Biol. Soc., vol. iii., pp. 261—278.)
59. Introduction to Vol. II. of Fauna of Liverpool Bay, by Prof. W. A. Herdman (pp. v—viii, and cut, 1889).

[Papers 38, 39, 44, and 47—59 form Volume II. of Reports on the Fauna of Liverpool Bay, published by the L.M.B.C. in 1889.]

60. The Liverpool Marine Biology Committee's Easter Dredging Cruise, by Prof. W. A. Herdman. (Nature, vol. xl., p. 47, May 9th, 1889.)

61. On the Structure and Function of the Dorsal Papillæ in Nudibranchiata, by Prof. W. A. Herdman, D.Sc., F.L.S. (British Association Report Newcastle-upon-Tyne, 1889, pp. 630—633.)
62. On some new and rare Copepoda recently found in Liverpool Bay, by Isaac C. Thompson, F.L.S. (British Association Report, Newcastle-upon-Tyne, 1889, p. 638.)
63. On the Electric Light as a means of attracting Marine Animals, by Prof. W. A. Herdman, D.Sc. (British Association Report, Newcastle-upon-Tyne, 1889, pp. 633—635.)
64. Report of the Committee, consisting of Professors E. A. Schäfer and W. A. Herdman and Mr. W. E. Hoyle (Secretary), appointed to improve and experiment with a deep-sea Tow-net for opening and closing under water. (British Association Report, Newcastle-upon-Tyne, 1889, pp. 111—112.)

1890.

65. Third Annual Report of the Liverpool Marine Biological Station on Puffin Island, by Prof. W. A. Herdman, D.Sc., &c.; with first list of the Plants of Puffin Island. (Trans. L'pool Biol. Soc., vol. iv., pp. 36—83, with cuts and chart.)
66. Note on some habits of Crustacea, by A. O. Walker, F.L.S. (Trans. L'pool Biol. Soc., vol. iv., pp. 84—86.)
67. Report on the Land Mollusca of Puffin Island, by Alfred Leicester, Southport. (Trans. L'pool Biol. Soc., vol. iv., pp. 87—90.)
68. On the Structure and Functions of the Cerata or Dorsal Papillæ in some Nudibranchiate Mollusca, by Prof. W. A. Herdman. (Quarterly Journal of Microscopical Science, vol. xxxi., pp. 41—63, pls. vi.—x., 1890.)
69. *Monstrilla* and the Cymbasomatidæ, by I. C. Thompson, F.L.S. (Trans. L'pool Biol. Soc., vol. iv., pp. 115—124, and pl. iv.)
70. Third Report upon the Nudibranchiata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., and J. A. Clubb. (Trans. L'pool Biol. Soc., vol. iv., pp. 131—169., and pls. vi.—ix.)
71. The Sixth Scientific Cruise of the Steamer "Hyæna" with the Liverpool Marine Biology Committee, by Prof. W. A. Herdman. (Nature, vol. xlii., p. 132, June 5, 1890.)
72. Some Experiments on Feeding Fishes with Nudibranchs, by Prof. W. A. Herdman. (Nature, vol. xlii., pp. 201—203, June 26th, 1890.)
73. Report of the Committee, consisting of Professor Haddon, Mr. W. E. Hoyle (Secretary) and Professor W. A. Herdman, appointed for improving and experimenting with a Deep-sea Tow-net for opening and closing under water. (Report of British Association, Leeds, 1890.)

74. Third Report on the Porifera of the L.M.B.C. district, by Richard Hanitsch, Ph.D. (Trans. L'pool Biol. Soc., vol. iv., pp. 192—238, and pls. x—xv.)
75. Report on the Higher Crustacea of Liverpool Bay taken in 1889, by A. O. Walker, F.L.S. (Trans. L'pool Biol. Soc., vol. iv., pp. 239—251, and pl. xvi.)
76. Fourth Annual Report on the Puffin Island Biological Station, by Prof. W. A. Herdman, D.Sc.; with list of the Foraminifera dredged during 1890. (Trans. L'pool Biol. Soc., vol. v., pp. 19-72, with cuts).

Appendix C.

SUBSCRIPTIONS and DONATIONS.

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LIVERPOOL MARINE BIOLOGY COMMITTEE.

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Audited and found correct,
ALFRED LEICESTER.

LIVERPOOL, 31*st December*, 1890.

NOTES on some FORAMINIFERA from the RIVER MERSEY.

By E. Burgess.

[Read November 14th, 1890.]

Last year Mr. I. C. Thompson gave me a bottle full of a black mud to examine for Foraminifera. The mud had been collected at low-water in the Mersey, near Aigburth, on the Lancashire side, where the exposed part is all soft mud. It is of importance with gatherings of Foraminifera to give the local conditions, and to determine, if possible, which of the forms are associated together in a living state and which have been washed from greater distances and depths. Both J. D. Siddall ("Foraminifera of the River Dee," Proc. Chester Soc. Nat. Sci., part II., 1878) and H. B. Brady (in Brady, Robertson and Brady on "Ostracoda and Foraminifera of Tidal Rivers," Ann. and Mag. Nat. Hist., ser. 4, vol. vi., 1870, pp. 273—306, pls. xi., xii.) have given us information of the greatest importance on the brackish water Foraminifera. The wonderful variety of texture, size, and form that is to be found is surprising. The tests or shells are formed both from the lime to be extracted from the water (where the water seems to contain but very little lime, the envelope becomes of a chitinous character), and also from lime in the shape of minute grains cemented together, along with spicules, grains of sand, and at times smaller foraminiferous shells also agglutinated together, each species having its own peculiar form of shell.

Notes on some of the Forms.*

Biloculina elongata, only a few found. There being no other forms would lead one to think that *elongata* under such conditions was a starved variety.

Spiroloculina, d'Orb. The few examples of *planulata*, consisting of from three to five or six chambers, would lead one to think them starved also. But when one finds *S. acutimargo* comparatively frequent, having been only found as a great rarity before, it would seem as if it were more at home in brackish water. J. Wright gives as habitat 45, 50 and 25 fathoms; J. D. Siddall, one from estuary of the Dee; H. B. Brady gives from 15 to 1425 fathoms, also shore sand, Madagascar. The Mersey specimens are smaller and not so robust as the "Challenger" specimens.

Miliolina, Will. The species *M. seminulum* and *M. subrotunda* are the only ones common in this district, and the latter are principally chitinous examples of *Miliolina*; one example might perhaps have been classed as *M. tricarinata*, but under such altered conditions it was thought better not to include it in the list of species. The *M. sclerotica* was compared with Karrer's plate before naming.

Adelosina, d'Orb. *A. bicornis*, the earlier chamber of which is rather rare in this gathering. Mr. C. D. Sherborn has kindly given me a translation of the description of this form from "Note sur le Genre Adelosina," Charles Schlumberger, *Bull. Soc. Zool. France*, vol. xi., 1886, p. 546.

"*Adelosina*, shell free, inæquilateral when adult, angular, commencing with a compressed chamber, suborbicular,

* See list given below, p. 77.

provided with a prolongation; the chambers being placed in a winding series on five opposing faces. The first, circular and compressed, forms a complete whorl; the others occupy a portion of the whorl, rolling themselves round with age, so that it appears that there are five chambers with a simple cavity. Mouth armed with teeth, as in other Agathistéques, and in adults alternately at one or the other extremity of the longitudinal axis."

Ophthalmidium inconstans, Br. Here again it would seem as if the ground was adapted for the growth of this species, many having been found here.

Haplophragmium canariense, d'Orb. Found in abundance in this mud.

Ammodiscus gordialis, J. and P. Of this only one specimen was found. In appearance it is flattened, and like an unwound *Trochammina squamata*, without septation. On the suggestion of Mr. J. D. Siddall I have placed it under the above heading.

Trochammina, P. and J. Of this four forms were found, and though marked rather rare, compared with many gatherings, the rather rare might be called frequent in the amount of material to be examined; several of the variety *macrescens* consisted of but very few chambers.

Textularia, Defrance. The few specimens found here named *T. agglutinans* are very small, and might, in some gatherings, but for the earlier chambers, have been mistaken for *T. filiformis*.

Bulimina, d'Orb. Of the five species of the above that were found, *B. elegantissima* was the most frequent, except the ever present *B. pupoides*.

Lagena, Walker and Boys. Seventeen species or varieties of this genus would seem to show that this

locality was favourable to their existence. And, indeed, of all the Foraminifera these were found in greatest abundance.

Nodosaria, Lamarck. Both *N. communis* and *N. scalaris* were found of but from two to three chambers, and in great rarity.

Polymorphina, d'Orb. *P. lactea* was frequent, but only one specimen of *P. concava* was found, which is not surprising, as it is very small and of great rarity.

Uvigerina, d'Orb. *U. angulosa* were frequent, but no other variety found.

Patellina, W., *P. corrugata*, are small but of great distinctness in their spiral formation, a form almost peculiar to muddy bottoms.

Discorbina, P. and G. The form recently described as *D. ochracea*, both figured and described by Prof. Williamson (Rec. Foram. Gt. Brit., 1858, p. 112; pl. v., fig. 113), has been removed to *Trochammina ochracea*. Of the three forms, *D. globularis* and *D. rosacea* are frequent, but of *D. parisiensis* only two were found.

Pulvinulina, Parker and Jones. *P. repanda*, variety *concamerata*, Mont. is figured as a Rotaline shell, both faces convex. But the British forms figured by Williamson (1858, Rec. Foram. Gt. Brit., pl. iv., figs. 101—103), are concave on the inferior side. H. B. Brady (Syn. Brit. Rec. Foram., 1887, p. 921), speaks of there being no record of the above form either on the east coast of England or Scotland, nor in the Irish sea; if the last is correct, this form is new to the latter neighbourhood.

Nonionina, d'Orb. *N. depressula* is common, and shows such variety of form and marking that at times it is puzzling to identify it, as it runs so close to other varieties.

N. scapha is very rare, and so also is *N. pauperata*, which H. B. Brady describes as "Possibly only the starved condition of *N. scapha*."

Polystomella, Lamarck. *P. striato-punctata* is ever present, but *P. crispa* is rather rare.

List of the Aigburth (R. Mersey) Foraminifera.

Family II.—Miliolidæ.

Biloculina elongata, d'Orb., rare, an elongated variety of *B. ringens*.
Spiroloculina planulata, d'Orb., rare, and consisting of only a few chambers.
S. acutimargo, Brady, comparatively common, frequent.
Miliolina oblonga, Mont., rare.
M. seminulum, Linn., common.
**M. auberiana*, d'Orb., very rare.
**M. sclerotica*, Karrer, very rare.
M. subrotunda, Mont., very common.
M. fusca, Brady, rare.
Adelosina bicornis, W. and G., rare.
Ophthalmidium inconstans, Brady, comparatively common.
Cornuspira involvens, Rss., common.

Family IV.—Lituolidæ.

Reophax nodulosa, Brady, rare.
Haplophragmium canariense, d'Orb., common.
Ammodiscus gordialis, J. and P., specimen doubtful.
**Trochammina squamata*, J. and P., rare.
**T. ochracea*, Will., rather rare.

* Those species marked with a star are new to the L.M.B.C. district.

T. inflata, Mont., rather rare.
do., var. *macrescens*, Brady, rather rare.

Family V.—TEXTULARIDÆ.

Textularia agglutinans, d'Orb., very rare.
Bigenerina digitata, d'Orb., very rare.
Verneuilina polystropha, Rss., frequent.
Bulimina pupoides, d'Orb., frequent.
B. ovata, d'Orb., rare.
**B. fusiformis*, Will., frequent.
B. marginata, d'Orb., rare.
B. elegantissima, d'Orb., frequent.
Virgulina schreibersiana, Csjzek., rare.
Bolivina punctata, d'Orb., frequent.
B. plicata, d'Orb., frequent.
B. difformis, Will., very rare.
B. dilatata, Rss., very rare.
Cassidulina crassa, d'Orb., very rare.

Family VII.—LAGENIDÆ.

Lagena globosa, Mont., rare.
L. lævis, Mont., very rare.
do., var. *clavata*, d'Orb., common.
**L. lineata*, Will., rare.
L. sulcata, W. & G., frequent.
L. williamsoni, Alcock, common.
L. costata, Will., very rare.
L. striata, d'Orb., common.
L. gracilis, Will., very rare.
L. semistriata, Will., common.
L. squamosa, Mont., frequent.
L. hexagona, Will., rare.
L. melo, d'Orb., rare.

L. marginata, W. & B., frequent.
L. lucida, Will., frequent.
L. orbignyana, Seg., very rare.
L. ornata, Will., very rare.
Nodosaria pyrula, d'Orb., very rare.
N. communis, d'Orb., very rare.
N. scalaris, Batsch., very rare, two to three chambers.
Marginulina glabra, d'Orb., very rare.
Cristellaria crepidula, F. and M., rare.
C. rotulata, Lamk., rare
**C. variabilis*, Rss., very rare.
Polymorphina lactea, W. and J., frequent.
P. concava, Will., very rare.
Uvigerina angulosa, Will., frequent.

Family VIII.—Globigerinidæ.

Globigerina bulloides, d'Orb., rare.
Orbulina universa, d'Orb., rare, and of a brown colour.
Sphæroidina dehiscens, P. and J., very rare.

Family IX.—Rotalidæ.

Spirillina vivipara, Ehrenb., very rare.
Patellina corrugata, Will., frequent.
Discorbina globularis, d'Orb., frequent.
D. rosacea, var. *mammilla*, Will., frequent.
**D. parisiensis*, d'Orb., very rare.
Planorbulina mediterranensis, d'Orb., frequent.
Truncatulina lobulata, W. and J., frequent.
T. haidingerii, d'Orb., very rare.
**Pulvinulina repanda* var. *concamerata*, Mont., very rare, concave on inferior side.
Rotalia beccarii, Linn., frequent.
R. nitida, Will., frequent.

Family X.—Nummulinidæ.

Nonionina depressula, W. and J., common.
**N. pauperata*, B. and W., very rare,
N. scapha, F. & M., very rare.
Polystomella crispa, Linn., rare.
P. striato-punctata, F. and M., common.

NOTE.—The previously published lists of the Foraminifera of the Liverpool Marine Biology Committee's District are:—Report on the Foraminifera by J. D. Siddall, in "Fauna of Liverpool Bay" vol. I., 1886; and List of Foraminifera dredged during 1890, in Fourth L.M.B.C. Puffin Island Report, App. A., Trans. Biol. Soc., L'pool, vol. V. p. 58.

[Editor L.M.B.C. Reports].

[From Trans. Biol. Soc., L'pool. Vol. V.]

NOTES on CUCUMARIA PLANCI.

By Herbert C. Chadwick.

With Plate I.

[Read December 12th, 1890.]

On June 26th last, while dredging in the Turbot Hole, off Puffin Island, I obtained about twenty specimens of the Holothurian *Cucumaria planci*. The majority of these were of small size, not more than five or six exceeding an inch in length. Selecting three of the largest and most vigorous looking, I placed them in a glass jar holding about a pint of water, in order to watch their habits. Two days later one of the specimens discharged about fifty ova. These were rather less than $\frac{1}{50}$ of an inch in diameter, pale cream in colour and quite opaque. Each ovum had a mucilaginous investment which, after some hours contact with the surrounding water became distinctly thicker. During the following two or three days I had a number of ova under observation, but beyond the extrusion in one instance of two polar bodies, I saw no signs of development.

On July 6th one of the adult specimens assumed the condition represented in fig. 1, and remained almost motionless until early on the morning of the 8th. The middle portion of the body then became much more attenuated, and a slowly elongating rupture, of which an enlarged representation is given in fig. 2, brought the tightly stretched intestine into view. Then the two ends snapped asunder, and the anterior slowly crawled onward,

leaving the posterior motionless. Fig. 3 represents the condition of things at noon, and immediately afterwards the intestine was detached at its junction with the cloaca in the posterior end *p*, and during the next two or three days was trailed about by the anterior portion *a*. Eventually it decomposed and disappeared in fragments. At no time during the process of division were the tentacles visible. On July 21st I noticed that the posterior end had developed a new mouth and a circlet of minute tentacles. The latter slowly increased in size, but were seldom protruded except after aeration of the water.

On July 26th another specimen repeated the above process of spontaneous division in much the same way and in about the same time, the only variation being that the anterior portion took possession of the whole of the intestine soon after its detachment from the cloaca. This specimen had previously discharged a large number of ova, assisting their dispersion by active play of the tentacles. The process of division was again repeated at the middle of August by the third specimen, and a fortnight later the posterior end of this divided, so that at the end of the month I had seven specimens. *Cucumaria planci* appears to be a hardy species, and well adapted for marine aquaria.

Explanation of Plate I.

Figs. 1 and 3, show stages in the fission of *Cucumaria planci*, natural size.

Fig. 2, shows rupture of middle of body, enlarged.

A REVISED LIST of the MARINE ALGÆ of the L.M.B.C. DISTRICT.

By R. J. Harvey Gibson, M.A., F.L.S., F.R.S.E.,

LECTURER ON BOTANY IN UNIVERSITY COLLEGE, LIVERPOOL.

With Plates II., III., IV., V.

[Read December 12th, 1890, and January 23rd, 1891.]

The present Report on the Marine Algæ of the district mapped out by the Liverpool Marine Biological Committee as the area of their explorations is a revision and extension of the First Report on the same subject presented to this Society in 1889.* In that paper I incorporated the observations of previous investigators so far as these seemed of value for the purposes of the Report, and recorded all the species noted by them whether I had myself observed them or not. The list so compiled was necessarily incomplete and faulty—incomplete, seeing that a more careful examination of our coast, keeping in view the very numerous additions to the list of British Marine Algæ since the days of Harvey and Greville, could not but result in a substantial increase to a local list such as the present,—faulty, because many species have been recorded as occurring on our shores almost certainly through mistaken identification, although I was not able at the time to express an opinion on the subject. After consulting algologists like Mr. E. A. L. Batters, Mr. A. W. Bennett and others who have carefully studied the British Marine Flora, I have decided to exclude all such

* Proc. Biol. Soc., Liverpool, vol. iii., pp. 128—154.

doubtful forms from my list, although I have added an appendix (I) in which these are enumerated, together with the reasons which lead me to suppose that they are very doutfully natives to our area.

The rapid development of our knowledge of the morphology and life history of Marine Algæ renders necessary many alterations in classification and nomenclature. I have followed the nomenclature and classification used in Messrs. Holmes and Batters' recently published list of the Marine Algæ of Britain.*

At first I fancied that an appendix containing records of new species and localities, together with abstracts of any observations I had been able to make on certain forms, would meet the present case, but I soon found that scarcely a single line of my former and provisional list expressed precisely what I wished to say with regard to the species therein enumerated, and, moreover, that the additional notes which I desired to insert were so numerous that I felt that it would be much the better way to reprint the entire list, introducing these alterations and additions in their proper places. Where I have altered the name of a species in accordance with more recent views as to its affinities, I have given as well the name (within brackets) by which I designated it in my previous paper. Save in these and other special cases I have not given synonyms nor references to literature. It seemed to me unnecessary to do so, seeing that these are given in full in such easily accessible works as Hauck's *Meeresalgen*, Kjellman's *Algæ of the Arctic Sea*, Farlow's *New England Algæ*, &c.

I have added, with certain necessary modifications, the artificial key to the genera of Marine Algæ, appended to

* Annals of Botany, vol. v., p. 63.

Prof. Farlow's *List of New England Algæ*, and I have to record my best thanks, not only to Dr. Farlow for his kind permission to use his tables, but also to my friend Mr. E. A. L. Batters, LL.B., F.L.S., for his kindness in adapting the tables to suit our local Marine Flora. I must also express my great indebtness to Mr. Batters for constant help and advice freely given me during the compilation of this list. My thanks are also due to Mr. George Murray, F.L.S., Mr. A. W. Bennett, F.L.S., and Dr. Edouard Bornet for help in indentification of specimens, &c.

My attention has been drawn to certain additional works in which references are made to the Marine Algæ of our district. These are as follows:—

(1) *Welsh Botanology* (1813) by Rev. H. Davies, F.L.S. I am indebted to Prof. Phillips of Bangor for a copy of this work;

(2) *Marine Algæ of the I. of Man*, (*Ann. Nat. Hist.*, vol. vii.) by Dr. G. S. Brady, F.R.S. to whom I beg to return my best thanks for the use of his MS. notes on an interleaved copy of his paper;

(3) *Marine Algæ of Douglas Bay, I. of Man*, (*Proc. I. of Man Nat. Hist. Soc.*, 1890) by Rev. T. Talbot.

(4) *Marine Algæ of the I. of Man*, (*Wesley Naturalist*, 1889) by Mr. King.

My own work, since the publication of my former report, has consisted of investigations on the Algæ of Puffin Island during a number of visits to the Biological Station there. On one of these occasions I had the advantage of the company of Mr. Batters and Mr. Murray, when many additional forms new to our list were observed. Mr. Batters and I also paid a visit to Hilbre Island and were successful in making further records. During the Xmas vacation (1890), I paid a visit to Port Erin, I. of

Man, when I was able to confirm many records from that locality made by previous observers. I have incorporated abstracts of two morphological investigations published in the journal of the Linnean Society. I have to record my thanks to the Council of that Society for their kindly granted permission to reprint Plate III.

Much yet remains to be done both on the general Marine Flora and on certain special points in Morphology, Physiology and Distribution. On some of these points I have already prepared a few notes, but they are not in a sufficiently advanced state of preparation to warrant publication at present.

The British Algæ number according to Holmes and Batters over 500 species. The present list includes the names of 256 species and varieties, of which 21 belong to the Cyanophyceæ, 41 to the Chlorophyceæ, 65 to the Phæophyceæ, and 129 to the Rhodophyceæ. Of these 66 were not recorded in my previous list. Several additional species are recorded in Appendix I. as doubtfully natives of our shores.

The following are the names of the species added to the list previously published.

CYANOPHYCEÆ.

Dermocarpa prasina, Born.
D. schousbœi, Born.
Spirulina tenuissima, Kütz.
S. pseudotenuissima, Crn.
Oscillaria corallinæ, Gom.
Symploca hydnoides, Kütz.
Lyngbya spectabilis, Thur.
Nodularia harveyana, Mert.
Calothrix pulvinata, C. Ag.

CHLOROPHYCEÆ.

Prasiola stipitata, Suhr.
Enteromorpha canaliculata, Batt.
Epicladia flustræ, Rke.
Diplonema confervoides, Holm. et Batt.

Entoderma wittrockii, Wille.
Urospora bangioides, Holm. et Batt.
Ulothrix implexa, Kütz.
Codium tomentosum, Stakh.

PHÆOPHYCEÆ.

Punctaria latifolia, Grev.
P. latifolia, f. *zosteræ*, Le Jol.
Desmarestia ligulata, Lamx.
Stictyosiphon subarticulatus, Hauck.
Ectocarpus terminalis, Kütz.
Isthmoplea sphærophora, Kjellm.
Halopteris filicina, Kütz.
Ascocyclus reptans, Rke.
Sphacelaria plumigera, Holm.
Elachista flaccida, Aresch.
Asperococcus echinatus, var. *vermicularis*, Griff.
Sporochnus pedunculatus, C. Ag.
Arthrocladia villosa, Duby.
Laminaria hyperborea, Fos.
Saccorhiza bulbosa, De la Pyl.
Fucus ceranoides, Linn.
Dictyota dichotoma, var. *implexa*, J. Ag.
Taonia atomaria, J. Ag.
Phyllitis zosterifolia, Rke.

RHODOPHYCEÆ.

Chantransia secundata, Thur.
Helminthocladia purpurea, J. Ag.
Helminthora divaricata, J. Ag.
Phyllophora traillii, Holm. et Batt.
P. palmettoides, J. Ag.
Calliblepharis jubata, Kütz.
Lomentaria clavellosa, Gaill.
Champia parvula, Harv.
Bostrychia scorpioides, Mont.
Laurencia obtusa, Lamx.
L. hybrida, Lenorm.
Chondria tenuissima, C. Ag.
Polysiphonia urceolata, var. *patens*, J. Ag.
P. parasitica, Grev.
Dasya arbuscula, C. Ag.
D. ocellata, Harv.
Sphondylothamnion multifidum, Näg.
Spermothamnion turneri, Aresch.
Rhodochorton membranaceum, Magn.

R. seiriolanum, Gib.
Compsothamnion gracillimum, Schmitz.
Callithamnion tetragonum, var. *brachiatum*, J. Ag.
Halymenia ligulata, C. Ag.
Hildenbrandtia prototypus, var. *rosea*, Kütz.
Polyides rotundus, Grev.
Schmitziella endophlœa, Born. et Batt.
Lithophyllum lenormandi, Rosan.
Chylocladia ovalis, Hook.
Melobesia confervoides, Kütz.

In Professor Herdman's Third Report on the Marine Biological Station on Puffin Island,* reference is made to the presence in the sea of vast numbers of "gelatinous spherical bodies containing minute spicules." The occurance of these bodies in countless myriads renders the water "foul," and the phenomon has been observed not only at Puffin Island by members of the L.M.B. Committee, but also at Sheerness by Mr. Shrubsole, at St. Andrew's by Professor McIntosh, and by the naturalists at the Plymouth Station. I have tried to obtain some of this material on several visits to Puffin Island, but hitherto without success. Mr. I. C. Thompson has, however, kindly given me a bottle containing the organisms in question, and this material I handed on to Mr. A. W. Bennett, F.L.S., who is a well known authority on the lower forms of algal life. I am glad to be able to incorporate the following notes which he has kindly sent me.

"The sample sent to me by Mr. Harvey Gibson, from the Menai Straits, contains various diatoms in an interesting condition, but in a very fragmentary state. They belong mostly to the families Melosireæ and Biddulphieæ, and are most nearly allied, as far as I am able to determine, to *Melosira nummuloides* Kütz. and *Biddulphia aurita*, Bréb. (*Odontella aurita*, Ag.) The siliceous coating

* Liverpool Biol. Soc., vol. iv., p. 40.

is always excessively thin and entirely destitute of markings as far as is shewn by the highest powers at my disposal, though it is probable that under exceptionally good conditions as to light and with still more powerful objectives, the characteristic markings of these families might be detected. But the interesting fact is that the contents of some of the cells are to be found floating free, destitute of any siliceous envelope, and (apparently) in a living condition. This is frequently the case with deep sea species belonging to the allied genus *Rhizosolenia*. I also noticed detached "hones" of *Chætoceros*, and fronds which I should refer to *Fragilaria striatula*, Lyngb. Besides diatoms there are several other marine algæ, but mostly in a fragmentary condition. There is a *Rhizoclonium*, probably *R. riparium*, Harv. and what I take to be fragments of an epiphytic *Endocladia*."

Mr. Bennett expresses a desire to see further samples of "foul" water, and I take this opportunity of making his desire known, in the hopes that members of the L.M.B. Committee may be able to send him material in a fresh condition.

NOTE.—In using the nomenclature and classification employed by Messrs. Holmes and Batters (*loc. cit.*), I have thought it best to give their authorities for specific nomenclature also. I do so, however, with great reluctance and for the following reasons. In the paper referred to (p. 64) these authors say:—"The authority given for the name of a species is in every case that of the botanist who first employed the name as it now stands, not that of the author who first described the species under another name." Thus, to take an instance, *Urospora bangioides* appears in their list with the authority "Holmes et Batters." This species was, I believe, first described and published

by Harvey under the name of *Conferva bangioides* (Phyc. Brit., pl. 268). Holmes and Batters have on the strength of my observations on the tailed spores of this species, placed it in Areschoug's genus *Urospora*. I think that such a system, substituting as it does the name of the botanist who simply renames for the name of the first discoverer and describer is fundamentally wrong in principle. "Palmam qui meruit ferat," and he who discovers and describes is surely much more worthy of honour than he who merely changes the name originally given. If this system be logically followed out by other botanists, we may expect soon to have a flora in which not a single species appears with the name of the first describer appended to it. *Urospora bangioides*, Holm. et Batt. ought, in my opinion to be *Urospora bangioides*, Harv. placed under the genus *Urospora*, Aresch. In the present paper I have used Holmes and Batters' system, only because I do not feel myself competent to say in *all* cases who deserves to be named as the authority, without referring (which I cannot at present do) to the original specimens. In Zoology, I believe, the authority given by almost all authors is the name of the first describer, and that seems to me to be the most just principle on which to go in such matters.

Localities where I have myself collected a species are distinguished by marks of exclamation.

Series I.—CYANOPHYCEÆ.

Cohort I.—CHROOCOCCINÆ.

Order I.—CHROOCOCCACEÆ.

Glœocapsa crepidinum, Thur.

Puffin I. !, Point of Ayr.

Order II.—Chamæsiphonaceæ.

Dermocarpa *prasina*, Born.

Puffin I.!, Hilbre I.!

D. schousbœi, Born.

Puffin I.!, Hilbre I.!

Cohort II.—NOSTOCHINÆ.

Section I.—*Homocysteæ*.

Order I.—Oscillariaceæ.

Tribe I.—Oscillarieæ.

Spirulina *tenuissima*, Kütz.

Menai Bridge.

S. pseudotenuissima, Crn.

Point of Ayr.

Oscillaria *nigroviridis*, Thw.

Eastham.

O. corallinæ, Gom.

Point of Ayr.

Phormidium *papyraceum*, Gom.

(*Oscillaria spiralis*, Report I.)

Point of Ayr, Eastham, Anglesea.

Tribe II.—Lyngbyeæ.

Lyngbya *semiplena*, J. Ag.

Point of Ayr, Puffin I.!

L. æstuarii, Liebm.

Bromborough Pool, Hilbre I.!, Point of Ayr.

L. majuscula, Harv.

Hilbre I., Eastham, Wallasey, Puffin I.! I found this plant growing at the last mentioned locality in colonies often half a foot or more in diameter.

L. spectabilis, Thur. in herb.

Point of Ayr.

Symploca *hydnoides*, Kütz.

Puffin I.!

Tribe III.—Vaginarieæ.

Microcoleus *chthonoplastes*, Thur.

Point of Ayr.

Section II.—*Heterocysteæ.*

Order II.—Rivulariaceæ.

Tribe II.—Mastichotricheæ.

Calothrix *confervicola*, C. Ag.

Hilbre I.!, Puffin I.!, I. of Man, Anglesea.

C. pulvinata, C. Ag.

Puffin I.!

C. scopulorum, C. Ag.

Puffin I.!

Rivularia *biasolettiana*, Menegh.

Eastham!, Hilbre I.!, Point of Ayr.

R. atra, Roth.

Hilbre I., Mersey, Anglesea.

Order V.—Nostochaceæ.

Anabœna *torulosa*, Lagerh.

(*Sphærozyga carmichælii*, Report I.)

Eastham, Point of Ayr, Anglesea.

Nodularia *harveyana*, Thur.

Point of Ayr.

Series II.—CHLOROPHYCEÆ.

Cohort II.—CONFERVINÆ.

Order I.—Blastosporaceæ.

Prasiola *stipitata*, Suhr.

Hilbre I.!

Order II.—Ulvaceæ.

Monostroma *grevillei*, J. Ag.

Puffin I.!, I. of Man!. *Enteromorpha intestinalis*, var. *cornucopiæ*, Ahln. recorded from the I. of Man, is only a form of this species.

Diplonema *confervoides*, Holm. et Batt.

Point of Ayr.

Enteromorpha *clathrata*, J. Ag.

Eastham, Hilbre I.!, Puffin I.!, I. of Man.!

E. ralfsii, Harv.

Bangor. Though a rare species I retain it on the authority of Mr. Ralfs. Marrat records it as "general," which is very unlikely.

E. erecta, J. Ag.

New Brighton.

E. ramulosa, Harv.

Hilbre I.!

E. percursa, C. Ag. var. *ramosa*, J. Ag.

(*E. percursa*, Report I.)

Point of Ayr.

E. compressa, Grev.

Hilbre I.!, Puffin I.!, I. of Man!, Mersey and Dee estuaries!

E. linza, J. Ag.

Puffin I.!, Hilbre I.!, Anglesea, I. of Man.

E. intestinalis, Link.

Puffin I.!, Hilbre I.!, Anglesea.

E. canaliculata, Batt.

Point of Ayr.

Ulva *latissima*, J. Ag.

(*Ulva lactuca*, var. *genuina*, Report I.)

Hilbre I.!, New Brighton, Puffin I.!, Anglesea, I. of Man.

Order III.—ULOTHRICHACEÆ.

Ulothrix *implexa*, Kütz.

Point of Ayr.

Order IV.—CHÆTOPHORACEÆ.

Entoderma *wittrockii*, Wille.

Puffin I.!

E. flustræ, Rke.

Puffin I.!, Hilbre I.! I have found this species

more frequently on zoophytes than polyzoa, and especially on *Diphasia pumila*.

Order V.—CLADOPHORACEÆ.

Urospora pencilliformis, Aresch.

(*Conferva youngana*, Report I.)

Puffin I.!, Anglesea!

U. flacca, Holm. et Batt.

(*Ulothrix flacca*, Report I.)

I. of Man, Anglesea, Puffin I.!

U. bangioides, Holm. et Batt.

Puffin I.!, Anglesea!

I found this form growing in considerable quantity at the situations named, in the spring of 1890, and thinking at the time that I had found the rare species *Urospora collabens*, I made a careful study of its structure and life history. Through the kindness of Professor E. P. Wright I was enabled to compare my plant with the type specimen of *U. collabens* in the Harveyan Herbarium at Dublin, with the result that my plant proved to be not that species but *Urospora bangioides*. I publish, however, my observations on the species, although in doing so I in great measure repeat Areschoug's work* on the allied *U. pencilliformis*. The filaments vary greatly in length according to age, an average full grown frond being 6—10 cm. long. The frond is unbranched and tapers to base and apex. Narrower regions also occur in the course of its length. The base is an irregular disc formed by the terminal cell, and frequently two or more cells above the terminal cell. The cell wall is markedly two layered. Cell division is usually regular, but frequently irregular. I have found that this oblique mode of division is associated with a peculiar method of vegetative multiplication.

* *Observationes Phycologicæ*, Pt. I.

Separation of pale green or colourless portions of the protoplasm first of all takes place, followed by oblique septation of the green central portion. One of the tapering cells thus formed then grows outwards, forming a pseudo-branch. The filament then separates into two parts, the isolated portion fixing itself by means of the pale thick-walled process, whilst the already attached part is terminated by a tapering pale green or colourless filament.

Two kinds of zoospores are formed, large and small. The megazoospore is pear-shaped, with a long, tapering hyaline tail, and a large, often distinctly knobbed, colourless but granular head, from the centre of which arise four long flagella, which project at right angles and bend backwards along the sides of the conical body when at rest. When in motion all four flagella move together with a paddling movement. The megazoospores are more plentiful than the zoogametes. Their mode of development is as follows:—A cell usually about the middle of a filament enlarges, the chlorophyll retreats to the centre, and a broad, granular, colourless layer is seen lying nearest to the wall. Radial segmentation then takes place, and the chlorophyll again spreads outwards, still leaving, however, a narrow outer portion colourless or only faintly green, more difficult to see at this stage owing to the spores being crushed against the wall by their rapid increase in size. When ripe the cuticular layer of the cell-wall bursts, and the entire inner wall, with the enclosed spores, escapes. The inner wall speedily deliquesces and the spores are set free. They move slowly, and after a time settle down on some adjacent rough surface. I have watched them settle on a sporiferous filament of *Bangia fuscopurpurea*, and observed the first stages in the development of new filaments. In the course of examination of hundreds of

filaments I have never seen fewer than 32 megazoospores in a cell.

The microzoospores, or zoogametes, are much smaller. They are ovate biciliate, actively motile cells, very pale green at the broader end, and colourless at the point of attachment of the two long cilia. They are produced in vegetative cells, and, so far as I could make out, in other filaments than those which produce megazoospores. The contained mass of zoogametes is much paler in colour than is the content of a megasporangium. The number of zoogametes is 64 or more. Their movements are so rapid that it is almost impossible to count them as they escape, the calculation "64 or more" is based, therefore, on the appearance of the gametangium previous to their escape. I have no doubt that conjugation takes place between cells of the same filament. The mode of conjugation does not differ from that described for *Ulothrix zonata*, by Dodel Port,* although the tailed megazoospore and the number of these produced in a sporangium places this species in the genus *Urospora*, Aresch. I have not been able to trace the after history of the zygote.

The extrusion of mega- or micro-zoospores from a cell lying between two others whose contents have not been shed is followed by the protusion of the special cell-wall of one of the lateral cells into the cavity, the gametes, or spores of the latter escaping by the rupture already formed in the outer wall of the empty cell. (See Pl. III.)

Chætomorpha *tortuosa*, Kütz.

Prince's Pier, I. of Man, Anglesea.

C. linum, Kütz.

Anglesea!, Puffin I.!

C. melagonium, Kütz.

Puffin I.! I. of Man. Marrat records this spe-

* Pringsheim's Jahrb. f. wiss. Bot., Bd. X.

cies as "general." He probably mistook *C. linum* for it.

C. ærea, Kütz.
Mersey, I. of Man, Puffin I.!

Rhizoclonium riparium, Harv.
Hilbre I.!, Puffin I.!, Eastham.

Cladophora pellucida, Kütz.
Hilbre I., I. of Man, Puffin I.!

C. hutchinsiæ, Kütz.
New Brighton, Anglesea, I. of Man, Hilbre I.

C. utriculosa, Kütz. var. *lætevirens*, Hauck.
New Brighton, Anglesea, I. of Man, Puffin I.!

C. rupestris, Kütz.
Hilbre I.!, I. of Man!, Puffin I.!, Anglesea!

C. glaucescens, Griff.
Puffin I.!, Hilbre I.!

C. fracta, Kütz.
Bromborough Pool, Anglesea.

C. flexuosa, Griff.
New Brighton, Hilbre I., Eastham, Anglesea, I. of Man, Puffin I.!

C. albida, Kütz.
Eastham, Puffin I.!, I. of Man.
var. *refracta*, Holm. et Batt.
Puffin I., I. of Man.

C. arcta, Kütz.
Bromborough Pool, Eastham, Wallasey Pool, Hilbre I., I. of Man, Puffin I.!

C. lanosa, Kütz.
Puffin I.!, I. of Man, Anglesea.
var. *uncialis*, Thur.
Puffin I., I. of Man.

Cohort III.—SIPHONINÆ.

Order I.—BRYOPSIDACEÆ.

Bryopsis *hypnoides*, Lamour.

Hilbre I., I. of Man, Puffin I.

B. plumosa, C. Ag.

I. of Man!, Hilbre I., Puffin I.! Anglesea! New Brighton.

Order III.—VAUCHERIACEÆ.

Vaucheria *dichotoma*, Lyngb. var. *marina*, C. Ag.

New Brighton. I have found *Vaucheria* filaments frequently, but as none were in fruit it is impossible to say to what species they belonged.

V. thuretii, Woron.

Eastham.

Order IV.—CODIACEÆ.

Codium *tomentosum*, Stackh.

I. of Man!

Series III.—PHÆOPHYCEÆ.

Cohort I.—ECTOCARPINÆ.

Order I.—DESMARESTIACEÆ.

Desmarestia *viridis*, Lamx.

I. of Man, Puffin I.!

D. aculeata, Lamx.

I. of Man!, Puffin I.!

D. ligulata, Lamx.

I. of Man, Abergele.

Order II.—DICTYOSIPHONACEÆ.

Dictyosiphon *fæniculaceus*, Grev.

Hilbre I.!, Puffin I.!, Penmon Point!, Isle of Man.

Order III.—PUNCTARIACEÆ.

Litosiphon *pusillus*, Harv.

Hilbre I., Bangor, I. of Man, Puffin I.!

Stictyosiphon subarticulatus, Hauck.
Carnarvon.
Punctaria plantaginea, Grev.
Hilbre I.!, Puffin I.!, I. of Man!
P. latifolia, Grev.
I. of Man.
var. *zosteræ*, Le Jol.
I. of Man.

Order IV.—Asperococcaceæ.

Myriotrichia clavæformis, Harv.
I. of Man, Hilbre I.!
var. *filiformis*, Farl.
(*M. filiformis*, Report I.)
Hilbre I.!
Asperococcus echinatus, Grev.
Hilbre I.! Puffin I.!, I. of Man.
var. *vermicularis*, Griff.
Puffin I.!
Streblonema velutinum, Thur.
(*Ectocarpus velutinus*, Report I.)
Puffin I.!

Order V.—Ectocarpaceæ.

Ectocarpus terminalis, Kütz.
Puffin I.!, I. of Man.
E. confervoides, Le Jol.
var. *siliculosus*, Kjellm.
Puffin I.!, Hilbre I.! New Brighton, I. of Man.
E. fasciculatus, Harv.
Hilbre I.!, Puffin I.!
E. granulosus, C. Ag.
New Brighton, Puffin I.!, Hilbre I.!
E. tomentosus, Lyngb.
Puffin I.!, Hilbre I.!, New Brighton, I. of Man.

Isthmoplea *sphærophora*, Kjellm.

Puffin I.!

Pylaiella *litoralis*, Kjellm.

Puffin I.!, I. of Man!

Order VI.—ARTHROCLADIACEÆ.

Arthrocladia *villosa*, Duby.

Anglesea.

Order VII.—ELACHISTACEÆ.

Elachista *scutulata*, Duby.

I. of Man.

E. fucicola, Fries.

Puffin I.!, Anglesea!, Hilbre I.!, I. of Man!

E. flaccida, Aresch.

Penmon Point!

Marrat records this species on *Cystoseira barbata* at Puffin I., though the host plant does not occur in his list nor on the island.

Order VIII.—SPHACELARIACEÆ.

Sphacelaria *radicans*, Harv.

Mersey, New Brighton, Hilbre I.!, Puffin I.!, I. of Man!

A specimen which I collected in Nov., 1890, at Hilbre I. is, I am informed by Mr. Batters, a monosiphonous variety of this species.

S. cirrhosa, C. Ag.

Eastham, Hilbre I.!, Puffin I.!, I. of Man!

var. *fusca*, Holm. et Batt.

(*S. fusca*, Report I.)

Hilbre I.!, Puffin I.!, I. of Man, Anglesea.

S. plumigera, Holm.

Carnarvon (*fide* Holmes).

Chætopteris *plumosa*, Kütz.

I. of Man!, Anglesea, Hilbre I.!, Puffin I.!

***Halopteris** filicina*, Kütz.
Anglesea, I. of Man!

***Stypocaulon** scoparium*, Kütz.
(*Sphacelaria scoparia*, Report I.)
Hilbre I.!, Puffin I.!, I. of Man!, Anglesea.

***Cladostephus** spongiosus*, C.Ag.
Puffin I.!, Hilbre I.!, I. of Man!, Anglesea.

C. verticillatus, C.Ag.
Puffin I., Anglesea, I. of Man.

Order IX.—MYRIONEMACEÆ.

***Myrionema** strangulans*, Grev.
Puffin I.!, I. of Man.
var. *punctiforme*, Thur.
(*M. punctiforme*, Report I.)
Hilbre I.

***Ascocyclus** leclancherii*, Magn.
(*Myrionema leclancherii*, Report I.)
Hilbre I., I. of Man.

A. reptans, Rke.
Puffin I.!

***Ralfsia** verrucosa*, Aresch.
Puffin I.!, Hilbre I.!

Order X.—CHORDARIACEÆ.

***Chordaria** flagelliformis*, C.Ag.
Hilbre I., Eastham, I. of Man!, Puffin I.!

***Mesoglœa** vermiculata*, Le Jol.
Puffin I.!, Hilbre I.!, I. of Man.

***Castagnea** virescens*, Thur.
I. of Man.

***Leathesia** difformis*, Aresch.
Hilbre I., Anglesea, I. of Man, Puffin I.!

Cohort II.—LAMINARINÆ.

Order I.—SCYTOSIPHONACEÆ.

***Phyllitis** zosterifolia*, Rke.
Puffin I.!, Hilbre I., I. of Man.

***Scytosiphon** lomentarius*, J. Ag.

Hilbre I.!, Puffin I.!, I. of Man!

Order II.—CHORDACEÆ.

***Chorda** filum*, Stackh.

Hilbre I.!, Puffin I.! I. of Man.

Order III.—LAMINARIACEÆ.

***Laminaria** saccharina*, Lamx.

I. of Man!, Puffin I.!, Anglesea.

L. hieroglyphica, J. Ag.

var. *phyllitis*, Le Jol.

New Brighton, Puffin I.!

L. digitata, Edm.

Puffin I.!, Anglesea!, I. of Man! Hilbre I.!

L. hyperborea, Fos.

Puffin I.!, Anglesea!, I. of Man!, Hilbre I.!

For a discussion of this and the preceding species, usually grouped under *L. digitata*, see Foslie's *Contribution to Knowledge of the Marine Algæ of Norway*, Tromsö, 1890, p. 80 *et seq.*, or Batters' *Algæ of Berwick-on-Tweed*, p. 77.

***Saccorhiza** bulbosa*, De la Pyl.

I. of Man!

***Alaria** esculenta*, Grev.

I. of Man!, Hilbre I., Anglesea.

I have never met with this species either at Hilbre I. or Puffin I., though it occurs in abundance at the I. of Man.

Cohort III.—SPOROCHNINÆ.

Order I.—SPOROCHNACEÆ.

***Sporochnus** pedunculatus*, C.Ag.

Anglesea, I. of Man, Puffin I.!

I found only a few fragments of this species at the last-named locality. These were kindly identified for me by Mr. Batters.

Cohort IV.—CUTLERINÆ.

Order I.—CUTLERIACEÆ.

Cutleria *multifida*, Grev.

Hilbre I.!, Puffin I.!, I. of Man.

Cohort V.—FUCINÆ.

Order I.—FUCACEÆ.

Fucus *ceranoides*, Linn.

Hilbre I.!, Anglesea.

F. vesiculosus, Linn.

All rocky parts of the coast!

F. serratus, Linn.

All rocky parts of the coast!

F. platycarpus, Thur.

Puffin I.!, Hilbre I.!, Point of Ayr.

Ascophyllum *nodosum*, Le Jol.

All rocky parts of the coast!

Himanthalia *lorea*, Lyngb.

Anglesea, I. of Man! and cast up on the beach at Southport.

Halidrys *siliquosa*, Lyngb.

Puffin I.!, Anglesea!, I. of Man!

Pelvetia *canaliculata*, Decne. et Thur.

Hilbre I.!, Puffin I.., Anglesea! I. of Man!

I have gathered this species in situations considerably above high water mark. The plants were in a quite healthy condition, although a dash of spray or an occasional wave at high tide must have furnished them with their entire supply of salt water for twelve hours at a time. I have no doubt that the canaliculate nature of the frond enables them to retain what little water they obtain on these occasions to serve them until the recurrence of high tide. It is worth noting that *Enteromorpha canaliculata* is also a characteristically high water species.

Cohort VII.—DICTYOTINÆ.

Order I.—DICTYOTACEÆ.

Dictyota *dichotoma*, Lamx.

I. of Man, Puffin I., Anglesea.

var. *implexa*, J. Ag.

Puffin I.!

Taonia *atomaria*, J. Ag.

Anglesea.

Series IV.—RHODOPHYCEÆ.

Cohort I.—PORPHYRINÆ.

Order I.—PORPHYRACEÆ.

Porphyra *laciniata*, C. Ag.

Puffin I.!, Hilbre I.!, I. of Man!

Bangia *fuscopurpurea*, Lyngb.

Puffin I.!, Anglesea!

Cohort II.—NEMALIONINÆ.

Order I.—HELMINTHOCLADIACEÆ.

Tribe I.—Chantransieæ.

Chantransia *virgatula*, Thur.

Hilbre I.!, Puffin I.!, Eastham, I. of Man!

C. secundata, Thur.

Puffin I.!

C. daviesii, Thur.

Puffin I.!, I. of Man, Anglesea, Mersey.

Tribe II.—Nemalieæ.

Helminthocladia *purpurea*, J. Ag.

I. of Man.

I leave this species in the list, and do not place it among the "doubtfuls" in Appendix I., because the flora of the I. of Man appears to include many rare forms which one would not expect so far north. I have my doubts, however, as to its being a native of our district. This record stands on Mr. Talbot's authority.

Helminthora *divaricata*, J. Ag.

Anglesea (*fide* Ralfs).

Order III.—GELIDIACEÆ.

Tribe III.—Wrangelieæ.

Naccaria *wigghii*, Endl.

I. of Man.

Tribe IV.—Gelideæ.

Gelidium *corneum*, Lamx.

I. of Man!, Puffin I.!, Hilbre I.!

G. crinale, J. Ag.

Eastham, Hilbre I., I. of Man.

Cohort III.—GIGARTININÆ.

Order I.—GIGARTINACEÆ.

Tribe I.—Gigartineæ.

Chondrus *crispus*, Stackh.

Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!, Eastham.

Gigartina *mamillosa*, J. Ag.

Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!

Tribe II.—Tylocarpeæ.

Phyllophora *rubens*, Grev.

Hilbre I.!, Puffin I.!, I. of Man!

P. membranifolia, J. Ag.

Hilbre I.!, Puffin I.!, I. of Man!, Anglesea.

P. traillii, Holm. et Batt.

Puffin I.!

P. palmettoides, J. Ag.

I. of Man.

Gymnogongrus *griffithsiæ*, Mart.

New Brighton, I. of Man.

G. norvegicus, J. Ag.

Hilbre I., I. of Man, Rhyl.

Ahnfeltia *plicata*, Fries.

Hilbre I., I. of Man, Puffin I.!

Tribe III.—Callymenieæ.

Callophyllis laciniata, Kütz.

Anglesea!, Puffin I.!

Order II.—RHODOPHYLLIDACEÆ.

Cystoclonium purpurascens, Kütz.

Anglesea!, Puffin I.!, Hilbre I.!, New Brighton, I. of Man.

Catenella opuntia, Grev.

Hilbre I.!, Puffin I.!, Eastham, I. of Man,

In the end of October, 1890, whilst on a visit to the Biological Station on Puffin I., I devoted part of my time to collecting *Catenella opuntia*, which grows there in abundance on the protected faces of rocks near high water mark. On examining the plants on my return to Liverpool I was glad to find many, if not all, bearing cystocarps, antheridia and tetraspores. The structure of the cystocarps is practically unknown, indeed they have seldom been seen. I believe that this is the third time they have been found in Britain, and Prof. Schmitz alone has found them abroad. Mr. Buffham found some at Sidmouth in 1886, and Harvey says he received specimens from Mrs. Griffiths. Harvey's figure and description are totally wrong, and as no detailed account of their structure exists anywhere, I examined them minutely, and the conclusions I arrived at were communicated to the Linnæan Society in Dec., 1890. I may here briefly summarise the main points in that paper. The cystocarpic ramuli are borne on erect branches, each articulation bearing one or two such ramuli. The ramulus is spherical and has imbedded in it 50 to 200 carpogenic systems. Only a few of these (10—30) however come to maturity, although most seem to be fertilized. A large placental cell occupies the centre of the ramulus, and radiating from it are numerous branched filaments, which on approaching the surface become short rows

Since the printing off of the pages on which the accompanying account of the cystocarps of *Catenella opuntia* occurs, better sections of very young cystocarpic ramuli, together with critical remarks kindly furnished me by Prof. Schmitz, have led me to considerably modify my interpretation of the structure of the "fruit" of this species. In place therefore of the sentences from "The ramulus is spherical" on page 106 to "with that genus" on page 107, read :—"The ramulus is spherical and shortly stalked. When young it consists of a central axial filament composed of four or five cells, surrounded by a reticulum of short hyphæ from which branched chains of coloured cells arise as in the ordinary vegetative ramulus. In the inner rind of the ramulus there arise very numerous trichophoric systems, each composed of a long and delicate trichogyne which appears on the surface of the ramulus as a short process, and a trichophoric portion of one or sometimes two cells. After fertilization of the trichogynes (many or all) chains of carpospores are given off from the reticulum of hyphæ surrounding the axis, and the terminal cell of the axial row enlarges to become a nourishing cell for the carpogenous reticulum. Frequently secondary vegetative cells appear round the trichophoric cells, but these do not (as I at first thought) become carpospores. After fertilization the trichogynes wither and the carpospores are seen forming a dense spherical layer among the sterile hyphæ which lie between the rind cells and the inner reticulum."

For further details I would refer the reader to my Linnæan paper soon to be published. I may add that Plate II. is drawn in accordance with this revised account.

of bead-like cells. From several of these filaments there arise the female organs, each consisting of a carpogenous cell, a unicellular trichophore and a long delicate trichogyne which passes outwards and appears on the surface of the ramulus as a short hair. After fertilization the carpogenous cell produces a mulberry-like mass of carpospores which gradually increase in size and deepen in colour. Pollinoids may be seen in the act of fusing with the apex of the trichogyne. The carpogenous cells nearest the placental cell most frequently develop carpospores, though rudimentary cystocarps are common nearer the periphery. The conclusion come to by Schmitz* is that *Catenella* belongs to the *Cystoclonium* group of the Rhodophyceæ, although the great number of carpogenic systems, it seems to me, does not point to a very close relationship with that genus. I have represented some of the more important features on Plate II. (see explanation of Plates).

Tribe II.—Rhodophyllideæ.

Rhodophyllis bifida, Kütz.

Puffin I.!, I. of Man.

Cohort IV.—RHODYMENINÆ.

Order I.—SPHÆROCCACEÆ.

Tribe I.—Sphærocceæ.

Sphærococcus coronopifolius, Grev.

I. of Man.

Tribe II.—Gracilarieæ.

Gracilaria confervoides, Grev.

I. of Man, Coast of Wales, Hilbre I.!

Calliblepharis ciliata, Kütz.

I. of Man, Anglesea!, Puffin I.!, Hilbre I.!

C. jubata, Kütz.

I. of Man.

**System. über d. Florideen*, Flora, 1889.

Order II.—RHODYMENIACEÆ.

Tribe I.—Rhodymenieæ.

Rhodymenia *palmata*, Grev.

Puffin I.!, Hilbre I.!, I. of Man!

R. palmetta, Grev.

Puffin I.. Anglesea.

Lomentaria *articulata*, Lyngb.

(*Chylocladia articulata*, Report I.)

Hilbre I.!, New Brighton, Puffin I.!, Eastham, I. of Man!

L. clavellosa, Gaill.

I. of Man.!

Champia *parvula*, Harv.

I. of Man.

Chylocladia *kaliformis*, Grev.

I. of Man, Anglesea.

C. ovalis, Hook.

I. of Man.

Tribe II.—Plocamieæ.

Plocamium *coccineum*, Lyngb.

Puffin I.!, Anglesea!, Hilbre I.!, I. of Man! New Brighton.

Order III.—DELESSERIACEÆ.

Tribe I.—Nitophylleæ.

Nitophyllum *punctatum*, Grev.

New Brighton (*fide* Marrat), I. of Man.

N. laceratum, Grev.

Puffin I.!, Hilbre I.!, I. of Man!

Tribe II.—Delesserieæ.

Delesseria *alata*, Lamx.

Puffin I.!, Hilbre I.!, I. of Man!, Anglesea!

D. sinuosa, Lamx.

Puffin I.!, Anglesea!, Hilbre I.!, I. of Man!

D. hypoglossum, Lamx.
Hilbre I.!, Puffin I.!, I. of Man!

D. ruscifolia, Lamx.
I. of Man,

D. sanguinea, Lamx.
(*Hydrolapathum sanguineum*, Report I.)
Puffin I.!, Anglesea!, I. of Man!

Order IV.—BONNEMAISONIACEÆ.

Bonnemaisonia *asparagoides*, C. Ag.
I. of Man.

Order V.—RHODOMELACEÆ.

Tribe I.—Rhodomeleæ.

Bostrychia *scorpioides*, Mont.
Point of Ayr!, Anglesea.

Rhodomela *subfusca*, C. Ag.
Hilbre I.!, Puffin I.!, I. of Man!, Anglesea.

R. lycopodioides, C. Ag.
Puffin I.!, Hilbre I., Eastham, I. of Man.

Odonthalia *dentata*, Lyngb.
I. of Man!, Hilbre I., Puffin I. I have not seen this plant at the two latter localities, but it may occur there as it is fairly common at the I. of Man.

Tribe II.—Laurencieæ.

Laurencia *obtusa*, Lamx.
I. of Man.

L. hybrida, Lenorm.
Puffin I.!

L. pinnatifida, Lamx.
Puffin I.!, Hilbre I.!, I. of Man!

Tribe IV.—Polysiphonieæ.

Chondria *tenuissima*, C. Ag.
I. of Man.

Polysiphonia *sertularioides*, J. Ag.

(*P. pulvinata*, Report I.)

Puffin I., Eastham, New Brighton, Hilbre I. All these localities are on Marrat's authority, but I have not been able to confirm his record.

P. fibrata, Harv.

Puffin I.!, Hilbre I.!, I. of Man.

P. urceolata, Grev.

Puffin I.!, I. of Man.

var. *patens*, J. Ag.

Puffin I.!

var. *formosa*, J. Ag.

Puffin I.!

P. elongella, Harv.

Puffin I.!, Anglesea, I. of Man.

P. elongata, Grev.

Puffin I.!, I. of Man!

P. violacea, Wyatt.

Carnarvon, I. of Man.

P. fibrillosa, Grev.

Anglesea!, I. of Man.

P. fastigiata, Grev.

Puffin I.!, Hilbre I.!, Anglesea!, I. of Man! Mersey!

This species is an almost constant epiphyte on *Ascophyllum nodosum*; I have found it however more than once on *Fucus vesiculosus*. Some notes of observations which I made on the minute structure of the frond and on the origin and development of the tetraspores will be published in an early number of the Journal of Botany.

P. atrorubescens, Grev.

I. of Man.

P. nigrescens, Grev.
Anglesea!, Puffin I.!, Hilbre I.!, I. of Man!, Eastham, New Brighton.

P. parasitica, Grev.
I. of Man.

P. byssoides, Grev.
I. of Man. I have not found this species growing, but have often met with it in rejectamenta and in dredgings at Puffin I.

P. brodiæi, Grev.
Puffin I., I. of Man.

P. thuyoides, Harv.
(*Rhytiphlœa thuyoides*, Report I.)
Puffin I., Hilbre I., I. of Man.

P. fruticulosa, Spreng.
(*Rhytiphlœa fruticulosa*, Report I.)
Puffin I., Hilbre I., I. of Man.

Tribe V.—Dasyeæ.

Dasya *coccinea*, C. Ag.
Puffin I.!, Hilbre I.!, I. of Man!, Anglesea!

D. arbuscula, C. Ag.
I. of Man.

D. ocellata, Harv.
I. of Man.

Order IV.—Ceramiaceæ.

Tribe I.—Spermothamnieæ.

Sphondylothamnion *multifidum*, Näg.
Port Jack, I. of Man (1876) (*fide* Talbot).

Spermothamnion *turneri*, Aresch.
I. of Man.

var. *repens*, Le Jol.
Puffin I.!, Hilbre I.!

Tribe II.—Griffithsieæ.

Griffithsia *corallina*, C. Ag.
I. of Man.

G. setacea, C. Ag.

I. of Man!, Hilbre I.!, Puffin I.!, New Brighton.

Halurus *equisetifolius*, Kütz.

(*Griffithsia equisetifolia*, Report I.)

North Wales (*fide* Ralfs).

Tribe III.—Monosporeæ.

Monospora *pedicellata*, Solier.

Hilbre I.!, Puffin I.!

Pleonosporium *borreri*, Näg.

I. of Man, Hilbre I., New Brighton.

Tribe IV.—Callithamnieæ.

Rhodochorton *rothii*, Näg.

Puffin I.!, Anglesea!, Hilbre I.!, I. of Man! Mersey.

R. floridulum, Näg.

Puffin I.!, Hilbre I.!, Anglesea!, I. of Man!

R. membranaceum, Magn.

Puffin I.!, Hilbre I.!, I. of Man!

R. seiriolanum, Gib.

This species of *Rhodochorton* I have ventured to record as new to science.* In character it seems intermediate between the genera *Callithamnion* and *Rhodochorton*. The erect filaments are unbranched and spring from a membranous disc. The tetrasporangia are borne secundately near the apex of the filaments, the oldest near the apex. The species is a very minute one, the filaments being on an average less than 1 mm. long. I found it as an epiphyte on the main stems of *Polysiphonia urceolata* var. *patens*, in the Beacon Channel, West Spit, Puffin I. In the same paper (*l.c.*) I described the mode of formation of sporangia in the genus *Rhodochorton* by a process of innovation, a phenomenon which has been observed in

*Jour. Linn. Soc. Bot. Vol. part 33.

certain Phæophyceæ also. After the tetraspores have been shed the cell next below the empty sporangium grows up within the empty cell-wall and by abstriction and segmentation of its contents forms a new sporangium. This process may be repeated several times. For permission to reprint Plate III. I am indebted to the courtesy of the Council of the Linnæan Society.

Callithamnion *polyspermum*, C. Ag.
Hilbre I.!. Puffin I.!, Anglesea!, I. of Man.

C. roseum, Harv.
Hilbre I.!, I. of Man.

C. hookeri, C. Ag.
Puffin I.!, New Brighton, I. of Man.

C. arbuscula, Lyngb.
I. of Man.

C. tetragonum, C. Ag.
Puffin I.!, I. of Man.
var. *brachiatum*, J. Ag.
I. of Man.

C. corymbosum, Lyngb.
Hilbre I.!, Puffin I.!, I. of Man.

C. granulatum, C. Ag.
Puffin I.!, I. of Man!

C. seirospermum, Griff.
Hilbre I.!, I. of Man.

Tribe V.—Compsothamnieæ.

Compsothamnion *thuyoides*, Schmitz.
I. of Man.

C. gracillimum, Schmitz.
Beaumaris (*fide* Gulson).

Tribe VI.—Ptiloteæ.

Ptilota *plumosa*, C. Ag.
Puffin I.!, Hilbre I.!, I. of Man!, Holyhead.

Plumaria *elegans*, Schmitz.
(*Ptilota elegans*, Report I.)
Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!

Tribe VII.—Crouanieæ.

Antithamnion *cruciatum*, Näg.
Hilbre I.!

A. plumula, Thur.
I. of Man (*fide* Brady, Gatty).

Tribe VIII.—Spyrideæ.

Spyridea *filamentosa*, Harv.
Holyhead (*fide* Marrat).

Tribe IX.—Ceramieæ.

Ceramium *tenuissimum*, J. Ag.
Hilbre I.!, Puffin I.!, I. of man.

C. fastigiatum, Harv.
Hilbre I., I. of Man.

C. deslongchampsii, Chauv.
Hilbre I.!, Puffin I.!, New Brighton, I. of Man!

C. strictum, Harv.
var. *divaricata*, Holm. et Batt.
(*C. diaphanum*, Report I.)
New Brighton, Hilbre I., Puffin I.!, I. of Man.

C. circinatum, J. Ag.
(*C. decurrens*, Report I.)
Hilbre I.!, Puffin I.!, I. of Man.

C. rubrum, C. Ag.
Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!
var. *proliferum*, J. Ag.
I. of Man.

C. ciliatum, Ducluz.
Puffin I.!, I. of Man.

C. echionotum, J. Ag.
Puffin I.!, I. of Man.

C. flabelligerum, J. Ag.
Puffin I.!, I. of Man.
C. acanthonotum, Carm.
Hilbre I.!, Puffin I.! I. of Man!

Cohort V.—CRYPTONEMINÆ.

Order I.—GLŒOSIPHONIACEÆ.

Glœosiphonia capillaris, Carm.
I. of Man, Anglesea.

Order II.—GRATELOUPIACEÆ.

Halymenia ligulata, C. Ag.
Anglesea, I. of Man.

Order III.—DUMONTIACEÆ.

Dumontia filiformis, Lamx.
Hilbre I., I. of Man, Anglesea!, Puffin I.!
Dilsea edulis, Stackh.
(*Sarcophyllis edulis*, Report I.)
Puffin I.!, I. of Man!, Anglesea.

Order IV.—NEMASTOMACEÆ.

Tribe II.—Halarachnieæ.

Furcellaria fastigiata, Lamx.
I. of Man!, Hilbre I.!, Eastham, New Brighton, Rock Ferry. The last three localities stand on Marrat's authority. I have never met with it in these situations.

Order V.—RHIZOPHYLLIDACEÆ.

Polyides rotundus, Grev.
Puffin I.!, Anglesea!, I. of Man!

Order VI.—SQUAMARIACEÆ.

Tribe I.—Cruorieæ.

Petrocelis cruenta, J. Ag.
Puffin I.!, Hilbre I.!, Mersey, New Brighton.

Tribe II.—Squamarieæ.

Peyssonnelia dubyi, Crn.
I. of Man (*fide* Leicester).

Order VII.—HILDENBRANDTIACEÆ.

Hildenbrandtia *prototypus*, Nardo.

var. *rosea*, Kütz.

Puffin I.!, I. of Man!

Order VIII.—CORALLINACEÆ,

Schmitziella *endophlœa*, Born. et Batt, MS.

Puffin I.!

"This very interesting endophytic alga, which forms rose-red, membranous, veined expansions within the outer cell-wall of the articulations of *Cladophora pellucida*, was first noticed on the coast of France by Dr. E. Bornet, in 1854. Dr. Bornet delayed publishing a description of the plant as he wished to more thoroughly examine it in a living state. Meanwhile I found the plant at Torquay, in 1885, and, believing it to be an undescribed alga, proposed to call it *Erythrocelis cladophoræ*, but on learning that Dr. Bornet had previously found and provisionally named the plant, I discarded my manuscript name of *Erythrocelis* in favour of his name of *Schmitziella*, and we propose to publish a description of the plant under that name very shortly. The alga has been found at various places in France and England, and I may here mention that Mr. G. Murray has kindly called my attention to the fact that in Edw. Forbes's collection of Algæ, now in the British Museum, there is a specimen of *Cladophora pellucida* apparently gathered by Dillwyn at Yarmouth which has this curious alga endophytic in it. Dr. Bornet informs me that he has seen similar specimens gathered by Ralfs." (E. A. L. Batters).

Melobesia *confervoides*, Kütz.

I. of Man.

M. pustulata, Lamx.

Puffin I.!, I. of Man.

M. farinosa, Lamx.
Puffin I.!
M. membranacea, Lamx.
Puffin I.!, I. of Man.
M. verrucata, Lamx.
Puffin I.!
Lithophyllum *lichenoides*, Phil.
I. of Man!
L. lenormandi, Rosan.
Puffin I.!, I. of Man!
Lithothamnion *polymorphum*, Aresch.
I. of Man!
L. calcareum.
Dredged from the Irish Sea!
Corallina *officinalis*, Linn.
Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!
C. rubens, Ellis et Sol.
Puffin I.!, I. of Man!

APPENDIX I.

I have thought it best to add in an appendix species recorded by previous collectors which require confirmation, or are almost certainly recorded through mistaken identification.

CYANOPHYCEÆ.

Rivularia nitida, Ag., recorded by Brady and Talbot from the I. of Man.

CHLOROPHYCEÆ.

Enteromorpha granulosa,——? recorded by Marrat from New Brighton is not a species of *Enteromorpha* known to science.

Rhizoclonium casparyi, Harv., recorded by Marrat from Eastham must be considered as doubtful. Harvey himself was doubtful of its specific value, and Holmes and Batters make it a variety of *R. riparium*.

Cladophora rudolphiana (Ag.) Harv. Hilbre I. (Marrat), very doubtful and certainly wants confirmation.

PHÆOPHYCEÆ.

Litosiphon laminariæ, Harv., is recorded by Marrat as epiphytic on *Chorda filum* at Bangor and Hilbre I. This species is an epiphyte on *Alaria esculenta*. Marrat records *Alaria esculenta* from these localities, but, as I have stated above, I have not been able to confirm his observation.

Striaria attenuata, Grev., is recorded by Marrat, but he gives no locality.

Asperococcus bullosus, Lamx., is recorded by Marrat without locality.

Aglaozonia parvula, (Grev.) Zanard. "General" (Marrat)! The "general" occurrence of the species (which is *A. reptans*, Kütz.) is, I fear, not correct. Even its local occurrence is doubtful and requires confirmation.

Sargassum linifolium, (Turn.) Ag., recorded in my last report, is of course an ocean waif, and has no place amongst British Algæ.

Ascophyllum nodosum, var. *scorpioides*, Hauck., was recorded in my last Report. I withdraw it as my plant turned out on further examination to be only a dwarf specimen of the type.

Cystoseira, Ag. Four species of this genus, viz.: *ericoides*, *fæniculaceus*, *fibrosa*, and *barbata*, are recorded by Garner and Marrat from I. of Man and Hilbre I. It is certainly remarkable that these species should be found growing with *Odonthalia dentata* at the I. of Man, and I prefer to place them in this list of "doubtfuls" until authentic specimens are forthcoming.

Dictyopteris polypodioides, (Desf.) Lamx. is recorded by Garner from I. of Man. This must also be confirmed before it can be received as a known native of our coast.

RHODOPHYCEÆ.

Nemalion multifidum, (Web. et Mohr.) J. Ag., recorded as "general" by Marrat!

Callithamnion brodiæi, Harv. I. of Man (Marrat) is probably a mistake for *C. hookeri*.

Callithamnion pluma (Dillw.) Ag. A mistaken identification of my own for *Spermothamnion turneri*, var. *repens*.

Griffithsia barbata, (Eng. Bot.) Ag. New Brighton! (Marrat). This is almost certainly a mistake.

Microcladia glandulosa, (Soland.) Grev., recorded by Garner from the I. of Man requires confirmation.

Euthora cristata (Linn.) J. Ag., recorded by Talbot from I. of Man, but marked doubtful.

Rhytiphlœa pinnastroides, Harv., which has now been placed in the genus *Halopithys*, is recorded without locality by Marrat.

Melobesia rubra, Menegh., recorded by Marrat, is a name unknown to me and to other algologists to whom I mentioned it.

Lithothamnion fasciculatum, (Lamx.) Aresch. Puffin I. (Marrat), requires confirmation.

Appendix II.

LITERATURE dealing with the LOCAL MARINE FLORA.

1. Welsh Botanology (1813), by Rev. H. Davies, F.L.S.
2. Algæ of the I. of Man, &c., by Dr. G. S. Brady, F.R.S. *Ann. Nat. Hist.*, Jan., 1861.
3. Articles by F. P. Marrat of the Liverpool Museum. *Liverpool Nat. Scrapbook*, 1863—4.
4. Preliminary list of Algæ of L. M. B. C. District, by Alf., Leicester. *First Report upon the Fauna of Liverpool Bay*, 1886.
5. Algæ of Puffin I., by C. S. Gregson. *Naturalist*, Vol. II.
6. First Report on the Marine Algæ of the L. M. B. C. District by R. J. Harvey Gibson, M.A., F.L.S. *Proc. Liv. Biol. Soc.*. Vol. III.
7. Marine Algæ of Douglas Bay, by Rev. T. Talbot. *Yn Lioar Manninagh.*, April, 1890.
8. Records in Greville's *Algæ Britannicæ*, Croall and Johnstone's *British Seaweeds*, Harvey's *Phycologia Britannica*, &c.

Appendix III.

I have subdivided the coastline of the district into four sections:—(1) The Mersey and Dee Estuaries, (2) Hilbre I., (3) Anglesea and Puffin I., (4) I. of Man. The first is characterised by mud flats and sand banks with occasional rocks; Hilbre Island has many forms not found in the estuary which prefer caves and rock shelves; Anglesea and Puffin I. have a rich flora, the coastline being precipitous and more favourable to Rhodophyceæ and Phæophyceæ, whilst the I. of Man is peculiar on account both of its isolated position and also of its climate, which permits of an approximation of northern and southern forms.

Map of the L. M, B. C. District. H, Hilbre I.; P, Puffin I. (The island itself is not marked); D, Douglas; R, Ramsey; E, Port Erin; C, Calf of Man.

The tables of distribution indicate only records of observed occurrence, and are not to be taken as indicating negative as well as positive distribution.

CYANOPHYCEÆ.	1	2	3	4
Glœocapsa crepidinum	×		×	
Dermocarpa prasina		×	×	
D. schousbœi		×	×	
Spirulina tenuissima			×	
S. pseudotenuissima	×			
Oscillaria nigroviridis	×			
O. corallinæ	×			
Phormidium papyraceum	×		×	
Lyngbya semiplena	×		×	
L. æstuarii	×	×		
L. majuscula	×	×	×	
L. spectabilis	×			
Symploca hydnoides			×	
Microcoleus chthonoplastes	×			
Calothrix confervicola		×	×	×
C. pulvinata			×	
C. scopulorum			×	
Rivularia biasolettiana	×	×		
R. atra	×	×	×	
Anabæna torulosa	×		×	
Nodularia harveyana	×			
CHLOROPHYCEÆ.				
Prasiola stipitata		×		
Monostroma grevillei			×	×

	1	2	3	4
Diplonema confervoides	×			
Enteromorpha clathrata	×	×	×	×
E. ralfsii			×	
E. erecta	×			
E. percursa, var. *ramosa*	×			
E. compressa	×	×	×	×
E. linza		×	×	×
E. intestinalis		×	×	
E. canaliculata	×			
Ulva latissima	×	×	×	×
Ulothrix implexa	×			
Entoderma wittrockii			×	
E. flustræ		×	×	
Urospora pencilliformis			×	
U. flacca			×	×
U. bangioides			×	
Chætomorpha tortuosa	×		×	×
C. linum			×	
C. melagonium			×	×
C. ærea	×		×	×
Rhizoclonium riparium	×	×	×	
Cladophora pellucida		×	×	×
C. hutchinsiæ	×	×	×	×
C. utriculosa, var. *lætevirens*	×		×	×

	1	2	3	4
C. rupestris	×	×	×	×
C. glaucescens		×	×	
C. fracta	×		×	
C. flexuosa	×	×	×	×
C. albida	×		×	×
,, var. *refracta*			×	×
C. arcta	×	×	×	×
C. lanosa			×	×
,, var. *uncialis*			×	×
Bryopsis hypnoides		×	×	×
B. plumosa	×	×	×	×
Vaucheria dichotoma, var. *marina*	×			
V. thuretii	×			
Codium tomentosum				×
PHÆOPHYCEÆ.				
Desmarestia viridis			×	×
D. aculeata			×	×
D. ligulata			×	×
Dictyosiphon fœniculaceus		×	×	×
Litosiphon pusillus		×	×	×
Stictyosiphon subarticulatus		×	×	×
Punctaria plantaginea		×	×	×
P. latifolia				×
,, var. *zosteræ*				×

	1	2	3	4
Myriotrichia clavæformis		×		×
,, ,, var. *filiformis*		×		
Asperococcus echinatus		×	×	×
,, ,, var. *vermicularis*			×	
Streblonema velutinum			×	
Ectocarpus terminalis			×	×
E. confervoides, var. *siliculosus*	×	×	×	×
E. fasciculatus		×	×	×
E. granulosus	×	×	×	
E. tomentosus	×	×	×	×
Isthmoplea sphærophora			×	
Pylaiella litoralis	×	×	×	×
Arthrocladia villosa			×	
Elachista scutulata				×
E. fucicola		×	×	×
E. flaccida			×	
Sphacelaria radicans	×	×	×	×
S. cirrhosa	×	×	×	×
,, var. *fusca*		×	×	×
S. plumigera			×	
Chætopteris plumosa		×	×	×
Halopteris filicina			×	
Stypocaulon scoparium		×	×	×
Cladostephus spongiosus		×	×	×

	1	2	3	4
C. verticillatus			×	×
Myrionema strangulans			×	×
,, ,, var. *punctiforme*		×		
Ascocyclus leclancherii		×		×
A. reptans			×	
Ralfsia verrucosa		×	×	
Chordaria flagelliformis	×	×	×	×
Mesoglæa vermiculata		×	×	×
Castagnea virescens				×
Leathesia difformis		×	×	×
Phyllitis zosterifolia		×	×	×
Scytosiphon lomentarius		×	×	×
Chorda filum		×	×	×
Laminaria saccharina			×	×
L. hieroglyphica, var. *phyllitis*	×		×	
L. digitata		×	×	×
L. hyperborea		×	×	×
Saccorhiza bulbosa				×
Alaria esculenta		×	×	×
Sporochnus pedunculatus			×	×
Cutleria multifida		×	×	×
Fucus ceranoides		×	×	
F. vesiculosus	×	×	×	×
F. serratus	×	×	×	×

	1	2	3	4
F. platycarpus	×	×	×	
Ascophyllum nodosum	×	×	×	×
Himanthalia lorea				×
Halidrys siliquosa			×	×
Pelvetia canaliculata		×	×	×
Dictyota dichotoma			×	×
,, ,, var. *implexa*			×	
Taonia atomaria			×	
RHODOPHYCEÆ.				
Porphyra laciniata		×	×	×
Bangia fuscopurpurea			×	
Chantransia virgatula	×	×	×	×
C. secundata			×	
C. daviesii	×		×	×
Helminthocladia purpurea				×
Helminthora divaricata			×	
Naccaria wigghii				×
Gelidium corneum		×	×	×
G. crinale	×	×		×
Chondrus crispus	×	×	×	×
Gigartina mamillosa		×	×	×
Phyllophora rubens		×	×	×
P. membranifolia		×	×	×
P. traillii			×	

	1	2	3	4
P. palmettoides				×
Gymnogongrus griffithsiæ	×			×
G. norvegicus	×	×		×
Ahnfeltia plicata		×	×	×
Callophyllis laciniata			×	
Cystoclonium purpurascens	×	×	×	×
Catenella opuntia	×	×	×	×
Rhodophyllis bifida			×	×
Sphærococcus coronopifolius				×
Gracilaria confervoides		×	×	×
Calliblepharis ciliata		×	×	×
C. jubata				×
Rhodymenia palmata		×	×	×
R. palmetta			×	
Lomentaria articulata	×	×	×	×
L. clavellosa				×
Champia parvula				×
Chylocladia kaliformis			×	×
C. ovalis			×	×
Plocamium coccineum	×	×	×	×
Nitophyllum punctatum	×			×
N. laceratum		×	×	×
Delesseria alata		×	×	×
D. sinuosa		×	×	×

	1	2	3	4
D. hypoglossum		×	×	×
D. ruscifolia				×
D. sanguinea			×	×
Bonnemaisonia asparagoides				×
Bostrychia scorpioides	×		×	
Rhodomela subfusca		×	×	×
R. lycopodioides	×	×	×	×
Odonthalia dentata		×	×	×
Laurencia obtusa				×
L. hybrida			×	
L. pinnatifida		×	×	×
Chondria tenuissima				×
Polysiphonia sertularioides	×	×	×	
P. fibrata		×	×	×
P. urceolata			×	×
,, var. *patens*			×	
,, var. *formosa*			×	
P. elongella			×	×
P. violacea			×	×
P. elongata			×	×
P. fibrillosa			×	×
P. fastigiata	×	×	×	×
P. atrorubescens				×
P. nigrescens	×	×	×	×

	1	2	3	4
P. parasitica				×
P. byssoides			×	×
P. brodiæi			×	×
P. thuyoides		×	×	×
P. fruticulosa		×	×	×
Dasya coccinea		×	×	×
D. arbuscula				×
D. ocellata				×
Sphondylothamnion multifidum				×
Spermothamnion turneri				×
,, ,, var. *repens*		×	×	
Griffithsia corallina				×
G. setacea	×	×	×	×
Halurus equisetifolius			×	
Monospora pedicellata		×	×	
Pleonosporium borreri	×	×		×
Rhodochorton rothii	×	×	×	×
R. floridulum		×	×	×
R. membranaceum		×	×	×
R. seiriolanum			×	
Callithamnion polyspermum		×	×	×
C. roseum		×		×
C. hookeri	×		×	×
C. arbuscula				×

	1	2	3	4
C. tetragonum			×	×
,, var. *brachiatum*				×
C. corymbosum		×	×	×
C. granulatum			×	×
C. scirospermum		×		×
Compsothamnion thuyoides				×
C. gracillimum			×	
Ptilota plumosa		×	×	×
Plumaria elegans		×	×	×
Antithamnion cruciatum		×		
A. plumula				×
Sprydia filamentosa			×	
Ceramium tenuissimum		×	×	×
C. fastigiatum		×		×
C. deslongchampsii	×	×	×	×
C. strictum, var. *divaricata*	×	×	×	×
C. circinatum		×	×	×
C. rubrum		×	×	×
,, var. *proliferum*				×
C. ciliatum			×	×
C. echionotum			×	×
C. flabelligerum			×	×
C. acanthonotum		×	×	×
Glœosiphonia capillaris			×	×

	1	2	3	4
Halymenia ligulata			×	×
Dumontia filiformis		×	×	×
Dilsea edulis			×	×
Furcellaria fastigiata	×	×		×
Polyides rotundus			×	×
Petrocelis cruenta	×	×	×	
Peyssonelia dubyi				×
Hildenbrandtia prototypus, var. *rosea*			×	×
Schmitziella endophlœa			×	
Melobesia confervoides				×
M. pustulata			×	×
M. farinosa			×	
M. membranacea			×	×
M. verrucata			×	
Lithophyllum lichenoides				×
L. lenormandi			×	×
Lithothamnion polymorphum				×
L. calcareum				×
Corallina officinalis		×	×	×
C. rubens			×	×

Analysis of Tables.

	1	2	3	4
Cyanophyceæ	14	7	13	1
Chlorophyceæ	21	16	31	21
Phæophyceæ	11	36	54	46
Rhodophyceæ	23	57	91	109
	69	116	189	177

Appendix IV.

ARTIFICIAL KEY to the GENERA of MARINE ALGÆ found within the L.M.B.C. District.

(Adapted by Mr. E. A. L. Batters, F.L.S., from the Artificial Key appended to Prof. Farlow's *New England Algæ*).

Note.—"As far as possible the characters used are those which can be seen by the naked eye, but in many cases the generic distinctions absolutely depend on microscopic characters. It should, of course, be understood that the key is entirely artificial and does not represent the true botanical relations of our genera." Moreover, in many cases the characters given refer only to the species found in the L.M.B.C. District.

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1. Colour bluish or purplish green*; Algæ of small size, usually more or less gelatinous (Cyanophyceæ) 5
2. Colour grass green ... ... (Chlorophyceæ) 14
3. Colour from yellowish brown to olive green or nearly black ... ... (Phæophyceæ) 25
4. Colour red or reddish purple, rarely blackish, in fading becoming at times greenish (Rhodophyceæ) 56
5. Cells arranged in filaments 7
   Cells in colonies, but not forming filaments ... 6
6. Cells grouped in twos or multiples of two... *Glœocapsa*
   Cells wedge-shaped or spherical, united into hemispherical or irregular colonies ... *Dermocarpa*
7. Filaments ending in a hyaline hair 13
   Filaments not ending in a hair 8

* *Glœocapsa crepidinum* is an exception; it is yellowish brown in colour.

8. Filaments provided with heterocysts 9
   Filaments destitute of heterocysts 10
9. Filaments with a thin gelatinous sheath, spores not adjacent to the heterocysts ... *Nodularia*
   Filaments without a sheath, spores next to the heterocysts ... ... *Anabæna*
10. Filaments with a gelatinous sheath 12
    Filaments without a gelatinous sheath 11
11. Filaments spirally twisted ... ... *Spirulina*
    Filaments not spirally twisted ... ... *Oscillaria*
12. Filaments free ... ... *Lyngbya*
    Filaments adherent in meshes ... ... *Symploca*
    Filaments united into a membranous layer *Phormidium*
    Filaments united in bundles and surrounded by a general gelatinous sheath ... *Microcoleus*
13. Filaments free... ... ... *Calothrix*
    Filaments imbedded in a mass of jelly ... *Rivularia*
14. Fronds unicellular 15
    Fronds multicellular... 17
15. Cells free 16
    Cells united into a branched spongy frond *Codium*
16. Cells large, filamentous, pinnately branched *Bryopsis*
    Cells very long, cylindrical with irregular or subdichotomous branches, spores large, solitary, in special lateral or terminal cells ... *Vaucheria*
17. Minute endophytic algæ, growing in the cell-walls of *Pylaiella* ... ... *Entoderma*
    Algæ not endophytic... 18
18. Fronds tubular ... ... *Enteromorpha*
    Fronds membranaceous 19
    Fronds filamentous 21
19. Fronds formed of a single layer of cells 20
    Fronds composed of two layers of cells ... *Ulva*

20. Fronds minute, stalked, cells quadrate *Prasiola*
Fronds saccate when young, more or less laciniate when old, not distinctly stalked, cells irregular in shape ... ... *Monostroma*
21. Fronds simple 29
Fronds branched 24
22. Fronds composed of a double row of elongated cells ... ...*Diplonema*
Fronds composed of a single row of elongated cells (monosiphonous) 23
23. Small algæ, filaments soft and flaccid, megazoospores, not tailed ... ... *Ulothrix*
Megazoospores tailed ... ... *Urospora*
Rather coarse algæ, filaments more or less rigid, often twisted together ... ... *Chætomorpha*
24. Branches small and root-like ... *Rhizoclonium*
Branches distinct ... ... *Cladophora*
25. Fronds irregularly globose, hollow, gelatinous, sporangia at the base of the coloured cortical filaments ... ... *Leathesia*
Fronds cup shaped, fruit on very long strap-shaped receptacles ... ... *Himanthalia*
Fronds forming crusts or expanded pellicles ... 26
Fronds small, tufted, composed of a dense basal portion and an outer portion composed by free filaments ... ... *Elachista*
Fronds tubular 28
Fronds filamentous 30
Fronds membranaceous, expanded 42
26. Fronds densely parenchymatous throughout, fruit in external spots ... ... *Ralfsia*
Fronds minute, thin, formed of a basal horizontal layer of cells with short vertical filaments, between which the sporangia are borne ... 27

27. Fronds furnished with colourless hairs, plurilocular sporangia formed by the transformation of vertical filaments ... ... *Ascocyclus*
Fronds not provided with colourless hairs, unilocular sporangia oval, plurilocular sporangia unknown ... ... *Myrionema*
28. Fronds simple, hollow throughout, substance thin 29
Fronds simple, cylindrical, somewhat cartilaginous, with numerous diaphragms ... *Chorda*
29. Sporangia densely covering the surface *Scytosiphon*
Sporangia external in scattered spots *Asperococcus*
30. Fronds capillary, branching, formed of a single row of cells (monosiphonous) 31
Fronds cylindrical, solid or occasionally becoming partially hollow with age... 32
31. Both unilocular and plurilocular sporangia formed by transformation of special branches, plurilocular sporangia in the form of pod-like branches, unilocular sporangia globose, sessile or shortly stalked ... ... *Ectocarpus*
Both forms of sporangia formed from the cells in the continuity of the branches and not by a transformation of special branches *Pylaiella*
Filaments partly polysiphonous, unilocular sporangia partly immersed in the frond, plurilocular sporangia formed by direct transformation of the cells of the branches ... ... *Isthmoplea*
Primary branches creeping in the subtance of other Algæ, secondary and fructifying ramuli erect ... ... *Streblonema*
32. Fronds slimy, composed of an axial layer of elongated filaments and a distinct cortical layer of short horizontal filaments 33

Fronds composed of elongated internal cells, which become smaller at the surface ... 35

Fronds, at least in the younger portions, formed of cells of nearly uniform length, arranged in transverse bands, without any proper cortical layer 39

33. Fronds tough and dense ... ... *Chordaria*

Fronds soft and flaccid 34

34. Outer cells of cortex producing plurilocular sporangia ... ... *Castagnea*

Outer cells of cortex not producing plurilocular sporangia ... ... *Mesoglœa*

35. Fronds traversed by a central filament formed of larger cylindrical cells 36

Fronds destitute of axial filament 38

36. Sporangia inconspicuous, formed from the cortical cells ... ... *Desmarestia*

Sporangia conspicuous external 37

37. Plurilocular sporangia moniliform, attached to branching, monosiphonous filaments which form tufted whorls on the branches ... *Arthrocladia*

Unilocular sporangia spheroidal, accompanied by club-shaped paraphyses, in stalked, knob-like, lateral receptacles ... ... *Sporochnus*

38. Frond simple, beset with pellucid hairs, spores formed from the cortical cells ... *Litosiphon*

Fronds branching 39

39. Unilocular sporangia covering the surface in dense patches, at maturity projecting above the surface of the frond ... ... *Stictyosiphon*

Unilocular sporangia scattered, immersed *Dictyosiphon*

40. Fronds minute, ending in a hyaline hair, monosiphonous below, densely beset above with

very short branches between which are the sporangia ... ... *Myriotrichia*

Fronds ending in a large, single cell, the cells of the lower part giving off descending filaments, which become interwoven and form a false cortex 41

41. Rhizoidal filaments few and limited to base of plant, branching irregularly pinnate... *Sphacelaria*

Rhizoidal filaments numerous 42

42. Branches whorled ... ... *Cladostephus*

Branches not whorled 43

43. Spores formed in the axils of the ultimate ramuli 44

Spores on special branches arising from the cortical layers of the main axis, branches distichously pinnate ... ... *Chætopteris*

44. Lower part of main stem imperfectly corticated with rhizoidal filaments, spores solitary in the axils ... ... *Halopteris*

Lower part of main stems covered with a dense felt of interlaced rhizoidal filaments, spores clustered in the axils ... ... *Stypocaulon*

45. Fronds simple or occasionally proliferous ... 46

Fronds branching 50

46. Midrib present ... ... *Alaria*

Midrib wanting 47

47. Fronds thin, subsessile 48

Fronds thick and coriaceous, distinctly stipitate 49

48. Sporangia densely covering the surface of the frond ... ... *Phyllitis*

Sporangia immersed or partly immersed in the frond, in scattered spots ... ... *Punctaria*

49. Cryptostomata present, stem flat, arising from a hollow warty base ... ...*Saccorhiza*

Cryptostomata wanting, stems cylindrical attached by branching rhizoids ... ... *Laminaria*

50. Midrib present ... ... *Fucus*
Midrib wanting 51
51. Fronds destitute of air bladders 52
Fronds furnished with air bladders 55
52. Fronds thick and coriaceous, channelled, fruit in terminal receptacles ... ... *Pelvetia*
Fronds thin, membranaceous 53
53. Sporangia sessile 54
Sporangia, and antheridia stalked, collected in spot-like tufts on the surface of the frond *Cutleria*
54. Fronds regularly dichotomous, spores scattered irregularly over the surface of the frond *Dictyota*
Fronds more or less fan-shaped, deeply and irregularly laciniate, sporangia arranged in undulating transverse bands ... ... *Taonia*
55. Air-bladders simple, immersed in the frond *Ascophyllum*
Air-bladders stalked, furnished with numerous diaphragms, fruit terminal ... ... *Halidrys*
56. Fronds calcareous 57
Fronds not calcareous 59
57. Fronds erect, filiform, articulated ... *Corallina*
Fronds thin, horizontally expanded 58
Fronds thick, horizontally expanded, but rising at intervals in irregular knobs *Lithothamnion*
58. Epiphytic Algæ ... ... *Melobesia*
Algæ growing on rocks ... ... *Lithophyllum*
59. Fronds horizontally expanded or membranaceous 60
Fronds erect or umbilicate 62
60. Minute alga endophytic in *Cladophora pellucida*, fruit in hemispherical nemathecia *Schmitziella*
Fronds cartilagino-membranaceous 61
Fronds gelatino-coriaceous, tetraspores cruciate *Petrocelis*

61. Spores in external warts, tetraspores cruciate *Peyssonnelia*
Spores in cavities sunk in the frond, tetraspores zonate ... ... *Hildenbrandtia*
62. Fronds tubular 63
Fronds filamentous or slightly compressed ... 65
Fronds membranaceous 85
63. Fronds brownish-purple, thick, soft, hollow, fruit immersed in the frond, tetraspores cruciate *Dumontia*
Fronds more or less gelatinous, compressed or cylindrical, branches much contracted at the base, often constricted at intervals with pseudo-articulations, tetraspores tripartite 64
Fronds purple or nearly black, constricted at intervals, tetraspores zonate ... ... *Catenella*
64. Fronds slender, much contracted at the joints, but without diaphragms, tetraspores tripartite in depressed cavities ... ... *Lomentaria*
Fronds slender, nodose, with diaphragms at the nodes, tetraspores tripartite in the cortical layer ... ... *Champia*
Fronds contracted at the joints, but without diaphragms, tetraspores tripartite in the cortical layer ... ... *Chylocladia*
65. Fronds formed of a single row of cells (monosiphonous) without proper cortex... 66
Fronds with distinct axial and cortical layers ... 75
66. Fronds monosiphonous throughout 67
Fronds composed below of a single row of cells, becoming densely cellular above, spores formed by the division of any of the cells, filamentous simple, gelatinous, dark purple *Bangia*

Fronds composed of a single row of cells above, but below with a false cortex formed by the growth of descending filaments given off from the cells 72

Fronds formed of large cells placed end on end, with bands of smaller cells at the nodes, in some cases the nodal cells extending in a thin layer over the internodal cells 73

67. Spores on short pedicels distinct undivided ... 68

Fronds composed of prostrate, creeping filaments from which arise erect, dichotomous or irregularly branched filaments ... ... *Rhodochorton*

Both tetraspores and cystocarps present 69

68. Spores terminating short lateral branches *Chantransia*

Spores axillary ... ... *Monospora*

69. Cystocarps terminal, involucrate, spores irregularly grouped not surrounded by a common gelatinous envelope when mature 70

Cystocarps terminal or lateral, spores irregularly grouped at maturity, covered by a general gelatinous envelope 71

70. Fronds formed of prostrate filaments from which arise erect pinnate filaments *Spermothamnion*

Fronds pinnate, ramuli whorled *Sphondylothamnion*

71. Fronds dichotomous formed of delicate vesicular cells, tetraspores in involucrate whorls at the nodes or on the inner side of short fascicled branches ... ... *Griffithsia*

Fronds dichotomous or pinnate, branches alternate, tetraspores tripartite, favellæ binate, lateral ... ... *Callithamnion* (in part)

Fronds pinnate, favellæ terminal, involucrate; tetraspores polysporic ... ... *Pleonosporium*

Branches opposite or whorled, tetraspores cruciate ... ... *Antithamnion*

Fronds with a monosiphonous axis, partly concealed by the densely whorled branches, cystocarps terminal on short branches, tetraspores in whorls one above another on special branches ... ... *Halurus*

72. Fronds capillary or bushy, densely branching, corticated confined to the larger branches, and evidently formed of vein-like descending filaments ... ... *Callithamnion* (in part)

Fronds compressed, ancipital, branches, pectinate-pinnate, covered everywhere, except at the tips, by polygonal areolated cells 74

73. Fronds dichotomous, tips usually incurved *Ceramium*

Fronds pinnate, main branches corticated throughout with cells arranged in transverse bands, secondary branches corticated only at the nodes ... ... *Spyridia*

74. Opposite pinnæ of equal size, cystocarps terminal on the branches, tetraspores solitary on the ends of the branches ... ... *Plumaria*

Pinnæ of unequal sizes, one being short and simple the opposing one comparatively long and pinnately divided or compound, cystocarps on special short pinnæ or on the upper margins of the ultimate branches, tetraspores clustered ... ... *Ptilota*

75. Fronds dark-red or nearly black, substance dense 76

Fronds rose-red or purple, rather succulent or gelatinous, sometimes capillary 78

76. Fronds compressed, fringed with minute ramuli, cystocarps terminal on the ramuli *Sphærococcus*

Fronds dichotomous, cylindrical, cartilaginous 77

Fronds pinnate or pinnatifid, compressed or cylindrical, cartilaginous, purple or yellowish tetraspores tripartite, cystocarps external sessile ... ... *Laurencia*

Fronds filiform, rigid, irregularly branching forming dense intricate bundles... ... *Ahnfeltia*

Fronds cylindrical slightly compressed, cartilaginous, sparingly and irregularly branching, composed of an inner layer of very large angular colourless cells, and a cortical layer of small coloured cells, tetraspores cruciate, immersed in the frond, cystocarps external sessile *Gracilaria*

Fronds small compressed, pinnate, forming small tufts, spores borne on an axial placenta in the enlarged terminal branches ... ... *Gelidium*

77. Root an expanded disc, spores borne in external flesh-coloured warts, tetraspores cruciate, immersed in the frond ... ... *Polyides*

Root attached by branching rhizoids, cystocarps and tetraspores immersed in the swollen tufts of the branches, tetraspores zonate *Furcellaria*

78. Cystocarps immersed in frond 79

Cystocarps internal, ovate or urceolate, fronds traversed by a distinct central filament ... 82

79. Fronds gelatinous, composed internally of a dense mass of slender longitudinal filaments which give off short corymbose, lateral branches which form the cortex 80

Fronds soft, succulent, consisting of an internal layer of slender longitudinal filaments and a cortex composed of polygonal cells, becoming smaller towards the surface ... *Cystoclonium*

80. Cortical filaments throughout the frond free ... 81

Cortical filaments of ramuli (only) free, main

stem solid, ramuli tapering at both extremities *Naccaria*

81. Axis composed of loosely woven, elongated vertical filaments, peripheral filaments composed of large pear-shaped cells. Fronds undivided, beset with numerous simple or slightly branched tapering branches ... ... *Helminthocladia*

Axis composed of oblong cells, surrounded by slender, long-jointed filaments, from which the dichotomously radiating peripheral filaments arise. Fronds very much and irregularly branched ... ... *Helminthora*

82. Branches much contracted at the base *Chondria*

Branches not contracted at base 83

Fronds red-brown, hollow below, branches tapering to both extremities, spores arranged in irregular masses ... ... *Glœosiphonia*

83. Fronds rose-red, stems slender, ramuli simple, subulate, acute, apices not involute, cystocarps stalked alternate with the ramuli *Bonnemaisonia*

Fronds dark-red, much branched, rather robust, superficial cells small, polygonal, irregularly placed, apices of branches not involute, tetraspores in the young branches or palmately divided receptacles (stichidia) ... ...*Rhodomela*

Fronds purple or brownish purple, superficial cells quadrate, apices of the branches strongly involute, tetraspores in swollen pod-like branches (stichidia) ... ...*Bostrychia*

Fronds purple or red, occasionally blackish, articulated either throughout or at least in the young branches, the articulations longitudinally striate 84

84. Fronds brown-red (turning bright red in fading) main stems corticated with irregularly shaped cells, densely clothed with bright red hairs, young branches naked, tetraspores in swollen pod-like branches (stichidia) ... ... *Dasya*
Fronds purple or dark-red, tetraspores borne in young branches ... ... *Polysiphonia*
85. Fronds gelatinous but firm 86
Fronds cartilaginous or rigid, sometimes dense 87
Fronds delicate or somewhat coriaceous ... 90
86. Fronds purplish, composed of a single layer of cells, spores in marginal bands or spots *Porphyra*
Fronds rose-red, composed of a double layer of cells connected by a loose network of colourless anastomosing filaments, spores attached to the inner surface of the membrane *Halymenia*
87. Fronds formed internally of numerous anastomosing filaments which divide corymbosely at the surface 88
Fronds formed of roundish angular cells throughout 90
88. Fronds plain or slightly channelled ... *Chondrus*
Fronds beset with small papillæ in which the spores are borne ... ... *Gigartina*
89. Fronds with a more or less evident stipe which passes into a proliferous lamina, cystocarps external ... ... *Phyllophora*
Fronds linear, regularly dichotomous, cystocarps immersed ... ... *Gymnogongrus*
90. Midrib present 91
Midrib wanting 92
91. Fronds rose-red, leaf-like ... ... *Delesseria*
Fronds dark brownish purple, narrow, dentate, midrib scarcely distinct ... ... *Odonthalia*

92. Fronds narrow, much divided, ultimate ramuli pectinate ... ... *Plocamium*
Fronds palmately or dichotomously divided ... 93
Fronds undivided, dull red, tetraspores and cystocarps immersed ... ... *Dilsea*

93. Fronds very thin and delicate 94
Fronds thickish, sub-cartilaginous or sub-membranaceous 95

94. Fronds rose-red or purplish, margins entire, usually more or less veined, tetraspores cruciate in scattered spots (sori) ... ... *Nitophyllum*
Fronds dark red, ciliate, tetraspores zonate *Rhodophyllis*

95. Tetraspores cruciate 96
Tetraspores zonate ... ... *Calliblepharis*

96. Fronds deep red broadly palmate or dichotomous, sometimes repeatedly laciniate with narrow segments, margin proliferous *Rhodymenia*
Fronds bright red, broadly palmate or dichotomously divided, spores immersed in minute marginal cilia ... ... *Callophyllis*

Explanation of Plates.

Plate II.

Fig. 1. Two fronds of *Catenella opuntia*, shewing root-branch, and cystocarps, terminal and lateral. × 10.

Fig. 2. Trichophoric apparatus with one trichophoric cell, arising from cortical filament. × 450.

Fig. 3. Trichophoric apparatus with two trichophoric cells. × 450.

Fig. 4. Terminal cell of the axial row from which arise the filaments which bear the carpospores. × 450.

Fig. 5. Vegetative cells, with trichophoric cell and part of trichogyne. × 450.

Fig. 6. Mature carpospores in the cortex of a cystocarpic ramulus, two trichophoric systems nearer the periphery. × 350.

Fig. 7. Very young stage in the development of a cystocarpic ramulus. × 350.

Fig. 8. Young stage in the development of an ordinary vegetative frond. × 350.

Plate III.

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Figs. 1—5. *Rhodochorton seiriolanum*; figs. 6—11, *R. rothii*; fig. 12, *R. floridulum.*

Fig. 1. Part of a branch of *Polysiphonia urceolata* with *R. seiriolanum* epiphytic upon it. × 55.

Fig. 2. The same, shewing terminal and secund sporangia. × 350.

Fig. 3. The basal layer from which the upright filaments arise. × 350.

Fig. 4. Innovation of a vegetative filament after the escape of the tetraspores from a terminal sporangium. × 450.

Fig. 5. Terminal sporangium with tetraspores, and innovation of a subterminal sporangium. × 450.

Figs. 6, 7, 10. Various stages in the development of sporangia formed by innovation. × 450.

Figs. 8, 9. Innovation in vegetative filaments. × 350.

Fig. 11. Development of sporangia from buds of subapical cells; in one case the spores have escaped and a second bud is developing in the cavity of the empty sporangium. × 350.

Plate IV.

Fig. 1. Filaments of *Urospora bangioides*. (Nat. size.)
Figs. 2, 3. Vegetative multiplication by pseudo-branching. × 350.
Fig. 4. Base of filament. × 350.
Fig. 5. Micro-zoosporangia and micro-zoospores. × 450.
Fig. 6. Mega-zoosporangia and mega-zoospores. × 450.
Fig. 7. Stages in the germination of a mega-zoospore. × 350.

Plate V.

Figs. 1—5. Stages in the development of the peripheral cells and mother-cell of sporangium of *Polysiphonia fastigiata*, seen from above. × 350.
Fig. 6. Tetraspores in the act of escaping from the sporangium. × 350.
Fig. 7. Transverse section of a frond at the level of a sporangium shewing basal cell in connection with three peripheral cells. × 450.
Fig. 8. Longitudinal section of a frond, shewing the arrangement of intercellular spaces and the "plugs" closing the canals of communication between the cells of the frond. × 350.
Fig. 9. Isolated plugs, not yet closed by callus. × 450.

On the Genus ECTEINASCIDIA, and its Relations, with Descriptions of Two NEW SPECIES, and a Classification of the Family CLAVELINIDÆ.

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With Plates VI. and VII.

[Read December 12th, 1890.]

In my Report upon the Tunicata collected during the "Challenger" expedition, I formed the genus *Ecteinascidia** for three species of "social" Ascidians closely related to *Clavelina*, but forming a transition from the latter to the more typical Ascidiæ Simplices, such as *Ascidia*. The chief character of *Ecteinascidia*, which at once distinguished it from *Clavelina* and the other Clavelinidæ was that non-papillated internal longitudinal bars were present in the branchial sac. The three species found during the Challenger expedition were:—*E. turbinata* from Bermuda, *E. crassa* from near Ki island in the Malay Archipelago, and *E. fusca* from Banda in the Moluccas. *E. crassa* was obtained from a depth of 129 fathoms, the other two were from shallow water.

Sluiter, in his paper "Ueber einige einfachen Ascidien von der Insel Billiton," † published in 1885, describes two new species of "social" Ascidians, which he refers to *Ecteinascidia*, viz., *E. rubricollis* and *E. diaphanis*. These species are both evidently well-marked members of the genus, and are closely related to *E. turbinata* from Ber-

*Prelim. Rep., Part II., Proc. Roy. Soc. Edin. 1879-80, p. 722; and Chall. Exp. Zool., vol. VI., p. 239, 1882.

† Natuurkundig Tijdschrift voor Nederlandsch Indie, Bd. XLV, p. 160.

muda, but are distinct from any of the Challenger species. The examination of these species enabled Sluiter to support with some additional arguments my contention that the family Clavelinidæ was more closely related to the Simple than to the Compound Ascidians.

In 1887, Ed. Van Beneden published a paper* dealing with the classification of this group of Ascidians, in which he contends that of these five known species referred to *Ecteinascidia* two ought to be placed in the old genus *Rhopalæa* of Philippi, two others remain in the genus *Ecteinascidia*, and the fifth form the type of a new genus for which he proposes the name *Sluiteria*. To understand his reasons for doing this it is necessary to go into the history of the genus *Rhopalæa*.

In 1842 Philippi found in the Gulf of Naples, and described,† the remarkable form *Rhopalæa neapolitana*, the type and only species of the genus. It was described as a Simple Ascidian, and no definite information was given as to whether it reproduced by gemmation. But at the time when I examined the Challenger collection and formed *Ecteinascidia*, I was distinctly of opinion‡ that *Rhopalæa*, although closely allied to the Clavelinidæ, differed from *Ecteinascidia* and other genera in having the internal longitudinal bars of the branchial sac papillated, a condition which is shown clearly in Philippi's figure. This was the position of affairs until, in 1884, Roule§ announced to the Academy of Sciences at Paris that he had rediscovered *Rhopalæa* on the coast near Marseilles, and followed up his preliminary communication by a full

* Les genres *Ecteinascidia*, Herd., *Rhopalæa*, Phil., et *Sluiteria* (nov. gen.), Bull. de l'Acad. Roy. de Belgique, 3 sér., t. xiv., p. 19.

† Ein neues Genus d. einfach. Ascidien, Müller's Archiv. 1843, p. 45.

‡ See Challenger Report, part I., p. 238.

§ Comptes rendus of 19 Mai, 1884.

anatomical description, with figures, in his "Revision des espèces de Phallusiadées des côtes de Provence."* Roule relied upon the property of budding as distinguishing his form from *Ecteinascidia*. He considered *Rhopalæa* as a solitary Ascidian (monozoic) while the species of *Ecteinascidia* are capable of reproducing by gemmation (polyzoic). Ed. Van Beneden also examined some of the Marseilles specimens, and found them to be identical with some examples which he had found at Naples in 1881, and which he regarded as *Rhopalæa neapolitana*, and both he and Roule consider that these recently-found specimens belong to Philippi's species, which had been practically lost sight of for forty years.

There is, however, this important difference between Philippi's description and the specimens investigated by Roule and by Van Beneden that in the latter the internal longitudinal bars of the branchial sac are non-papillated, as in *Ecteinascidia*, while Philippi distinctly described and figured papillæ upon these vessels. Ed. Van Beneden† now regards this as an error of observation on the part of Philippi, and by altering in this important respect the original description of *Rhopalæa* he makes it practically identical (if it possesses the property of reproducing by gemmation) with my genus, *Ecteinascidia*, as defined in the Challenger Report.

This genus (*Rhopalæa* = *Ecteinascidia*) he then breaks up into three sections which he raises to generic rank under the titles *Rhopalæa*, Philippi; *Ecteinascidia*, Herdman; and *Sluiteria*, n. gen. To this there can be no possible objection provided Roule and Van Beneden are correct in regarding Philippi's observation of the papillæ in the branchial sac as an error; but that is just the point that

* Recueil Zool. Suisse, t. iii, p. 209.

† Bull. de l'Acad. Roy. de Belgique, 1887, p. 23.

remains unsettled, and until Philippi's original specimen of *Rhopalæa neapolitana* (if it is still in existence) is compared anatomically with the specimens recently found in the Mediterranean it must be regarded as open to doubt whether these latter forms really belong to the same species. However, although this is a matter which cannot be settled by individual opinion, I am perfectly willing to admit that, from the evidence now before us, I consider it most probable that it is the true *Rhopalæa neapolitana*, Phil., which has been re-discovered, and that Philippi was mistaken in regard to the condition of the internal longitudinal bars.

Van Beneden regards the power of gemmation as not being of sufficient value to distinguish even genera from one another, so that even if *Rhopalæa neapolitana* were proved to be a monozoic form he would not on that account separate it from the polyzoic species of *Ecteinascidia*.

In regard to Ed. Van Beneden's division of the group of six species into three genera, my two species *E. fusca* and *E. crassa* certainly agree in the relations of the alimentary canal to the branchial sac, and in the condition of the test, more closely with *R. neapolitana* than with my remaining species *E. turbinata*, and might, therefore, naturally fall into the genus *Rhopalæa*, provided always that the modern zoologists are justified in their assumption of Philippi's error of description, and of there being no fundamental difference in the reproduction by gemmation. The three species of this genus would then be, as Van Beneden points out, *Rhopalæa neapolitana*, Phil.; *R. crassa*, Herdm.; and *R. fusca*, Herdm.

But there are considerable differences in the structure of the branchial sac, quite independently of the question of papillæ, between *Rhopalæa neapolitana* (as described and figured by Roule) and my two "Challenger" species. The

well-marked minute plication of the branchial sac, as seen on its outer surface,* in *R. neapolitana*, is quite sufficient to separate that form from the species *crassa* and *fusca*. If then these two species are to be separated from *Ecteinascidia*, it seems clear that they must be distinguished also from *Rhopalæa*, and I would propose for them the generic name *Rhopalopsis* (characterized by the elongated body, the thick test, and the simple non-plicated branchial sac), so that they would now become *Rhopalopsis crassa* and *R. fusca*.

The third "Challenger" species, *E. turbinata*, Herdm., is separated generically from the rest by Ed. Van Beneden, and is made the type of the restricted genus, *Ecteinascidia*, characterised by various features which will be found described and figured in the "Challenger" Report,† viz., the thin membranous test, the narrow point of attachment of the posterior end of the body to the stolon, the absence of any constriction dividing the body into thorax and abdomen, the position of the alimentary canal alongside the branchial sac, the shape of the connecting ducts, and of the stigmata of the branchial sac, the tentacular shape of the dorsal languets, the condition of the musculature of the mantle, and the position of the genital organs in the intestinal loop. I am not sure that all of these characteristics will prove to be of generic value. If some new species of *Ecteinascidia* (in the restricted sense) came to be known I would not be surprised to find that they differed from *E. turbinata* in some of the points enumerated above, such as the shape of the stigmata and of the connecting ducts, and possibly even of the dorsal languets, and in fact that is partly the case with the new species described below. But the remaining features, and

* See Roule's figure, Rec. Zool. Suisse, t. iii. pl. xiii., fig. 7.

† Part I., p. 243, and pl. xxxvi.

especially the absence of a distinct abdomen, the position of the alimentary canal, and the condition of the test and mantle are certainly of sufficient importance to characterize the genus.

Ed. Van Beneden places one of Sluiter's species, *Ecteinascidia diaphanis*, from the island of Billiton, in the Malay Archipelago, in this genus; and it is evident, as both Sluiter and Van Beneden point out, that this form is very closely related to my *E. turbinata*, from which it differs chiefly in the colour, the number of tentacles, and the shape of the dorsal languets. The supposed difference in the genital organs, pointed out by Sluiter and by Ed. Van Beneden, probably does not exist. I think now that there can be no doubt I was mistaken in my description of the relation of those parts in *Ecteinascidia turbinata*, and that the testis is really peripheral, and the ovary central in that species just as in *E. diaphanis*, and the new species described below.

The second species from the Island of Billiton, described by Sluiter under the name of *Ecteinascidia rubricollis*, is separated off by Ed. Van Beneden as the type of a new genus *Sluiteria*, characterized by the remarkable condition of the dorsal lamina, which (according to Van Beneden) is a membrane with marginal processes* in place of a series of languets, as in all the other Clavelinidæ, and by the test having vessels terminating in conical papillæ. The other characters given by Van Beneden are only slightly marked, or are shared with a new species described below, which must be placed alongside *E. turbinata* and *E. diaphanis*, in the restricted genus *Ecteinascidia*.

Some time after the present paper had been written, and read before the Biological Society, and just as it was going

* This is certainly not indicated in Sluiter's figure, Natuurk. Tijdsch. v. Nederl. Indie, Bd. XLV., taf. II. fig. 4.

to the printer, I received through the kindness of M. Fernand Lahille a copy of his recent comprehensive work* on the French Tunicata. In this volume Lahille combines with some very useful original investigations an unfortunate attempt to remodel the entire classification of the Tunicata in accordance with his previously published, and I consider quite erroneous, views in regard to the relative importance of the characters usually employed in defining groups. He has, I believe, in most of those portions of his system of classification which are novel, departed from the natural or genetic arrangement, but as I intend to deal with this general question elsewhere,† I shall merely insert here a few remarks upon those passages of Lahille's work which bear upon *Ecteinascidia* and the Clavelinidæ.

By practically ignoring the important characteristic of reproduction by gemmation so as to form colonies, and by giving an undue importance to certain structural features of the branchial sac, Lahille is led to dismember the family Clavelinidæ, and to place (1) *Clavelina* beside *Distaplia* in the family Distomidæ; (2) *Ecteinascidia* and *Rhopalæa*‡ along with the Compound Ascidian *Tylobranchion* and *Diazona* beside the Simple Ascidian *Ciona*, and (3) *Perophora*, *Perophoropsis* and *Sluiteria* in the family Ascidiidæ beside the typical Simple Ascidians,—thus separating Sluiter's two species of *Ecteinascidia* much more widely even than Ed. Van Beneden does, and placing them in distinct families. Lahille recognises *Ecteinascidia* (in the restricted sense) and *Rhopalæa* as distinct though closely related genera, and he describes a new species, *Rh. cerberiana*, which has the minute plication of the branchial sac

* Recherches sur les Tuniciers des cotes de France ; Toulouse, 1890.

† In a work giving a detailed classification, with diagnoses, of the Tunicata, upon which I have been engaged for some time.

‡ Or "*Rhopalona*," as the genus is generally spelt by the French authors.

less marked, and the internal longitudinal bars less complete than in *Rh. neapolitana*.

So much for the previously described species of this interesting group: I now turn to some new material. A few years ago Mr. T. J. Moore, curator of the Liverpool Free Public Museum, placed in my hands for examination a small group of "social" Ascidians, dredged by Captain A. Browne, in Alexandria Harbour, from a depth of 3—5 fathoms. I saw at once that this form belonged to *Ecteinascidia* in the wide sense, and was closely allied to *E. turbinata*, but the pressure of other work prevented me from examining it more minutely until lately, when I found that it was undoubtedly a new species of *Ecteinascidia* in the restricted sense, as employed by Van Beneden.

A few days ago I received from Mr. E. Thurston, Superintendent of the Government Central Museum, Madras, a small group of "social" Ascidians, dredged from the pearl banks in the Gulf of Manaar, with the request that I would investigate it. Upon examination it proved to be also a new species of *Ecteinascidia*, closely allied to *E. turbinata*, but distinct. The description of these two additional species is as follows:—

1. *Ecteinascidia thurstoni*, n. sp. (Pl. VI, figs. 1—9)

External appearance:—A large number of Ascidiozooids are found united together by a delicate branched stolon, which is fixed to the stem of a Hydroid Zoophyte (see Pl. VI, fig. 1). The Ascidiozooids are closely placed on the stolon, so as to form a thickly-clustered mass. Each Ascidiozooid is of an elongated ovate or almost cylindrical shape, somewhat compressed laterally and tapering towards the posterior end (Pl. VI, figs. 2, 3) where it joins the stolon by a very narrow pedicle. The anterior end is truncated or flat, and bears at its extremities two small but

distinct papillæ which are terminated by the branchial and atrial apertures. The colour is light yellowish grey, and the bodies are almost quite transparent, the viscera showing through distinctly (fig. 2). An ascidiozooid varies from 7 mm. to 2 cm. in length, and from 3 mm. to 6 mm. in greatest breadth.

The Test is very thin and membranous, and perfectly transparent, and is easily torn off from the mantle. No vessels are present, and no test cells are visible in the transparent homogeneous matrix.

The Mantle is thin and transparent, but moderately muscular. The siphons are indistinctly lobed at their extremities, and are provided with strong sphincter and radial muscle bands. The muscle bands over the rest of the body are all transverse in direction, and are rather numerous. They are in the main parallel, but branch and re-unite occasionally, so as to form a long-meshed network (Pl. VI, fig. 4). The small blood spaces in the mantle are all engorged with blood corpuscles, and so become visible as a close network (Pl. VI, fig. 5).

The Branchial Sac is large, and extends nearly to the posterior end of the body. The transverse vessels are wide and are all of the same size (Pl. VI, fig. 6). The internal longitudinal bars are not wide. They are joined to the transverse vessels at the angles of the meshes by narrow papilliform connecting ducts which are distinctly wider at their distal ends than where they leave the transverse vessels (fig. 6, *c. d.*) The meshes are elongated antero-posteriorly, and contain each about four long narrow elliptical stigmata. The vessels of the branchial sac, like those of the mantle, are for the most part engorged with blood corpuscles.

The Dorsal Lamina consists of a rather narrow plain membrane from which spring, at the level of the trans-

verse vessels, short tentacular languets, which are, however, merely prolongations of the edge of the membrane (Pl. VI, fig. 7) On each side of the dorsal lamina two internal longitudinal bars are absent, but their places are indicated by the rows of papilliform connecting ducts (Pl. VI, fig. 7, *c. d'*) At each side of the endostyle there is a single such row of papilliform connecting ducts, with no corresponding longitudinal bar.

The Tentacles are very numerous and slender, and are closely placed. There are about 80 altogether, of which 40 are very short, and are placed alternately with the 40 much larger ones, which, however, are not all of one size, but vary considerably in length (see Pl. VII., fig. 8), some being twice as large as others.

The Dorsal Tubercle has a simple elongated, elliptical aperture placed close behind the tentacles (Pl. VI, fig. 8).

The Alimentary Canal is placed on the left side of the branchial sac, and there is no distinct abdomen. There is only a single well-marked loop, that between the stomach and intestine, in which the genital organs lie (see Pl. VI, fig. 9). The œsophagus is short and narrow, and runs posteriorly to the ovate stomach (fig. 9, *st.*) The intestine runs posteriorly for a short distance from the stomach, and then turns ventrally, and then anteriorly in a wide curve. When it reaches a level in front of the œsophagus it turns dorsally and runs to the dorsal edge of the body, where it turns abruptly forwards to form the rectum running towards the atrial aperture. The rectum thus runs almost exactly at a right angle to the preceding part of the intestine. There is an extremely delicate digestive gland ramifying over the walls of the intestine, with a distinct duct, which leaves the intestine on the inner side of the intestinal loop and after crossing a portion of the testis opens into the stomach.

The Genital Organs are placed in the intestinal loop close to the stomach. The ovary forms a small rounded lump in the centre, and is surrounded by the testis, composed of a very large number of elongated spermatic vesicles arranged in a crescentic curve around the ovary. The spermatic vesicles are united in twos and threes by fine ducts (Pl. VI, fig. 9), which converge to the centre of the ovary, and finally all unite to form two ducts which run side by side dorsally till they pass between the horns of the crescent formed by the testis, when they join to form the vas deferens, which turns anteriorly and first crosses the intestine, so as to reach the ventral side of the rectum, and then crosses that tube obliquely and terminates on its dorsal side not far from the anus (Pl. VI, fig. 9, *v. d.*).

This species,* which was dredged in the Gulf of Manaar, is closely related to *Ecteinascidia turbinata* from Bermuda, and *E. diaphanis* from the Malay Archipelago, but differs from both notably in the condition of the tentacles and the dorsal lamina, and less markedly in other points. The dorsal lamina is in a particularly interesting state as it shows a transition from the tentacular languets of *E. turbinata* to the broad membrane with marginal teeth of Sluiter's *E. (Sluiteria) rubricollis*, as described by Ed. Van Beneden.

The course of the alimentary canal also shows an approach to the latter species in the abrupt right-angled bend between the intestine and the rectum. The course of the vas deferens is remarkable, and differs from that of *E. diaphanis*. There is not the least doubt that it crosses the rectum, as shown in fig. 9.

* The type specimen has been returned to Mr. Thurston, and will, I have no doubt, be deposited in the Government Central Museum, Madras.

2. *Ecteinascidia moorei*, n. sp. (Pl. VII, figs. 1—8)

External appearance :—A number of Ascidiozooids are grouped together to form a hemispherical mass (Pl. VII, fig. 1) measuring about 3 cm. by 2 cm., and are attached at their posterior ends by very slight pedicles to a short branching delicate stolon which appears to have been attached in its turn to sand and shell fragments. The shape of the Ascidiozooids varies a little, but is nearly cylindrical (Pl. VII, fig. 2) with a truncated anterior end bearing the two sessile apertures, and a rounded posterior end. The colour is a clear grey, and the body is transparent, allowing the viscera to show through. An average sized Ascidiozooid measures 1 cm. in length and 3 mm. in breadth.

The Test is very thin and transparent, and is easily removed from the mantle as a delicate homogeneous looking membrane. It has no vessels, and no test cells are visible.

The Mantle is thin, but fairly muscular. All the muscle bands, except on the short siphons, are transverse in direction. They branch and anastomose so as to form a network, but in their general direction all the bundles are parallel. They die away on each side of the endostyle so that the ventral median line has no musculature. On the siphons (Pl. VII, fig. 3) there are powerful sphincter muscles formed of a number of concentric bands, and also about forty well marked radial muscles which run outwards from the edges of the aperture and die away on the outer edge of the sphincter. The branchial aperture is distinctly 6 lobed and the atrial 5 lobed (Pl. VII, fig. 3, *at.*).

The Branchial Sac extends almost to the posterior end of the body. The transverse vessels are narrow, and are all of one size (Pl. VII, fig. 4). The internal longitudinal bars are exceedingly delicate and can scarcely be seen

under the microscope until they have been stained. They are united to the transverse vessels by triangular membranous flaps (Pl. VII, fig. 4) of considerable size. The meshes are slightly elongated antero-posteriorly and contain each 3 or 4 stigmata.

The Dorsal Lamina is represented by a series of large triangular tapering languets (Pl. VII, fig. 5, *l.*). On each side of these an internal longitudinal bar is wanting, and the usual wide connecting ducts are replaced by short rudimentary papillæ (Pl. VII, fig. 5, *c. d'.*).

The Tentacles are very numerous and closely placed. There are about forty very small ones placed alternately with the same number of larger, many of which are very long and slender. These larger tentacles seem in some places to be of two sizes occurring alternately, but this arrangement is not constant (see Pl. VII, fig. 8). There seems to be no appreciable difference between the tentacles of this species and of *E. thurstoni.*

The Dorsal Tubercle is circular in outline, but the aperture is a transversely directed elliptical slit (Pl. VII, fig. 6, *d. t.*)

The Alimentary Canal is placed on the left side, and scarcely extends behind the branchial sac. There is a single well marked loop between the stomach and the intestine (Pl. VII, fig. 7), and the rectum makes an obtuse angle with the intestine. The stomach is posteriorly placed. The digestive gland ramifies over the inner (or dorsal) side of the intestine, and the duct, lined by distinct cubical epithelium, runs posteriorly between the intestine and the genital organs (Pl. VII, fig. 7, *gl.*) to open into the stomach.

The Genital Organs are placed in the intestinal loop and have the same general arrangement as in *E. thurstoni.* The ova are large and few in number. They form the

central mass, while about sixty spermatic vesicles compose the crescentic testis outside. The ducts from the spermatic vesicles unite on the anterior edge of the ovary to form the vas deferens (Pl. VII, fig. 7) which, along with the oviduct, leaves the genital mass between the horns of the crescent and curves anteriorly to cross the intestine where it joins the rectum. The genital ducts then course along the ventral edge of the rectum to their termination near the anus.

This species, from Alexandria Harbour, resembles the preceding one closely in external appearance and in the condition of the tentacles. They differ, however, in the size of the transverse vessels of the branchial sac, the condition of the connecting ducts, the dorsal languets, and the course of the alimentary canal and genital ducts. The connecting ducts and dorsal languets differ from those of all the other members of the genus *Ecteinascidia* in the restricted sense, and resemble those of *Rhopalopsis crassa* and *Rh. fusca*, but in other points the present species is much nearer to *E. turbinata*, *E. diaphanis* and *E. thurstoni*.

It is curious that these four species, which are so very much alike in external appearance, but differ from one another in details of internal structure, should be known only from such very widely separated localities, viz.—

Ecteinascidia turbinata, Herdm., Bermuda, N. Atlantic.

E. diaphanis, Sluiter, from Billiton, Malay Archipelago.

E. thurstoni, Herdm., from Gulf of Manaar, India.

E. moorei, Herdm., from Alexandria, Mediterranean.

Lesueur's *Ascidia claviformis*, from the Bay of St. Vincent, West Indies, is evidently also an *Ecteinascidia*, but as the brief description* deals only with the external

* Journ. Acad. Nat. Sc., Philadelphia, April, 1823, vol. iii, p. 5.

appearance, and is not sufficient taken by itself to determine even the family, it is impossible to say what the species is. The figure (Lesueur, pl. i, fig. 3) is rather more like *E. thurstoni* than any other known form, but the superficial similarity is not sufficient to prove identity.

The primary classification of the Clavelinidæ is into those genera with internal longitudinal bars in the branchial sac, and those with none*; while it is a character of the family as a whole that the bars, if present, are not provided with proper papillæ. The forms with internal longitudinal bars are those which have been discussed in the preceding pages, and the only genera remaining without such bars are *Clavelina*, *Perophoropsis* and (partly) *Perophora*. But it has been stated in works on the Tunicata that *Perophora* has "papillæ" on the inner surface of its branchial sac; these structures, however, are not papillæ comparable with those found on the internal longitudinal bars of the Ascidiidæ, but are merely papilliform connecting ducts exactly like those on each side of the endostyle and dorsal lamina in some species of *Ecteinascidia* (see Pl. VI, fig. 7).

I have recently examined the two species *Perophora listeri* (from Liverpool Bay) and *P. viridis* (from the Coast of North America, the specimen being one of those named and sent out by the United States Fish Commission) with the object of determining afresh their specific characters,

* Lahille dismembers the family chiefly on this account, but I do not think he is justified in doing so. I believe it forms a natural group, the old "Social Ascidians" of H. Milne-Edwards.

and I find that the branchial sac of *Perophora viridis** is in a particularly interesting condition which forms a transition to the group containing *Ecteinascidia*, and shows at once the nature of the papillæ of *Perophora listeri*. *P. viridis* has well-marked papilliform connecting ducts placed at intervals along the transverse vessels, just as in *P. listeri*, but each such connecting duct bears at its free end two long tentacular prolongations, one directed anteriorly and the other posteriorly, which are evidently rudimentary or imperfect internal longitudinal bars. I have found (ten years ago) the same condition before as an abnormality in the branchial sacs of some Ascidiidæ† (e.g., *Ascidia plebeia*, *Corella japonica*, and *C. parallelogramma*), and have pointed out its bearing on the formation of the internal longitudinal bars. So that these two species of *Perophora* form a gradation from *Clavelina* to *Ecteinascidia*:—first the connecting ducts appear in *P. listeri*, then imperfect internal longitudinal bars grow out from the free ends of the ducts in *P. viridis*, and finally the adjacent ends of these outgrowths unite to form the perfect bars of the species of *Ecteinascidia*.

Perophora viridis has twenty tentacles of two sizes placed alternately; while *P. listeri* has forty tentacles of three sizes, but not placed with perfect regularity, the two larger sizes being in the main placed alternately, while between each pair of these occur two very short tentacles.

* I notice that Lahille has just described practically the same condition of affairs in the branchial sac of his new species *P. banyulensis*. He apparently does not know of Verrill's *P. viridis* as he makes no reference to that species, and as he describes his form as being "jaune-verdatre" and having twenty tentacles of two sizes it is not improbable that the two may prove to be identical.

† See Challenger Report, Part I, 1882, p. 192; and "Fauna of Liverpool Bay," Report I., 1886, p. 358, and Pl. IX, figs. 1—4, and 8.

The Family CLAVELINIDÆ* may now be classified as follows :—

Branchial Sac with internal longitudinal bars ... 1
Branchial Sac without internal longitudinal bars... 2

1 { Body divided into distinct abdomen and thorax ... 3
  { No distinct abdomen present 4

3 { Branchial Sac minutely plicated (*Rhopalæa*)... ... 5
  { Branchial Sac not minutely plicated (*Rhopalopsis*) ... 6

5 { Branch. aperture 8 lobed, atrial 6, *R. neapolitana*, Phil.
  { Branch. aperture 6 lobed, atrial 12, *R. cerberiana*, Lah.

6 { Test thin anteriorly, dark coloured...*R. fusca*, Herdm.
  { Test thick all over, light grey ... *R. crassa*, Herdm.

4 { Blood vessels in test (*Sluiteria*) ... *S. rubricollis*, Sl.
  { No blood vessels in test (*Ecteinascidia*)... 7

7 { Tentacles about 40 in number ... *E. diaphanis*, Sl.
  { Tentacles about 80 in number 8

8 { Dorsal languets and connecting ducts wide and membranous ... ...*E. moorei*, Herdm.
  { Dorsal languets and connecting ducts narrow and papilliform 9

9 { Tentacles of 3 distinct lengths, languets not united ... ...*E. turbinata*, Herdm.
  { Tentacles not distinctly of 3 lengths, languets united by a narrow membrane, *E. thurstoni*, Herdm.

2 { No distinct abdomen present 10
  { Abdomen distinct from the thorax 11

11 { Body divided into thorax, abdomen, and a well-marked peduncle (*Podoclavella*, n.gen.) 12
   { Body not pedunculated apart from the long abdomen 13

12 { Colour green, tentacles in two rows, *P. borealis*, Sav.
   { Colour purple, tentacles in 1 row, *P. meridionalis*, n. sp.†

**Clavelinopsis rubra*, Fewkes, probably does not belong to this family, but is a *Boltenia*.

†This new species, along with *Stereoclavella* (n. gen.) *australis*, will be described and figured in the "Catalogue of Tunicata of the Australian Museum," which I am now preparing.

13 { Stolons united in a basal mass of test (*Stereoclavella*) 14
Stolons distinct, delicate and branched (*Clavelina*) 15

14 { Dorsal languets short ... ... *S. oblonga*, Herdm.
Dorsal languets very large 16

16 { Horiz. membr. of branch. sac wide, *S. enormis*, Herdm.
Horizontal membranes narrow ... *S. australis*, n. sp.

15 { Thorax and abdomen of much the same size ... 17
Abdomen much longer than thorax... 18

17 { Two rows of stigmata in branch. sac, *C. pumilio** M.Edw.
At least six rows of stigmata 19

19 { Six to eight rows of stigmata ... .. *C. nana*,† Lah.
Twelve to sixteen rows of stigmata... 20

20 { With yellow or brown lines of pigment on the thorax... ... ... *C. lepadiformis*,† O.F.M
White pigment lines on thorax, *C. rissoana*, M.Edw.

18 { Only three or four rows of stigmata in branchial sac... ... ... *C. producta*, M.Edw.
About a dozen rows of stigmata, *C. savigniana*, M.Edw.

10 { With about four rows of stigmata (*Perophora*) ... 21
With more than a dozen rows of stigmata (*Perophoropsis*) ... ... *P. herdmani*, Lah.

21 { Ascidiozooids on distinct jointed pedicels, some adhering sand on test, *P. hutchinsoni*, Macd.
Ascidiozooids not on distinct pedicels, no jointing present, no adhering sand... 22

22 { Body colourless, 40 tentacles of 3 sizes, only papilliform connecting ducts... *P. listeri*, Wiegm.
Body greenish, 20 tentacles of 2 sizes, papilliform connecting ducts with rudimentary internal longitudinal bars... ... ... *P. viridis*, Verr.
(? = *P. banyulensis*, Lah.)

This family is of very great interest phylogenetically, (1) because *Clavelina* comes nearer than any other known form to what we have good grounds for believing the common ancestors of all the simple and compound Ascid-

*Possibly the young of *C. lepadiformis* or some other species.

†With several varieties.

ians (Proto-ascidiacea) to have been, and (2) because this group occupies one of several points of contact between the Ascidiæ Simplices and Ascidiæ Compositæ, *Rhopalæa* linking on in the one direction to *Ciona* and the Ascidiidæ, while *Clavelina* and *Ecteinascidia* pass in the other direction into *Diazona*,* *Chondrostachys* and the Distomidæ. For a further discussion of these phylogenetic relationships I may refer to the last part of the "Challenger" report on the Tunicata.†

Explanation of the Plates.

Reference Letters.

a. anus; *at.* atrial aperture; *br.* branchial aperture; *b.v.* blood vessel; *c.d.* connecting duct; *c.d'.* same in a rudimentary condition; *d.l.* dorsal lamina; *d.t.* dorsal tubercle; *gl.* digestive gland; *h.m.* horizontal membrane; *i.* intestine; *l.* languet; *m.b.* muscle bands; *i.l.* internal longitudinal bars; *œ.* œsophagus; *ov.* ovary; *sg.* stigmata; *st.* stomach; *r.* rectum; *o.d.* oviduct; *sl.* stolon; *t.* testis; *tn. tn'.* tentacles; *v.d.* vas deferens; *tr.* tranverse vessels.

* In fact *Diazona* comes so close to *Ecteinascidia* and *Rhopalæa* that I would have no great objection to place it beside them in the family Clavelinidæ. It seems to me to be a form as nearly as possible exactly intermediate between Distomidæ and Clavelinidæ, and consequently very difficult to place in a serial or tabular classification through presenting no difficulty in a phylogenetic arrangement.

† Zool. Chall. Exp., Part LXXVI, 1888, p. 121.

PLATE VI.

Ecteinascidia thurstoni, n. sp.

Fig. 1. The entire colony, natural size.
Fig. 2. An ascidiozooid, slightly enlarged.
Fig. 3. Another ascidiozooid, nat. size.
Fig. 4. Part of the mantle showing the transverse muscles, × 50.
Fig. 5. Part of the mantle showing the engorged blood spaces, × 50.
Fig. 6. Part of the branchial sac from the inside, × 50.
Fig. 7. Part of the dorsal edge of the branchial sac showing the languets, × 50.
Fig. 8. The dorsal tubercle, × 50.
Fig. 9. The alimentary canal and genital organs, × 10.

PLATE VII.

Ecteinascidia moorei, n. sp.

Fig. 1. The entire colony, natural size.
Fig. 2. A single ascidiozooid, slightly enlarged.
Fig. 3. The atrial aperture from the interior to show the lobes and the musculature, × 50.
Fig. 4. Part of the branchial sac from the inside, × 50.
Fig. 5. Part of the dorsal edge of the branchial sac, showing the languets, × 50.
Fig. 6. The dorsal tubercle, × 50.
Fig. 7. The alimentary canal and genital organs, × 10.
Fig. 8. Some of the tentacles, × 50. They seem to be exactly alike in the two species, *E. thurstoni* and *E. moorei*

The DISTRIBUTION of MARINE ALGÆ in SPACE and in TIME.

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At the outset it is necessary that I should expressly limit and define the headings of this address. By the distribution of Algæ in space, I mean not only their distribution in natural areas of the waters of the globe, but also their "vertical distribution" or "zonal distribution" or "range in depth" as it is variously termed. Their distribution in time is imperfectly ascertained by a study of their fossil remains. Farther, I propose to limit the consideration of the subject to Marine Algæ or seaweeds, since so little is known of the distribution of fresh water Algæ, that he would be a bold man who should venture to address you on it.

One of the first observations of general import made by a student of Algæ is that between tidemarks and beyond, their occurrence is more or less regulated by their colour. With certain notable exceptions the inshore Algæ are green, from half-tide mark olive and brown, mixed with, and sheltering red, and lowest of all red. They do not occur in definite zones since the red forms advance upwards under cover of the brown and olive forms, and, moreover, there are exceptions for which I cannot account on any theory. For example, to take extreme cases—a brown fucoid, *Pelvetia canaliculata*, occurs at high water mark, where it may be observed actually higher on the rocks than certain maritime lichens; and a green alga

Struvea is commonly found at considerable depths, one of the species at more than thirty fathoms. Besides these extreme cases there are many others not so marked in character, which modify this zonal distribution, but the fact remains generally true of much the larger proportion of forms. On what grounds are we to account for this regulation of pigment? We know that sea-water intercepts sunlight and that the deeper we go the darker it becomes—that at a depth of 700 fathoms, probably less, there is total darkness, and that fishes which live at great depths are blind, like those of the Kentucky caves.

If we apply this knowledge to our problem, the observation will not escape us that the forms living close inshore and most exposed to sunlight are green, as has just been noticed, that they are of the same colour as land vegetation and fresh water vegetation, the illumination being similar. Now though we know very little about the interception of sunlight by sea water, yet this much is certain, that not only is the quantity of light reduced, but its quality is also affected, as spectroscopic investigation has shown. It is precisely those rays that are most efficient in the work of assimilation by plants that are first intercepted, and only the green and blue rays travel far. This change of pigment we may then fairly take it, is an adjustment to the supply of sunlight, and if we enquire farther we shall find that the essential green pigment—the chlorophyll on which we know the nutrition of plants depends—is only masked by the red (phyco-erythrine) brown (phyco-phæine), blue (phyco-cyanine), and yellow (phyco-xanthine) pigments to be found in those seaweeds near and beyond low water mark. There is very little known as to the precise functions performed by these modifications of chlorophyll, whether their office is to heighten the susceptibility of the chlorophyll to sunlight

or to act as a shield against the excess of green and blue rays penetrating the water. This is a subject for experiment which I venture to urge upon the attention of plant physiologists since it cannot but prove fertile in results. To pursue our excursion into the depths, it may be noted that very few forms are to be found between 50 and 100 fathoms, and beyond, hardly any. *Phyllophora Brodiæi* and several other Algæ (excluding diatoms and calcareous Algæ which are brought up dead from great depths to which they have been drifted) have been recorded from greater depths than 100 fathoms, but the records are open to question. It is quite safe to place the absolute limit at 200 fathoms. The fact just alluded to that the *quality* of the light is affected by its passage through the water probably explains in part why Algæ do not go to a greater depth since light penetrates much farther. Of course other causes, such as pressure, etc., may operate also in this direction. We see then that the range in depth of marine Algæ is slight as compared with that of marine animals, in this respect affording a significant contrast with the relative distribution of the land flora and fauna, which I suppose may be said to have the same frontiers. It would be easy to support the statement that light is the regulator of the zonal distribution of Algæ by numerous observations, if these were necessary. I may cite one as a sample. It is well known that certain deep water species are frequently found near the surface, under shelter of dark rocks and caverns, which, at all events, proves that pressure has little to do with the matter, at least within comparatively narrow limits. Against this view of the high susceptibility displayed by Algæ, to the amount and nature of the supply of light I am bound to cite one staggering fact. Kjellman observed that in the polar sea, during the dark arctic night of three months duration

(and at a mean temperature of —1°C.), the Algæ of that region both grew normally and fructified! It is well that this observation should have weight, it is not crushing,—that it may teach us caution in dealing with sweeping rules. Let it be noted, however, that Kjellman's observation is no more potent than the exceptions I began by citing, and that no rigid rule of zonal distribution is laid down, and I think you will allow that a truth of general value emerges from this cloud of witnesses against it.

I have dwelt at some length on the details of zonal distribution because they furnish us with a consideration of some value. The natural classification of Algæ is based on the structure of the plants, especially valuable characters for this purpose being furnished by the organs of reproduction, as in the case of other plants. However, an artificial system founded solely on the colour of the plants leads to a strikingly similar result. With certain exceptions all the red Algæ form a natural group, the Rhodophyceæ, united and distinguished from other groups by structural characters; all the olive and brown form another group, the Phæophyceæ; all the green another, the Chlorophyceæ; and all the blue-green another, the Cyanophyceæ, though the character of colour is of much less importance here than in other groups.

Allowing for exceptions under these heads, and they are not numerous, under the first three at all events, we have here a striking arrangement without a parallel in organized nature. Colour, so far from being a character of value for the purpose of classification, is commonly of very subordinate importance, and more often than not is even deceptive as a mere specific character. To take a prominent example, the genus *Agaricus* (mushrooms and toadstools) has been arranged in sections on a system largely dependent for characterization on the colour of the spores;

that is, the colour of the spores is used as a means of recognition, and it is the common belief that this artificial method has led to an undue multiplication of the "species" of that genus—one of the largest genera of plants. If colour then be fallacious as a subordinate character elsewhere, on what grounds are we to account for its apparent ordinal importance among Algæ? The nature of the pigments themselves answer the question. The colours of land plants other than the green colour of vegetation, are produced by pigments which play no rôle of importance in their vital processes, while here in Algæ they are bound up with the essential process of nutrition—the pigments are adaptations, associated with the chlorophyll itself to the amount and nature of the sunlight reaching the Algæ. The colour is therefore of most profound biological importance in this case, and it follows that its variation is naturally accompanied by variations of structure both of thallus and of reproductive organs equally profound. The biological significance of colour is a subject that has been seized upon by easily satisfied speculators who are mostly incapable of a due study of the pigments, and who concern themseles with fanciful interpretations of their "meaning." The present case is one which fortunately does not lend itself to such treatment, and the coast is clear, if the play upon words may be pardoned, of such literature. This short digression from the strict subject of distribution may be excused on the ground that a consideration of the subject itself has here led to the recognition of a very striking case of correlation between physiological and structural variation. He who runs may read the lesson to be learnt from it.

The saying, that the character of vegetation changes entirely with every twenty-four degrees of latitude, is less

true of seaweeds than of the higher plants. The complex conditions that affect the distribution of land plants, and render it no mere affair of latitudes or even of isothermal lines, are fewer, so far as we know, in the case of marine plants, but some of them are far more potent. Local peculiarities play an important part. The fact that certain seas are tideless, for example, profoundly affects the character of their vegetation. The Mediterranean, to take an instance, does not possess a considerable number of forms which might be reasonably expected to occur in it were there an average rise and fall. So also with the Antilles, rich as they are in marine plants. As agents in distribution, let us take the case of the great ocean currents. They are not merely vehicles for transport, but they are streams of stable temperature as well. In all probability —though this is a matter on which we have little positive knowledge—seaweeds are more sensitive to fluctuations of temperature than are land plants. (There are cosmopolitan species of course, but these are out of consideration at present.) The conditions that surround seaweeds living in a medium of stable temperature such as the sea —not called upon to endure much change, in that respect, from day to night nor even from season to season—encourage this opinion. The difficulties that attend the procuring of the germination and the culture of seaweeds in aquaria are rightly suspected to spring from inaccurate adjustment of temperature. More than this, direct observation of the distribution of seaweeds within limits of temperature in the sea shows us that this is the case. We may, therefore, regard the great ocean currents as prime movers in the transport of marine vegetation. Let us take the familar instance of the Gulf Stream. As it leaves the shores of America we may note the contrast between the Florida Keys and Charlestown, not far to

the north of them, but out of direct influence. Contrast again with that of Charlestown the marine vegetation of Bermuda lying right in the path of the Gulf Stream—the most northern coral island in the world. To come nearer home—it is constantly bringing us waifs from the Sargasso Sea, which it skirts, in the form of the so-called "gulf-weed"; and there are settled on our southern and western shores Algæ which we have in common with the West Indian Islands and Florida—species which you will look for in vain but a short way up the North American coast itself. I can imagine few more interesting studies in distribution than a comparison of the marine flora of Orkney and Shetland with that of the neighbourhood of Cape Farewell in Greenland, lying precisely in the same latitude. On our side we have the influence of the Gulf Stream. At Cape Farewell this is not only absent, but there is another powerful current, believed by Nansen to come right over the Pole itself—which that gallant traveller hopes (and we hope) will bear him over it and "keep his chin up on the sea of life"—there is this other current setting from the frozen north and bearing on its icy bosom floes and bergs southwards in a dense stream.

A comparison of these two floras would assuredly instruct us in the ways of ocean currents in modifying our marine floras, as streams of stable temperature. The importance of the fact of transport of Algæ by the Gulf Stream to our shores will be seen later when I come to speak of the barrier interposed by the depths of the ocean. The question is worth asking, does man affect the distribution of seaweeds? That he does so to a far less extent than in the case of land plants is obvious enough. I have recently made a short investigation of the growth of Algæ on ships' bottoms, a subject of much practical importance, since it means, in spite of anti-fouling paints and

the like, many tons of coal per annum to most of our great ocean-going lines. Let us take the case of a steamer making the voyage from this country to the Cape and back, if she has received no overhauling in the meantime, her bottom will be so overgrown with seaweed on her second return trip, that it will need many extra tons of coal to drive her, especially if a record-breaking speed is demanded. (I may mention casually that this difficulty attends only iron and steel vessels—the old wooden copper-bottomed boats were protected by the exfoliating of the copper.) Now in such a case, I mean a voyage to the Cape and back, through many swiftly changing temperatures, the result is exactly as might be expected. Cosmopolitan forms—it is only right to say that these predominate in all cases—like *Enteromorpha*—are by far the most frequent; they practically exclude the others. Let us take on the other hand the case of one of Her Majesty's ships which has returned during the summer months from service in the Mediterranean, or a ship that has been lying in a foreign port not far distant. She has a varied marine flora arranged in green, red and olive and brown zones on her sides and bottom. In a few days' steaming she is in another natural region. The changes of temperature, etc., are doubtless fatal to the great majority so far as a chance of acclimatization is concerned. Are they so to all? I do not believe it. It would weary you to give here the details observed under this head, but I cannot refrain from mentioning one remarkable case. Mr. Batters has found at Berwick-on-Tweed an Australian seaweed, in all probility detached from a passing vessel. It is hardly likely that such migrations have occurred often, and they are not in contemplation, but rather such movements from one similar region to another as the Atlantic passage from this country to the United States,

the Mediterranean to the West Indies, and, most interesting of all, the Red Sea to the Mediterranean and vice-versa through the Suez Canal. We have here an interesting field for future work—and one that I may appropriately recommend to a Liverpool audience.

The great barriers interposed between the natural regions of the marine flora are continental areas, the depths of the sea, areas of different temperature in the sea and deserts of sand and friable rock. We have an excellent example of the continental barrier in the mass of Africa separating the tropical Atlantic from the Indian Ocean and stretching southwards into a colder region which effectively blocks the way. Geologists tell us that the continental areas are "permanent," that their antiquity is at least so great that their beginnings are lost in "the illimitable azure of the past." An examination of the marine flora of the tropical Atlantic and that of the tropical Indian Ocean discloses the fact that while the genera are very largely common to both, the species are in a high proportion different. Let us suppose an argument founded on this in favour of the high antiquity of the genera of Algæ—an argument that suggests itself with fatal facility. It is true that these regions are as effectively separated as if they were on different planets. But we know that the present areas of temperature have been by no means of such great duration as the continents, and their changes have been far reaching. It is also admitted as an important agent in determining such variations of climate in the northern and southern hemispheres (or at all events a constant accompaniment of such—which is the same thing so far as our argument is concerned) has been change of direction of the great ocean currents. Let us suppose in the past—a past by no means so remote as the birth of continents—a more genial climate in the

southern hemisphere, and we at once obtain conditions suitable for the migration and mingling of tropical forms, by way of the Cape of Good Hope. This consideration shows us that the continental barriers, great though their antiquity be, are, geologically speaking, modern obstacles to the distribution of tropical forms. A comparison of the tropical species of the Pacific with those of the Indian Ocean, between which are no such barriers, would throw a side light on the discussion of this question. Unfortunately our knowledge of the marine flora of the Pacific does not enable us as yet to deal adequately with the matter.

How effective a barrier is maintained by areas of different temperature in the ocean may be best seen by comparing the widely different floras of the north temperate and south temperate zones, separated as these are by the tropics. Here is a barrier which, though it has shifted its position with variations of climate, has yet been steadily interposed between north and south. Want of light prevents the migration of the temperate species *via* the cold depths of the ocean beneath the tropics; and, moreover, the cold currents come to the surface in the warm ocean, there to be heated. The marine floras on either side of this warm barrier are radically different. In the Pacific we have, in the great Laminarian *Macrocystis*, a striking example of wide distribution extending from the southern ocean right up to San Francisco, if not beyond. In the Atlantic we have two species of *Fucus (F. vesiculosus* and *F. serratus)* which occur in both north and south temperate zones, but not between, and there are others; but the general truth of the wide difference between north and south temperate zones, in the matter of marine vegetation, is not weakened greatly by special exceptions however striking.

The barrier interposed by the depths of the sea is not

so effective, but it is yet a marked one. There is a very considerable difference between the two sides of the Atlantic. It is bridged in a way by the great currents. The main Equatorial current—the parent of the Gulf Stream—first crosses the Atlantic from east to west under the tropics, and may there be considered a good bridge since the distance traversed is not enormous and the temperature is steady. But we know too little of the marine floras of the African and South American coasts to enable us to judge certainly of its effects. The Gulf Stream crosses from west to east with too great a slant to the north-east to have a very marked effect—it has had time to cool somewhat, and the distance it travels is great --but yet we have noted above that its effect is beyond question.

Sand makes deserts in the sea as on land. Every one has observed such coasts of small extent, but they occur over wide areas. For example, an enormous desert extends along the north coast of the Gulf of Mexico from Florida to Yucatan. Another occurs, as observed by Kjellman, in the Siberian Sea; and these areas combine with the depths of the ocean in forming barriers to distribution. I think I hear some one saying, "why is it necessary to lay down now and here these fundamental conditions that hedge about the distribution of marine Algæ? Surely all that has been done long ago." It is true that much that I have said, though true is not by itself new, but my experience of the study of phycology is that the idea of there being a distribution of Algæ at all is in its infancy. In the pages of the older writers we frequently meet with remarks on the local distribution of Algæ, in standard modern works like those of the venerable Agardh, the distribution of each species is carefully noted, but so far as I know, very little has been done with the subject

by itself. In Kjellman's *Algæ of the Arctic Sea* there are admirable tables of the distribution of these Algæ throughout the provinces into which he has divided that region. In the *Essai de classification des Algues de la Guadeloupe* by MM. Mazé and Schramm, there are exhaustive tables showing the relationship of the Algæ of Guadeloupe and in my *Catalogue of West Indian Algæ* there are tables showing the relationship of West Indian Algæ with other regions, viz., North Atlantic, Mediterranean, Warm Atlantic, South Atlantic and Cape of Good Hope, Indian Ocean, Australia and South Pacific, Warm Pacific, North Pacific and China Seas. It is much to be wished that the authors of catalogues of Algæ should furnish us with similar tables, though, knowing the labour of the performance arising from the diverse classifications in use, and from the necessity of verifying records—knowing that such labour rivals that involved in the production of the catalogue itself, I can understand the reluctance of authors. Certainly few tasks have less outward and visible result than the construction of such tables. But the more of them made the easier does the work of making the remainder become.

Now I have heard it said that the subject hardly exists—that species of Algæ are pretty well world-wide if we except such broad and obvious facts as that the Sargassa are more or less tropical and the Siphoneæ also; that the Laminarieæ are temperate and polar and so on. There is not much use wasting argument on such ignorance which the gods fight against in vain. The plants themselves intervene in this matter, and by appeal to them we can settle it. My object in constructing the table appended to this paper* is the very humble one of

* I have to acknowledge gratefully the aid of Miss Ethel Barton and of Mr. Carver in drawing up the table and checking results.

showing that there is such a subject and that it deserves to be pursued. For this purpose I have selected three regions of the ocean which are well cut off from each other, which have little or nothing in common except the fact that their Algæ have been well collected and studied. These regions are the Arctic Sea (taking Kjellman as the basis of calculation); the West Indian region (based on my own catalogue); and the Australian region (based on Sonder's catalogue in Baron von Mueller's *Fragmenta Phytographiæ Australiæ*, vol. XI., *Supplement* and also in *Additamenta*). The first and the second are purely natural regions, but the third is hardly so. Australia is both tropical and south temperate, but the fact may be urged in favour of our treating it as a whole that the portion of the coast best known at present is south temperate. I wish for the purpose of this table it had been possible to so delimit Australia as to exclude its tropical forms, but it was hardly possible to do this with accuracy. Nevertheless, the whole region is well cut off from the others, and the fact that the whole of its flora is included would concede chances against my argument for the geographical diversity of algal forms. So let it stand. Before entering upon an examination of this table, I would point to a discrepancy between the totals of forms common to the West Indies and Australia now given and those given in my catalogue of West Indian Algæ. The discrepancy arises from the fact that the present enumeration is based principally on Sonder's Catalogue and the former one on Agardh's *Species, Genera et Ordines Algarum*, and on other books. Sonder's Catalogue is more exhaustive than the Agardhian enumeration for the reason that part of the latter (the Phæophyceæ) was done long before Sonder's catalogue. There is here a difference of four. Again under the Florideæ there is a difference in excess of ten, arising

partly from Agardh's more just appreciation of the value of specific forms, notably in the Helminthocladiaceæ which contribute six of the excess of ten to be found in Sonder. Under Chlorophyceæ and Protophyceæ there are in the present estimate excesses of three and two respectively arising from my own judgment in framing the former lower estimate. It was necessary in constructing the former tables to use one plan, one estimate of specific value (the Agardhian) for the whole world flora and so Sonder's catalogue was not then taken bodily. However with these differences, amounting to nineteen only in the aggregate of the entire flora in question, we need not concern ourselves farther than to explain their origin.

Let us first look at the aggregate totals that we may form some idea of the extent of the floras we are dealing with. The arctic marine flora consists of 259 species contained in 111 genera; the West Indian of 788 species in 150 genera; and the Australian of 1132 species in 255 genera, the last owing its preponderance to its embracing subtropical and south temperate types. The most noteworthy observation on these totals is the proportions of genera to species. In the arctic regions the genus averages slightly more than two species only, while in the West Indies it averages rather more than five, and in Australia rather less than five. These proportions become more instructive when we trace them through the tables showing the numbers which the different regions have in common. The Arctic Sea and the West Indies have 42 genera and 30 species in common; the West Indies and Australia have 109 genera and 135 species in common; the Arctic Sea and Australia have 42 genera and 21 species in common; while 32 genera occur in all three regions and only 12 species. It will be seen that exactly the same number of genera are in common

between the Arctic Sea and the West Indies, and between the Arctic Sea and Australia, though of course, as the tables show, not the same genera. It will also be seen that the comparison of the West Indies with Australia alone shows a preponderance of specific over generic types in common (except in the case of the item Protophyceæ the least worked out group). This naturally shows a greater affinity between these floras, as was indeed to be expected, and it remains true when we substitute my previous lower estimate of 116 for 135 species. I have elsewhere remarked on the relationship of these floras so far removed from each other and on the fact that there is a greater correspondence between them than between the West Indian and the Indian ocean floras, though the generic types of these latter correspond closely. This table of figures speaks so plainly for itself that any discussion of it would be a mere reiteration of its obvious statements. I cannot help, however, calling attention to the totals of forms common to all three regions, viz., Florideæ, 17 genera and only 5 species; Phæophyceæ, 6 genera and only one species (*Eudesme virescens*); Chlorophyceæ, 5 genera and 6 species (four of which are notoriously cosmopolitan Ulvaceæ—plants which do their best if I may say so to become fresh water forms even, not content with a home in the boundless ocean; the one siphoneous alga is our beautiful *Bryopsis plumosa*); and finally Protophyceæ, 4 genera and no species.

It will be noticed also from a study of these totals that while in the Arctic and Australian Regions, the Phæophyceæ far out-number the Chlorophyceæ, in the tropical West Indian flora, the proportion is very markedly reversed and the green Algæ outnumber the olive brown. One is tempted to put this down to the strong illumination of the tropical sea but another reason is to be found in the fact

that a number of the Antilles richest as regards Algæ are subject to irruptions of fresh and brackish water from the Orinoco floods, a condition that would operate in the same direction. When I have finished the examination of Indian Ocean Algæ on which I am at present engaged, check results may be expected that will answer this speculation. The figures I have quoted to you with those in the table speak for themselves. Out of three diverse floras consisting of 259 species, 788 and 1132 respectively there are only 12 species in common. This one fact surely answers the question plainly enough that there is a subject of the distribution of Algæ, and that materials for its study exist; and moreover it exhorts us to undertake it.

I now come to the last part of my subject and on it I need not detain you long since the materials are scanty. The distribution of Algæ in time as evidenced by their fossil remains is a branch of study which is indeed somewhat starved for lack of material. In the early rocks there are many markings which have been dignified by imaginative palæontologists with such names as *Fucites, Confervites, Caulerpites*, etc. But these have been shown by Nathorst and others to be in most cases no other than casual impressions of miscellaneous objects, trails of creeping animals and the like. We have however certain fossil remains such as *Nematophycus* described by Mr. Carruthers, from the Erian of Canada (=lower Devonian). The minute structure of this Alga has been studied microscopically and it is apparent that in these far off times there flourished in the ocean, this gigantic siphoneous alga, resembling our *Udotea* or *Avrainvillea* in structure but attaining a girth to be measured by feet—a veritable marine tree. Besides this alga and a few questionable forms such as *Pachytheca*, we have only

certain fossil Dasycladeæ and fossil Diatoms from Tertiary beds as materials for discussion. The theory of development requires the supposition that we have in Algæ the least changed descendants of the earliest forms of life that appeared on the globe, but the testimony of the rocks is barren in this respect—nay it is worse than barren, since it is difficult to account on this hypothesis for the absence of Diatoms for example from the Silurian and other early beds in which one might expect from the nature of the deposit to find them or organisms of a like kind. It would be easy to insist on the comparative worthlessness of negative evidence in a case of this kind, but it is a duty to state the difficulty emphatically if it is ever to be removed. It is difficulties of this stubborn kind that stand in the path of the theory of evolution and not the ingeniously constructed and imaginary obstacles evolved from the fermenting brains of the new school of subjective naturalists who know not Darwin but who know Nature well—at second hand.

	Arctic Sea.		West Indies.		Australia.		Algæ common to							
							Arctic Sea and West Indies.		West Indies and Australia		Arctic Sea and Australia.		All three regions.	
	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.
Florideæ														
Ceramieæ	6	23	6	44	13	107	2	4	6	9	3	1	2	1
Cryptonemiaceæ	0	0	9	29	8	35	0	0	5	1	0	0	0	0
Gigartineæ	7	11	10	22	8	38	7	3	6	1	3	0	3	0
Dudresnayeæ	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Furcellarieæ	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Dumontiaceæ	3	5	0	0	2	2	0	0	0	0	1	0	0	0
Spyridieæ	0	0	1	6	1	10	0	0	1	2	0	0	0	0
Areschougieæ	0	0	1	1	3	18	0	0	0	0	0	0	0	0
Champieæ	1	2	2	6	4	17	1	0	2	2	1	1	1	0
Rhodymeniaceæ	5	6	6	20	11	59	2	2	5	3	3	1	2	1
Squamarieæ	5	6	1	1	3	8	1	1	1	0	2	0	1	0
Porphyraceæ	4	6	2	6	2	4	2	1	2	1	2	1	2	1
Sphaerococcoideæ	0	0	4	61	14	42	0	0	2	5	0	0	0	0
Delesserieæ	2	8	3	6	4	37	2	1	3	1	2	0	2	0
Helminthocladiaceæ	0	0	6	40	8	22	0	0	6	12	0	0	0	0
Chaetangieæ	0	0	2	2	5	7	0	0	2	1	0	0	0	0
Gelidieæ	0	0	2	13	4	9	0	0	1	2	0	0	0	0
Hypneaceæ	0	0	2	21	6	30	0	0	2	4	0	0	0	0
Solieriеæ	0	0	4	12	6	20	0	0	4	3	0	0	0	0
Wrangelieæ	2	5	1	2	3	26	0	0	1	0	0	0	0	0
Lomentarieæ	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Spongocarpieæ	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Chondrieæ	0	0	2	24	7	41	0	0	2	9	0	0	0	0
Rhodomeleæ	3	14	14	91	29	164	1	3	13	13	2	0	1	0
Corallineæ	4	16	7	37	8	44	3	3	6	10	3	2	3	2
Total	44	104	85	444	151	743	21	18	79	79	32	6	17	5

PHAEOPHYCEÆ														
Fucaceæ	5	14	4	33	20	118	1	2	4	3	1	1	1	0
Tilopterideæ	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Dictyotaceæ	0	0	7	44	7	29	0	0	5	10	0	0	0	0
Ectocarpaceæ	6	16	1	13	3	5	1	0	1	1	1	1	1	0
Sphacelariaceæ	4	6	1	2	2	10	1	0	1	0	2	2	1	0
Chordariaceæ	6	7	6	8	7	13	3	2	4	2	2	1	1	1
Punctariaceæ	7	13	1	1	2	2	0	0	0	0	2	0	0	0
Arthrocladiaceæ	0	0	1	2	1	3	0	0	1	2	0	0	0	0
Sporochnaceæ	2	3	3	8	7	23	2	0	3	3	2	2	2	0
Scytosiphoneæ	2	3	0	0	1	1	0	0	0	0	1	1	0	0
Laminarieæ	5	23	0	0	2	5	0	0	0	0	0	0	0	0
Lithodermeæ	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Aglaozonieæ	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Ralfsiaceæ	1	2	1	1	0	0	1	0	0	0	0	0	0	0
Total...	42	92	25	112	52	209	9	4	19	21	11	8	6	1
CHLOROPHYCEÆ														
Chaetophoraceæ	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Siphoneæ	2	2	22	95	18	75	2	1	11	18	1	1	1	1
Conferveæ	11	27	4	77	13	64*	3	2	2	8	2	1	2	1
Ulveæ	5	23	4	15	3	10	3	5	2	6	2	5	2	4
Total...	19	54	30	187	34	149	8	8	15	32	5	7	5	6
PROTOPHYCEÆ total ...	6	9	10	45	18	31	4	0	5	3	4	0	4	0
AGGREGATE	111	259	150	788	255	1132	42	30	109	135	42	21	32	12

* A few of these are probably fresh water,

	Arctic Sea.		West Indies.		Australia.		Algæ common to							
							Arctic Sea and West Indies.		West Indies and Australia		Arctic Sea and Australia.		All three regions.	
	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.
Florideæ														
Ceramieæ	6	23	6	44	13	107	2	4	6	9	3	1	2	1
Cryptonemiaceæ	0	0	9	29	8	35	0	0	5	1	0	0	0	0
Gigartineæ	7	11	10	22	8	38	7	3	6	1	3	0	3	0
Dudresnayeæ	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Furcellarieæ	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Dumontiaceæ	3	5	0	0	2	2	0	0	0	0	1	0	0	0
Spyridieæ	0	0	1	6	1	10	0	0	1	2	0	0	0	0
Areschougieæ	0	0	1	1	3	18	0	0	0	0	0	0	0	0
Champieæ	1	2	2	6	4	17	1	0	2	2	1	1	1	0
Rhodymeniaceæ	5	6	6	20	11	59	2	2	5	3	3	1	2	1
Squamarieæ	5	6	1	1	3	8	1	1	1	0	2	0	1	0
Porphyraceæ	4	6	2	6	2	4	2	1	2	1	2	1	2	1
Sphaerococcoideæ	0	0	4	61	14	42	0	0	2	5	0	0	0	0
Delesserieæ	2	8	3	6	4	37	2	1	3	1	2	0	2	0
Helminthocladiaceæ	0	0	6	40	8	22	0	0	6	12	0	0	0	0
Chaetangieæ	0	0	2	2	5	7	0	0	2	1	0	0	0	0
Gelidieæ	0	0	2	13	4	9	0	0	1	2	0	0	0	0
Hypneaceæ	0	0	2	21	6	30	0	0	2	4	0	0	0	0
Solieriеæ	0	0	4	12	6	20	0	0	4	3	0	0	0	0
Wrangelieæ	2	5	1	2	3	26	0	0	1	0	0	0	0	0
Lomentarieæ	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Spongocarpieæ	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Chondrieæ	0	0	2	24	7	41	0	0	2	9	0	0	0	0
Rhodomeleæ	3	14	14	91	29	164	1	3	13	13	2	0	1	0
Corallineæ	4	16	7	37	8	44	3	3	6	10	3	2	3	2
Total...	44	104	85	444	151	743	21	18	70	79	22	6	17	5
Phæophyceæ														
Fucaceæ	5	14	4	33	20	118	1	2	4	3	1	1	1	0
Tilopterideæ	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Dictyotaceæ	0	0	7	44	7	29	0	0	5	10	0	0	0	0
Ectocarpaceæ	6	16	1	13	3	5	1	0	1	1	1	1	1	0
Sphacelariaceæ	4	6	1	2	2	10	1	0	1	0	2	2	1	0
Chordariaceæ	6	7	6	8	7	13	3	2	4	2	2	1	1	1
Punctariaceæ	7	13	1	1	2	2	0	0	0	0	2	0	0	0
Arthrocladiaceæ	0	0	1	2	1	3	0	0	1	2	0	0	0	0
Sporochnaceæ	2	3	3	8	7	23	2	0	3	3	2	2	2	0
Scytosiphoneæ	2	3	0	0	1	1	0	0	0	0	1	1	0	0
Laminarieæ	5	23	0	0	2	5	0	0	0	0	0	0	0	0
Lithodermeæ	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Aglaozonieæ	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Ralfsiaceæ	1	2	1	1	0	0	1	0	0	0	0	0	0	0
Total...	42	92	25	112	52	209	9	4	19	21	11	8	6	1
Chlorophyceæ														
Chaetophoraceæ	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Siphoneæ	2	2	22	95	18	75	2	1	11	18	1	1	1	1
Conferveæ	11	27	4	77	13	64*	3	2	2	8	2	1	2	1
Ulveæ	5	23	4	15	3	10	3	5	2	6	2	5	2	4
Total...	19	54	30	187	34	149	8	8	15	32	5	7	5	6
Protophyceæ total ...	6	9	10	45	18	31	4	0	5	3	4	0	4	0
Aggregate	111	259	150	788	255	1132	42	30	109	135	42	21	32	12

* A few of these are probably fresh water.

The BIOLOGICAL RESULTS of the Cruise of the S.Y. "ARGO" round the WEST COAST of IRELAND in August, 1890.

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With Plates VIII., IX., X.

(And an Appendix on Sponges by Dr. R. Hanitsch, with Plates XI. and XII.)

[Read February 13th. 1891.]

Last Summer Mr. Alfred Holt very kindly invited me to be one of the party during a cruise of his steam-yacht "Argo" round the west coast of Ireland; and he was not only good enough to offer to give me facilities for dredging and collecting animals in other ways whenever possible, but he also, when I suggested the possibility of getting a few hauls of the dredge in deep water, at once agreed to devote a day or two to doing so, and with this object in view he laid in about 1200 fathoms of galvanized steel-wire rope, and devised a small hand winch for winding it in. Unfortunately the exceptionally bad weather we met with off the Donegal Coast prevented us from making any use of this special tackle in deep water; but we had some hauls of the dredges and trawl at various localities round the coast in depths up to 60 fathoms, and a good deal of tow-netting and some shore-collecting. I took with me a new double or reversible trawl, which worked very satisfactorily, several ordinary naturalist's dredges, one with a semi-circular scraping edge (which we left at the

bottom, off Dursey Head), several tow-nets, microscopes, boxes of bottles, jars and tubes, a swinging aquarium, and the usual preserving and mounting re-agents.

The "Argo" started from Greenock at 5 a.m. on Thursday, August 7th, and spent the rest of the month in coasting round the north, west and south of Ireland. The annexed map (Plate VIII.) shows approximately the course, and the numbers 1, 2, 3, &c., indicate the successive stations at which tow-net gatherings were taken, while the letters A, B, C, &c., mark the localities where we were able to dredge or trawl or collect shore specimens.

Mr. I. C. Thompson has kindly gone over all the tow-net gatherings for me, and has drawn up the lists (p. 185, &c.) of the species found at the different stations, which are arranged in chronological order. Mr. Thompson has also compiled the table on p. 194 which shews the distribution of the species of Copepoda over the various districts explored. Among the rarer forms attention may be drawn to *Pontella wollastoni*, *Pseudocyclops obtusus*, *Monstrilla rigida*, and *Porcellidium subrotundum*.

On several occasions we used two tow-nets, the one made of fine silk and the other of a coarser material, simultaneously, one on each side of the ship, and found that the finer net invariably contained by far the most material or "plankton." The coarser net only captured a few of the larger animals, such as *Megalopa*, *Sagitta*, and *Pleurobrachia*, so we soon gave up using it.

[In his recently published work, entitled "Plankton-Studien,"* Hæckel introduced a number of new terms applicable to the assemblages of forms collected by the tow-net, which will probably be found useful as giving

* Jena: Gustav Fischer, 1890.

precision to our ideas, and in enabling us to dispense with a good deal of circumlocution. He says if we apply the term "Halobios" to the entire assemblage of living organisms inhabiting the waters, we may divide these into two primary groups, "Benthos," or those that live on the ground at the bottom, and "Plankton,"† or those that move free in the water. Benthos may be divided conveniently into the "Littoral Benthos" and the "Abyssal Benthos," terms which require no explanation, and each of these again comprises "Sessile" and "Vagile" forms. Then Plankton in this wide sense can be divided into "Nekton," or those forms which can swim actively, and "Plankton" in the more restricted sense, comprising those that swim feebly or not at all, and so are liable to be carried about by currents. This Plankton again can be divided according as it belongs to fresh waters or to the sea into "Limnoplankton" and "Haliplankton," and the former of these assemblages may be sub-divided into Autolimnetic, Zonolimnetic, and Bathylimnetic groups, according as the organisms live on the surface, at a certain definite depth, or in deep-water close to the bottom. Then the Haliplankton may be divided into "Oceanic" and "Neritic." The former is what we find away from land in the open sea and may be conveniently grouped under the five great oceanic basins, (1) Arctic, (2) Atlantic, (3) Indian, (4) Pacific, and (5) Antarctic. The Neritic Haliplankton is what we find round the coasts of continents and islands, and it might be termed Littoral Plankton. Then the Oceanic Plankton of the great ocean basins may be further sub-divided into Pelagic, Zonary, and Bathybic, according as the organisms are found on the surface of the sea, at a particular depth or zone, or finally only in deep-water near the bottom. Then further, the

† A term introduced by Prof. V. Hensen, of Kiel, a few years ago.

Pelagic Plankton, always according to Hæckel, may be divided up into three groups, (1) "Autopelagic," those forms which are *only* found on the surface, (2) "Bathypelagic," those which occur on the surface and *also* at greater depths, and (3) "Spanipelagic," those forms which normally live at considerable depths (*i.e.*, are then zonary or bathybic forms), but periodically come to the surface for a short time—it may be only for a week or even for a single day in the year. The Bathypelagic includes the great mass of Plankton, and it may be distinguished into "Nyctipelagic," only coming to the surface during the night, "Chimopelagic," only found on the surface during winter, and "Allopelagic," which seem to make irregular vertical migrations, being sometimes on the surface and sometimes in the depths independently of temperature changes.

Then again, from another point of view, the terms "Holoplanktonic" and "Meroplanktonic" may be usefully applied, the former to those organisms which can be ranged under Plankton during the whole of their existence, and the latter to such forms as belong, in some stages of their life history, not to Plankton at all, but to the Benthos (either littoral or abyssal).

Finally, the Plankton wherever it occurs may be "Monotonic" when it is formed almost entirely of one particular organism or group of organisms, or "Polymiktic" when, as is usually the case, a gathering contains a mixture or assemblage of a number of different kinds of plants and animals.]

The dredged and shore material ("Littoral Benthos" of Hæckel) was collected as follows:—

(A) In Killybegs Harbour, August 10th: 3 hauls of the dredge in the forenoon, depth 5—10 fms.; and 3 in the afternoon, depth 10—15 fms.

(B) Killary Bay, August 11th, trawled in 20 fms.; and

August 13th, dredged from a small boat, 5—10 fms., mud.

(C) Island of Inishbofin, August 15th, shore collecting at low tide.

(D) Galway Bay, August 17th, shore collecting at Salthill, low tide.

(E) Off Inishmore, Arran Ids, due north of Killeany, 3 miles out, August 18th, dredged and trawled in 24 fms.

(F) Off Bull Island, Dursey Head, August 24th, dredged in 60 fms., gravel.

(G) Bantry Bay, August 26th, dredged in about 10 fms., sand.

I am indebted to a number of friends for help in drawing up the following lists and notes. Professor A. C. Haddon has kindly examined the Actiniæ, Professor Jeffrey Bell has named several of the more difficult Echinodermata, Dr. Hanitsch has examined the Sponges and Mr. A. O. Walker the Crustacea, Mr. F. Archer has furnished me with a small list of Shells, Miss L. R. Thornely has identified the Hydroid Zoophytes and the Polyzoa, Mr. J. Hornell has named the few Worms, while Miss A. E. Warham, B.Sc., and Miss J. H. Willmer have gone over all the Tunicata, under my direction, and have given me much assistance in the dissection and identification of the numerous specimens.

List of the Tow-net Gatherings.

1. Off Pladda, near Arran, Firth of Clyde, August 7th. (Deposit thick and yellow.)

Many Diatoms, *Coscinodiscus* and others.

Ceratium tripos	- - - -	very abundant
C. furca	- - - -	,,
C. fusus	- - - -	,,

Peridinium divergens - - - ,,
Thaumantias
Sagitta - - - - - - - a few
Young Annelids
Larval Echinoderms (Ophiurid Plutei) - ,,
Young Lamellibranchs and Veligers
Appendicularia - - - - - several
Nauplei
Schizopoda - - - - - - one
Megalopa of crabs - - - - - a few
Evadne nordmanni - - - - - several
COPEPODA—*Calanus finmarchicus* - - several
Temora longicornis - - ,,
Oithona spinifrons - - abundant
Pseudocalanus elongatus - ,,
Centropages hamatus - - ,,
Dias longiremis - - - ,,
Ectinosoma atlanticum - - a few

2. Lennan Bay, Lough Swilly, 3 gatherings from 9 p.m. Aug. 7th to 9 a.m. Aug. 8th.

(Deposit thick and full of debris, slightly phosphorescent.)
Radiolaria - - - - - - a few
Ctenophora - - - - - - very many
Thaumantias, and other Medusoid gonophores, many
Annelids, larval
COPEPODA—*Pseudocalanus elongatus* - several
Centropages hamatus - - ,,
Oithona spinifrons - - abundant
Cyclopina littoralis - - several

3. Near Gola Id., Gweedore Sound, August 8th, 6 p.m.

(Rather thick and yellowish, very prolific in Copepoda.)
Medusoid gonophores* - - - - a few

* Including a *Sarsia* budding both from the manubrium and from the base of the tentacles.

Appendicularia
Ascidian larvæ
Fishes' eggs
Nauplei (Cirripede and Copepod)

Evadne nordmanni	- - - - -	several
Schizopoda	- - - - - -	,,
Copepoda—*Calanus finmarchicus*	- -	,,
Centropages hamatus	- -	,,
Temora longicornis	- -	abundant
Pseudocalanus elongatus	-	,,
Dias longiremis	- - -	several
Oithona spinifrons	- -	abundant
Isias clavipes	- - -	several
Ectinosoma atlanticum	- -	a few
E. spinipes	- -	,,
Monstrilla rigida	- - -	one
Bradya typica	- - -	,,

4. Off Gola Id., Gweedore Sound, August 8th, at night.

Sarsia, and other small Medusoids
Annelid larvæ
Molluscan veligers
Appendicularia
Ascidian larvæ
Ostracoda, a few
Nauplei
Evadne (with young)

Amphipoda	- - - - - - -	a few
Schizopoda	- - - - - - -	,,
Copepoda—*Calanus finmarchicus*	- -	several
Pseudocalanus elongatus	-	,,
Oithona spinifrons	- -	,,
Isias clavipes	- - -	,,
Longipedia coronata	- -	one

5. Killybegs Harbour, Donegal Bay, Aug. 9th, all night.
(Thick, and mostly debris; phosphorescent.)

Ceratium tripos	abundant
Annelida	,,
Rotifera	some
Amphipoda	abundant
Copepoda—*Pseudocalanus elongatus*	several
Centropages hamatus	,,
Dias longiremis	,,
Ectinosoma spinipes	,,
E. erythrops	,,
Idya furcata	a few
Cyclopina littoralis	,,

6. Killary Lough, 2 gatherings, August 11th.
(Thick and dark green colour, full of debris.)

Copepoda—*Oithona spinifrons*	very abundant
Pseudocalanus elongatus	a few
Centropages hamatus	,,
Dias discaudatus	,,

7. Killary Lough, August 13th (not all examined).
(Very thick, olive green, debris.)

Copepoda—*Oithona spinifrons*

8. Galway Bay, morning of August 17th.
(Thick, dark green.)

Conferva	abundant
Diatoms	,,
Ceratium tripos	several
Pleurobrachia	many
Medusoid gonophores	
Larval Echinoderms	a few
Rotifera	
Annelid larvæ	
Ascidian larvæ	
Appendicularia	
Nauplei	

Podon intermedius - - - - - several
COPEPODA—*Pseudocalanus elongatus* - - abundant
Oithona spinifrons - - ,,
Harpacticus chelifer - - one

9. Galway Bay, afternoon of August 17th.
(Very thick, green; Diatoms abundant.)
Ceratium tripos - - - - - abundant
COPEPODA—*Oithona spinifrons* - - - ,,

10. Galway Bay, August 18th, forenoon, 2 gatherings.
(Thick and greenish yellow.)
Conferva and diatoms - - - - abundant
Ceratium tripos - - - - - several
Young Actinotrocha
Podon intermedius - - - - - a few
COPEPODA—*Oithona spinifrons* - - several
Harpacticus chelifer - - one

11. Due North of Killeany, Arran Ids., 3 miles out, Aug. 18th, afternoon.
(Thick and muddy appearance.)
Ceratium tripos - - - - - abundant
Tintinnus denticulatus - - - - several
Sagitta - - - - - - ,,
Tomopteris, sp. - - - - - ,,
Megalopa - - - - - - ,,
Schizopoda - - - - - - ,,
COPEPODA—*Calanus finmarchicus* - - a few
Pseudocalanus elongatus - abundant
Centropages hamatus - - ,,
C. typicus - - ,,
Oithona spinifrons - - ,,
Dias longiremis - - - ,,

12. In Killeany Bay, Arran Ids., 2 gatherings, Aug. 19.
(Rather thick and green, very prolific.)
Conferva - - - - - - - abundant

Tintinnus campanula	several
Ceratium tripos	abundant
C. fusus	several
Radiolaria	a few
Sagitta	,,
Appendicularia	several
COPEPODA—*Calanus finmarchicus*	few
Pseudocalanus elongatus	several
Centropages hamatus	,,
C. typicus	,,
Oithona spinifrons	abundant
Dias longiremis	,,
Porcellidium subrotundum	one
Laophonte similis	,,
L. curticauda	two

13. Off Carrigaholt, Shannon, Aug. 19th, all night.
(Very thick and dirty looking.)

Ctenophora	quantities
Amphipoda*	several
Cumacea*	,,
COPEPODA—*Temora longicornis*	,,
Oithona spinifrons	,,
Centropages hamatus	,,
C. typicus	,,
Dias longiremis	,,
Isias clavipes	,,
Peltidium depressum	two

14. Scattery Id., Shannon, Aug. 20th.
(Rather thick, light green.)

Actinomonas pusilla	several
Ceratium tripos	,,
Diatoms, several species	,,
Appendicularia	,,

* See lists on p. 204.

Megalopa and Zoea of crabs - - -	,,
Cumacean - - - - - -	one
COPEPODA—*Temora longicornis* - -	several
Centropages hamatus - -	abundant
Dias longiremis - - -	,,
Dias discaudatus - - -	,,
Longipedia coronata - -	one
Harpacticus chelifer - -	a few
do. var. *gracilis*,	one
Pontella wollastoni - -	,,
Parapontella brevicornis -	,,
Cyclopina littoralis - -	abundant
Harpacticus fulvus - -	one
Oithona spinifrons - -	a few

15. Templenoe, Kenmare River, Aug. 21st, all night. (Transparent.)

Ceratium tripos - - - - -	several
Peridinium divergens - - - -	,,
Ctenophora - - - -	,,
Mollusca, very small - - - -	,,
COPEPODA—*Temora longicornis* - -	a few
Oithona spinifrons - -	abundant
Dias longiremis - - -	several
Larval Copepoda - - -	abundant

16. Templenoe, Kenmare River, August 21st. (Very thick but contains little.)

Ceratium tripos - - - - -	several
Peridinium divergens - - - -	,,
Evadne nordmanni - - - -	,,
COPEPODA—*Dias longiremis* - - -	,,
Oithona spinifrons - -	abundant
Isias clavipes - - -	several
Parapontella brevicornis -	scarce

Ectinosoma atlanticum - -	,,
E. spinipes - -	,,
Thalestris longimana - -	,,
Laophonte longicauda - -	,,
Cletodes linearis - - -	one
C. limicola - - -	,,

17. Kenmare River, Aug. 24th, night and morning, water brown.

(Clear and contains little.)

Diatoms - - - - - -	several
Ceratium tripos - - - - -	,,
Copepoda—*Oithona spinifrons* - -	several
Harpacticus chelifer - -	one

18. Berehaven, Bantry Bay, Aug. 24th—25th, all night.

(Thin, containing little.)

Ceratium tripos - - - - -	several
C. furca - - - - -	,,
C. fusus - - - - -	,,
Peridinium divergens - - - -	,,
Cumacean - - - - - -	one
Copepoda—*Temora longicornis* - -	several
Oithona spinifrons - - -	,,
Centropages hamatus - -	,,
Isias clavipes - - -	,,
Harpacticus chelifer - -	one
Caligus rapax - - -	,,

19. Berehaven, Bantry Bay, August 25th.

Contains very little except debris and Ctenophora (Lobata).

20. Berehaven, Bantry Bay, August 25th.

Ctenophora (Lobata) forms chief bulk.

Peridinium divergens - - - -	several
Amphipoda - - - - - -	,,

COPEPODA—*Centropages hamatus*	- -	a few
Dias longiremis	- - -	,,
Thalestris longimana	- -	one
Cyclopina littoralis	- -	a few

21. Glengariff, Bantry Bay, August 25th, evening.
(Clear, containing very little.)

Ceratium tripos - - - - -	abundant
C. fusus - - - - -	,,
C. furca - - - - -	a few
Peridinium divergens - - - -	abundant
Actinomonas mirabilis - - - -	several
Radiolaria - - - - - -	a few
Ctenophora, small - - - - -	several
Podon intermedius - - - - -	one
COPEPODA—*Pseudocalanus elongatus* -	several
Dias longiremis - - -	,,
D. discaudatus - - -	,,
Isias clavipes - - -	,,
Centropages hamatus - -	,,
Pseudocyclops obtusus - -	one
Oithona spinifrons - -	very abundant
Cyclopina littoralis - -	several

22. Glengariff, Bantry Bay, Aug. 25th—26th, all night.
(Clear with yellow tinge, very little material.)

Ceratium tripos - - - - -	several
Podon intermedius - - - - -	a few
COPEPODA—*Oithona spinifrons* - -	very abundant
Ectinosoma atlanticum -	scarce

The following table, drawn up by Mr. Thompson, shews the distribution of the species of Copepoda over the different districts.

"ARGO" TOW-NETTINGS—DISTRIBUTION OF COPEPODA.

Number in List.	1	2	3, 4	5	6, 7	8,9,10	11, 12	13	14	15,16,17	18,19,20	21, 22
Locality.	Off Pladda.	Lough Swilly.	Gola Id.	Killybegs.	Killary Bay.	Galway Bay.	Killeany Bay, Arran Ids.	Carrigaholt.	Scattery Id.	Templenoe, Kenmare River	Berehaven.	Glengariff.
SPECIES.												
Calanus finmarchicus	×		×				×					
Pseudocalanus elongatus	×	×	×	×	×	×	×					×
Temora longicornis	×							×	×	×	×	
Centropages hamatus	×	×	×	×	×		×	×	×		×	×
C. typicus							×	×				
Dias longiremis	×		×	×			×	×	×	×	×	×
D. discaudatus					×				×			×
Isias clavipes			×					×		×	×	×

Pontella wollastoni									×			
Parapontella brevicornis									×	×		
Oithona spinifrons	×	×	×		×	×	×	×	×	×	×	×
Pseudocyclops obtusus												×
Ectinosoma atlanticum	×		×							×		×
E. erythrops				×								
E. spinipes			×	×						×		
Longipedia coronata			×						×			
Cyclopina littoralis		×		×					×		×	×
Harpacticus chelifer						×			×	×	×	
do. var. *gracilis*									×			
H. fulvus									×			
Idya furcata				×								
Thalestris longimana										×	×	
Bradya typica			×									
Peltidium depressum								×				
P. interruptum											×	
Laophonte similis							×					
L. curticauda							×					
L. longicauda										×		
Cletodes limicola										×		
C. linearis										×		
Monstrilla rigida			×									
Porcellidium subrotundum							×					
Caligus rapax											×	

ALGÆ.

I made small collections of Algæ from near low water mark on the shore at two points where we happened to be on land at the right state of the tide, viz.: at the Island of Inishbofin off the coast of Connemara on August 15th, and at Galway on August 17th. The specimens were handed over to Mr. Harvey-Gibson, and they have been identified in his laboratory and under his supervision by Miss A. E. Warham, B.Sc., who has furnished me with the following lists.

The collection of Marine Algæ is a small one, and contains few species of any rarity. Amongst the more interesting forms are *Dermocarpa schousbœi*, *Halopteris filicina*, *Ascocyclus reptans*, *Lomentaria clavellosa*, *Chylocladia ovalis*, and *C. kaliformis*. All the other species are common. The nomenclature adopted is that of Holmes and Batters' "Revised List of British Marine Algæ." (Ann. Bot., vol. v., p. 63).

Species found at Inishbofin are indicated by the figure (1), those at Galway Bay by (2).

CYANOPHYCEÆ.

Dermocarpa prasina, Born. (1)
D. schousbœi Born. (1)
Lyngbya majuscula, Harv. (1)
L. semiplena, J. Ag. (1)
Calothrix pulvinata, C. Ag. (1, 2)

CHLOROPHYCEÆ.

Enteromorpha compressa, Grev. (1, 2)
E. clathrata, J. Ag. (1, 2)
Urospora pencilliformis, Aresch. (1)
Cladophora rupestris, Kütz. (1, 2)
C. pellucida, Kütz. (1)
Chætomorpha linum, Kütz. (1)

PHÆOPHYCEÆ.

Dictyosiphon fæniculaceus, Grev. (1)
Ectocarpus confervoides, Le Jol. (1, 2)
Ascocyclus reptans, Rke. (1)
Asperococcus echinatus, Grev. (1)
Chordaria flagelliformis, C. Ag. (1)
Pylaiella litoralis, Kjellm. (1, 2)
Sphacelaria cirrhosa, C. Ag. (1, 2)
Chætopteris plumosa, Kütz. (1, 2)
Halopteris filicina, Kütz. (1)
Stypocaulon scoparium, Kütz. (1)
Halidrys siliquosa, (1, 2)

RHODOPHYCEÆ.

Bangia fuscopurpurea, Lyngb. (1)
Chantransia virgatula, Thur. (2)
Chondrus crispus, J. Ag. (1, 2)
Cystoclonium purpurascens, Kütz. (1, 2)
Rhodymenia palmata, Grev. (1, 2)
Lomentaria clavellosa, Gaill. (1, 2)
Chylocladia kaliformis, Grev. (1)
C. ovalis, Hook. (1)
Plocamium coccineum, Lyngb. (1,2)
Nitophyllum laceratum, Grev. (1, 2)
Delesseria sinuosa, Lamx. (1, 2)
D. sanguinea, Lamx. (1, 2)
Rhodomela subfusca, C. Ag. (1, 2)
Laurencia pinnatifida, Lamx. (2)
Polysiphonia fastigiata, Grev. (1, 2)
P. nigrescens, Grev. (1, 2)
P. byssoides, Grev. (2)
Dasya coccinea, C. Ag. (1)
Callithamnion hookeri, C. Ag. (1)
C. corymbosum, Lyngb. (1)

Ceramium rubrum, C. Ag. (1, 2)
C. tenuissimum, J. Ag. (1)
C. circinatum, J. Ag. (1)
C. ciliatum, Ducluz. (1)
Polyides rotundus, Grev. (1)
Melobesia farinosa, Lamx. (1)
Corallina officinalis, Linn. (1)

SPONGES.*

CALCAREA—*Ascetta coriacea*, Fl., var. *osculata*, and *Sycandra ciliata*, Fl., on rock, off Arran Ids.
MONAXONIDA—*Halichondria caruncula*, B., off Arran Ids.
Reniera (*densa*, B.?) do.
Esperella sordida, B., rock, off Arran Ids.
Desmacidon fucorum, J., off Arran Ids.
Suberites ficus, E., Killybegs, 5—15 fms.
Suberites domuncula, N., Killary, 10 fms., incrusting shells inhabited by Paguri.
Iophon hyndmani, B., rock, off Arran Ids.
CERATOSA—*Aplysilla rubra*, Hn., do.

CŒLENTERATA.

HYDROIDA.

Hydractinia echinata, Flem., abundant.
Bougainvillea (?)
Clytia johnstoni, Ald.
Obelia flabellata, Hincks.
Obelia geniculata, Linn.
Campanularia neglecta, Ald.

* Dr. Hanitsch has written some further notes about some of these species of Sponges which will be found as an Appendix at the end of this paper (p. 213).

Calycella syringa, Linn.
Filellum serpens, Hass.
Halecium halecinum, Linn.
Sertularia pumila, Linn.
Plumularia setacea, Ellis.
P. halecioides, Ald., on sponge.
P. pinnata, Linn.
Aglaophenia tubulifera, Hincks.

ALCYONARIA.

Alcyonium digitatum, Linn., white, yellow, and deep orange varieties.

Virgularia mirabilis, Linn., very fine, and in quantity, brought up by the anchor from stiff blue mud at Glengariff.

ACTINIARIA.

Professor A. C. Haddon reports as follows:—"Professor Herdman submitted to me a few specimens of Actiniæ collected by himself when on the 'Argo': they consisted of two species—

"(1) *Anthea cereus*, Johnst., which is extremely common on the west coast of Ireland, especially on Zostera beds, the Actinian looking like an inflorescence on the Zostera. The ashy grey variety is the most common, occasionally the tentacles have a distinct green sheen.

"(2) *Sagartia (?) herdmani*, n. sp. (cut, fig. 1).

"It is extremely difficult to investigate the anatomy of this form owing to the greatly contracted condition of the spirit specimens, and therefore I cannot yet speak with confidence as to the genus. I am however pretty confident that this is a new species; unfortunately I have not had the opportunity of seeing it alive, nor are there any sketches of the living and expanded animal. Provision-

ally I have the pleasure of naming it after my friend and its discoverer.

Fig. 1. *Sagartia (?) herdmani*, n. sp.

"The presence of acontia makes it a Sagartian, the mesenteries appear to have the arrangement which characterises the more typical Sagartidæ, it is probably not one of the Chondractininæ (cf. Trans. Roy. Dublin Soc., 1889, p. 305). The external characters are as follows:—

"Highly contracted Sagartiæ of a low dome shape (in spirit) with an expanded pedal disc; surface finely corrugated; capitulum when retracted with twelve ridges; acontia emitted through mouth (?); pedal disc in most specimens becomes remarkably folded, the folds being transformed into new Actiniæ which gradually become separated from the parent and creep away (see cut, fig. 1) —twenty or more buds may be formed at the same time. Colour.*

"Dimensions—long diameter of base of column 12—14 mm., short diameter 8 mm.; height of contracted column 5—7 mm.; the pedal disc extends from 1 to 2 mm. beyond the column.

"Habitat—on *Turritella* shells, in Killary Lough, W. of Ireland, 5 to 10 fms., August, 1890; abundant.

"It is well known that some Actiniæ proliferate from their pedal disc, *Metridium* (*Actinoloba*) *dianthus* is a

* [When alive, the colour was a pale brick-red with whitish markings on the tentacles. The animal when dredged had the same low dome shape as now; when expanded in the aquarium it became a short cylinder: the tentacles were numerous, small, slender and pointed.—W.A.H.]

case in point; but I know of no Actinian which has this habit in so marked a degree as has the above species. I cannot at present say whether this is a constant character or whether it has a purely seasonal significance."

Caryophyllia borealis, off Killeany, Arran Ids., 24 fms.

CTENOPHORA.

Pleurobrachia, (sev. sp.) in great abundance round the coast.

ECHINODERMATA.

Astropecten irregulare, Penn.

Luidea sarsii, Düb. and Kor. (?), trawled off Killeany, Arran Ids. 24 fms.

Asterina gibbosa, Inishbofin, low tide.

Ophiothrix pentaphyllum, Penn.

Ophiocoma nigra, Abild.

Amphiura filiformis, Forb.

Ophioglypha lacertosa, Linck.

O. albida, Forb.

Echinus esculentus, Linn.

Echinocyamus pusillus, Müll., many, off Dursey Head.

Holothuria nigra, Peach.

Cucumaria hyndmani, Forb.

Ocnus brunneus, Forb.

The only one of these species which calls for further remark is :—

Holothuria nigra, Peach.

This is the "nigger," or "cotton spinner" of the Cornish fishermen, a form which has usually been considered very rare, and was not recorded as British until recently. It is known now from several points on the southern and western coasts of Ireland and the southern coast of England. It belongs to the group of Aspidochirotæ, forms with 20 shield-shaped tentacles, and is the only representative of that set known to inhabit British

seas. It has received its popular name of cotton-spinner from its unpleasant property of emitting from the cloaca, when irritated, its cuvierian organs in the form of a number of white sticky threads of great strength, tenacity, and extensibility. Prof. Jeffrey Bell, to whose kindness I am indebted for my information, found that one of these threads on exposure to water elongated twelve-fold and swelled up to seven times its original diameter; it would then become exceedingly attenuated and elongated, and stick to everything it came in contact with, but was so strong that six such threads would hold up a weight of from 800 to 1000 grains.

On account of this peculiarity, the "nigger" is greatly detested by the Cornish crab and lobster fishermen, as they find their lobster pots besmeared with its sticky threads. Mrs. Fisher (Miss Arabella Buckley) has given in "Nature" (June 26, 1884, p. 193) an account of her experiences with a Mediterranean specimen which she had dredged, and which cast some of its threads at her hands. My own experience with the present specimen from Inishbofin was very much the same. A few seconds after picking it up it began to eject the white threads, and very soon I felt them sticking to my skin and joining my fingers together in a most unpleasant manner. The remains of the threads and the sticky feeling were difficult to get rid of afterwards. Prof. Bell, who exhibited this specimen at a meeting of the Zoological Society of London on Nov. 18th, remarks that it is specially interesting, as it has entangled itself in its own threads.* The threads are usually regarded as organs of offence and defence. This holothurian is supposed to live at a depth of from 10 to 20 fathoms, and has always been taken

* For further information see Bell, Proc. Zool. Soc., 1884, pp. 372 and 563; also Nature, June 12, 1884, p. 146, June 26, p. 193, and Aug. 7, p. 335.

previously, I think, by dredging or trawling. The present specimen was collected between tide-marks under a ledge of seaweed-covered rock near Cromwell's Fort on the Island of Inishbofin, off the Coast of Connemara.

POLYZOA.

Schizoporella linearis, Hass.
S. alderi (?)
Smittia trispinosa, John.
S. reticulata, Macg.
Cellepora avicularis, Hincks.
Crisia eburnea, Linn.
Cribrilina punctata, Hass.

All attached (along with 5 species of Sponges and some Cœlenterates) to a piece of rock trawled off the Arran Islands.

Membranipora dumerilii, Aud., on Ascidian.
Valkeria uva, Linn. var., *cuscuta*.
Lepralia canthariformis, on Ascidian.
Bowerbankia imbricata, Adams, erect form.
Pedicellina cernua, Pall., on seaweed.

BRACHIOPODA.

Terebratula caput-serpentis, Linn., several.
Crania anomala, Müll., 2 or 3.

VERMES.

Gephyrea.

Echiurus, sp. (?) brought up on anchor at Glengariff.

Polychæta.

Terebella nebulosa, Mont., several.
Nereis dumerilii, Aud. and Edw., several.

CRUSTACEA.

Decapoda.

Ebalia tumefacta, Mont., one male.
Portunus depurator, Leach.
Pinnotheres sp., from branchial sac of *Ascidia aspersa*, from Killybegs, 10 fathoms.

Eupagurus bernhardus, Linn.
E. cuanensis, Thomp.
Pandalus annulicornis, Leach.
Also some larval forms of Decapoda.

CUMACEA.

Iphinoe trispinosa, Goodsir, 2 females - Carrigaholt
Diastylis rathkei, Kröyer, 1 young male - ,,
Pseudocuma cercaria, van Beneden, several ,,

ISOPODA.

Idotea linearis, Linn., 1 adult, 1 young - ,,
Ligia oceanica, Linn. - - - - ,,

AMPHIPODA.

Gitana sarsii, Boeck, 1 female - - ,,
Monoculodes longimanus, Bate and West, 2 females ,,
Megaluropus agilis, Norman, 1 young - ,,
Dexamine spinosa, Mont., 4 or 5 young - ,,
Atylus swammerdamii, M. Edw., several ,,
Halirages bispinosus, Bate, 2 or 3 - ,,
Gammarus locusta, Linn., 4 or 5 young, Carrigaholt and Killybegs.
Microdeutopus anomalus, Rathke, several females and 2 or 3 males, Killybegs.
Microprotopus maculatus, Norman, males and females, Killybegs and Carrigaholt.
Podocerus variegatus, Bate and West, 4, Killybegs and Carrigaholt. I am aware that this species has been referred to *P. falcatus*, Mont., but as I have some doubt on the point I prefer to leave it as above. It is not *Janassa variegata*, of Boeck; it may or may not be *Podocerus variegatus* of Leach.
Corophium crassicorne, Bruzelius, 1, Killybegs.

MOLLUSCA.

Anomia ephippium, Linn.

Pecten opercularis, Linn.

P. varius, Linn.

P. tigrinus, Müll.

Arca tetragona, Poli, many, alive and dead, off Killeany, Arran Ids., 24 fms.

Nucula nucleus Linn., off Leenane, Killary Bay, 20 fms.

Pectunculus glycimeris, Linn., young.

Cardium norvegicum, Speng.

Venus gallina, Linn.

V. ovata, Penn., common.

Tellina, sp., ?

Thracea, sp.,.?

Emarginula fissura, Linn., many.

Puncturella noachina, Linn.

Capulus hungaricus, Linn., sev., young.

Trochus tumidus, Mont.

Natica, sp.

Aporrhais pes-pelicani, Linn., many, alive.

Turritella terebra, Linn., many, alive, and spawning, in Killary Bay. Spawn abundant.

Nassa incrassata, Ström.

Nassa reticulata, Linn., many, alive, off Leenane, Killary Bay, 20 fms.

Mangelia rufa, Mont.

Odostomia, sp.,

Rissoa abyssicola, Forb. (or *beanii* ?) several.

Philine aperta, Linn., many, alive, off Leenane, Killary Bay, 20 fms.

Hermæa dendritica, Ald. and Han., on *Codium tomentosum*, low water, Inishbofin.

TUNICATA.

Molgula holtiana, n. sp., on *Ascidia*, Killybegs, 10 fms.

Styela grossularia, v. Ben., Galway Bay, under stones, abundant.

Polycarpa argoensis, n. sp., Killary Lough, 20 fms.
Ascidiella aspersa, O.F.M., abundant, Killary Lough, 5—10 fms.
do., form *pustulosa*, A. and H., many large, Killybegs, 5—10 fms.
Corella parallelogramma, O.F.M., Killary Lough, 5—15 fms., mud.

Some compound Ascidians which have not yet been sufficiently examined, including a beautiful slate-blue Didemnid and a red Polyclinid, were collected at low tide on Inishbofin.

The descriptions of the two new species are as follows:—

Molgula holtiana,* n. sp. (Pl. IX., figs. 4-8).

External appearance.—The body is of oval form, and is attached by nearly the whole of the right side (Pl. IX., fig. 4). The edges and the posterior end are rounded, while the anterior end is flattened, and bears the siphons at its two extremities. The branchial aperture is at the ventral edge on a short rounded projection, while the atrial is placed on a longer, narrower siphon at the dorsal edge. The surface is even, and is not covered with sand, but has merely some fine particles of mud and a matted coating of the Alga *Cladophora lanosa*, which gives a dull brown colour to the specimen. The length and the greatest breadth are about the same, 2 cm.

The Test is moderately thick and tough, but flexible. It is of a whitish blue tint on the inner surface. It bears short slightly-branched hairs on the outer surface, which have attached to them a little mud, sand grains, &c., and a great number of algal filaments, which are matted together so as to cover up the greater part of the outside of the animal (Pl. IX, fig. 4.)

* Dedicated to my host, Mr. Alfred Holt.

The Mantle is thin, and has the usual molgulid fusiform muscles, which, however, are feebly developed. The sphincters are strong (Pl. IX., figs. 5 and 6).

The Branchial Sac has six folds on each side. There are five internal longitudinal bars on a fold. The stigmata are, in most places, not much curved, and run in the main antero-posteriorly. There are occasional wide transverse vessels with broad horizontal membranes, which, with the branchial folds, form large meshes crossed by smaller and more irregularly placed horizontal membranes. These meshes are about twice as long as they are broad (Pl. IX., fig. 7).

The Dorsal Lamina is a plain membrane.

The Tentacles are of two sizes, 5 large and 5 small. They are bipinnate (Pl. IX., fig. 8, *tn.*)

The Dorsal Tubercle is linear and undulating, with its ends slightly coiled.

The Alimentary Canal is long, and is recurved so that the intestinal loop comes close to the atrial aperture.

The Reproductive Organs are developed on both sides. Each forms an elongated sausage-like yellow mass.

This specimen had about 20 copepoda (*Notodelphis agilis*, both males and females,) in its branchial sac, four or five of them with egg masses.

Polycarpa argoensis,* n. sp. (Pl. IX., figs. 1—3).

External appearance.—The body is erect and elongated antero-posteriorly. It is scarcely compressed, and is attached by the posterior end and a small area at the end of the right side (see Pl. IX., fig. 1). The anterior end is rather wider than the posterior, and bears the two apertures on prominent siphons. The branchial aperture is terminal while the atrial is a little way down the dorsal edge; both are distinctly four-lobed. The surface is even

* From the ship "Argo."

and smooth, except at the place of attachment where the test is prolonged into several short tag-like processes. The colour is a light yellowish grey.

The length is 1·5 cm. The greatest breadth is 6 mm. and the greatest thickness 5 mm.

The Test is thin and flexible, but tough, over the greater part of the body. At the posterior end it becomes thicker and cartilaginous. It is white in section.

The Mantle is very thin, but the muscle bands, though delicate, are numerous. They run both longitudinally and transversely and form a close rectangular network. The mantle adheres very closely to the inner surface of the test. The sphincters are strong.

The Branchial Sac is large, but very delicate and transparent. It has four slight but perfectly distinct folds upon each side. Each fold has about six internal longitudinal bars, and there are two bars in each interspace. The bars are narrow, but very regular. The transverse vessels are all of the same size and are moderately wide. They have narrow horizontal membranes, and the meshes are in some places divided horizontally by similar membranes which do not interrupt the stigmata. The meshes are nearly square and contain four to six stigmata each (Pl. IX., fig. 2).

The Dorsal Lamina is a very narrow plain membrane with a straight edge and no ribs or other markings.

The Tentacles are simple. There are about 20, and they are of two sizes placed alternately.

The Alimentary Canal forms a simple and rather narrow loop. The œsophageal aperture is placed far back in the branchial sac. The œsophagus runs posteriorly and ventrally to the narrower end of the ovate stomach which has longitudinal ridges, eight on a side. The intestine at first runs ventrally and then turns anteriorly and then

dorsally so as to make a narrow loop and reach the anterior edge of the stomach. It then turns anteriorly and runs parallel to the œsophagus as the rectum which ends behind the middle of the branchial sac in an anus, the margin of which is cleft into 14 finger-like processes (Pl. IX., fig. 3). The usual delicate branched gland is found ramifying over the surface of the intestine.

Reproductive Organs were not found, but the mantle has a number of endocarps projecting from its inner surface, so no doubt polycarps would be developed later on.

The single specimen for which this species is formed was dredged with a large number of specimens of *Ascidiella aspersa* in Killary Lough.

This species comes near to Heller's *Polycarpa gracilis*,* but differs from it in the more anterior position of the atrial aperture, the less prominent folds in the branchial sac, the very narrow dorsal lamina, the fringed anus, the shape of the stomach, and the course of the intestine.

Ascidiella aspersa, O. F. M., var. *pustulosa*, A. & H. (Pl. X.)

In Killybegs harbour the dredge brought up from a muddy bottom great numbers of a large ascidian, which corresponds exactly with Alder and Hancock's description of *Ascidia pustulosa*, but that species is undoubtedly merely a large and rough form of *Ascidia aspersa*, and so *pustulosa* cannot be regarded as more than a variety. Miss Warham has examined, under my supervision, all the specimens preserved, with the object of finding parasitic copepoda, and has come upon a few abnormalities, which are noted below. The copepoda were submitted to Mr. I. C. Thompson, who has kindly identified them.

Out of 26 large specimens taken by chance from one store bottle, 21 contained copepoda, and one had a small

* Denkschr. d. K. Akad. d. Wissensch., Wien, Bd. XXXVII., p. 262, 1877.

Pinnotheres in the branchial sac, four only being free from parasites. The copepoda were *Doropygus pulex*, many, males and females, and *Ascidicola rosea*, a few, all females, and were scattered over the inner wall of the branchial sac, a few being attached to the endostyle, the dorsal lamina, the peripharyngeal bands, the tentacles, and even in the branchial siphon. Five or six copepoda is an ordinary number to find in a branchial sac, but one *Ascidia* examined contained 15.

Amongst many slight variations noted occurred that of the tentacles shown in Pl. X., fig. 1, where, besides the two ordinary alternately-placed sizes, a third very much smaller size of tentacle was found scattered irregularly. Another specimen showed the curious abnormality of the alimentary canal represented in Pl. X., fig. 2, where a large cæcum (*cæ.*) was present, running anteriorly from the highest part of the intestinal loop and parallel with the rectum. Two specimens (Pl. X., figs. 3 and 4) showed extensive deficiencies in the wall of the branchial sac. Although these may be the result of former injuries from which the animal has recovered, they cannot be due to very recent tearing at the time of capture or death, as the edges of the gaps are smooth and provided with a slight seam or margin, and have no projecting or torn blood vessels. On the other hand, they may be congenital deficiencies. The one specimen (fig. 3) shows an ⅃ shaped space on the left wall of the sac, of which the vertical limb measures 2·2 cm. and the horizontal 1·5 cm., while the breadth of the gap is in most parts from 6 to 8 mm. The second (fig. 4) has a gap on its left wall 12 mm. long and 6 mm. broad in its middle, while on the right wall, close to the dorsal lamina, there is an elliptical space measuring 8 mm. by 2 mm.

Two of the specimens had the posterior end of the test

torn off (Pl. X., figs. 5 and 6), evidently an old standing injury which had involved the area of attachment and the point where the blood vessels crossed from the mantle to the test, as in both large tufts of hypertrophied and freely-branched vascular processes were found hanging from the aperture. Fig. 7 shows the posterior end of the mantle of one of these specimens with the vessels hanging from it. In the other they were much more bushy. Figures 8, 9 and 10 show some of these abnormal vascular outgrowths magnified.

Explanation of Plates VIII.—X.

Reference Letters.

a. anus; *at.* atrial aperture; *br.* branchial aperture; *br.f.* fold in branchial sac; *cæ.* cæcum; *d.l.* dorsal lamina; *d.t.* dorsal tubercle; *en.* endostyle; *h.m, h.m'.* horizontal membranes; *i.* intestine; *i.l.* internal longitudinal bars; *œ.* œsophagus; *r.* rectum; *st.* stomach; *tn. tn.'* tentacles; *tr.* transverse vessels; *v.* vessel of test.

Plate VIII.

Sketch map showing the contours of depth in fathoms, and the course of the S.Y. "Argo" in August, 1890, from Greenock to Liverpool, round the West Coast of Ireland.

1, 2, 3, &c., stations where the tow-net was used.

A, B, C, &c., stations where dredges, &c., were used.

Plate IX.

Figs. 1—3. *Polycarpa argoensis*, n. sp.

Figs. 4—8. *Molgula holtiana*, n. sp.

Fig. 1. *Polycarpa argoensis*, from right side, nat. size.

2. Part of the branchial sac, × 50.

3. The alimentary canal, × 20.
4. *Molgula holtiana*, from left side, nat. size.
5. Body with test removed, from left side, nat. size.
6. Same from right side, nat. size.
7. Part of branchial sac, × 50.
8. Dorsal tubercle, tentacles, &c., × 50.

Plate X.

Ascidiella aspersa, var. *pustulosa*.

Fig. 1. Abnormal small tentacle, × 50.
2. Abnormal cæcum from intestine, slightly enlarged.
3 and 4. Abnormal deficiencies in wall of branchial sac, nat. size.
5 and 6. Large holes at posterior end of test, nat. size.
7. Posterior end of body of specimen drawn in fig. 6, showing branched vessels, nat. size.
8—10. Some of the twigs of these vessels, × 50.

Appendix.

NOTES on some SPONGES collected by Professor Herdman off the West Coast of Ireland from the "Argo."

By Richard Hanitsch, Ph.D.,
DEMONSTRATOR OF ZOOLOGY IN UNIVERSITY COLLEGE, LIVERPOOL.

With Plates XI and XII.

The Sponges dredged by Professor Herdman from the S.Y. "Argo" on the west coast of Ireland were only a few in number and small, but there were some very interesting forms amongst them, and all were in a state of splendid preservation. There were altogether ten species, five of which (including all the rarer forms) were attached to one small piece of rock dredged off the Arran Islands.

Ascetta coriacea, Fl., var. *osculata*.

The flat, encrusting form of *Ascetta coriacea*, with its beautiful basket-like structure, has long been known, and has been described by Montagu, Johnston, Bowerbank, and Carter. These authors, as well as Grentzenberg, in his recent paper,* did not find any oscula in their specimens. This form is frequently met with in Liverpool Bay. Apparently much rarer is the erect variety of our species, with its comparatively large oscules placed upon distinct conules. It was first figured by Hæckel,† but as he has not given a special name to the variety, I propose to call it *A. coriacea*, var. *osculata*. The collection contains four or five small specimens, which were attached to

* Die Spongienfauna der Ostsee. Inaugural Dissertation. Kiel, 1891.

† Hæckel, Die Kalkschwæmme, vol. iii., pl 3, figs. 13, 16, 17, 19, 20.

a piece of rock dredged off the Arran Islands. The largest of the colonies is laterally compressed, measuring 14 by 3 mm. horizontally, and 10 mm. vertically. It bears seven oscula, with an average diameter of 1 mm. The conules are about 2 mm. in height. Its colour (in spirit) is a transparent white.

Sycandra ciliata, Fleming.

One specimen, on rock, Arran Islands.

Halichondria caruncula, Bowerbank.

A small erect specimen, dredged off the Arran Islands.

Reniera (densa, Bowerbank, ?*)*

A small piece of a renierid sponge was dredged off Arran Islands, which may possibly belong to above species.

Desmacidon fucorum, Johnston.

A few small fragments were dredged off Arran Islands.

Esperella sordida, Bowerbank (Pl. XI, figs. 1-9).

Rhaphiodesma sordida, B., Brit. Spong., vol. iii., p. 230, pl. lxxvi..

This sponge has been described only by Bowerbank, who gave it the specific name on account of its poor and ragged outer appearance, but a more interesting and more beautiful aspect than that which the skeleton of this species offers can scarcely be imagined. The only specimen obtained is about half the size of a pea, and encrusted a piece of rock dredged off the Arran Islands. Its colour in spirit is straw-yellow. It is of a very soft consistency, and almost fell to pieces when touched. The megascleres in the specimen are styli, 0·26 by 0·0045 mm., whilst Bowerbank figures spicules of a more tylostylote character. The microscleres are of three forms: firstly, palmate anisochelæ, 0·032 by 0·0122 mm., which are mostly arranged in beautiful rosettes. The axes of the anisochelæ may either lie in one plane, occupying the radii of a circle (see Pl. XI, fig. 2), or they may lie in various planes, generally occupying the radii of a hemi-

sphere (or sphere?), similar to Bowerbank's* figure of the rosette in *Esperella lingua*, B.; secondly, sigmata, 0·1 by 0·006 mm., generally simple, a few also contort; thirdly, toxa, varying greatly in size, from 0·1 to 0·25 mm. by 0·002 to 0·005 mm.

A number of most interesting embryos were found in this specimen. They are generally of an oval shape, 0·3 by 0·21 mm, the one pole (ventral) being slightly broader and more flattened than the other one (the dorsal pole). The outer wall, except on the ventral pole, consists of high and exceedingly narrow columnar cells (the ectoderm) with the nuclei quite at their bases. Since a section through such an embryo is bound to be thicker than the diameter of its ectodermal columnar cells, and since the embryo is round, we must of course expect to see several rows of ectodermal nuclei, which will be the more numerous the thicker the section is. This is shown in the section represented in Pl. XI, fig. 9. Cilia or flagella could not be detected on the ectoderm. The ectoderm is absent on the ventral pole of the embryo. The central mass of tissue which also forms the ventral pole of the embryo, seems to be gelatinous, and contains numerous nuclei which are larger, but less intensely stained than the ectodermal nuclei. This tissue also contains spicules and for this reason one is inclined to take it to be mesoderm; so what part of the embryo represents the endoderm is a mystery to me. These embryos already possess a skeleton, both megascleres and microscleres. The megascleres are styli, 0·184 by 0·0028 mm. They are arranged in a sheaf, converging with their pointed ends and directed towards the ventral pole of the embryo, and diverging with their blunt ends and directed towards and beyond the centre of the mesoderm (see Pl. XI., fig. 8).

*Bowerbank, British Spongiadæ, vol. i., pl. xviii., fig. 297,

The microscleres are palmate anisochelæ, 0·023 mm. in length, which are not arranged in rosettes, and toxa, 0·112 by 0·002 mm. Most of the microscleres are found towards the dorsal pole. Sigmata do not seem to occur in the embryo. The embryos are enclosed in a loose membranous capsule which apparently is derived from the parent sponge.

From the foregoing it will be seen that the structure of the embryos of *Esperella sordida*, B, agrees almost completely with what Ridley and Dendy* state in regard to the Halichondrina generally: "the embryo consists of a sac of small, probably prismatic, ciliated cells, enclosing a central mass of mesodermal (?) tissue containing the developing spicules. In some cases, perhaps in all"—— "the ectoderm appears to be absent from one pole at which the mesoderm comes to the surface." But although this description agrees very well with what I found in *E. sordida*, still Ridley and Dendy's figures show only a very slight similarity with mine. These authors had examined especially the embryos of *Esperella biserialis*, *Esperella mammiformis* and *Myxilla nobilis*, and they state that similar embryos had been found by Keller in *Chalinula fertilis*, by Carter in *Halichondria simulans* and *Esperella œgagropila*, by Marshall in *Reniera filigrana* and by Schulze in *Euspongia officinalis adriatica*. I have only been able to see Carter's† paper in which he figures living embryos with cilia dorsally and laterally and with a circle of flagella near the ventral pole. The embryo of *Halichondria simulans* is in shape somewhat similar to that of *Esperella sordida*, but differs from it in its quite

* Ridley and Dendy, Report on the Monaxonida collected by H. M. S. "Challenger," p. liii.

† Carter, Annals and Magazine of Natural History, 4th ser., vol xiv., pls. 21 and 22.

irregular arrangement of the spicules. Two germ-layers can easily be made out in it, but there is no clue as to the third one. An embryo very similar to that of *Esperella sordida* has recently been figured by Lendenfeld* for *Phorospongia chaliniformis*. It also resembles it in the regular arrangement of the spicules, but differs from it in its cubical ectoderm. Lendenfeld calls the central portion of the embryo "endodermal mass," although in contains spicules and shows generally no great similarity to the endoderm of the adult sponge. It is certain that this embryonic stage has not yet been explained satisfactorily and that additional work is necessary.

Iophon hyndmani, Bowerbank.

The specimen which I refer to above species, does not differ from the type described by Bowerbank except very slightly in the relative thickness of the megascleres, and I think it safe to include the two forms under a common name. The only specimen obtained is a minute fragment of brownish colour, about 3 mm. in diameter, which was attached to the piece of rock dredged off Arran Islands. The megascleres are of two kinds, viz:—Strongyla, 0·18 by 0·003 mm. Although slender, they are not so slender as those figured by Bowerbank.† Secondly: spined styli, varying greatly in size, from 0·088 by 0·0035 mm. to 0·28 by 0·006 mm. They are more slender than those figured by Bowerbank. The microscleres are also of two forms, viz:—bipocilli which are so characteristic of the genus, 0·0087 mm. in length, and palmate anisochelæ, 0·02 mm. in length.

Bowerbank described four species of this genus, *Halichondria pattersoni*, *H. hyndmani*, *H. scandens* and *H.*

* R. v. Lendenfeld, A Monograph of the Horny Sponges, pl. xli., fig. 2.

† Bowerbank, loc. cit., vol. iii, pl. xlvi, fig. 2.

nigricans. Ridley and Dendy* regarded these species, together with some other forms, merely as varieties of one type, *Iophon pattersoni*, B. Whether they are right in doing so, is doubtful. Certainly their table on p. 118, in which they wish to show the affinities of the so called varieties, is not quite free from error. For the tylota of *I. nigricans* are not, as these authors state, "very slender; heads barely visible, or absent, not spined," but on the contrary they are not very slender, heads spined. Further the "tylota" of *I. hyndmani* have not "very slight, faintly spined heads," but they have no heads at all and no trace of spines. These spicules should rather be called strongyla, as I have done above.

Better material than was found on this occasion was obtained from the West Coast of Anglesey, on the "Hyæna" cruise, of June, 1890, and probably I shall give a detailed description of it in a future report on the Porifera of the L.M.B.C. District.

Suberites domuncula, Nardo.

Several specimens were dredged in Killary Bay at a depth of 10 fathoms. They incrusted univalve shells, inhabited by hermit-crabs, as it is usually the case with this species. I take this opportunity of correcting an oversight in my "Third Report on the Porifera of the L.M.B.C. District," p. 215. I omitted there to mention the microscleres of this form which are centrotylote. Dr. Carter was kind enough to point out this error to me and also to send me a slide and specimens which showed their spicules exceedingly well. These spicules had not been mentioned either by Johnston or by Bowerbank, although, as Dr. Carter writes me, their type-specimens, now in the British Museum, contain these spicules plentifully. Nardo and O. Schmidt had also not seen them.

* Ridley and Dendy, loc. cit., p. 117.

Suberites ficus, Esper.

Two specimens were dredged off Killybegs, August 10th, at depths of 5—15 fathoms.

Aplysilla rubra, Hanitsch (Pl. XII, figs. 1-6.)

Halisarca rubra, Hn., Trans. L'pool Biol. Soc., vol. iv., p. 196, pl. x.

The doubts which I expressed in regard to the systematic position of this form, when describing it for the first time, were not unfounded. The examination of additional and well-preserved material has convinced me that I must remove this sponge from the genus *Halisarca* to *Aplysilla*, a genus of the true Ceratosa. The skeleton of *Aplysilla*, Schulze, consists, according to Lendenfeld,† of "numerous, isolated, small, dendritically ramifying, upright fibres." In young specimens these fibres are simple, not branching, and arise about at right angles from the limiting membrane. I had noticed these fibres when describing the sponge in my "Third Report on the Porifera of the L.M.B.C. district," but I thought them to be hairs of *Mytilus*, on which the sponge was found encrusting. But the fact that the material dredged on the "Argo" expedition was encrusting a stone, and a more careful perusal of literature, have shown me that the fibres are essential parts of the sponge.

The specimen formed a small dark blood-red patch (3 mm. in diameter, 0·6 mm. in thickness) on the piece of rock dredged off Arran Islands. Its surface is raised into numerous sharp-pointed prominences, caused by the erect spongin-fibres projecting through and dragging upwards the neighbouring parts of the dermal membrane and other tissues. These fibres are isolated and simple, and spring about at right angles from the limiting membrane. Their diameter in the centre of the sponge is 0·007 mm. We

* R. v. Lendenfeld, "A Monograph of the Horny Sponges, p. 698.

may expect that in large specimens these fibres would be branched, as is the case in other species of *Aplysilla*.

A vertical section through the sponge shows a well-defined dermal membrane, 0·024 mm. thick; large but flat subdermal cavities (0·25 mm. broad, 0·028 mm. deep). The floor of the subdermal cavities is frequently seen to be perforated and to open by a narrow passage into large cavities, the inhalent canals (this is not figured on Pl. XII). The subdermal cavities, therefore, seem to be distinct from the inhalent canals. The flagellated chambers are large and sac-like, somewhat irregularly oval (in cross sections, of course, more or less round), and may be simple or bilobed (see Pl. XII, fig. 1.) Their average size is 0·08 by 0·04 mm; but the large flagellated chamber on Pl. XII, fig. 1 measures 0·24 by 0·06 mm. They open directly with a wide mouth into the large exhalent canals. The chamber system is therefore eurypylous. The lining of the flagellated chambers consists of cells in the shape of truncated cones. In a few cases I could see something like highly transparent pointed projections in front of these cells. They might have been "Kunstprodukte," or amœboid processes, or, in fact, anything, but certainly they did not show the slightest resemblance to those notorious structures, the collars and flagella, which are so often met with in literature, and so rarely in reality. The endodermal lining of inhalent and exhalent canals is distinctly squamous epithelium.

The ground-substance of the mesoderm is probably hyaline. It is full of fibrous tissue, and contains numerous stellate (amœboid) cells and large gland cells. The stellate cells are met with in all parts of the mesoderm, but they are found most crowded along the spongin-fibres. They become elongated and finally thread-like, where the fibres project beyond the level of the sponge.

Also the gland-cells are not restricted to a special part of the mesoderm, but they are most numerous in the dermal membrane, just beneath the ectoderm. They are large, round, granular, with a small nucleus, and were often seen to project with a small pointed prominence (the mouth) beyond the ectoderm. They contain a varying amount of red pigment and seem to fulfil the double function of gland cells and pigment cells. In my former paper I described these cells only as pigment cells.

According to Lendenfeld two species of *Aplysilla* have been described as British: *A. sulphurea*, Schulze, found off the Shetland Islands; and *A. rosea*, Schulze, which Lendenfeld regards as identical with *Aplysina nævus*, Carter, dredged on the "Porcupine" expedition, 1869, between Scotland and Faroe Islands (345 fathoms) and north-west of the Shetland Islands (312 fathoms). *A. sulphurea* of course differs from my species in its colour. *A. rosea* comes much nearer to it, but it is very difficult to get a correct idea of the degree of its relationship with *A. rubra*, since, as far as I know, no sections of it have been figured. Carter gives only the figure of a spirit-specimen, Lendenfeld even only a figure of a dried specimen. However, as Lendenfeld states that in *A. rosea* "the pigment occurs in the shape of large red spherical granules which are found in the amœboid and collar cells," we may take this as distinguishing it from *A. rubra*, which contains no pigment in those cells, but only in the gland-cells.

Explanation of the Plates of Appendix.

Plate XI.

Fig. 1. Style of *Esperella sordida*, Bowerbank, × 400.
Fig. 2. Rosette of palmate anisochelæ of the same, × 400.
Fig. 3. Isolated palmate anisochela, × 800.
Figs. 4 and 5. Simple and contort Sigmata, × 400.
Figs. 6 and 7. Toxa, × 400.
Fig. 8. Embryo in optical section, × 100.
Fig. 9. Vertical section through an embryo, enclosed by membranous capsule

Plate XII.

Fig. 1. Inner portion of a vertical section through *Aplysilla rubra*, Hanitsch, showing an exhalent canal with flagellated chambers opening into it, × 120.
Fig. 2. Outer portion of a vertical section through the same, showing dermal membrane with gland-cells and subdermal cavities, × 250.
Fig. 3. Outer portion of a vertical section showing one of the spongin-fibres projecting beyond the level of the sponge and dragging upwards the dermal membrane, etc. × 250
Fig. 4. Part of limiting membrane and spongin-fibre arising from it, × 250.
Fig. 5. Flagellated chamber, × 800.
Fig. 6. Diagrammatic vertical section to show arrangement of the spongin-fibres, × 15.

REPORT on the POLYCHÆTOUS ANNELIDS of the L.M.B.C. DISTRICT.

By James Hornell.

With Plates XIII., XIV., XV.

[Read 13th March, 1891.]

Introduction.

The dredged material with which the following report deals was collected in great part on the various dredging cruises instituted by the Liverpool Marine Biology Committee during the years 1886—90; while the littoral species were mostly obtained by myself during 1890 from selected local centres. Great help was in addition rendered by the keeper of the Biological Station on Puffin Island, especially during the past winter.

I offer hearty thanks to Professor Herdman for the uniform kindness he has shown in facilitating my labours. Indeed to one with my limited leisure, his words of encouragement and advice furnished an incentive I could ill have spared. Messrs. A. O. Walker, I. C. Thompson, F. Archer, and Dr. Chaster have also at various times kindly procured specimens for me, and I gladly avail myself of this opportunity to express my thanks. Finally, I have to express my obligation to Professor M'Intosh for help in the determination of a few of the more critical species.

In the arrangement and nomenclature of the larger divisions I have followed Claus,* but with the generic

* *Traité de Zoologie*, 1884.

nomenclature I have used a free hand—especially among the Polynoinæ, the Syllidæ, and the Nereidæ where I have followed the example set by Théel, Hansen, and other recent authors in suppressing many of the genera instituted by Malmgren and adopted by Professor M'Intosh in his "Challenger" Report and elsewhere. Lists of synonyms are dispensed with, as such can be found by reference to the *Nordiska Hafs-Annulater* and the *Annulata Polychæta* of Malmgren, and to the memoir on the *Polychæta Sedentaria of the Firth of Forth* by Cunningham and Ramage. The specific nomenclature of these works I follow closely; the few exceptions being noted.

To make the present report as far as possible, a complete chronicle of the Polychætous fauna of the district, such species as I have not met with, but which appear in previous lists and are well authenticated, have been inserted. Re-examination, however, of some of the material described by Mr. R. J. Harvey Gibson in his paper upon the Vermes of the district, (*Fauna of Liverpool Bay*, vol. I., p. 144) shows that he had fallen into the following errors, viz.:—(*a*) His "*Malmgrenia castanea*" found in the ambulacral groove of *Astropecten* turns out to be nothing more than the usual *Astropecten* commensal *Acholoe astericola*; (*b*) his "*Spiochætopterus typicus*" is the diagnostic portion of the body of *Chætopterus insignis*; (*c*) his (new British species) "*Iphione muricata*" is in reality the not uncommon *Nychia cirrosa* from the tube of *Chætopterus*; (*d*) his *Nereis viridis* is one form of *N. pelagica*; while (*e*) the identity of *Pectinaria auricoma* with *P. belgica* which he tried to prove, is, as has been shown by Cunningham and Ramage, founded upon oversights and erroneous premises. There are some other cases where I suspect Mr. Gibson's identification to be at fault, and in this uncertain category I am inclined to place

Sthenelais zetlandica—the original specimen of which unfortunately I cannot discover.

This list—including the last mentioned doubtful species—ennumerates 88 species and two varieties. Both the latter—*Polynoë haliæti* var. *hyænæ*, and *Sabella pavonia* var. *bicoronata* are hitherto undescribed: while of the former, one—*Dasychone herdmani*—is new to science; three are new to British waters, viz.:—*Polynoë (Lagisca) extenuata*, *Autolytus alexandri*, and *Ampharete grubei*; and 39 have been found for the first time in this district. Of these the most important are *Polynoë castanea*, *P. johnstoni*, *Halosydna gelatinosa*, *Hermadion pellucidum*, *Sthenelais boa* and *S. limicola*, *Spinther oniscoides*, *Eunice harassii*, *Onuphis conchilega*, *Nereis virens*, *Syllis tubifex*, *Psamathe fusca*, *Castalia punctata*, *Phyllodoce maculata*, *Glycera goësi*, *Ammotrypane aulogaster*, *Capitella capitata*, *Nicomache lumbricalis*, *Axiothea catenata*, *Scoloplos armiger*, *Cirratulus tentaculatus*, *Nerine cirratulus*, *Amphitrite figulus*, *Nicolea venustula*, *Amphicora fabricia*, and *Serpula reversa*. Species recorded for the first time in this district are prefixed by an asterisk, thus:—**S. boa*. At the end a table is given showing the world-distribution of local species side by side with details of the distribution of these forms in our own area. The bathymetrical range is also supplied so far as the often scanty data permit of. I fear the details of distribution outside our local area are not so complete as could be wished—several memoirs being out of my reach for consultation. However, so little has been done in the way of tabulating records of distribution that I venture to think that the present may prove useful to students of the group.

From my observations on the vertical range of local Annelids, I would divide them under three heads—(*a*) littoral forms, (*b*) deep water forms, i.e., ranging down-

wards from low water mark, and (*c*) species extending from the littoral to considerable depths, i.e., indefinite. The following short list embodies these observations.

LITTORAL.	DEEP WATER.	INDEFINITE.
	Hermioninæ	
**Polynoë imbricata*	*Polynoë haliæti*	*Polynoë propinqua*
	,, *castanea*	,, *impar*
	,, *lunulata*	
	,, *johnstoni*	
	Acholoë astericola	*Nychia cirrosa*
	Hermadion assimile	*Lep. squamatus*
	,, *pellucidum*	
Sthenelais boa	*Sthenelais limicola*	
	Spinther oniscoides	
	Eunicinæ	Nereidæ generally
	Lumbrinerinæ	
	Nephthys cæca	*Nephthys hombergi*
Psamathe fusca	*Castalia punctata*	*Ephesia gracilis*
**Eulalia viridis*		
Capitella capitata	*Ophelia limacina*	
Arenicola marina	*Ammotry. aulogaster*	*Scoloplos armiger*
Axiothea catenata		*Owenia filiformis*
Cirratulidæ		Chlorhæmidæ
Spionidæ		Terebellidæ
Sabellaria alveolata	*Sab. spinulosa*	
		Sabella pavonia
	Filigrana implexa	
	Serpula vermicularis	*Pomatoc. triqueter*
Spirorbis borealis	*Spirorbis lucidus*	

Although I put the foregoing forward provisionally, I believe it to be accurate in the main, and I would draw attention to the graphic manner in which it depicts the

* Occasionally found in deep water.

fact that where a species has (in the same district) one nearly related form only, the one is nearly always found to be littoral, the other to belong to deep water. It was only very gradually as I gained in familiarity with annelid life that there dawned upon me the full significance of the fact that every organism occupies its own particular niche in nature. It was as though a key to nature had been placed in my hands. For instance, in this district *Sthenelais boa* lives under stones between tide-marks; its near neighbour *S. limicola*, characterised by but very minute though constant differences, invariably frequents deep water. *Sabellaria alveolata* is littoral; *S. spinulosa* is always dredged. *Polynoë castanea* is only met with among the spines of *Spatangus purpureus, Acholoë astericola* never elsewhere than in the ambulacral groove of *Astropecten*. *Nereis virens* burrows in boulder clay, while its congener *N. fucata* lives commensally with Hermit-crabs (*Pagurus*).

A few notes on embryology will be found under the names of several species. Those on the development of *Arenicola marina* are of the greatest interest, as they deal with points hitherto undescribed.

The following numbers and letters will be employed to indicate the stations where the species were collected, viz. :—

SHORE COLLECTING.

S. Southport and Formby (sand)
E. Egremont (sand, clay and stones)
N.B. New Brighton and Leasowe (sand)
H. Hilbre Island (sandstone)
L. Lavan sands, Bangor (mud and stones)
B. Beaumaris (mud and stones)
P. Puffin Island (limestone)
M. Port Erin, Isle of Man (Schist)
Mp. Peel, Isle of Man (Schist)

DREDGINGS.

1. Mouth of Mersey (sand) - - 1—8 fathoms.
2. Mouth of Dee (sand) - - - 1—9 ,,
3. Colwyn Bay - - - - 3—5 ,,
4. Turbot Hole, Beaumaris Bay - 14 ,,
5. Menai Straits - - - - 5—10 ,,
6. Off Puffin Island - - - 5—7 ,,
7. Off N.E. Coast of Anglesey - 10—16 ,,
8. Off N. ,, ,, - - 16—20 ,,
9. 20 miles N.W. of Holyhead - - 45—57 ,,
10. Off S.W. coast of Holy Id., Anglesey 16—18 ,,
11. W. and S.W. of Port Erin - - 15—18 ,,
12. 25 miles N.W. of Bar Lightship, - 20—22 ,,
("Spindrift" cruise, 12 July, 1890).
13. do. do.
("Spindrift" cruise, 27 Sept., 1890).
14. 20 miles S.E. of I. of Man - - 20—25 ,,
("Weathercock" cruise, 28 Aug., 1886).

Stations 12, 13 and 14 proved the most productive in results; stations 1 and 2 the most meagre.

Section I.—ERRANTIA.

Family.—APHRODITIDÆ.

Sub-Family.—HERMIONINÆ.

Aphrodita aculeata, Linn.

Stations:—1, 6, 7, 8, 10, 13, 14. (From low water to 40 fms.)

This worm is generally obtained from ground of a sandy or muddy character, thus differing markedly in habit from the closely allied species *Hermione hystrix* which I have found to prefer rougher surroundings—shell-debris, gravel and the like. As is the case with so many of the Hermioninæ *A. aculeata* has a very considerable deep water range. A specimen was brought up from a depth of 530

fathoms from oozy bottom in the Faröe Channel, "Knight Errant" expedition, 1880.*

Hermione hystrix, (Savigny).†

Stations:—8, 10, 11, 14 (15—40 fms.). Never found in this district in purely sandy or muddy localities.

Sub-Family.—POLYNOINÆ.

The genera of this division stand greatly in need of revision. Since Malmgren's publication in 1865 of his valuable *Nordiska Hafs-Annulater*, with the erection therein made of many new genera, there has been great confusion and changing of boundaries. Indeed when a new species turned up, it was almost certain not to fit with any of Malmgren's narrow generic definitions, and consequently had to have a brand new genus formed for its special reception. In my belief, Malmgren, misled by his great capacity for perceiving minute differences, attached too much generic value to what were often altogether secondary divergences—the result being that he erected a host of needless new genera. To this class, I am of opinion, belong the genera *Lagisca*, *Harmothoë*, *Evarne*, and *Lœnilla*. All are characterized by the possession of 15 pairs of elytra, stout notopodial setæ, and bidentate apex to the setæ of the neuropodium.‡ These I have placed

* M'Intosh, "*Challenger*" *Report*, p. 34.

† Brackets round author's name signifies that the generic designation of the species is different to that originally used by said author.

‡ As Moquin-Tandon remarks (Claus "*Traité de Zoologie*"), great confusion reigns in the nomenclature of the appendages of Polychætes, and as a guide I now apppend the following list of synomyms:—

Huxley.	M'Intosh & Malmgren.	Grube.
Parapodium	= Foot	
Neuropodium	= Ventral branch of the foot	
Notopodium	= Dorsal Branch of the foot	
Præstomial tentacle	= Tentacle	= Unpaired tentacle
Superior præstomial cirri	= Antennæ	= Middle tentacles
Inferior ,, ,,	= Palpi	= Lateral ,,
Peristomial cirri	= Tentacular cirri	= Tentacular cirri

together in the old genus *Polynoë*, together with Johnston's *Polynoë scolopendrina* which however might perhaps with advantage be removed to a separate genus.

COMMENSALISM. This favourite habit of the Polynoinæ is well illustrated in the following pages. To summarize the local facts on this point we have *Nychia cirrosa* and *Polynoë setosissima* living in the tube of *Chætopterus insignis; Polynoë castanea* upon the test of *Spatangus purpureus; P. lunulata* and *Acholoë astericola* in the ambulacral groove of *Astropecten irregularis; P. johnstoni* in the tube of *Thelepus cincinnatus; Hermadion assimile* close to the mouth of *Echinus esculentus*, and finally the nearly allied species *H. pellucidum* has been found upon three different kinds of star-fishes.

Lepidonotus squamatus, (Linn.).

Stations:—6, 7, 8, 10, 12, 13, 14; H, P, M. (From between tide marks to 22 fms).

This widely distributed form is more frequently found in deep water than *Polynoë propinqua*. The most prolific ground was in 18—20 fathoms, Porthwen Bay, Anglesey, where a large number were dredged. These were of a greater size than any elsewhere procured, and the largest were very strongly marked on the elytra. Many of the warts towards the postero-internal direction were filled with very conspicuous black pigment.

Nychia cirrosa, (Pallas).

Hab: B, 5, 7. Low water of spring tides to 18 fms.; sometimes commensal with *Chætopterus insignis* and *Thelepus cincinnatus*.

Malmgren (*loc. cit.*) was the first authority to recognise this to be an undoubted British species. He found that certain British Museum specimens named *Lepidonotus cirratus* v. *parasiticus*, W. Baird, and hailing from Beaumaris, N. Wales, in the majority of cases belonged

in reality to Pallas' *Aph. cirrosa*, the remainder pertaining to *P. setosissima*, Sav. (*Lænilla glabra*, Mgrn.). Both species had been found living commensal within the tubes of *Chætopterus insignis*, Baird. Curiously enough, the first example I obtained was dredged from 5 fathoms in the Menai Straits within a few miles of the spot whence came Baird's specimens in 1864. It came up from ground covered with the valves of dead mussels, and when first noticed it was crawling from the broken end of a *Terebella* tube, probably *Thelepus cincinnatus*—thus denoting a wider range of its commensal habit. The *Iphione muricata* of Mr. Gibson's report is this species, as I can certify from an examination of the original very fine specimen now in the Zoological Museum of University College, Liverpool.

Polynoë (Harmothoë) imbricata, (Linn.).

Hab: 6, P. M, Mp, under stones. Abundant at low water.

But few of my specimens were dredged, and these were from shallow water; the great majority were shore collected. Hj. Théel however records dredging it as deep as 80—100 metres.* The species is predominant and exceedingly abundant under stones on the south side of Port Erin Bay, attracted and provisioned—directly or indirectly—by the large quantity of fishing refuse present at the quay. In colouration of the elytra *P. imbricata* is the most variable of our Polynoinæ—from black and blue-black it grades to grey and light rose. Usually the colouration is more or less over the whole surface of the elytron, but sometimes it is restricted to the inner third or half of each elytron leaving the outer portion colourless. Several Puffin Island specimens and others from Port Erin with this peculiar marking are especially beautiful. The inner black margins of the elytra to the eye appear to coalesce and thus give the animals the appearance of having

* "Les Ann. polych. des Mers de la N. Zemble." 1879.

a black band extending medianly from head to tail, being edged with a pale uncoloured margin on either side.

Théel is correct in saying that only the largest individuals possess on the scales any notable rounded processes and I cannot imagine how so able a naturalist as Möbius could for a moment confound the species in question with *P. impar*. Indeed the globosely tuberculated elytra of *P. imbricata* approach much more closely to those of *P. propinqua*, but otherwise the differences between these two are striking. (Pl. XIII, fig. 2).

Polynoë (Harmothoë) halicti, (M'Intosh), var. *hyænæ*, n.

Hab: Port Erin, Isle of Man, 15 fms.

The specimens described by Mr. Gibson (*loc. cit.*) unfortunately wanted the scales, but in one recently obtained ("Hyæna" cruise of Easter, 1889) a few scales were present. These differ considerably from Professor M'Intosh's description.* Instead of the margin being "quite smooth throughout," it is densely fimbriated after the manner seen in *Lepidonotus squamatus* otherwise they agreed closely with the characters given. (Pl. XIII, fig. 5).

**Polynoë (Evarne) impar*, Johnston.

Hab: 10, 12, S, H, L, P. From littoral to 22 fms.

The number of large pear shaped tubercles on the margin of the scales varies greatly, but few have so many as Malmgren gives in his figure. Many have only one very large one, others none whatever, while again a few of the largest approach Malmgren's engraving—having 3, 4, 5, and 6 tubercles. The number varies even on adjacent scales of the same individual—some with none, others overlapping these with one or more. A number of the largest of these remarkable processes are made even more so by the presence on the broad summit of numer-

* "Challenger" Report, p. 96.

ous tiny spines, (Pl. XIII, fig. 6). The inferior cirrus is shortly and sparsely ciliated, not smooth as represented in Malmgren's plate. The largest specimens were from Southport—33 mm. long—and in these the bristle bearing segments sometimes reached 37. Malmgren gives 34—35 for the oldest. Notopodial seta, Pl. XIII, fig. 3.

* *Polynoë (Lagisca) extenuata*, Grube.

Hab: Port Erin, Puffin Id., and Colwyn Bay; under stones.

A single specimen was found at each of the above localities. This is the first record of its occurrence in British seas. Superficially it has considerable resemblance to *Polynoë (Evarne) impar*. The serration of the dorsal bristles is however distinctly finer. (Pl. XIII, fig. 4). The bristles are nearly colourless and without the brilliant golden hue so noticeable in those of the last-named species. The tips of the ventral bristles are very characteristic and reliable, especially among the strongly bifid superior bristles of the bundle. Their angle of incision is formed by nearly straight lines, wherein it differs from what is seen in *P. imbricata*, *impar* and *propinqua*, where the angle is made by curved lines. The upper median ones, however, possess curved bifid apices, while the inferior bristles show curved entire tips. These specimens agree closely with the plates in Marenzeller's "*Zur Kenntniss der Adriatische Anneliden*" except in one point in the structure of the scale. In mine, the surface of the scale is mapped out into a large number of separate areas, each containing usually several papillæ, giving the appearance of a line having been drawn around every three or four papillæ, thus forming the latter into groups (see Pl. XIII, fig. 8). All the specimens show this very peculiar marking, which is not to be found in Marenzeller's figures.

This species must be classed close to *P. impar* and *P.*

propinqua, between which it is intermediate in many respects.

Polynoë (Lagisca) propinqua, (Malmgren).

Hab: 6. 8, 9, 12, 13, S, P, M, and Mp. Abundant from mid-tide to 57 fms. Beneath stones and in rock cavities.

This species, which Malmgren constituted to receive a single individual received from Bohus, and which M'Intosh has sometimes found in the debris of fishing boats at St. Andrews, is here one of the most constant and abundant of the Polynoïnæ—present at the greatest depth yet dredged in our local area viz:—45-57 fathoms, 20 miles N.W. of Holyhead, ("Spindrift" cruise, 20 July, 1889), as well as being taken in profusion on the rocky shores of Puffin Island, Hilbre Island and the Isle of Man. At Puffin Island it is especially plentiful and is undoubtedly the characteristic Polynoë of the island.

Malmgren's figures absolutely tally with the majority of my specimens. A few deviate in that the outer edges of the elytra bear a few weak and inconspicuous cilia, and occasionally some of the smallest show none of the characteristic globose processes on the elytron edge. (Pl. XIII, fig. 7). In colour, as in most other points, my specimens agree closely with Malmgren's, while differing markedly from that described by M'Intosh from St. Andrews (Trans. Zool. Soc., vol. IX, p. 375).

The structure of the bristles is identical with that of those belonging to *Polynoë floccosa* as figured by M'Intosh. Were it not that all the specimens examined possess 15 pairs of elytra, the margins of which are unfurnished with aught save a row of sub-globular processes, in contrast with the more numerous and ciliate elytra of *P. floccosa* I should incline to unite the two species. (Pl. XIII, fig. 1 and 9).

Polynoë (Lænilla) setosissima, Savigny.

Hab: Beaumaris. Low water mark, commensal with *Chætopterus insignis*, Baird.

Ray Lankester* records it under the name of *Harmothoë malmgreni* living with the same host on the shores of Herm, one of the Channel Islands. His remark anent its commensalism—"It appears to be only met with in this habitat" I am able to confirm, as under the guidance of my good friend Mr. J. Sinel, of Jersey, I have dug up in Herm a number of *Chætopteri* and have found this *Polynoë* invariably present. It is the *L. glabra* of Malmgren.

* *Polynoë (Malmgrenia) castanea*, (M'Intosh).

Hab: 7, 12, 13 in 20-22 fms. Commensal with *Spatangus purpureus*.

Every living *Spatangus* I have examined—and this Echinoderm was several times dredged in considerable numbers on the "Spindrift" cruises 1890—has had one of these worms clinging to the test close to the mouth. All Prof. M'Intosh's examples were obtained from the same host. The curious fact noted in the first Report on the Vermes by Mr. Gibson† of finding this worm in the ambulacral groove of *Astropecten* turns out to be erroneous —for having occasion to refer to Mr. Gibson's specimen, I discovered it to be the ordinary *Acholoë asterícola*, which Carrington recorded long ago as a common guest of the starfish named. This species is very unlike *P. castanea*.

Polynoë floccosa, Savigny.

Hab: The South of the Isle of Man.

I give this as a member of our local fauna on Mr. Gibson's authority. I have searched long and carefully for it without success. Prof. Ray Lankester observes that in the Channel Islands this form—his *H. sarniensis*—seems

* "*On New Brit. Polynoina.*" Trans. Linn. Soc. vol. xxv.

† *Fauna of Liverpool Bay*, p. 149.

to take the place of *P. imbricata* so common in more northern localities.

Polynoë (Harmothoë) lunulata, Delle Chiaje.

Hab: Southport.

Found in company with *P. astericola* D.Ch., occupying the ambulacral grooves of *Astropecten irregularis* cast ashore by storms.

* *Polynoë johnstoni*, Marenzeller.

Hab: 8, 10 (numerous).

During the "Hyæna" expedition, Whitsuntide, 1890, nearly every haul of the dredge (12-20 fathoms) off the S.W. coast of Holy Island, Anglesey, brought up at least one specimen of this Polynoë. In one case, an individual emerged from an inhabited tube of *Thelepus cincinnatus*, suggesting another instance of the habit of commensalism so frequently noticed among the Polynoina. Quatrefages was the first to point out the presence of certain differences between Johnston's and Savigny's *P. scolopendrina*. Subsequently Marenzeller (*loc. cit.*) gave this belief definite form, by separating the two and giving separate diagnoses of each thus:—

P. scolopendrina, Savigny. Tentacle much shorter than the palps. The tentacular cirri longer than the palps. No wart-like tubercles projecting from the dorsum of the segments.

P. johnstoni (the *P. scolopendrina* of Johnston, Malmgren and M'Intosh.) The tentacle longer than the palps. The tentacular cirri shorter than the palps. Three wart-like tubercles on the dorsal aspect of each segment.

Acholoë astericola, (Delle Chiaje).

Hab:—Southport, and 6 m. N. of Gt. Ormes Head 14 fms.

I have to thank Dr. G. W. Chaster, of Southport, for a number of specimens of this interesting annelid which, together with *P. lunulata*, he procured in the above

named locality from the ambulacral grooves of *Astropecten irregularis* cast upon the beach. This worm ranges from the Mediterranean to Galway in Ireland. At Naples, Claparède found it in company with *Ophiodromus flexuosus* on *Astropecten aurantiacus*, while *A. aurantiacus*, *bispinosus*, *platyacanthus* and *pentacanthus* from Trieste all furnished to Marenzeller (*loc. cit.*) the same two guests.

Examples of this worm were identified as *M. castanea* by Mr. Gibson in his "Report on the Vermes" of this district. I note that in the "Challenger" Report the generic name is spelled *Achloë*.

**Halosydna (Alentia) gelatinosa*, (Sars).

A very large specimen was found under a stone at extreme low water at Puffin Island, October, 1887. It measured 6½ cm. by 16 mm. (including the bristles).

Hermadion assimile, M'Intosh.

Hab: 12 (21 fms.) and 11 (10 fms.).

One small specimen was found crawling among the spines of an *Echinus esculentus* dredged from 21 fathoms in the Irish Sea, 25 miles N.W. of Liverpool Bar, and Mr. Gibson recorded two from the same host dredged near Port Erin.

* *Hermadion pellucidum*, (Ehlers).

Hab: 6, 10, 12, 13, (16-22 fms.)

This species was taken for the first time locally at Station 12, ("Spindrift," September, 1890), when three small specimens were dredged. All were commensal with Echinoderms. One was in the ambulacral groove of *Astropecten irregularis;* another upon *Solaster papposa* and the third was upon a brittle-star—*Ophiothrix rosula*. Marenzeller (*loc. cit.*) speaks of obtaining a specimen from *Ophiothrix alopecurus* from the Bay of Muggia, near Trieste.

One of these specimens was perhaps the most beautiful

Polynoë I have ever met with. Each of the pellucid body scales had on the hinder margin a crescent of orange-hued pigment, varied on the two head scales by the orange margin being carried completely round as a resplendent girdle.

Sub-family.—SIGALIONINÆ.

* *Sthenelais boa*, (Johnston).

Hab: P, M, Mp, under stones from mid-tide to low-water.

Malmgren (*loc. cit.*) stated his belief that Rathke's *S. idunæ* is synonymous with Johnston's *S. boa*, a view with which I unreservedly concur. He, however, in his list of synonyms, gives Cat. Br. Mus. 1865 as date of Johnston's name, and omits reference to the British author's prior description and naming of the species in question, viz: 1833, in Loudon's Mag. of Nat. Hist. In this way Rathke's nomenclature, dating from 1843, is wrongly given priority and I gladly follow Prof. M'Intosh's lead in the retention of our countryman's title.

S. boa is in this district essentially a shore species. I have never taken it in the dredge but always littoral. The nearly related species *S. limicola* on the other hand is characteristic of a lower zone, being invariably obtained by dredging. The fact that in "Invert. Fauna of St. Andrew's" M'Intosh notes that storms cast up abundance of the latter species, and gives the habitat of *S. boa* as between tide mark would point to this limitation of vertical range as a constant feature.

* *Sthenelais limicola*, Ehlers.

Hab: 12, 13.

As noted all specimens without exception were taken in the dredge, at depths varying from 18-22 fathoms. The present is the first recorded instance of the occurrence of either the present or the preceding species in this district.

Sthenelais zetlandica, M'Intosh.

The mutilated fragment mentioned by Mr. Gibson* as dredged from 20 fathoms off Port Erin remains without successors.

Pholoë minuta, (Fabricius).

Dredged, Whitsuntide, 1890, in Menai Straits. Carrington records it as rare at Southport.

Webster and Benedict† record it from Massachusetts, U.S.A. and it has an exceedingly wide range within the Arctic circle. This is an interesting form, as through the structure of its falcate compound setæ it hints at the not distant relationship of the Syllidæ with the Polynoidæ.

Family.—APHINOMIDÆ.

Sub-Family.—HIPPONOINÆ.

**Spinther oniscoides*, Johnston.

Six specimens of the usual yellow hue were dredged during the "Hyæna" cruise, Whitsuntide, 1890, from about 17 fathoms, off Holy Island, Anglesey. As they were picked from off the yellow hydroid *Antennularia ramosa* and also from the yellow *Halichondria panicea*—to both of which they assimilate absolutely in colouring—they furnish another addition to the long list that is accumulating of protectively coloured animals.

Family.—EUNICIDÆ.

Sub-Family.—EUNICINÆ.

**Eunice harassii*, Au. and M. Ed.

Hab: 12. Dredged from 21 fms.

I refer this single specimen to the above species with some hesitation as in the spirit preparation the characteristic spots on the dorsum do not show, and again the filaments to the largest branchiæ are more numerous —(20)—than is given in previous diagnoses of this species.

* Report on Vermes, Fauna Liverpool Bay, Vol. i.

† Annel. Chaet. from Princetown, &c., 1884.

To facilitate future reference, a figure is given of the branchia pertaining to the 21st setigerous somite. (Pl. XIII, fig. 10).

**Onuphis (Northia) conchilega*, Sars.

Great numbers of this widely distributed worm were taken on the "Spindrift" cruise (September 27th, 1890), 25 miles N.W. of Liverpool Bar—depth, 21 fathoms—for the first time in this district. The animals are very irritable when expelled from their homes; breaking into fragments at once. The anterior part of the body is firm; the middle and posterior soft and indefinite. The scabbard shaped tubes which *O. conchilega* constructs bears some analogy to the stick or stone encrusted tubes of the larvæ of the caddis-fly. Like the latter, they are unattached to any fixed object and can be dragged from place to place by their owners, who can turn themselves if they please in the tube. All sorts of shell fragments and bits of echinid tests are requisitioned and fitted into place. When we remember the diversity in shape and size of the material and that when completed neither are the edges of adjoining fragments allowed to overlap, nor are any unarmoured spaces left in the tough membranous tissue forming the framework of the tube we must concede a considerable amount of ingenuity and skill to *Onuphis conchilega*. Such a tube is protective both by reason of its strength and great relative size as compared with the worm itself and also on account of the admirable way in which it assimilates to the general appearance of the sea-bottom where it is found.

M'Intosh in the "Challenger" Report (where he uses the form *Nothria* for *Northia* as the name of this genus) says—"The Onuphididæ are distinguished from the Eunicidæ by their bathymetrical distribution for while the latter are often found between tide-marks, the Onuphididæ

are characteristic of deep water, many of them ranging to very great depths. Even in our own seas they frequent the deeper waters of the coralline ground." None of the "Challenger" series came from a less depth than 100 fathoms, and only one at that. Two came from 2225 fathoms.

Sub-Family.—LUMBRICONEREINÆ.

Lumbriconereis fragilis, O. F. Müller.

Hab: 12—13; from 20—22 fms.

True to name this beautiful iridescent annelid broke into pieces immediately on capture on the only two occasions on which I was fortunate enough to procure it. There is no doubt in my mind that this is a habit acquired and practised with the aim to save its existence when seized by enemies, as I noticed that the pieces broken off were in both cases short lengths from the posterior end. The piece left with the head was by far the longest and probably sufficient to start life afresh with had the animal escaped capture.

Family.—NEREIDÆ.

Nereis pelagica, L.

Hab: 13, H, P, M, Mp.

Met with at all depths and on rocky or stony ground, with as high a vertical range as *Arenicola* displays on a sandy or muddy shore.

**Nereis (Hediste) diversicolor*, Müller.

Hab: S, 2.

A large number were found burrowing in the peat at Hightown at the mouth of the Mersey.

Nereis (Leontis) dumerilii, Aud. and M. Edw.

Hab: E, P, M, 6, 7, 8 (numerous).

Specimens of this worm are frequently obtained lying in cocoon-like structures composed of hardened grey mucus, often with foreign bodies attached to the outside.

In one case, an individual had seized upon a shore blown beech leaf, constructing on its surface a mucus tunnel in which it lay hid—very similar in appearance to the cocoons of many insects. A species of pycnogonid is frequently found parasitic (?) clinging to the outside of these mucus tubes.

Nereis (Nereilepas) fucata, (Savigny).

Hab: 4, 8, 10, 11, S, M, Mp.

The *Nereis bilineata* of Carrington. It is frequently met with in dead *Fusus* and whelk shells. Also in about 90°/₀ of such shells which have been taken possession of by Hermit-crabs (*Pagurus*). If a shell containing one of these strangely assorted couples be watched in an aquarium, the forepart of the worm's body will be seen to emerge slowly from the interior depths and sway gently from side to side, above the back of the crab, surveying keenly the environment. The fellow-lodgers together dwell in amity, though what the mutual relationship existing between the two is I have never seen explained. My own opinion—seeing how often the worms occupy otherwise uninhabited shells—is that *Nereis fucata* is the first tenant and that it tolerates the intrusion of the Hermit-crab chiefly because it can easily steal morsels of the plentiful supply of food which the latter can generally manage to procure. Besides the *Pagurus* furnishes means of locomotion unattended with danger, and his presence in the mouth of the shell prevents other intruders who might be unwelcome from getting entrance. The Hermit-crab on the other hand, I believe, derives no benefit from the partnership and takes no notice of the worm as long experience has taught him that he cannot dislodge the latter, who occupies the coign of vantage, possesses superior agility and a pair of stout mandibles. Indeed the worm can easily turn the Hermit out if so disposed.

N. fucata is sometimes taken free. Such specimens, as well as those forcibly taken from their refuge in shells, display a very peculiar mode of swimming. Turning on their side they assume the outline of an S much drawn out, and move through the water with a gentle undulating shivering motion with a weakness suggesting want of training, and without any of the vigorous lashing seen in *Nephthys* and in *Nereis virens*, *N. pelagica*, &c. These latter swim upon the ventral surface of the body. Used for bait sometimes by the Manx fishermen.

* *Nereis (Alitta) virens*, Sars.

Hab: E, NB.

Abundant between tide-marks along the Mersey shore from Egremont to New Brighton, burrowing in patches of very stony boulder clay. Its extensive burrows are mucus lined. This mucus is secreted by enormous numbers of tubules found along the dorsum and in the lobes of the feet, especially in the great leaf-like upper lobe of the notopodium, the so-called "branchia" of Kinberg. This lobe seems pre-eminently modified to act as a great secretive organ, its great expanse and lamellar form giving the maximum of available surface while occupying the minimum of room. Each is richly supplied with blood vessels and its substance is crowded with masses of tubuli opening on the surface. The cirri (dorsal and ventral) contain no tubules. Immense quantity of mucus is thrown off very rapidly after capture, so filthy and dense that it is difficult to make out the presence of the worms at all.

N. virens (the *N. Yankiana* of Quatrefages) is the most esteemed of bait worms in this district. The fishermen have given it the name of "Creeper."

Family.—NEPHTHYDÆ.

* *Nephthys cæca*, (Fabr.).

Hab: "Hyæna" and "Despatch" expeditions, 1886.

In this district much less common than *N. hombergi*. Its range is also more restricted than the latter, having been taken only by the dredge.

Nephthys hombergi, Aud. and M. Edw.

Hab: S, E, NB, L, 3, 6, 10, 13, "Despatch" exped., 1886.

The characteristic *Nephthys* of the Irish Sea, common along the N. Welsh, English and Scottish coasts bordering this basin, wherever sand occurs. Together with this constancy on all our shores it posesses a wide bathymetrical range, having been taken frequently with the dredge at varying depths. Thecate Infusoria are frequently met with parasitic upon the bristles. This is the *N. assimilis* of Malmgren and *N. longisetosa* of Oersted.

Family.—GLYCERIDÆ.

Glycera capitata, Oersted.

Hab: P, S, 10. The *G. alba* of previous local lists.

* *Glycera nigripes*, Johnston.

Hab: Puffin Island; 5 fathoms.

* *Glycera dubia*, Blainville.

I have several times found traces of a large species —referred provisionally to *G. dubia*—within the stomachs of Cod. The length would be nearly six inches and the four stout black teeth present within each were of corresponding size.

* *Glycera goësi*, Mgrn.

Hab: B, 10; common.

Family.—SYLLIDÆ.

* *Syllis (Eusyllis) tubifex*, Gosse.

Hab: 3, 12, 13, 10, 6.

Common in dredged material—3 to 21 fms.

Syllis armillaris, (O. F. Müller).

Found at low water Puffin Island, August, 1889.

Specific characters:—Dorsal cirri quite short, of 8—10 joints. Setæ falcate with entire apex. Two more or less interrupted transverse markings on the dorsum of each segment.

* *Autolytus alexandri*, Malmgren.

Hab: Tow-netted off Puffin Island.

A single specimen, a male as shown by possessing the curious forked palps characteristic, as Verrill remarks, of the sex in this genus. The anterior falcate setæ-bearing segments numbered 14. The dorsal cirri were somewhat shorter than depicted by Verrill* Length of body 12·5 mm.

This species has not before been recorded from British waters.

Autolytus prolifer, (O. F. Müller).

Recorded by Carrington as abundant at Southport.

Ephesia gracilis, H. Rathke.

Hab: S, P, 12, 14.

This aberrant annelid is not uncommon under stones at low water mark at Puffin Island. It is the *Sphærodorum flavum* of Oersted and the *Pollicita peripatus* of Johnston and Carrington.

Family.—Hesionidæ.

* *Psamathe fusca*, Johnston.

Hab: Puffin Id., and Lavan sands, Bangor; under stones.

Two large specimens. The feet are uniramous, with compound bristles.

* *Castalia punctata*, (Müller).

Dredged off Anglesey, Whitsuntide, 1890.

The foot is biramous, the notopodial setæ being simple, the neuropodial compound, thus sharply marking the animal off from the preceding.

* New England Annelida, 1881.

Family.—PHYLLODOCIDÆ.

* *Phyllodoce maculata*, (O. F. Müller).

Hab: Egremont, under stones in clay, near low water mark, and dredged of S. W. coast of Anglesey.

Malmgren's exclusion of Johnston's *P. maculata* is, I believe, incorrect. Many of the latter author's figures are very poorly drawn and in the case in question the figure does not agree with the letterpress, the markings on the back being represented while the dot on each lamellar process of the feet is omitted. I can easily reconcile my specimens with both author's figures and descriptions. Length 3·5 cm.

Phyllodoce laminosa, Sav.

Hab: P and M. Under stones, Laminarian zone.

Of a most lovely delicate yellow-tinged green in life. It is able to secrete very great quantities of mucus—from the large leaf-like lobes of the feet as in *Nereis virens*—which in spirit becomes very tough, enveloping and binding together the body and feet as in a web.

Eulalia viridis, (Müller).

Hab: P, M, Mp. Over the entire tidal zone.

This bright, dark grass-green *Phyllodoce* is unquestionably the characteristic errant annelid of Puffin Island, finding in the weathered and molluscan bored (*Saxicava rugosa*, L.) cavities and tunnels of the limestone rocks and boulders, the perfection of sheltering places always at hand to which to retreat on sign or suspicion of danger.

From my observations of annelid life characteristic of localities having different geological formations, I arrive at the inference that this species can appear in great abundance only in spots where its environment provides innumerable retreats always open. The honeycombed surface of limestone rocks answers such requirements admirably, and in this district such spots—of which

Puffin Island is typical—are homes of *Eulalia viridis*. The only other rock surroundings where I have found this species in any number was on rock surfaces encrusted with large *Balani* shells, many of which being dead and empty formed fairly good hiding places.

I cannot think that its bright green colour is in any way mimetic and protective as has been suggested. For it is most numerous on brown Fucus-covered rocks where green algæ are conspicuous by their absence. Besides its activity is incessant, and this alone prevents its enemies passing it unnoticed. Protectively coloured animals as far as I know, are usually sluggish in their movements, as for instance *Porcellana platycheles* as noted by Professor Herdman.

Family.—TOMOPTERIDÆ.

Tomopteris onisciformis, Esch.

Tow-netted off Puffin Island and Port Erin.

Section.—SEDENTARIA.

Family.—OPHELIADÆ.

* *Ophelia limacina*, Rathke.

Hab: "Despatch" expedition, 1886, from 18 fms.

The dredge, during this expedition ("central area") brought up two individuals—the only ones I have been able to obtain in this district, although the species is not uncommon in the stomachs of Cod.

**Ammotrypane aulogaster*, H. Rathke.

Hab: 3, 6, 12. Dredged from 3—21 fms.

To judge by the great number of examples dredged at each of the above stations, this worm seems to be very plentiful in our local area. The great majority were collected in May, and these were in all cases minute, not exceeding 4 mm. in length.

Family.—CAPITELLIDÆ.

* *Capitella capitata*, (Fabr.).

Hab: Port Erin, and Lavan sands, Bangor.

Very numerous amid decaying *Fucus* under overturned boulders.

Family.—TELETHUSIDÆ.

Arenicola marina, (Linn.).

Hab: S, E, NB, H, L, B, P, M, Mp.

Abundant everywhere, between tide marks wherever a patch of sand or mud occurs.

NOTE on the Embryology of *Arenicola* and *Scoloplos* (Plate XIV.)

Max Schultze in 1856 (*Entwickelung von Arenicola*) described certain egg-masses and embryos found on the Cuxhaven shore as belonging to *Arenicola*. In 1887 Cunningham and Ramage figured and described identical embryos in the Trans. Roy. Soc. of Edinburgh, Vol. XXXIII, part 3, (*Polychæta Sedentaria* of the Firth of Forth), but in the text they point to certain facts, chiefly connected with characteristics of form in the larvæ, which inclined them to believe that the parent was in reality *Scoloplos armiger* and not *Arenicola* as Schultze averred. These authors were, however, unable to describe either the embryos or the manner of spawning of *Arenicola*, though they give a sketch of immature ova taken from the body cavity in February. This gap I am fortunate enough to be able to fill up from observations made in 1890—91, and I am also able to confirm in its entirety, Cunningham and Ramage's correction of Schultze.

On 2nd March, 1890, I procured on the sandy beach at Egremont several small pear-shaped brownish egg-masses and a few larger green ones about the size and shape of a large grape. The latter were invariably associated with

Arenicola castings, while wherever I found the smaller the worm *Scolopos armiger* was sure to be present. Both kinds of egg-cocoons were anchored in the sand by a gelatinous cylindrical stalk descending some two or three inches into the sand. In the case of the green cocoons the stalk soon became ragged and shredded; in the brown, it continued perfectly cylindrical and entire for most of the distance traced.

I. Development of *Scoloplos*:—The small brown cocoons certainly appertain to this animal, for besides the fact that this worm is always found close to the egg masses—animals examined February 21st contained ova identical with those least developed in the cocoons. The size of the cocoons differed somewhat; the largest being 2 cm. by 1 cm., stalk 10 cm. at least. The later stages of development are well figured by Cunningham and Ramage and also by Schultze, and I have nothing to add to their descriptions. As to the progress of segmentation, hitherto undescribed, the following is a summary of what I have observed:—The ova are 0·25 mm. in diameter. Each shows a very distinct germinal vesicle. Two polar bodies are excluded and following quickly is the division of the vitellus into macromere and micromere (Pl. XIV, fig. 3). The latter very rapidly sub-divides into very small cells which gradually overspread the few large cells derived from the primitive macromere, until finally only a small opening—the blastopore—is left in the enveloping layer of micromeres. Usually the number of derived macromeres is either two or four at the stage of enclosure by the micromeres. These latter are, I believe, not all derived from the primitive micromere, being added to from time to time by small cells fissioned off from certain of the macromeres. (Salensky observed a similar process during his elaborate investigation of the embryology of *Nereis*

cultrifera and of *Psygmobranchus protensus*). This being so, it is evident that the primitive micromere in this case contains a part only, of the entire epiblastic material. The cocoons were found at various dates ranging from March 2nd to April 18th. (Pl. XIV, figs. 1—11).

II. Development of *Arenicola marina* :—The ova are deposited in vast numbers within a grape-shaped gelatinous matrix furnished with an anchoring stalk as described. The mass is delicate ulva-green in hue due to the colouration of the contained ova, the matrix being transparent and colourless. In size the masses vary from 2 to 2·5 cm. in length by 1·75 to 2 cm. in breadth. The ova are spherical and 0·08 mm. in diameter. Segmentation is unequal and a cephalotrochous embryo is the result. I was anxious to watch the stages of segmentation but beyond the bare fact noted nothing could be made out, owing to the opacity of the vitellus.

To describe the embryo (Pl. XIV, figs. 12—21) :—The first appearance of cilia is in the form of an equatorial zone, and a tuft of long cilia at the anterior pole or apex of what eventually develops into the præoral segment. With the advent of these organs the embryo begins to rotate slowly within the gelatinous matrix of the cocoon ; and shortly two reniform pinkish eye-spots appear on opposite sides above the zonal band of cilia : soon after this the embryo become free-swimming. Either upon liberation or it may be a little prior thereto, a ciliated pit—which eventually becomes the mouth—makes its appearance a little behind the zone of cilia, and this again becomes connected with the posterior pole by a band of short cilia. In this advanced stage— the latest I was able to observe—it is noteworthy that what was the apical tuft of cilia in the first stage has changed its position, moving a little distance ventrally ; one of the cilia of this tuft has become extremely elongated

while the rest are shortened. When freed from the investing mass of the cocoon, this trochosphere moves through the water with a rotary motion, the long cilium of the anterior tuft conspicuously directed stiffly forwards, and apparently forming a larval sense organ. The most advanced embryos showed a decided lengthening of the body, chiefly of the post-oral part, and the beginning of a constriction a little behind the mouth.

Last year I observed these egg-masses of *Arenicola* about the middle of March, on the Egremont shore; April 4th, at Port Erin, I.O.M., and April 24th, at Hilbre Island. Mr. Sinel, of Jersey, has also sent me specimens gathered in that Island on February 29th. This year, on April 11th, I found large numbers of the usual bright green hue in sandy pools among the sandstone rocks of Hilbre Island associated with numerous castings. I noted on the last mentioned occasion and also in the Isle of Man, that no cocoons were to be seen on the exposed sandy flats, though castings innumerable were there, and in the pools where they were abundant were masses of *Ulva* and of *Enteromorpha* to which the cocoons assimilated exactly in colour. On the other hand, the cocoons of *Scoloplos* were frequently to be noticed anchored among the bare ripple-furrows of the sand expanses. Now these egg-masses of *Scoloplos* are hardly to be distinguished in colour from the muddy sands, the surface of the cocoons becoming so coated with mud that the brownish contents —themselves only a little darker than the sands—do not show through.

Family.—MALDANIDÆ.

**Nicomache lumbricalis*, (Fabr.).

Hab: 10.

Three of the hindmost segments together with the characteristic equally lobed anal funnel, were dredged off

Holy Island, Anglesey, from 16 fathoms. Colour, rosy pink. The two ante-anal segments are without setæ.

**Axiothea catenata*, Malmgren.

Hab: L.

Immense numbers live in the muddy, evil-smelling sands stretching out from Bangor into the Menai Straits. Cunningham and Ramage aptly remark on the similitude of the projecting ends of their numberless tubes to a miniature forest. A similar ragged appearance on a larger scale is given to the Egremont and New Brighton shore by the exposed ends of *Lanice conchilega* especially when a storm has removed some of the surface sand. Tubes 5—7 inches long and 1—1½ mm. broad. The anal funnel is distinguished from that of the preceding species by the fact that the processes are of unequal length, there being about seven long tapering ones, each separated from its neighbour by from one to three short ones, and instead of two ante-anal segments being without setæ four are naked in the present species.

Family.—AMMOCHARIDÆ.

Owenia filiformis, Del. Chiaje.

Hab: 12, 13, 5, S, L.

Is plentiful at all these stations; but most numerous in the deep water. It ranges from extreme low water mark to 21 fathoms. It is the *Ammochares ottonis* of Grube; and is the worm described by Carrington under the name of *Ops digitata*.

Family.—ARICIIDÆ.

**Scoloplos armiger*, (Müller).

Hab: 1, 2, 6, E, NB, Mp.

A common species in sand from mid-tide mark to 6 fms.

From observations made in the beginning of March, 1890, and April, 1891, upon the egg-cocoons of this worm,

I confirm Cunningham and Ramage's statements and deductions (*loc. cit.*). Max Schültze* certainly described the eggs and cocoons of *S. armiger* in error for those o *Arenicola marina*. His figures, if we remember them to represent *S. armiger*, are accurate and beautiful. For details of early embryology see notes under *Arenicola marina*, page 249.

Family.—CIRRATULIDÆ.

**Cirratulus tentaculatus*, (Montagu).

Attains to a large size at Puffin Island, where it is commonly found under stones partly buried in mud near low water mark.

Cirratulus cirratus, (Müller).

Hab: P, M.

During Easter, 1890, I collected a large number of small specimens—about $\frac{3}{4}$—1 in. in length—from narrow clefts in the schist rocks of Port Erin Bay, Isle of Man. The colour varied; very beautiful were a few where the entire body and long branchial filaments were intense black, relieved by the tentacular filaments of the anterior end being milk white.

This species can be distinguished from *C. tentaculatus* among other characteristics by (*a*) having a transverse series of tentacular filaments on the 1st setigerous somite and not on the 5th and 6th as in *C. tentaculatus*, (*b*) the lateral filaments are fewer and usually originate at a distance from the bases of the notopodia; in the other form they are more numerous and arise close to bases of notopodia; (*c*) annulations are much finer on buccal somite in *C. tentaculatus*.

Mr. Gibson enumerates, in this district two species of this family, viz:—*C. borealis*, Lamarck, and *C. cirratus*,

* Entwick. von *Arenicola piscatorum*, 1856.

O. F. M. In fact, these two names are now accepted by all authorities as synonyms.

**Chætozone setosa*, Malmgren.

Hab: Egremont, in clay between tide-marks.

Specimens found February 21st, 1891, contained ova quite ripe. An egg mass found on the same spot with these I believe belongs to this species. It was about the size and shape of a pea, of a faint green colour, and was anchored in the sand by means of a cylindrical stalk. The embryos which I was unfortunately unable to examine in detail appeared to be cephalotrochs approaching closely in form to those of *Arenicola*.

Family.—SPIONIDÆ.

Carrington (*loc. cit.*) mentions three species from Southport, viz:—*Spio seticornis*, (Fabricius), *Spio quadricornis*, Lamarck, and *Nerine coniocephala*, Johnston (=*N. foliosa*, Sars), and catalogues *N. vulgaris* as doubtful. I have not had the good fortune to find the second or the third of these, but on the other hand I have procured a number of specimens of *N. cirratulus* which previously has been but once recorded as British (Firth of Forth). I am also able to say with certainty that *N. vulgaris* is included in our local fauna.

Spio seticornis, (Fabr.).

Very abundant on the Mersey shore between Egremont and New Brighton—chiefly about or a little above mid-tide level. As half-an-inch of their fragile sand-tubes projects from the surface, their multitude gives some patches of sand quite a ragged appearance.

**Nerine cirratulus*, (D. Chiaje).

Hab: Egremont (common between tide-marks).

Specimens found 1st March, 1890, were full of elliptical ova exhibiting the peculiar and characteristically marked vitelline membrane described by Claparede (*Chét. du Golfe*

de Naples, 1868). This is so sculptured as to present the appearance of a network of hexagonal meshes, each mesh being a concavity.

Diagnosis:—the first setigerous somite bears no branchiæ. The lamina extends, at most, little more than half-way along the branchial process. In *N. coniocephala* the lamina extends to the tip of the branchia in the anterior somites.

Nerine (Scolecolepis) vulgaris, Johnston.

Hab: Port Erin and Southport.

Plentiful in mud, under stones, at the former locality. On none of the branchial filaments does the lamina extend to the tip. The first setigerous somite bears branchiæ, thus differing from *N. cirratulus*. There appears to me no sufficient reason for excluding this species from the genus *Nerine* as Malmgren has done. I revert to Johnston's nomenclature.

Leucodore ciliata, Johnston.

Hab: Port Erin and Southport.

A few were found living in narrow clefts in schist rock near low water mark. Also in old shells.

Family.—MAGELONIDÆ (Cunningham and Ramage).

Magelona papillicornis, Fr. Müller.

Hab: New Brighton and Southport.

Found not uncommonly in sand between tide-marks. The *Mœa mirabilis* of Johnston and Carrington.

Family.—CHÆTOPTERIDÆ.

Chætopterus insignis, Baird.

Hab: Beaumaris (low water); and Turbot Hole off Puffin Island (14 fms.).

An excellent illustration, together with figures of the various kinds of setæ, is given in a paper by Mr. J. Williams, published in vol. xviii of the Proc. of the Lit. and Phil. Soc. of Liverpool, 1864. A number of Mr.

Williams' specimens gathered from extreme low water at Beaumaris are now in the British Museum. Examination of the large specimen of "*Spiochætopterus typicus*, Sars," described by Mr. R. J. H. Gibson (*loc. cit.*) as obtained at Beaumaris shows it to be in reality an example of *C. insignis*.

Nychia cirrosa and *Polynoë glabra*—one or other—are usually present in the tubes as commensals; *N. cirrosa* more frequently of the two in this district; *P. glabra* (*H. malmgreni* of Ray Lankester) in the Channel Islands.*

Our local species is identical with specimens from Herm, Channel Islands. The species differs from Quatrefages' *C. valencinii* procured from St. Malo, in that the latter shows a bundle of black bristles on the 4th and 5th pairs of feet, whereas the Herm and the Beaumaris specimens have these on the 4th pairs of feet only. Quatrefages' species has also a larger number of segments in the posterior section of the body. A Herm specimen procured for me by Mr. Sinel of Jersey had about 21 segments in this part.

Family.—CHLORHÆMIDÆ.

**Trophonia plumosa*, (Müller).

Hab: 6, 9, P. A few small specimens from 5 fathoms off Puffin Island; numbers from the deep water (45—57 fathoms) between Anglesey and the Isle of Man.

Parasitic thecate infusoria are occasionally to be seen on the head tuft of bristles and also much minute filamentous matter similar to that clogging the dorsal bristles and the fimbriæ of the elytra of *Lepidonotus squamatus*.

Siphonostoma diplochaitos, Otto.

Hab: H, P, 6, 7, 9.

The *S. gelatinosum* of Mr. Gibson's previous local list. It is more frequently taken on the littoral than *Trophonia*

* On some new British Polynoina, 1866.

plumosa, indeed it is fairly common at low water at Puffin Island. After careful examination of specimens of the undoubted *S. diplochaïtos* obtained from the Naples Zoological Station and home specimens of *Flabelligera affinis*, Sars, I cannot but conclude that specifically they are identical. The slight differences there are, are amply accounted for by the varying states of contraction consequent upon divergent preservative agents and to the considerable difference in latitude between the two habitats. Quatrefages could certainly never have seen a specimen of the Naples *S. diplochaïtos* else he would not have defined the genus *Siphonostoma* as destitute of hairs or glandular papillæ.

Family.—TEREBELLIDÆ.

**Amphitrite figulus*, (Dalyell).

Hab: Puffin Island and Egremont.

The *A. Johnstoni* of Malmgren according to Marenzeller. The presence of 24 pairs of notopodial fascicles of capillary setæ is characteristic of this species. Tube of mud, the corrugated end projecting about an inch above the surface of the mud-flat where it is found.

Terebella nebulosa, Montagu.

Dredged off Port Erin.

Lanice conchilega, (Pallas).

Abundant on the littoral, and taken frequently in the dredge.

Thelepus cincinnatus, (Fabr.)

Hab: 4, 8, 10, 13, 14, P. Littoral to 22 fms.

Shares with *Lanice conchilega* the honour of being the characteristic species of Terebellidæ of this district. It however has not so high a littoral range as the latter, but, on the other hand, it is, of the two, much the more frequently found in deep water.

Since Malmgren's time the name has continually been

spelled wrongly "*circinnata*." As Marenzeller points out (*loc. cit.*) Fabricius called the branchiæ "cincinni" (locks of crisped hair) hence the species "cincinnata." It is the *Venusia punctata* of Johnston.

**Nicolea venustula*, (Montagu).

Hab: 12, 13, 14, i.e, the central area of the Irish Sea.

Dredgings in deep water (20—22 fms.) usually yield specimens of this worm—the *N. zostericola* of Malmgren.

The species seems subject to frequent variation in the number of bristle tufts and of branchiæ. Malmgren defines it as having 2 pairs of branchiæ and 15 pairs of bristle-bundles; Tauber (*Ann. danica*) gives 16—17 pairs of the latter and 3 pairs of the former. Again, R. Leuckart's *T. parvula* (= *N. venustula*, Mont.) is endowed with 15 pairs of bristle bundles and 3 pairs of branchiæ, while Marenzeller who first pointed out the agreement of *N. zostericola*, Malmgren, with the *Terebella venustula*, Mont., diagnoses the same species, from specimens gathered both at St. Malo and in the Adriatic as possessing 17 bristle-bearing fascicles and 2 pairs of branchiæ.* Finally all of the individuals I have examined from the Irish Sea have had the characters as given by the last named author, with the exception of two half-grown ones which differed in having 15 pairs of fascicles.

Family.— AMPHARETIDÆ.

**Ampharete grubei*, Malmgren.

Hab: Station 14. A single specimen.

Two species of the genus *Ampharete* have previously been reported as British, viz:—*A. gracilis*, and *A. arctica*. The former is characterized according to Malmgren—by elongated filiform branchiæ and apex of palmular setæ much attenuated; the latter by stout short branchiæ, the palmular setæ having a mucronate apex. The present

* Zur Kenntniss der Adriat. Anneliden.

species (recorded now for the first time as British) has short branchiæ and apices of palmular setæ very much drawn out.

Family: AMPHICTENIDÆ.

This is a family wherein Malmgren has introduced much unnecessary sub-division. For instance, take his two genera *Amphictene* and *Pectinaria*, the former containing *P. auricoma*, the latter, *P. belgica*. His generic definitions for the two are nearly word for word the same, almost the only divergence being that he states that in *Amphictene* the margin of the post palmular area is cirrate-dentate whereas in *Pectinaria* the same region is entire. Again, the former constructs a curved tube—the latter a straight one—all which, while they may be good specific distinctions, seem to me altogether too trivial to possess generic value. Again, Malmgren erects the genus *Lagis* to contain species possessing 15 and 12 pairs of capillary and uncinigerous setæ respectively in contradistinction to *Amphictene* and *Pectinaria* with 17 and 13 pairs. This division is apparently founded upon an error as both *P.* (*Amphictene*) *auricoma* and *P. belgica* possess only 15 and 12 pairs. If Malmgren's *Lagis* really possesses the number of bristle bundles stated by him, then *Lagis* as a genus must cease to exist and must be merged into *Pectinaria*.

Pectinaria (Amphictene) auricoma, (Müller).

Hab: 12, 13.

Dredged from 20—22 fathoms in company with *P. belgica*, which they generally surpass in size. Not found at any time in great number. Malmgren gives the number of fascicles of capillary bristles as 17 pairs, and the uncinigerous rows as 13 pairs, but careful examination of all the specimens available showed but 15 pairs of the former and 12 pairs of the latter.

Pectinaria belgica, (Pallas).

Hab: 1, 2, 4, 12, 13, E. NB.

Immense numbers people the far-stretching sandbanks skirting the Lancashire and Cheshire coasts. The animals live head downwards in the sand, and range from mid-tide mark (exceptional) to a depth of 21 fathoms.

As in the preceding species there are 15 pairs of capillary fascicles and 12 pairs of uncinigerous rows, not 17 and 13 as stated by Malmgren, nor 15 and 11 pairs respectively as amended by Cunningham and Ramage.

Family.—HERMELLIDÆ.

Sabellaria alveolata, Linn.

Hab: S, E, NB, H.

Enormous encrusting masses attaining in favourable situations a thickness of quite two feet, occur at the tide-swept end of Hilbre Island. As the geological formation of the Island is soft Red Triassic sandstone liable to rapid denudation, these incrustations have an important retarding effect, as has been pointed out by Prof. Herdman.* Damage wrought by storms on the brittle sand constructed tubes is very rapidly righted by the gregarious occupants. A species of mite is frequently found parasitic upon this species.

* *Sabellaria spinulosa*, R. Leuckart.

Hab: 5, 8, 9, 10, 12, 13, 10—50 fms.

This animal is met with everywhere in deep water in our area often in considerable abundance, and is without doubt one of the commonest worms. It is brought up both in broken masses and also singly upon valves of dead shells. It appears to be confined pretty straitly to the depths of the sea and not to trench on the shallow water and littoral range of *S. alveolata*.

*Proc. L'pool Biol. Soc., vol. II. p. 39.

Family.—SERPULIDÆ.

1. Sub-family.—SABELLINÆ.

Sabella pavonia, Savigny.

Hab: 4, 7, 8, E, H, M.

I have found considerable variation in this species, both in size and in the colouration of the branchial filaments. In this district it ranges from some feet above low water level to 16 fathoms, but specimens which are ever left uncovered by the tide never attain to the largest size.

Sabella pavonia, var. *bicoronata*, n.

Hab: Rock pools at extreme low water at Hilbre Id.

This variety is found in considerable numbers as above. From the type it differs in *nothing* save the arrangement of the branchiæ. These are in two unequal tufts forming two closely superposed cirles of filaments when expanded—nearly 4 in. in diameter in large specimens.

Of the two fully grown specimens obtained one had 61 filaments in one tuft, and 30 in the other. The second had 55 and 37 respectively. The smaller tuft usually forms more than half a circle, the larger meets this on one side and forms the remainder of the outer circle and then curves inwards to make a more or less complete inner circle. The anterior part has 8—13 segments. At first I was inclined to form a new species for this animal and to place it in the genus *Spirographis* but for the present I incline to count it merely a variety. Numbers of normal *S. pavonia* are found associated. Probably many of the species of *Spirographis* described in various works will in time be eliminated and found to be varieties of different species of *Sabella*. In *Dasychone herdmani*, mentioned next a specimen is noted having unequal tufts after the same manner.

**Dasychone herdmani*, n. sp. (Pl. XV, figs. 1—9.)

Hab: Puffin Island and off the coast of Anglesey, from low water to 18 fms. Stations 5, 6, 10, P.

The body is short and thick, composed of about 60 segments. The anterior or thoracic region is about as broad as long, having 8 bristle-bearing segments. The dorsal edges of the cephalic collar incline towards each other and nearly touch. Thence the collar is continued as a slightly everted rim of even height, terminating in two boldly everted lappets on each side of the median ventral line. A shallow notch separates the lappets from the rest of the collar laterally. The branchiæ are in two equal tufts of 15—20 filaments each. Apex of each radiole is naked, rather stout or digitate. The distal pinnæ rapidly diminish and end as mere bud-like eminences at the base of apex. At equal distances on the rachis are disposed paired eye-spots. Between each two pairs of eye-spots is a pair of dorsal appendages; usually the position is just behind one of the pairs, but in some specimens it is nearly midway between the two. In shape they are ample, long, and *broadly spathulate, the margin of the broad apex being puckered and indented.* There are in general 20—22 pairs of these processes on each filament and an equal number of eye-spots. The tentacula are two in number, channelled on the opposing faces, acuminate, about a third as long as the filaments.

Colour. Body of dark yellowish or brownish red; a dark brown spot below each tuft of capillary setæ in the thoracic region, but above each tuft in the posterior or abdominal portion of the body. Collar pale and uncoloured as are also the tentacula. The branchiæ are white, beautifully variegated with narrow bands of intense purple, brown and yellow.

The tube is short and corrugated, dark grey in colour

and chitinous in structure. Length about 3 to 5 cm. Animal about the same length.

This species while agreeing in all other essential details with the previously known British representative of this genus, *Dasychone dalyelli*, Kölliker (the *Sabella bombyx* of Johnston) is sharply differentiated by the shape of the dorsal processes. A similar difference marks it off from the Neapolitan *D. lucullana* with which species Mr. Gibson, in the previous local list erroneously identified the present. In both *D. dalyelli* and *D. lucullana*, which I fancy will be found to be one and the same species, the dorsal appendages have the form of elongated sublinear processes slightly dilated at the apices—giving them a graceful club-like form—totally different from the broad spathulate appendages of *D. herdmani*. This latter form approaches more closely to that seen in *D. infarcta*, (Kroyer), but Kroyer's species has no eye-spots.

In one specimen I noticed with interest a similar varietal departure from the normal arrangement of the branchiæ such as I elsewhere note concerning *Sabella pavonia*. In the individual I refer to, the left tuft of branchial filaments was much larger than the right—containing 33 filaments for the other's 16.

**Amphicora* (*Othonia*) *fabricia*, (Müller).

It is to the courtesy of Mr. C. H. H. Walker that I am indebted for having my attention directed to this tiny tube builder as an inhabitant of this district. It is fairly numerous attached to the surface of seaweed, &c. at the extremity of Egremont slip—than which no more prolific hunting-ground exists in the Mersey whenever the Ferry authorities for even a short period cease from troubling about repairs. *A. fabricia* is at times met with free—without trace of any protecting tube—crawling about among weed.

2. Sub-family:—SERPULINÆ.

Filigrana implexa, Berkeley.

Hab: N. E. coast of Anglesey and south coast of Isle of Man—Low water to 18 fms.

Serpula vermicularis, (Ellis).

Hab: Deep water area of Irish Sea, about 20 fms.

* *Serpula reversa*, Montagu.

Hab:—P, 6, 12, 13.

From low water mark to 22 fathoms. The most abundant deep water Serpulid. I have seen a crab dredged up carrying two or three large ones upon its carapace; the usual situation is upon shells of dead molluscs. Probably the *Eupomatus pectinatus* of Philippi.

Pomatoceros triqueter, (Linn).

Hab: P, 5, 10. Common on the littoral, extending more sparingly to deep water—18 fms.

Apparently a variable species—in the colour of the branchiæ and in the shape of the operculum. Cunningham and Ramage are in error in giving *S. conica*, Johnston, as a synonym, unless indeed it be that the latter is found to be a variety *P. triqueter*. In any case Johnston's figure of the operculum of *S. conica* is not a typical form of that of *P. triqueter*, while that figured under the name of *S. armata* is perfectly characteristic, agreeing even with C. and R.'s own delineation of the operculum of the present species.

Spirorbis borealis, Mörch.

Hab:—On all our rocky shores and wherever it can find lodgment, characteristic of the littoral—*Fucus serratus* is its commonest host.

Spirorbis lucidus, (Mont), Mörch.

The characteristic *Spirorbis* of deep water. Its tiny translucent spirals frequently occur in rows along the stalk and branches of *Sertularia* dredged from various depths.

Geographical and Bathymetrical range of local Polychætous Annelids.

NOTE.—The following abbreviations are used:—E = East coast of Great Britain; Ch = English Channel coasts; Ir = West and South coasts of Ireland; WS = West Scotland; Shet = Orkney, Shetland and Faroë region; UK = all British coasts. US = East coast N. America, south of Labrador and north of N. Carolina; Gr = Greenland and Arctic America; Sp = Spitzbergen; NZ = Nova Zembla; Sc = Scandinavian, Danish and German coasts; Med = Mediterranean Sea.

L = Littoral; O = Low water mark. (×) cast ashore by storms.

SPECIES.	Local—Irish Sea Area						RANGE in BRITISH SEA.	OTHER SEAS.
	Central Area.	Isle of Man.	N. Wales & Anglsy.	Lancas. & Chesh.	Hilbre Island.	Bathymetrical range.		
Aph. aculeata	×	...	×	×	...	O—20	UK.	US, Sc, Med.
Hermione hystrix	×	×	×	...	...	15—40	Ch, Ir.	Sc, Med, C. Verde I.
Lep. squamatus	×	×	×	...	×	L—22	UK.	US, Gr, Sc, Azores.
Nychia cirrosa	...	..	×	..	...	O—18	E, Ch.	US, Gr, Sp, NZ, Sc.
Polynoë imbricata	...	×	×			L—5	UK.	US, Gr, Sp, NZ, Sc, S. Jpn, Ochotsk S, Sitcha
,, *halizæ*	×	×				15	WS, Sh.	
,, *impar*	×	...	×	×	×	L—22	Sh, E, Ch.	US, Gr, NZ, Sc, off Gibraltar, Med (probably)
,, *extenuata*	...	×	×	...	...	L	...	Med.
,, *propinqua*	×	×	×	×	...	L—57	E, Shet.	US, Sc, Madeira.
,, *setosissima*	...	...	×	...	...	O	E, Ch.	Sc, Med (probably).
,, *castanea*	×	...	×	...	...	20—22	Shet, Ir, Ch.	
,, *flocculosa*		×				L	E, Ch.	
,, *lunulata*				(×)		deep w.	UK.	Med.
,, *johnstoni*	...	...	×	...	...	12—20	Sh, WS, Ch.	Sc. La Rochelle.
Acholoë astericola	×	...	...	(×)	...	14	Ir	Med.
Hal. gelatinosa	...	...	×	...	...	O	E, WS, Ch.	Sc.

Hermadion assimile	×	×	...	...	...	10—21	E, Ir, Ch.	off C. de Gatte (M'I).
,, *pellucidum*	×	...	×	...	...	16—22	E, WS.	Med.
Sthenelais boa..	...	×	×	...	...	L	UK.	Sc.
,, *limicola*	×	...	...	...	...	20—22	Shet, E.	US.
,, *zetlandica* (?)	...	×	...	...	...	20	Shet.	
Pholoë minuta.....	...	...	×	×	...		E, Ch.	US, Gr, Sp, NZ, Sc.
Spinther miniscoides..	...	...	×	...	...	17	WS,& Blfast	Sc.
Eunice harassii.....	×	...	...	...	...	20—22	Ch.	
Onuphis conchilega ..	×	...	...	...	...	20—22	UK.	US, Gr, Sp, NZ, Sc, Portugal.
Lumbr. fragilis.....	×	×	×			20—22	E, Shet.	US, Gr, Sp, NZ. Sc.
Nereis pelagica.....	×	×	×		×	L—20	UK.	US,Gr,Sp, NZ,Sc,Jn.
,, *diversicolor*				×		L	UK.	Gr, Sc, Med, Japan.
,, *dumerilii*..		×	×	×		L—16	UK.	US, Sc, Med, Madeira, C. Verde Ids. & Japan.
,, *virens*				×		L	E, WS.	US, Sc.
,, *fucata*		×	×	×		L—18	E, Ch.	US, Sc
Nephthys cæca.....	×					18	E, WS, Ch.	US, Gr, Sc.
,, *hombergii*..	×	×	×	×	...	L—20	E, WS.	US, Gr, NZ, Sc.
Goniada maculata...				×		L	E.	US. Sc.
Glycera capitata.....			×	×		L—17	E, WS, Ch.	US, Gr, Sp, NZ, Sc, Portugal and Azores.
,, *nigripes*.....			×			5	E.	
,, *dubia*		St	om	ach	s	of Cod	E, WS, Ch.	
,, *gœsii*.....			×				E.	Sc.
Syllis tubifex.....	×		×			3—21	E, WS, Ch.	N. Scotia, Madeira.
,, *armillaris*			×			O	E, Ch.	Sc.
Autolytus alexandri..	To	w-	×	net	ted	...	...	US, Gr.
,, *prolifer*....				×		E.		Sc.
Ephesia gracilis.....	×		×	×		O—25	UK.	Gr, Sp, NZ, Sc.
Psamathe fusca.....			×			L	E, Ch.	
Castalia punctata....			×			18	E.	Sc, Iceland.
Phyll. maculata.....			×	×		O—18	E.	Iceland.
,, *laminosa*.....		×	×			O	E, Ch.	Med.
Eulalia viridis.....		×	×			L	E, Ch.	Gr. Sc.
Tomopt. miscæformis			×	×	To	w-	netted	E, Ch, Shet. ?
Ophelia limacina.....	×					18	E.	Gr, Sp, NZ, Sc, US.
Ammot. aulogaster...	×		×			3—21	E, WS.	Gr, Sp, NZ, Sc.
Capitella capitata....		×	×			L	E, WS.	Gr, Sp, NZ, Sc, Med.
Arenicola marina....		×	×	×	×	L	UK.	US, Gr, Sp, Sc, Med.
Nic. lumbricalis			×				E.	US, Gr, Sp. NZ, Sc.
Axiothea catenata.....			×			O	E, Shet.	US, Gr, Sp.
Owenia filiformis.. ..	×		×	×		O—22	E.	Gr, Med.
Scoloplos armiger...		×	×	×		L—6	Sh, E, Ch.	US, Gr. Sp, NZ, Sc.
Cirratulus cirratus...			×			O	UK.	US, Gr, NZ, Sc.
,, *tentaculatus*		×	×			L	E, Ch.	Med.
Chætozone setosa.....				×		L	E.	US, Sp, NZ, Sc.
Spio seticornis.....				×		L	E, Ch.	Gr, Sc.
Nerine cirratulus.....				×		L	E.	Med.
,, *vulgaris*		×		×		L	E, Ch.	Sc.
Leucodore ciliata.....		×		×		L	E, Ch.	Iceld, Sc, Philippms & Australia (Haswell).
Mag. papillicornis ...				×		L	E.	
Chætopterus insignis			×			O—14	WS, Ch.	
Trophonia plumosa..	×		×			O—57	Sh, E, Ch.	Gr, Sp, NZ, Sc.
Siphon. diplochaitos			×		×	L—18	WS, E, Ch.	US,Gr,Sp,NZ,Sc Med
Amphitrite figulus....			×	×		L	E.	US, Sc.
Terebella nebulosa....		×				14	UK.	Sc, Med.

Lunice conchilega....	×	×	×	×	×	L—22	E, Ch.	Cattegat, Belgium, Med, and Madeira.
Thelepus cincinnatus	×		×			L—22	UK.	US, Gr, Sp, NZ, Sc Med
Nicolea venustula....	×					20—24	Sh, E, Ch.	Gr, Sc, Med.
Ampharete grubei....	×						...	Gr, Sp, NZ, Sc.
Pectin. auricoma.....	×					20—22	E, WS.	Sc, Med.
,, *belgica*.....	×		×	×		O—22	UK.	Sc.
Sabellaria alveolata.				×	×	L	E, Ch.	Med.
Sabellaria spinulosa	×		×			10—50	E, Ch.	Sc.
Sabella pavonia.....		×	×	×	×	M—16	E, Sh, Ch WS	US, Sc.
Dasychone herdmani			×			O—18	...	
Amphicora fabricia..				×		O	E, Ch, WS.	Gr, Sc,
Filigrana implexa....		×	×			O—18	E, Ch.	US, Sc.
Serpula vermicularis	×					20	UK.	Sc, La Rochelle
,, *reversa*.....	×		×			O—22	E, Ch, Ir.	
,, *triqueter*....			×			L—18	E, Ch.	Sc, Med.
Spirorbis borealis....		×	×	×	×	Litt.	E, Ch.	US, Gr, Sc.
,, *lucidus*...	×	×	×			10—20	E.	US, Gr, NZ.

Explanation of Plates.

Plate XIII.

Fig. 1. Notopodial seta of *Polynoë propinqua*, × 250.

Fig. 2. ,, ,, ,, *imbricata*, × 250.

Fig. 3. ,, ,, ,, *impar*, × 250.

Fig. 4. ,, ,, ,, *extenuata*, × 250.

Fig. 5. ,, ,, ,, *halicti*, var. *hyænæ*, × 250.

(These figures show the minute but constant relative differences in the degree of serration exhibited by the bristles of the respective species.)

Fig. 6. *Polynoë impar*. Portion of scale showing single large pear-shaped papilla, × 130.

Fig. 7. *Polynoë propinqua*. One of the large sub-globular margin processes, × 190.

Fig. 8. *Polynoë extenuata*. Entire scale, × 44.

Fig. 9. *Polynoë propinqua*. Parapodium, × 20.

Fig. 10. *Eunice harassii*. Parapodium and branchia from the 21st setigerous somite, × 20.

PLATE XIV.

Fig. 1. Egg capsule of *Scoloplos armiger*, nat. size.

Fig. 2. Ovum separated from capsule, × 80.

Fig. 3. Extrusion of polar bodies, × 80.

Figs. 4—11. Stages in segmentation of an ovum, × 80. *p.b.* polar bodies; *mic.* micromeres; *mac.* macromeres.

Fig. 11. Shows macromeres entirely enclosed by micromeres except at the blastopore.

Fig. 12. Egg capsule of *Arenicola marina*, nat. size.

Figs. 13—18. Stages in the larval development of same, × 225. *e.g.* eye-spots; *z.* zonar band of cilia; *a.* anterior tuft of cilia; *m.* mouth; *v.* ventral band of cilia; *c.* first segmental constriction of larval body.

Figs. 17, 18 are diagrams to show the ciliary arrangement.

Fig. 19. Appearance of zonar cilia as seen from above while the embryo is whirling rapidly, × 225.

Figs. 20, 21. Most advanced embryos observed; *c.* first segmental constriction, × 400.

PLATE XV.

Dasychone herdmani, n. sp.

Fig. 1. Entire animal, dorsal view, × 3.

Fig. 2. Lateral view of anterior portion of body, × $4\frac{1}{2}$.

Fig. 3. Ventral view of same, × $4\frac{1}{2}$.

Fig. 4. Part of a branchial filament, × 44. *a.* dorsal processes; *b.* eye-spots; *p.* pinnæ.

Fig. 5. Extremity of a radiole, × 44.

Fig. 6. Dorsal process from a different specimen to Fig. 4; here the margin is less puckered, × 60.

Figs. 7, 8. Capillary setæ. 7, superior; 8, inferior, × 250.

Fig. 9. Uncinus, × 250.

On the preparation of MARINE ANIMALS as LANTERN SLIDES to show the FORM and ANATOMY.

By Dr. H. C. Sorby, F.R.S.

[Read April 10th, 1891.]

The author exhibited 30 lantern-slide preparations of marine animals, including representatives of most of the leading groups. Flat fishes, like soles or dabs, about $1\frac{1}{2}$ inch long, when mounted in Canada balsam are sufficiently transparent to show their general form and anatomy very well. Crustaceans which are not too thick may be digested in diluted alcohol, to which a little hydrochloric acid has been added, to remove the carbonate of lime. Their form then remains perfect, though they become so pliable as to make it easy to gum them flat on the glass. Those, like *Caprella*, which become too transparent when mounted in balsam, may be previously stained with carmine.

Success in the case of soft bodied animals, like Ascidians, Nudibranchs, Annelids and Medusæ, depends to a great extent on the fact that, when properly arranged out, they dry first round their edges, and adhere to the glass in such a manner that on subsequent complete drying contraction takes place almost entirely in a direction perpendicular to the plane of the glass, so that they become quite flat and thin, without material change in the original outline. Those which, like Medusæ, contain so much salt water must be digested for some time in diluted alcohol, but some Nudibranchs and worms must be kept in the alcohol no longer than is absolutely necessary, or the natural

colour may be destroyed. Many worms make excellent preparations, especially *Nereis* and coloured varieties of *Sabella*.

Medusæ, first digested for some time in diluted alcohol and then stained with carmine, make splendid preparations. They dry down quite thin and transparent; but, without care, are almost sure to crack and break up. As they become partially dry their surface should be coated with clear and colourless gum, and the slide kept under a saucer with wet blotting paper, so that the gum may remain liquid, and soak well into the tissues. By careful management perfect and uncracked specimens may be prepared and finally mounted in balsam, so as to show both the general form and anatomical structure extremely well.

Probably on the whole the most satisfactory preparations are those in which the animals are partially dissected, and so arranged as to show the internal viscera, as in the case of a slide of *Arenicola*, which shows to great perfection the intestine, the digestive glands, and the principal blood vessels. Partially dissected and subsequently stained *Priapulus* and *Synapta* show very well the arrangement of the muscles moving the body and proboscis, and also the digestive and reproductive organs. When shown on the screen these last preparations look more like anatomical drawings than real animals.

The principal difficulty in making the slides is the final mounting in Canada balsam, which is indispensible for lantern purposes. Small bits of black cardboard should be fixed at the four corners, of such a thickness that the cover glass is just clear of the dried animal. Before mounting, the object should be sufficiently soaked in benzole, and any bubbles included in the balsam got rid of by keeping the slide warm. By fixing well gummed

paper round the edges, and, after this has dried, by varnishing it, and, when the varnish is hard, by glueing strips of black paper round the slide, the soft balsam may be so confined as not to run out; but it seems probable that, by a modification of the process, the balsam may be made sufficiently hard before the glass cover is put on, so as to greatly reduce the risk of leakage, which, without care, may be very troublesome. Excellent results can be attained, but it is very desirable that the necessary processes should be materially simplified, and made more certain.

LIST of the FRESH WATER ALGÆ of the LIVERPOOL DISTRICT.

By Wm. Narramore, F.L.S.

With Plates XVI., XVII.

[Read April 10th, 1891.]

During the past six or seven years I have interested myself, more or less as far as limited time and opportunity would permit, in the collection and the examination of the Fresh Water Algæ of the District of Liverpool, say for fifteen or twenty miles round. I did not set out with the intention of writing a report, otherwise this list would have been much more extended than it is; it is simply a preliminary list of the unicellular and filamentous forms of the Fresh Water Algæ exclusive of the Desmidiaceæ and the Diatomaceæ. The list is fairly representative, and I may hope for it that it will serve as a basis for further work. With a systematic list in hand no doubt many of our local naturalists will feel at liberty to add considerably to this division of the "Flora of Liverpool." Whatever has been done by local workers among this group of Cryptogams, I know of no list available as a guide to systematic work. I shall be only too glad to hear of workers among the Fresh Water Algæ and to receive additions to the present list from any sources.

The district is undoubtedly rich in Fresh Water Algæ, either side of the Mersey is well provided with flats and shallows, ponds and ditches, canal and stream, moss and marsh, and bog and sandy hollows; habitats so many and so varied are rich in both genera and species. The nature

of the rocks and subsoils, especially the sandstones and clays, are important factors in the determination of this richness. On the Cheshire side one may walk for miles and pass scores of fields and find one or more ponds in each field. Now it will readily be expected that many forms of Algæ will occur frequently, and particularly the simpler forms, and such is the case, for many of the unicellular Algæ are met with in almost every gathering and at almost any time of the year.

The difficulties of certifying to the specific characters of many of these forms are great indeed; form, size, condition, still or active, singly or in mass, vary with many changing conditions and many times in a short period. Be it remembered that the very simplicity of structure of these simple plants makes them susceptible and responsive to relatively feeble changes in the conditions that are at once remarkable and surprising to students of higher forms of plant life. Of course active cell structures of the higher plants are acted and reacted upon by slight changes of conditions, e.g., food, temperature, light, moisture, etc., but the changes largely pass unnoticed as they require longer time, and the influence is evident only in the result.

These minute plants all require microscopical examination to determine even the most superficial characters, whilst the characters determining specific differences often require close, skilful and patient investigation. Again and again conclusions have to be postponed for want of stages in the life history or development of the plant; the factor of reproduction is so important to a true classification that much material has frequently to be cast aside as incomplete for determination. As in other groups of organisms careful selection and cultivation of the particular forms to determine the true life history is all important, so in the

group of plants now under consideration a similar course must be followed. For instance, I take a gathering of Algæ from a ditch or pond, keep it in a vessel, and from time to time examine it. If the gathering happens to be mixed, I shall find perhaps that the reproductive bodies proceeding from two or three different Algæ are similar in size, form, &c.; now deductions made from the course of events that follow are very liable to error, and at all events as a matter of science, would be open to doubt. The following case will illustrate my meaning even more strongly. Quite recently I gathered from a dripping sandstone rock at Storeton quarries some jelly-looking material which I thought at the time might be some of the Nostoceæ. Placing it under the microscope I made out the following forms, *Glœocystis rupestris*, Lyng,, *Glœocapsa arenaria*, Rabh., *Glœocapsa quaternata*, Breb., *Palmella mooreana*, Harv. Here we have three genera and four species, composed of similar pseudocysts, all existing together in a gelatinous matrix. Is there any connection between them? Is there genetic affinity? Are any of these forms but stages in the life history of either these or higher forms of Algæ? It is generally admitted that *Glœocapsa* is analogous to *Glœocystis* in the two divisions, the chlorophyll-green and the blue-green divisions of the Algæ, and Richter goes so far as to suggest there is identity. It must be clear that nothing short of separation and pure cultivation of these several forms can give us the solution to these questions. When we are able to accurately trace the development of many so-called unicellular Algæ, I have no doubt that the classification of the Fresh Water Algæ will be very much simplified.

The question of classification is always a difficulty, but as I have worked chiefly with Dr. M. C. Cooke's British Fresh Water Algæ, in the main I have followed the

arrangement given in his work. In a few cases I have modified this arrangement by accepting the newer classifications of Goebel and of Bennett and Murray. As the tendency of workers in the present day is to group together a large number of the simpler forms of plant life, I have fallen in with the provisional division the "Protophyta" of Bennett and Murray for the Protococcoideæ and Chroococcaceæ. In fact I think in the present state of our knowledge of the more or less distinctly unicellular organisms that the division Protophyta is at least a convenient one.

The practice of certain writers of giving the time of reproduction or "fruiting" as it is termed, is unwise and misleading. In making these statements, often made on too limited observation, due consideration has not been given to the character of the season, conditions of surroundings, geographical position, free or limited supply of water, etc. Among the Conjugatæ, the Multinucleatæ and some of the Confervaceæ times of reproduction given have certainly been misleading as far as this district is concerned.

I have to thank several students who have afforded me help by supplying material gathered from different parts of the district; I have especially to acknowledge the help rendered by Mr. T. Birks and Mr. R. H. Day both of whom have collected and named several species which are duly noted in this list. The total number of genera recorded is 69, and of species 176.

Letters L and C indicate counties Lancashire and Cheshire. Letters (N), (B), (D) after the locality stand for Narramore, Birks and Day, by whom the Algæ were found.

Division.—RHODOPHYCEÆ.

Order.—FLORIDEÆ.

Family.—HILDENBRANDTIACEÆ.

Hildenbrandtia rivularis,, Ag.

Incrusting stones at the bottom of a stream at Bromborough, C. (N).

Family.—BATRACHOSPERMACEÆ.

Batrachospermum moniliforme, Roth.

Raby, C. (N) on shells of *Limnæus stagnalis*, Barton, L. (D), Woodville, C. (N), sparingly found.

B. vagum, Roth.

Ainsdale. L. (B) sparingly found. It is probable that only detached specimens of these species have been found, no doubt large masses will be met with in the district as it is usual for this alga to be found in abundance.

Family.—LEMANEACEÆ.

Lemanea torulosa, Roth.

Little Sutton, C. (N) in stream with *Prasiola crispa*.

Family.—PORPHYRACEÆ.

Bangia ceramicola, Thur.

In brackish ditch, Wallasey, C. (N).

Division.—CHLOROPHYCEÆ.

Family.—ULVACEÆ.

Prasiola crispa, Kütz.

Little Sutton, C. (N) stream, attached to stones; Formby, L. (N) in ditches; Raby, C. (N) stream.

P. furfuracea, Men.

Bootle, L. (D) damp ground.

P. calophylla, Cam.

Sefton Park, L. (B).

Enteromorpha intestinalis, Linn.

Little Sutton, C. (N) stream; Raby, C. (N) stream;

Leasowe, C. (N) brackish water; Wallasey, C. (N) brackish water; Sefton, L. (N) ditch.

E. ramulosa, Hook.

Not given in Dr. M. C. Cooke's British F. W. Algæ. Found in quantity in a ditch at Sefton, L. with *E. intestinalis*, (N), identified by Dr. J. G. Baker of Kew.

Monostroma laceratum, Thur.

Formby, L. (N, B, D) ditch.

CONFERVOIDEÆ, HETEROGAMÆ.

Family.—COLEOCHÆTACEÆ.

Coleochæta scutata, Bréb.

Shotwick, C. (N), Bromborough, C. (N), Spital, C. (N), Newsham Park, L. (N), Green Lane, L. (N). Growing on water plants and also on the sides of fresh water aquaria.

C. orbicularis, Prings.

Bromborough, C. (N), Princes Park, L. (N), Bootle, L. (D). Attached to water plants.

C. soluta, Prings.

Huyton, L. (N), Rufford, L. (N). On water plants.

Aphanochæta repens, Br.

Burton, C. (N) on leaves of *Myriophyllum spicatum*, Sefton Park, L. (B) on *Cladophora flavescens*; spines long and not articulate, but thallus the form of *A. repens* rather than *A. hystrix*.

A. hystrix, Thur.

Sefton Park, L. (B) on *Cladophora flavescens*.

This form was decidedly in agreement with the characters of *A. hystrix* except that the spines were longer and resembled *A. repens* but were not articulate.

Family.—ŒDOGONIACEÆ.

Œdogonium petri, Wittr.

Œ. vernali, Hass.

Œ. urbicum, Wittr.

Œ. pluviale, Nord.
Œ. flavescens, Hass.
Œ. ciliatum, Hass.
Œ. calcareum, Wittr.
Œ. longatum, Kütz.
Œ. tenellum, Kütz.

Members of this genus are freely found in several places in the district. Individual species are subject to many variations and it is a matter of considerable difficulty to classify them with absolute certainty.

Bulbochæta gracilis, Prings.
B. polyandra, Cleve.
B. setigera, Ag.
B. mirabilis, Wittr.

Members of this genus very sparingly found, and rarely met with in the reproductive stage.

CONJUGATÆ.

Family.—ZYGNEMACEÆ.

Zygnema pectinatum, Ag.
Moreton, C. (B), Freshfield, L. (N), Huyton, L. (N), Shotwick, C. (N), Bromborough, C. (N).

Z. parvulum, Kütz.
Kensington, L. (N), Raby, C. (N).

Z. cruciatum, Ag.
Bromborough, C. (N).

Z. stellinum, Vauch.
Moreton, C. (B).

Z. insigne, Kütz.
Huyton, L. (N).

Z. anomalum, Ralfs.
Bromborough, L. (N). Found generally in ponds and ditches.

Spirogyra crassa, Kütz.
Huyton, L. (N).

S. orbicularis, Hass.

Probably the same as *S. crassa*; not satisfactorily determined in the absence of the zygospores.

S. orthospira, Näg.

Bromborough and Spital, (N). This species was recognised long ago by Mr. Archer in Ireland, but only discovered in England some few years since.

S. bellis, Hass.

Bebington, C. (N), Kensington, L. (N), Bromborough, (N, B, D), and other places not noted.

S. porticalis, *rivularis* and *decimina*. Bebington, C. (N), Bromborough, C. (N, B, D).

S. longata, Vauch.

Bebington, C. (N), Bromborough, C. (N, B, D).

S. condensata, Vauch.

Kensington, L. (N), Hooton, C. (N).

S. flavescens, Kütz.

Hooton, C. (N), Little Sutton, C. (N).

S. insignis, Hass.

Kirkby, L. (N), Sefton, L. (N).

S. calospora, Cleve.

Kirkby, L. (N), Spital, C. (N).

S. tenuissima, Hass.

Found in several places along with the above named species.

S. quadrata, Hass.

Sefton Park, L. (B).

This list does not include all species of the Zygnemaceæ found, but only those whose specific characters could be determined. The difficulty of securing specimens containing the zygospores compelled the writer to exclude many and even to leave a few of the present list in doubt.

Zygonium ericetorum var. *aquaticum*, D.By.

Several places but not in reproduction.

Staurospermum viride, Kütz.
Kirkby, L. (N).

S. gracillimum, Hass.
Fragments in gatherings of Algæ—places not noted.

Family.—MESOCARPACEÆ.

Mesocarpus parvulus, Hass.

M. parvulus, var. *angustus*, Hass.

M. depressus, Hass.

The above and other species freely met with in ponds and ditches, but in the absence of the reproductive stages, they have not with certainty been diagnosed.

CONFERVOIDEÆ ISOGAMÆ.

Family.—CONFERVACEÆ.

Chætophora pisiformis, Roth.
Bromborough, C. (N), Raby, C. (N), Spital, C. (N), Moels, C. (N), Kensington, L. (N), Formby, L., Birkdale, L., Storeton, C. (N, B, D), Aintree and Walton, L. (D).

C. elegans, Roth.
Bromborough, C., Kensington, L., Moreton, C., Formby, L. (N, B, D).

C. tuberculosa, Roth.
Kensington, L. (N), Green Lane, L. (N), Barton, L. (B and D).

C. endivæfolia, Ag.
Barton, L. (N and B), Leasowe, C. (D).

Draparnaldia glomerata, Ag.
Huyton, L. (N), Formby, L. (D).

D. glomerata var. *distans*, Kütz.
Huyton, L. (N).

D. plumosa, Ag.
Moreton, C. (N and B), Formby, L. (N and B), Sefton Park, L. (B), Hightown, L. (B).

Chroolepus aureum, Linn.

Along with *V. sessilis* on damp soil of flower pots (N).

Stigeoclonium tenue, Ag.

Pond Wavertree Park, L. (N), ditch Storeton, C. (N).

S. protensum, Kütz.

Cladophora fracta, Kütz.

Princes Park, L. (N), Raby, C. (N), Huyton, L. (N), Sefton, L. (N).

C. crispata, Kütz.

Princes Park, L. (N).

C. flavescens, Ag.

Princes Park, L. (N), Sefton Park, L. (B), Bromborough, C. (D).

C. glomerata, Linn.

Bromborough, C. (N), Sefton Park, L. (B), Kensington, L. (N), Newsham Park, L. (N), Sefton, L. (N).

Microspora vulgaris, Rabh.

Oxton, C. (N), Moreton and Leasowe, C. (N, B, D).

M. fugacissima, Thur.

Moreton and Leasowe; C. (N, B, D), Sefton Park, L. (B).

M. floccosa, Thur.

Formby, L. (N), Storeton, (N, B), Oxton, C. (N), Leasowe, C. (N, B, D), Sefton Park, L.

Conferva bombycina, Ag.

Bromborough, C. (N), Huyton, L. (N), Storeton, C. (B and N), Barton, L. (N).

C. fontinalis, Berk.

Formby, C. (N, B, and D), Raby, C. (N), Little Sutton, C. (N).

C. tenerrima, Kütz.

Oxton, C. (N), Wood Church, C. (N).

Chætomorpha sutoria, Berk.

Sefton Park, L. (B).

C. implexa, Dillw.
Walton, L. (D).
Rhizoclonium flavicans, Jurg.
In ditch Formby, L. (N).
R. casparyi, Harv.
In ditch Formby, L. (N).

Family.—ULOTRICHACEÆ.

Hormiscia catæniformis, Kütz.
Formby, L. (N, D), Oxton, C. (N), Bromborough, C. (N).
H. moniliformis, Kütz.
Bromborough, C. (N).
H. variabilis, Kütz.
Walton, L. (N).
Ulothrix tenuis, Kütz.
Formby, L. (N), Storeton, C. (N and B), Bootle, L. (D), Sefton Park, L. (B).
U. tenerrima, Kütz.
Wood Church, C. (N).
U. implexa, Kütz.
Sefton Pk., L. (B), Oxton, C. (N), Kensington, L. (N).
U. parietina, Kütz.
Litherland, L. (D), Sefton Park, L. (B).
U. radicans, Kütz.
Kensington, L. (N), Oxton, C. (N).
Schizogonium murale, Kütz.
Sefton Park, L. (B).

Ulothrix parietina, *Ulothrix tenuis*, *Schizogonium murale* and *Prasiola calophylla*, were found growing together, and upon careful examination they appear very fully to confirm the view of Dr. Braxton Hicks (Quart. Journ. Micros. Sc., 1861 and 1868) that *Schizogonium* is only a condition of *Ulothrix* in which the threads have become connate, of which *Prasiola* is only a frondose form.

MULTINUCLEATÆ.

Family.—VAUCHERIACEÆ.

Vaucheria sessilis, Vauch.

Moreton, C. (B), Walton, L. (D), Kensington, L. (N), Bromborough, C. (N).

V. sessilis, var. *cæspitosa*, Vauch.

Formby, L. (N), Barton, L. (N), Kensington, L. (N).

V. sessilis var. *repens*, Vauch.

Formby, L. (N).

V. dichotoma, Lyngb.

Aintree, L. (D, N).

V. terrestris, Lyngb.

Kensington, L. (N), Huyton, L. (N).

V. geminata, D. C.

Moreton, C. (B).

These species very freely distributed in ditches, damp stones, clayey soil and similar places, also found floating in mass on ponds. They are subject to attacks from parasitic Rotiferons of the genus *Notommata* (vide paper by W. Narramore, read before the Liverpool Microscopical Society, November, 1889).

V. sessilis is subject to much variation in the reproductive structures, one of the most striking examples is from a specimen gathered at Formby in March, 1891, an oogonium and antheridium of the specific type developed directly from the zoospore, whilst from the tubular portion of the same specimen are antheridia and oogonia of the types represented by *V. terrestris*, *V. dichotoma* and *V. hamata* (Pl. XVI., fig. 2, 3). This alga was taken from a ditch on sandy soil, the conditions being subject to many in the course of a season.

CŒNOBIEÆ.

Family.—VOLVOCINEÆ.

Volvox globator, Linn.

Bromborough, C., Spital, C., Kensington, L., Hooton, C., Barton, L., Seacombe, C., New Brighton, C., Bidston, C., Liscard, C., Wallasey, C. (N), Crosby, L. (N), Birkdale, L. (N), Churchtown, L. (N), Huyton, L. (N), Aintree, L. (N).

Eudorina elegans, Ehrb.

Croxteth, L. (N), Kensington, L. (N).

Pandorina morum, Bory.

Commonly found in ponds and pools along with other Algæ.

Gonium pectorale, Mull.

Croxteth, in a pond in the private grounds, in abundance, associated with other members of this family, (N).

Kensington, L. (N), Walton, L. (N), Sefton Park, L. (B).

Related to the Volvocineæ there is a form of alga represented in six positions by fig. 8, on Pl. XVII. It was met with in two gatherings from two places. It is free from other Cœnobial forms, made up of four cells held together by the faintest trace of a matrix; each cell has dark green contents, clear anterior end, pigment spot, nucleus and a pair of long cilia. When they swim the four cells are drawn after the cilia; they can spin round rapidly when the cilia may be seen either above or below the cells.

Another uncommon form of unicellular character is represented by fig. 9. The cell-wall is distinct with the cell contents which is of a pale green colour, drawn away from the wall except at five points; a nucleus is clearly seen, but no pigment spot and no hyaline end, a pair of long cilia exerted at one point of attachment. Although there was a steady movement of the organisms throughout the observation, the seven figures represent the appearance during twenty minutes, it was not until the end of this

time that the long cilia were clearly seen. No opportunity has yet offered for tracing the life history of these two forms.

Apiocystis brauniana, Näg.

Huyton, L. (N). In 1887, large specimens, no cilia observed. Kensington, L. (N). Autumn of 1890, no cilia observed. The same clay pit in the spring of 1891, cilia detected in most specimens.

Stephanosphæra pluvialis, Cohn.

Croxteth, L. (N).

Chlamydococcus pluvialis, Br.

C. pulvisculus, Ehrb.

These forms freely found associated with other Algæ, particularly in pits and ditches receiving drainage from organic matters. Several forms of *Euglena* invariably found with *Chlamydococcus*.

Pediastrum angulosum, Ehrb.

Princes Park, L. (N), Newsham Park, L. (N), Bromborough, C. (N).

P. bidentulum, Br.

Raby, C. (N), Formby, L. (N), in ponds among moss.

P. ehrenbergii, Corda.

Shallow water pools, (N).

Division.—PROTOPHYTA.

PROTOCOCCACEÆ. (including PALMELLACEÆ.

Palmella mucosa, Kütz.

Found on damp sandstones, moss and stems of water plants.

P. hyalina, Brèb.

On stones, &c., associated with *P. mucosa*.

P. moreana, Harv.

On moss at Raby, C.

P. prodigiosa, Elor.

Found in ponds along with *Botryococcus*.

Porphyridium cruentum, Ag.

Damp sand stone at Low Hill, L. (N).

Botryococcus braunii, Kütz.

Bromborough, C., Barton, L., Formby, L. (N).

Raphidium aciculare, Braun.

Not so common as the next species.

R. falcatum, Rabh.

Several places in ponds.

Schizochlamys gelatinosa, Br.

Little Sutton, (N and B).

Many of the so-called species of *Protococcus*, *Pleurococcus*, *Glœocystis*, *Chlorococcus* and other unicellular forms which are commonly found have purposely been left out of this list because of their uncertain position among Algæ.

Family.—EREMOBIEÆ.

Hormospora transversalis, Brèb.

Bromborough, C. (N).

H. ramosa, Thur.

Bromborough, C. (N), Burton, C. (N).

Sciadium arbuscula, Br.

Kensington, L. (N), attached to *Mesocarpus*.

Storeton, C. (N), Spital, C. (N).

Mischococcus confervicola, Näg.

Kensington, L. (N), Green Lane, L. (N), Formby, L. (N and B).

Dictyosphærium reniforme, Buln.

Kensington, L. (N).

Characium ornithocephalon, Br.

Storeton, C. (N), Kensington, L. (N).

C. tenue, Herm.

Kensington, L. (N).

C. sieboldii, Br.

Newsham Park, L. (N), Green Lane, L. (N), Maghull,

L. (D), Bromborough, C. (N), Little Sutton, C. (N).

Ophiocytium cochleare, Eich.

Kensington. L. (N), Formby, L. (N), Raby, C. (N), Huyton, L. (N), Walton, L. (N), Bromborough, C. (N), Little Sutton, C. (B and N), along with other Algæ in clay pits, ponds and ditches.

CYANOPHYCEÆ or PHYCOCHROMACEÆ.

Family.—CHROOCOCCACEÆ.

Chroococcus cohærens, Näg.

Frequently found on dripping rocks and stones in damp places.

C. turgidus, Näg.

Found among other algæ which mass together in shallow ponds and bogs.

Glœocapsa coracina, Kütz.

G. atrata, Rabh.

G. livida, Kütz.

G. quaternata, Brèb.

G. arenaria, Rabh.

G. æruginosa, Kütz.

Moist rocks, damp surfaces, stones, &c.

Aphanocapsa rivularis, Rabh.

Little Sutton, C. and Bromborough, C. (N), on stones in streams.

A. depressa, Rabh.

On damp rocks.

Microcystis protogenita, Rabh.

In ditches at Barton, L. (N), in clay pits at Little Sutton, C. (N).

M. marginata, Men.

In shallow water on swampy ground at Rufford, L.(N).

Glœotheca cystifera, Rabh.

G. granosa, Rabh.

These two species found associated with other Algæ in gelatinous matrix on damp rocks.

Aphanotheca prasina, Br.

Found in ditches at Woodville, L. in globular masses from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter, (N and B).

Family.—NOSTOCACEÆ.

Nostoc humifusum, Carm.

Found on other algæ in ponds at Bromborough, C. and Raby, C. (N).

N. sphæricum, Vauch.

Found in ponds among mosses at Raby, (N).

N. commune, Vauch.

In ditches.

N. rupestre, Kütz.

On damp soil.

N. muscorum, Ag.

On rocks at Huyton, (N).

N. pruniforme, Ag.

On mosses from ponds.

N. hyalinum, Benn.

Lydiate, L. (D).

Anabœna flos-aquæ, Fr.

Found floating among other Algæ in ponds.

A. variabilis, Kütz.

A. inæqualis, Ralfs.

Boggy ditches at Barton, L. (N).

Sphærozyga jacobi, Ralfs.

Pond at Capenhurst, C. and Shotwick, C. (N).

S. elastica, Ralfs.

Pond at Shotwick, C. (N).

Cylindrospermum macrospermum, Desm.

In fragments found three or four times.

C. comatum, Wood.

Found at Bromborough, C. (N), and at Little Sutton, C. in quantity, in which the heterocysts were fimbriated, the spore brown and coated in the older

trichomes. This agrees with Wood's figure except the minute globular bodies at the ends of the hair-like processes.

Family.—Lyngbyæ.

Spirulina tenuissima, Kütz.

Egremont, C. (Gould).

S. oscillarioides, Turp.

South End Mills, L. (N and B).

S. jenneri, Kütz.

Bromborough, C. (N, B, and D).

Oscillaria tenerrima, Kütz.

O. leptotricha, Kütz.

O. subfusca, Ag.

Sefton Park, L. (B), Kensington, L. (N).

O. tenuis, var. *viridis*, Ag.

Sefton Park, L. (B), Kensington, L. (N), Bebington, C. (D).

O. nigra, Kütz.

O. frölichii, Kütz.

Litherland, L. (D).

O. nigro-viridis, Hare.

South End Mills, (L).

O. spiralis, Carm.

Members of this genus have been found in several places besides those named, the species have not with certainty been made out.

Inactis tinctoria, Thur.

Found once at Storeton, C. (N), attached to other algæ.

Lyngbya rupestris, Ag.

L. subfusca, Ag.

L. turfosa, Carm.

L. vulgaris, Kütz.

L. papyrina, Kütz.

L. inundata, Kütz.

The above have been met with on damp soil, margins of ponds and in ditches and bogs but the places not recorded.

Symploca ralfsiana, Kütz.

Plectonema kirchneri, Cooke.

Attached to decaying rushes in boggy ditches at Barton, L. (N).

Family.—SCYTONEMEÆ.

Tolypothrix flaccida, Ag.

Rufford, L. (N).

T. distorta, Kütz.

Spital, C. (N).

T. coactilis, Kütz.

Boggy ditches Barton, L. (N), pond Spital, C. (N).

Family.—CALOTRICHEÆ.

Calothrix dillwyni, Berk.

Raby, C. (N).

Isactis plana, Thur.

Rivularia echinata, Eng. Bot.

In deep pond with *Riccia natans*, at Spital, C. (N).

R. dura, Kütz.

Attached to submerged plants, Raby, C. (N).

EXPLANATION OF PLATES.

PLATE XVI.

Figs. 1, 2. *Vaucheria*, showing variations of reproductive organs *(a) V. sessilis, (b) V. dichotoma, (c) V. terrestris* or *hamata*, × 75.

Fig. 3. *Enteromorpha ramulosa*, portion of filament in different stages of development, × 100.

Fig. 4. Portion of a branchlet of *Chætophora elegans*, *(d)* zoospores each with *two* cilia leaving the filament from alternate sides of contiguous cells, *(e)* showing an outer delicate cell-wall, × 400.

Plate XVII.

Figs. 1, 2, 3. *Cylindrospermum comatum*, young trichomes, × 400.

Fig. 4. Older trichomes with wall of spore thickened, echinated and coloured brown, × 400.

Fig. 5. Spores and heterocysts detached from trichomes all having the heterocysts rayed with fine hair-like structures, × 400. This condition prevails also in the young trichomes.

Fig. 6. An old spore and heterocyst, the rays shorter and bent over the heterocyst, × 400.

Fig. 7. A specimen from Cumberland; spore thickened and heterocyst rayed, × 400.

Fig. 8. Volvocineæ. A colony of four cells; *(a, b, c, d)* seen in four positions, × 400, *(e)* division of each of the four into other four cells; three cells in stages of division the fourth still possessed of cilia; *(f)* two cells under higher power.

Fig. 9. A form of *Chlamydococcus pluvialis*, slight changes noted during twenty minutes observation, number seven exhibited a pair of fine, long cilia, × 400.

Figs. 10, 11. *Apiocystis brauniana.* Attached to *Mesocarpus parvulus.* Cilia long, only a few shown, *(e)* shows two gonidia just begining to develop, × 250.

Fig. 1.

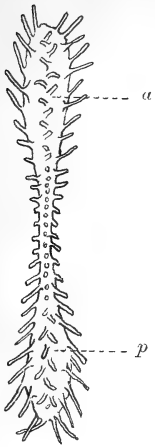


Fig. 2.

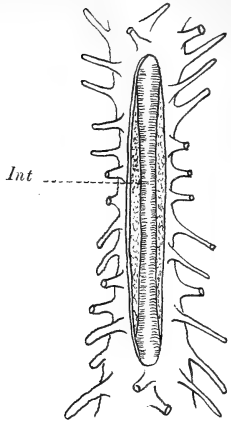
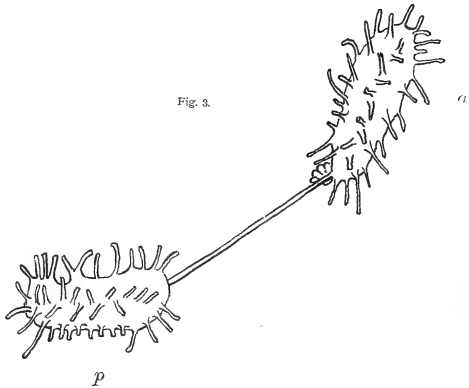


Fig. 3.



H. C. C., del.

CUCUMARIA PLANCI.

Fig. 2.

Fig. 3.

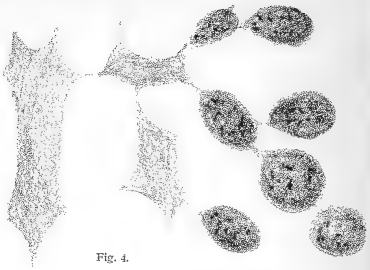


Fig. 4.

Fig. 1.

Fig. 5.

Fig. 6.

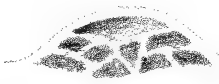
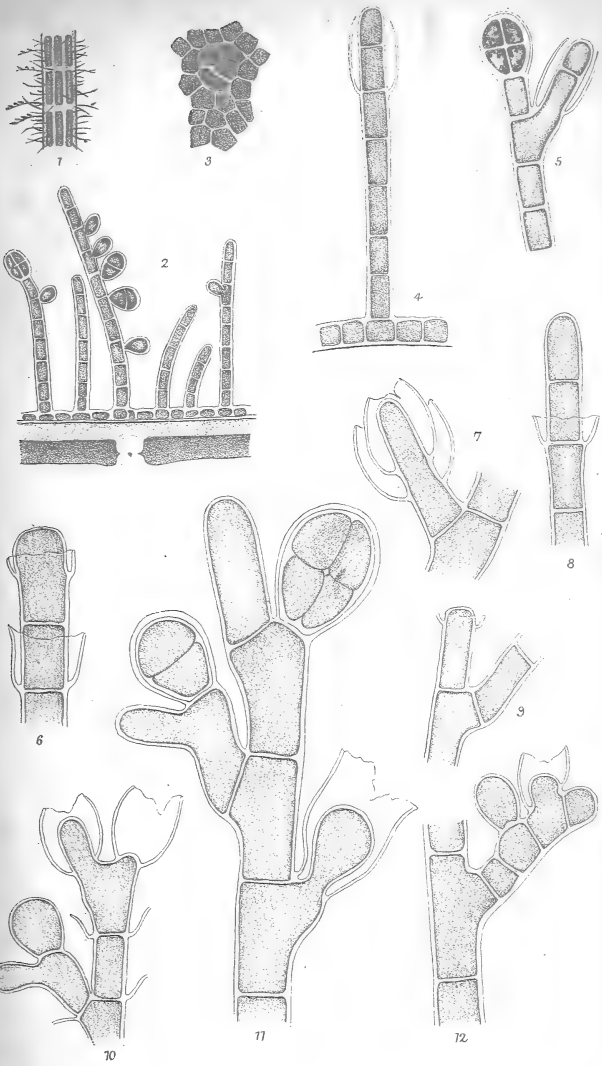


Fig. 7.

Fig. 8.

R. J. H. G., del.

CATENELLA OPUNTIA.



R.J.H.G. del.
C. Bevjeam lith.

West, Newman imp.

FIGS. 1–5. RHODOCHORTON SEIRIOLANUM, *n. sp.*

FIGS. 6–11. R. ROTHII. FIG. 12. R. FLORIDULUM.

Fig. 2.

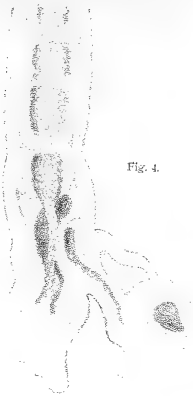


Fig. 4.

Fig. 6.

Fig. 8.

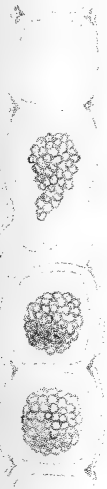


Fig. 5.

Fig. 1.

a

b

c

d

R. J. H. G., del.

Fig. 7.

UROSPORA BANGIOIDES.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 9.

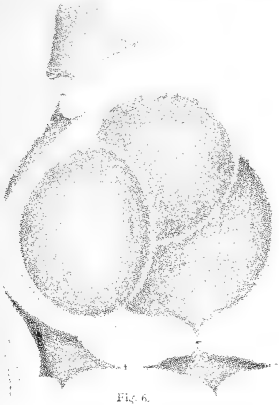


Fig. 6.

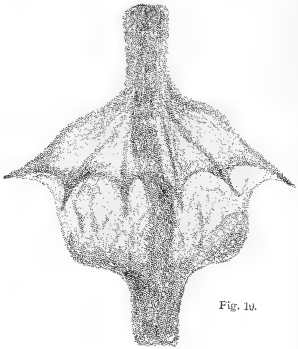


Fig. 10.

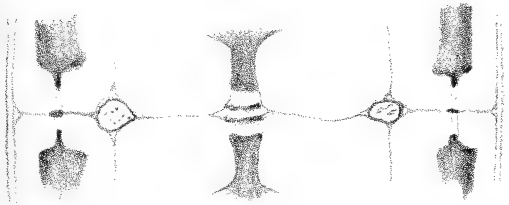


Fig. 8.

Fig. 7.

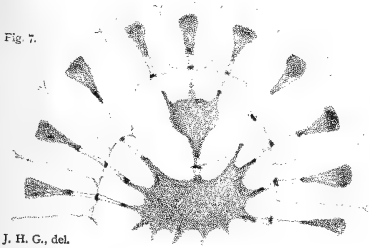


Fig. 11.

R. J. H. G., del.

POLYSIPHONIA FASTIGIATA.

Fig. 1.

Fig. 2.

Fig. 3.

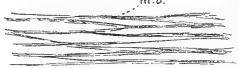


Fig. 4.

Fig. 5.

Fig. 8.

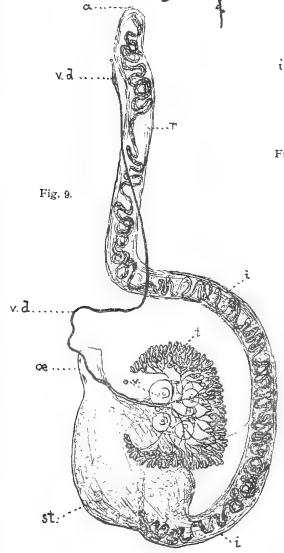


Fig. 9.

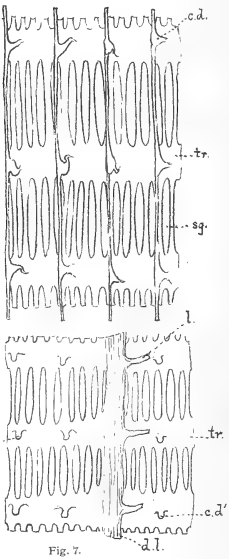


Fig. 6.

Fig. 7.

W. A. H., del.

ECTEINASCIDIA THURSTONI.

Fig. 1.

Fig. 2.

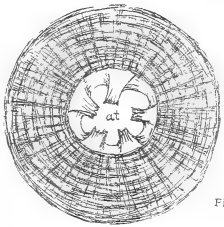


Fig. 3.

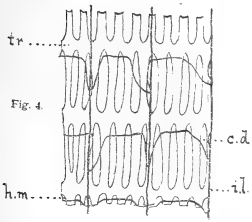


Fig. 4.

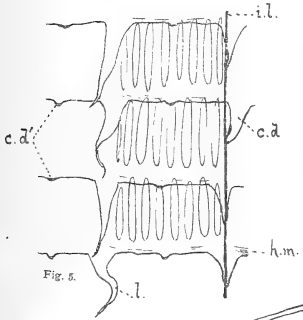


Fig. 5.

Fig. 6.

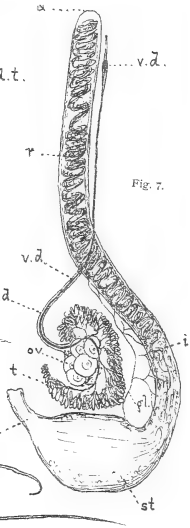


Fig. 7.

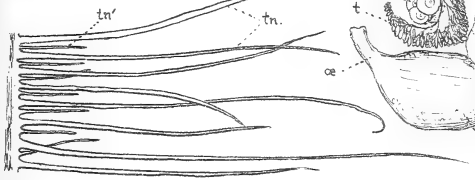
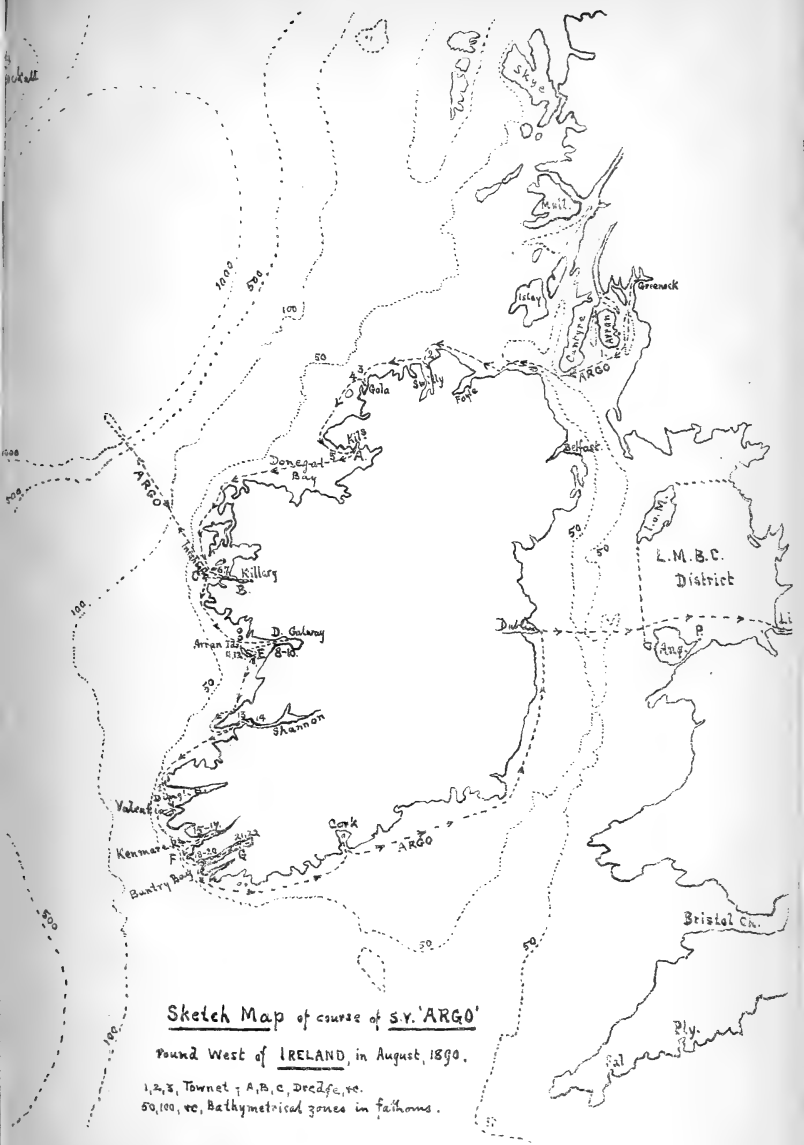


Fig. 8.

W. A. H., del.

ECTEINASCIDIA MOOREI.



Sketch Map of course of S.Y. 'ARGO'

Round West of IRELAND, in August, 1890.

1, 2, 3, Townet; A, B, C, Dredge, &c.
50, 100, &c, Bathymetrical zones in fathoms.

Fig. 1

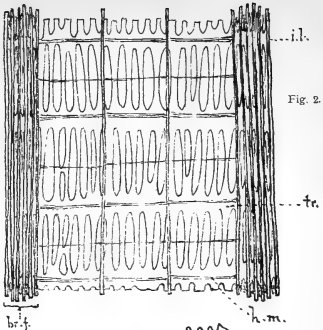


Fig. 2.

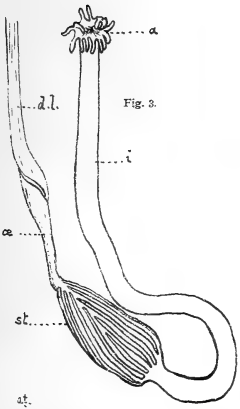


Fig. 3.

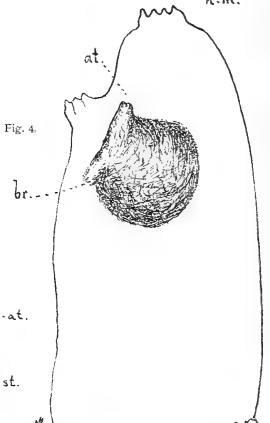


Fig. 4.

Fig. 6.

Fig. 5.

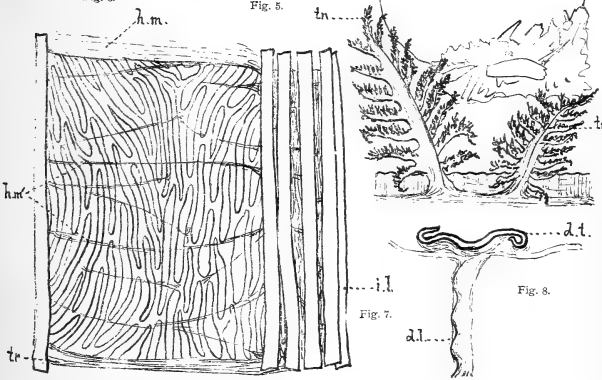
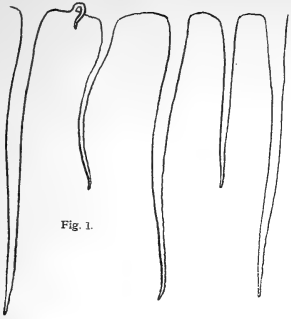


Fig. 7.

Fig. 8.

W. A. H., del.

FIGS. 1–3 POLYCARPA ARGOENSIS, N. SP.
FIGS. 4–8 MOLGULA HOLTIANA, N. SP.



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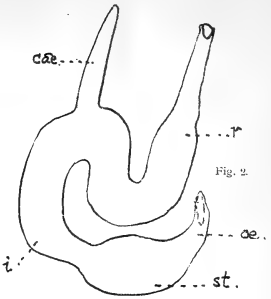

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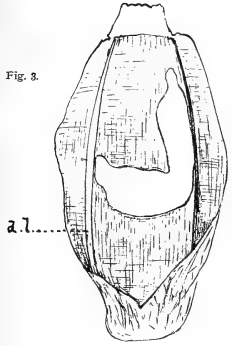

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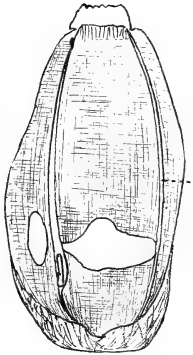

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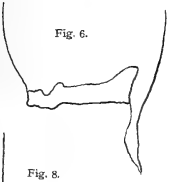

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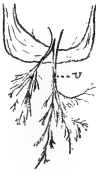

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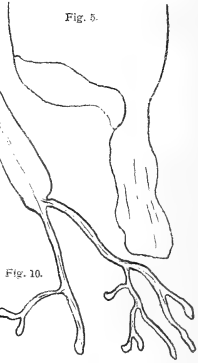

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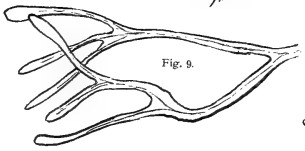
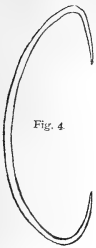


Fig. 9.

Fig. 10.

W. A. H., del.

ABNORMALITIES OF ASCIDIELLA ASPERSA.



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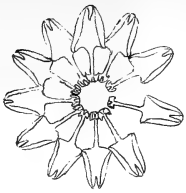

Fig. 2.

Fig. 3.

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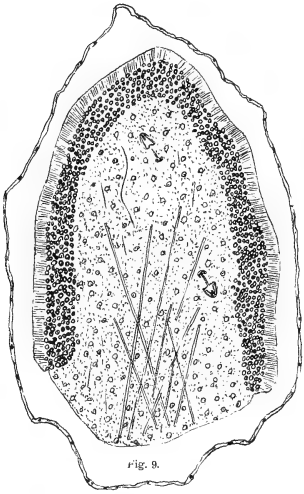

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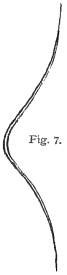


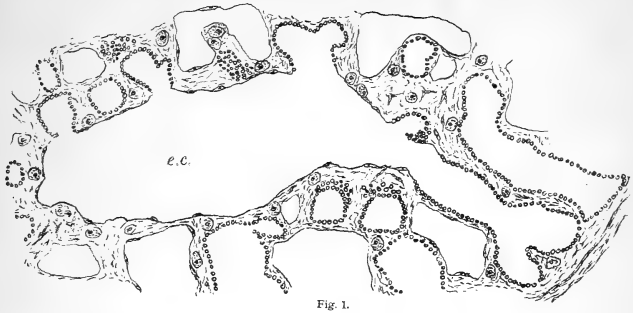
Fig. 7.

Fig. 8.

Fig. 5.

R. H., del.

ESPERELLA SORDIDA, BOWERBANK.



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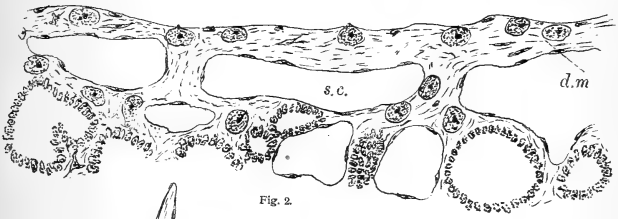


Fig. 2.

Fig. 4.

Fig. 3.

Fig. 6.

Fig. 5.

R. H., del.

APLYSILLA RUBRA, HANITSCH.

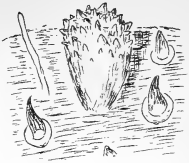
Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.



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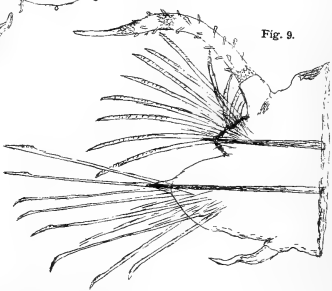

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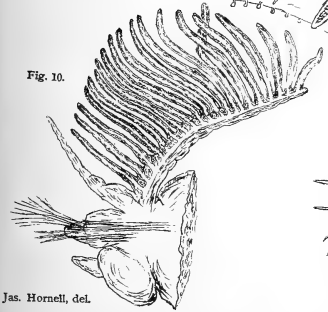
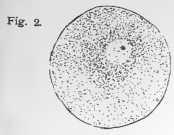


Fig. 10.

Jas. Hornell, del.

POLYNOINÆ AND EUNICINÆ.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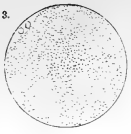
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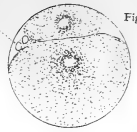

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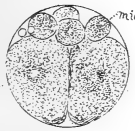

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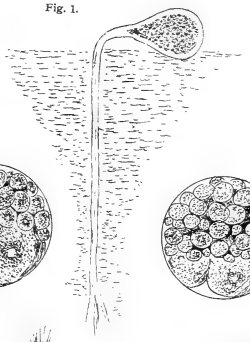
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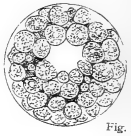
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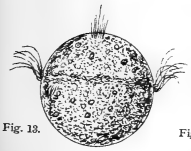
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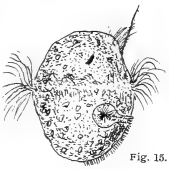
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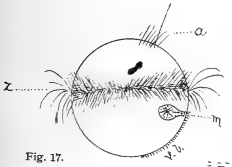

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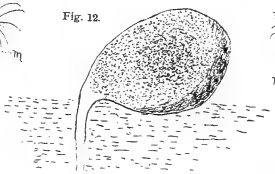
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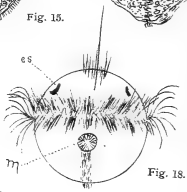

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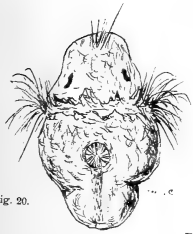

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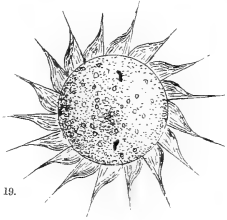
Fig. 19.

Fig. 21.

Jas. Hornell, del.

EMBRYOLOGY OF SCOLOPLOS ARMIGER.
AND ARENICOLA MARINA.

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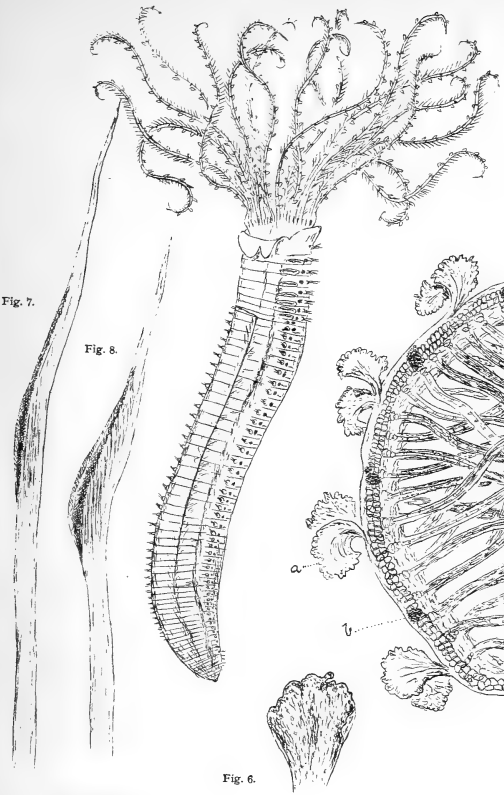

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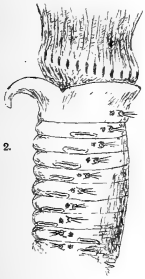

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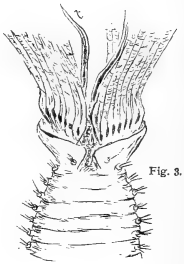
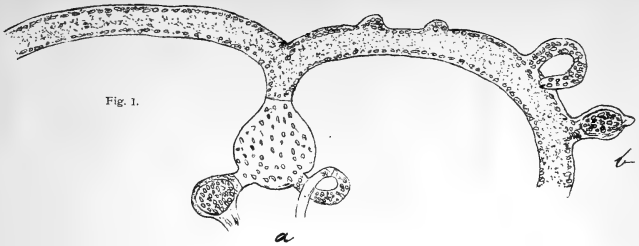


Fig. 3.

Jas. Hornell, del.

DASYCHONE HERDMANI, N. SP.



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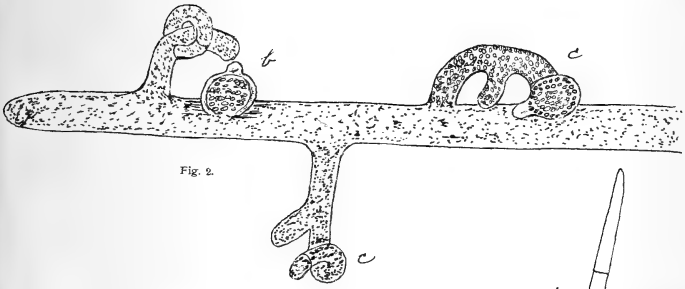

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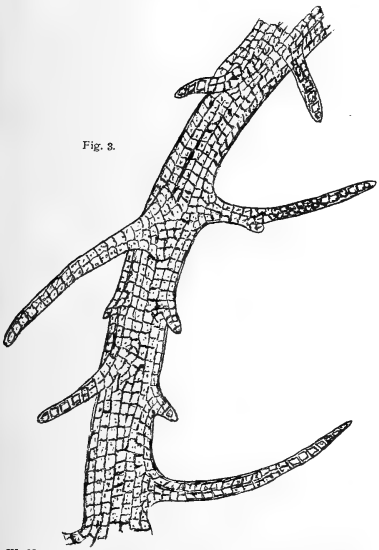

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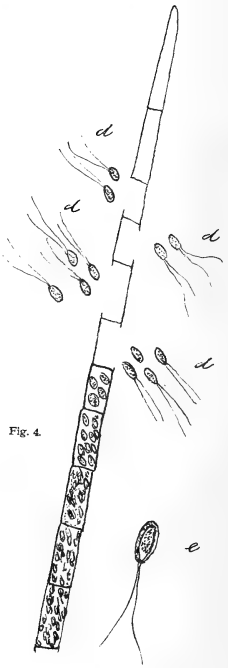

Fig. 4.

W. Narramore, del.

VAUCHERIA, ENTEROMORPHA, CHÆTOPHORA.

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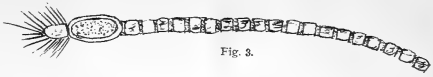

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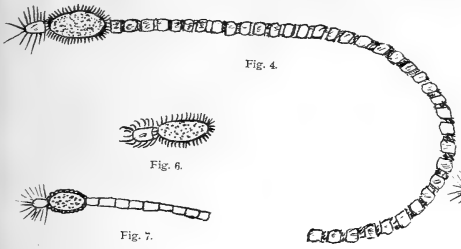

Fig. 4.

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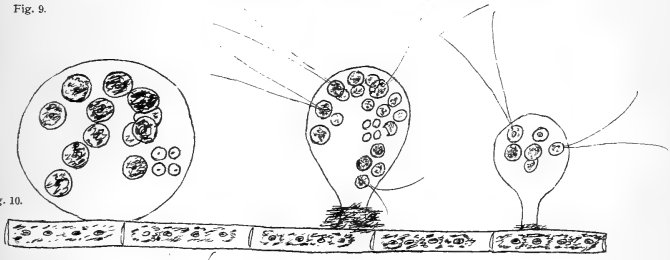

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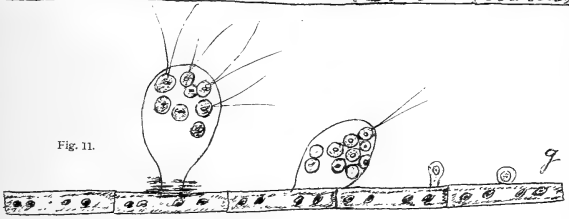

Fig. 11.

W. Narramore, del.

CYLINDROSPERMUM, VOLVOCINEÆ, CHLAMYDOCOCCUS, APIOCYSTIS.

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