TRANSACTIONS

OF THE

BOTANICAL SOCIETY.

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BOTANICAL SOCIETY.

VOLUME XVI.

EDINBURGH:
PRINTED FOR THE BOTANICAL SOCIETY.

MDCCCLXXXVI.

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LIST OF PLATES.

Botanical Society of Edinburgh.

March 1887.

I.—GENERAL VIEWS AND OBJECTS OF THE SOCIETY.

The attention of the Society is turned to the whole range of Botanical Science, together with such parts of other branches of Natural History as are more immediately connected with it. These objects are cultivated :—

1. By holding Meetings for the interchange of botanical information,—for the reading of original papers or translations, abstracts or reviews of botanical works, regarding any branch of botanical knowledge, practical, physiological, geographical, and palæontological,—and the application of such knowledge to Agriculture and the Arts.

2. By publishing annually Proceedings and Transactions, including a List of Members and Donations.

3. By the formation in Edinburgh of an Herbarium of Foreign and British Plants, and of a Library and Museum for general consultation and reference.

4. By printing from time to time Catalogues of Plants, with the view of facilitating the study of their geographical distribution, and furthering the principle of exchange.

5. By making Botanical Excursions both in the neighbourhood of Edinburgh and to distant parts of Britain.

6. By appointing Local Secretaries, from amongst the Members of the Society, from whom, in their respective districts, all information regarding the Society's objects and proceedings may be obtained.

II.—LAWS OF THE SOCIETY.

CHAPTER I.

FUNDAMENTAL LAWS.

1. The Society shall be denominated "The Botanical Society of Edinburgh."

2. The object of the Society shall be the advancement of Botanical Science, by means of periodical meetings, publications, correspondence, and interchange of specimens amongst its Members.

3. The Society shall consist of Honorary, Resident, Non-Resident, Foreign, and Corresponding Members, who shall have the privilege of denominating themselves Fellows of the Society; also of Ladies, who shall be denominated Lady Members; and of Associates, Ladies or Gentlemen.

CHAPTER II.

ORDINARY MEETINGS.

1. A Meeting of the Society shall be held on the Second Thursday of every month, from November to July inclusively.

2. Intimation of all papers to be brought before the Society must be given to the Secretary and submitted to the Council ten days at least previous to the Meeting at which they are to be read.

3. Any Member may transmit to the Society Papers and Communications, which, if approved of by the Council, may be read by the author, or, in his absence, by the President or Secretary at any of the Ordinary Meetings.

4. The following order of business shall be observed:—

PRIVATE BUSINESS.

1. Chair taken.
2. Minutes of Private Business of preceding Meeting read.
3. Report of Council read.
4. Applications for Admission read.
5. Members proposed at preceding Meeting balloted for
6. Motions intimated at previous Meetings discussed.
7. New Motions intimated.
8. Miscellaneous Business.
9. Society adjourned.

PUBLIC BUSINESS.

1. Chair taken.
2. Laws signed by new Members.
3. Minutes of Public Business of preceding Meeting read.
4. Papers and Communications for next Meeting announced.
5. Specimens, Books, &c., presented.
6. Communications and Papers read.
7. Society adjourned.

CHAPTER III.

EXTRAORDINARY MEETINGS.

An Extraordinary Meeting of the Society may be called at any time, by authority of the Council, on the requisition of three or more Resident Fellows.

CHAPTER IV.

ADMISSION OF MEMBERS.

SECTION I.—HONORARY FELLOWS.

1. The Honorary Fellows shall be limited to six British and twenty-five Foreign,—by British, being understood British subjects, whether resident in the British Islands or not.

2. The Council shall have the privilege of proposing Honorary Fellows,—the names of the gentlemen proposed being always stated in the Billet calling the Meeting at which they are to be balloted for. The election to be determined by a majority of at least two-thirds of the votes, provided fifteen Fellows are present and vote.

3. Any Fellow may submit to the Council the names of individuals whom he would wish proposed as Honorary Fellows; and should the Council decline to bring these forward, he may demand that they be balloted for.

4. Honorary Fellows shall be entitled to all the privileges of Resident Fellows, and shall receive copies of the Transactions free of charge.

SECTION II.—RESIDENT FELLOWS.

1. A candidate for admission into the Society, as a Resident Fellow, must present an application, with a recommendation annexed, signed by at least two Resident Fellows. The application shall be read at the proper time during private business, and at the next Ordinary Meeting shall be determined by a majority of at least two-thirds of the votes, provided fifteen Fellows are present and vote.

2. Resident Fellows shall, on admission, sign the Laws, and pay the sum of Fifteen Shillings to the funds of the Society; and shall contribute Fifteen Shillings annually thereafter at the November Meeting. Resident Fellows are entitled to receive the Transactions provided their subscriptions are paid.

3. Resident Fellows may at any time compound for their annual contributions by payment of Six Guineas. They shall be entitled to receive the Transactions yearly as published.

4. Resident Fellows leaving Edinburgh may be enrolled as Non-Resident Fellows, if they have paid by annual subscriptions the sum of Six Guineas, and have also paid any arrears due at their departure. By a further payment of Two Guineas they shall be entitled to receive the Transactions.

5. Fellows who are not in arrear in their subscriptions, and in their payments for the Transactions, will receive copies of the latter, provided they apply for them within two years after publication. Fellows not resident in Edinburgh must apply for their copies either personally, or by an authorised agent, to the Secretary or Treasurer.

6. The Society shall from time to time adopt such measures regarding Fellows in arrears as shall be deemed necessary.

SECTION III.—NON-RESIDENT FELLOWS.

1. Any person not residing in Edinburgh may be balloted for as a Non-Resident Fellow, on being recommended by two Fellows of

the Society, and paying a contribution of Three Guineas. From such no annual payment is required.

2. Non-Resident Fellows, by payment of Two Guineas additional, shall be entitled to receive the Transactions yearly as published.

3. Non-Resident Fellows, wishing to become Resident, must intimate their intention to the Secretary, who shall put them on the Resident list. They shall pay the annual subscription of Fifteen Shillings, or Three additional Guineas, or One Guinea if they have compounded for the Transactions.

4. Non-Resident Fellows must arrange with the Assistant-Secretary for the transmission of their copies of the Transactions; and they are requested to acknowledge receipt. Billets of the Meetings may, if desired, be also obtained.

5. Non-Resident Fellows coming to Edinburgh shall, for a period of two months, be entitled to attend the Meetings of the Society, and participate in the other privileges of Resident Fellows; after which, should they remain longer, they must pay the usual annual subscription of Resident Fellows, unless they have compounded by payment of Six Guineas.

SECTION IV.—FOREIGN FELLOWS.

1. Any person residing abroad may be balloted for as a Foreign Fellow, on the recommendation of the Council.

SECTION V.—ASSOCIATES.

1. The Society shall have power to elect by ballot, on the recommendation of the Council, Associates from those who, declining to become Resident or Non-Resident Members, may have acquired a claim on the Society by transmitting specimens or botanical communications. Associates have no vote in elections, or in the transaction of the business of the Society.

SECTION VI.—LADY MEMBERS.

1. Any Lady, whether Resident or Non-Resident, may become, on the recommendation of the Council, a Member for life, on payment of a single contribution of Two Guineas.

Note.—Diplomas may be procured by Fellows from the Vice-Secretary, the sum payable being Five Shillings, and Two Shillings for a tin case. But no Fellow shall be entitled to receive a Diploma until his contributions have amounted to Three Guineas.

CHAPTER V.

OFFICE-BEARERS.

1. The Office-Bearers of the Society may be chosen from the Resident or Non-Resident Fellows, and they shall consist of a President, four Vice-Presidents, ten Councillors, an Honorary Secretary, an Assistant-Secretary, a Foreign Secretary, and a Treasurer, who shall be elected annually, at the Ordinary Meeting in November. If a Non-Resident Fellow be elected an Office-Bearer, he must become a Resident Fellow, in conformity with Section III. Law 3.

2. The Council shall annually prepare a list of Fellows whom they propose to nominate as Office-Bearers for the ensuing year. This list shall be printed and put into the hands of Fellows along with the Billet of the November Meeting; and Fellows shall vote by putting these lists into the ballot-box, with any alterations they may think proper to make. The lists shall not be signed. Every Fellow present at the Meeting is entitled to vote.

3. All the Office-Bearers may be re-elected except the two senior Vice-Presidents, and the three senior Councillors, who shall not be re-eligible to the same offices till after the interval of one year.

4. These Office-Bearers shall form the Council for the general direction of the affairs of the Society. Three to be a quorum.

5. The Council shall nominate annually an Auditor and an Artist, to be recommended to the Society.

6. The Council shall appoint annually at the January Meeting five of their number, including the President and Honorary Secretary, to superintend the printing of the Transactions of the Society.

7. The Council may at any time be called upon by the President, Vice-Presidents, or Secretaries, to meet with them for the transaction of private business.

8. The Council shall hold a Meeting for business on the second Tuesday before each General Meeting.

CHAPTER VI.

THE PRESIDENT AND VICE-PRESIDENTS.

1. It shall be the duty of the President and Vice-Presidents when in the chair, and of the Chairman in their absence, to conduct the Business of the Society according to the order of the Business laid

down in Chapter II. Law 4, and to attend carefully to the enforcement of the Laws of the Society, and to signing the Minutes. The Chairman shall have a vote and a casting vote.

CHAPTER VII.

THE SECRETARIES.

1. The Honorary Secretary, with the aid of the Assistant-Secretary, shall give intimation of all General and Committee Meetings, shall Minute their Proceedings in Books to be kept for the purpose, and shall conduct all the Society's Correspondence in Britain. He shall also take charge of all Donations of Plants and Books, and shall see them deposited in the Herbarium and Library, in conformity with any arrangements made by the Society with Government.

2. The Foreign Secretary shall have charge of all the Foreign Correspondence.

Note.—Agreeably to an Act of the Town Council of the City of Edinburgh, dated January 8, 1839, the Professor of Botany in the University of Edinburgh is constituted Honorary Curator *ex officio*, with free access to the Society's Collection, whether a Member of the Society or not.

CHAPTER VIII.

THE TREASURER AND AUDITOR.

1. The Treasurer, subject to the inspection of the Council, shall receive and disburse all Money belonging to the Society, collecting the Money when due, and granting the necessary Receipts. His Accounts shall be Audited annually by the Auditor appointed by the Society.

2. It shall be the duty of the Treasurer to place all Money belonging to the Society in one of the Chartered Banks of this City, unless the same shall have been ordered by the Society to be otherwise invested; and he shall never keep more than Ten Pounds of the Funds of the Society in his hands at a time. The Bank Account shall be kept in the name of the Society, and all drafts thereon shall be signed by the Treasurer.

3. The Treasurer shall, at the December Meeting, submit a certified statement of the Receipts and Expenditure of the past year, with the Auditor's Report thereon.

CHAPTER IX.

VISITORS.

Each Fellow shall have the privilege of admitting one Visitor to the Ordinary Meetings of the Society, at the close of the private business.

CHAPTER X.

ADDITIONAL LAW.

In the event of any Member acting in such a way as shall seem to the Fellows of the Society to be detrimental to its interests, the Council may recommend that the name of such Member be deleted from the roll. The recommendation shall be brought before the Society at its first Ordinary Meeting. It shall be finally decided at the immediately succeeding Meeting by ballot. If confirmed by a majority of two-thirds of the votes of at least fifteen Fellows, the name of such person shall be deleted from the roll of membership, and all his privileges connected with the Society shall be forfeited.

CHAPTER XI.

MAKING AND ALTERING LAWS.

Any motion for the alteration of existing Laws, or the enactment of new ones, shall lie over till the second Ordinary Meeting, and shall then be determined by a majority of at least two-thirds of the votes, provided fifteen Fellows are present and vote. The motion must be intimated to the Council, and shall be printed in the Billet calling the Meeting at which it is to be brought forward, and also in the Billet of the Meeting at which it is to be discussed.

TRANSACTIONS AND PROCEEDINGS

OF THE

BOTANICAL SOCIETY.

VOL. XVI.—PART I.

EDINBURGH:
PRINTED FOR THE BOTANICAL SOCIETY.

MDCCCLXXXV.

Along with the 2nd and concluding Part of "Hepaticæ Amazonicæ et Andinæ," forming Vol. XV. Part 2 of the Society's *Transactions*, will be issued a short Introduction, mainly geographical, a Synopsis of the genera, an Index, and the remainder of the Plates, about 16 in number.

TRANSACTIONS

OF THE

BOTANICAL SOCIETY.

SESSIONS XLVII.-XLVIII.

9th November 1882.—Hugh Cleghorn, M.D., F.R.S.E., Vice-President, in the Chair.

The Chairman made the following introductory remarks:—

In the unavoidable absence of Professor Bayley Balfour, it has unexpectedly fallen on me to preside on this occasion. It is my duty to allude briefly to the life and labours of three distinguished members of our Society who have lately passed away—viz., Dr Dickie, honorary member; Dr Parnell, resident member; Dr Thwaites, foreign member. The two first were personally known to me; the third I never met, but for many years I had much friendly as well as official correspondence with him in the East. All three were earnest workers in different departments of botany, and all were men of singularly retiring disposition and habits.

George Dickie, M.D.

George Dickie, M.D., F.R.S., Emeritus Professor of Botany in the University of Aberdeen, died 15th July, aged 69. He was elected a non-resident Fellow of this Society on April 12, 1838, being then a Lecturer on Botany in Aberdeen. Further particulars of his life and labours are given below from the pen of his successor in the University Chair, Professor Trail. All that I now attempt is to give a chronological list of his botanical writings, many of which appeared in our own *Transactions*. Fifty-four of his memoirs are recorded in the

Catalogue of scientific papers published by the Royal Society. Many of these are scattered through the *Magazine of Zoology and Botany*, the *Annals of Natural History*, the *Phytologist*, Hooker's *London Journal of Botany*, the *British Association Reports*, the *Natural History Review*, and other periodicals. A complete list would be too long to read to you, though it might be useful for reference in our *Transactions*:—

Flora Abredonensis, comprehending a list of the flowering plants and ferns found in the neighbourhood of Aberdeen. 70 pp. 1838. A useful manual for the botanical students of Aberdeen. The catalogue includes such flowers, plants, and ferns as are found within fifteen miles. The stations are very exactly given. The total number is 584.—Vol. ii., 1846.

Remarks on the Structure and Morphology of *Marchantia*.—*Trans. Bot. Soc. Ed.*, vol. i., 1844, pp. 107–112.

Notice of the Occurrence of *Gelidium rostratum*, Harv., at Aberdeen, and of the Presence of Iodine in some Plants growing near the Sea.—Vol. i., 1844, pp. 165–168.

On the Development of Leaves.—Vol. i., 1844, pp. 169–171.

On a Monstrosity of *Gentiana campestris*.—Vol. ii., 1846, pp. 193–198.

Contributions to the Physiology of Fecundation in Plants.—Vol. ii., 1846, pp. 237–243.

Notes on the Altitudinal Range of Mosses in Aberdeenshire.—Vol. ii., 1846, pp. 277–282.

Notes on the Fructification of *Cutleria*.—Vol. ii., 1845, pp. 103–104.

On the Ovule of *Euphrasia officinalis*.—*Trans. Bot. Soc. Edin.*, vol. iii., 1850.

Notes of *Diatomaceæ* found in the Stomachs of certain Mollusca.—*Trans. Bot. Soc. Edin.*, vol. iii., 1850, pp. 43–46.

Notice of a Deposit of Fossil *Diatomaceæ* in Aberdeenshire.—*Trans. Bot. Soc. Edin.*, vol. iii., 1850, pp. 65–67.

Note on the Colour of a Fresh-water Loch.—*Ibid.*, pp. 79–80.

Typical Forms and Special Ends in Creation Plants, pp. 69–174.—*M'Cosh and Dickie, Edin.*, 1856.

The Botanist's Guide to the Counties of Aberdeen, Banff, and Kincardine.—344 pp. *Aberdeen*, 1860.

A Flora of Ulster, and Botanist's Guide to the North of Ireland.—Pp. 176, 1864.

Note on the Occurrence of *Buxbaumia indusiata*, Brid., in Aberdeenshire.—*Trans. Bot. Soc. Edin.*, vol. ix., 1868, pp. 142–143.

Notes of Mosses and Hepaticæ, collected by Mr Robert Brown on the North-West Coast of America.—*Trans. Bot. Soc. Edin.*, vol. ix., 1868, pp. 355–358.

Notes of Algæ collected on the Coast of North-West America, by Mr R. Brown.—*Trans. Bot. Soc. Edin.*, vol. ix., 1868, pp. 465–467.

Notice of *Grimmia contorta*, Schimper, a new British Moss.—*Trans. Bot. Soc. Edin.*, vol. x., 1870, pp. 19, 20.

Notes of *Diatomaceæ* from Danish Greenland, collected by Robert Brown.—*Trans. Bot. Soc. Edin.*, vol. x., 1870, pp. 65–67.

Remarks on some Deep-Sea Dredgings, transmitted by Captain William Chimmo.—*Trans. Bot. Soc. Edin.*, vol. x., 1870, p. 103.

Notes on Range in Depth of Marine Algæ.—*Trans. Bot. Soc. Edin.*, vol. x., 1870, pp. 155–160.

Notes on the Distribution of Algæ.—*Trans. Bot. Soc. Edin.*, vol. xi., 1873, pp. 97–100.

Notice of a Diatomaceous Deposit.—*Trans. Bot. Soc. Edin.*, vol. xi., 1873, p. 394.

On a Diatomaceous Deposit in the District of Cromar, Aberdeenshire.—*Trans. Bot. Soc. Edin.*, vol. xii., 1876.

Notice by Professor Trail of Aberdeen.

(Read at the December meeting, but inserted here for convenience.)

Dr George Dickie was born in Aberdeen on the 23rd November 1813. He graduated A.M. in Marischal College in 1830, after the usual course of study. He thereafter spent two years in the study of medicine in the Aberdeen Medical School, and also a session in Edinburgh, where he gained the medal for pathology and practice of physic in 1833, and in 1834 he became M.R.C.S. of London.

He originally intended to enter the naval medical service, but abandoned the intention, and began medical practice in Aberdeen. His tastes lay very strongly in the direction of natural science, especially botany; and in 1839 he was appointed Lecturer on Botany in King's College, Aberdeen. He also gave lectures on materia medica and natural history, and was librarian. The honorary degree of M.D. was conferred on him by King's College in 1842. He resigned his appointment in Aberdeen (receiving the thanks of the Senate of the University "for the excellent manner in which he had discharged the duties of these offices") on his appointment in 1849 to the newly-founded chair of Natural History in

Belfast. He returned to Aberdeen as Professor of Botany in the University on the foundation of the chair in 1860. In 1877 he was obliged to resign his duties because of ill health, but continued to reside in Aberdeen, and to occupy himself in the study of Algæ, when his health would permit, almost till his death on July 15, 1882. In 1838 he joined the Edinburgh Botanical Society (of which he was elected an Honorary Fellow in 1877), in 1863 the Linnean Society, and in 1881 the Royal Society of London. He was also a member of the Société des Sciences Naturelles de Cherbourg, and of various local societies.

From an early period his tastes lay markedly in the direction of the study of botany, and he investigated assiduously the flora of the district around Aberdeen, but seems not to have published anything before 1837. From 1837 onwards he published a number of articles in the *Magazine of Zoology and Botany*, the *London Journal of Botany*, the *Annals and Magazine of Natural History*, the *Reports and Transactions of the Edinburgh Botanical Society*, the *British Association Reports*, and latterly in the *Journal of the Linnean Society.* He also furnished botanical appendices to the works of certain Arctic travellers and to the transit of Venus expeditions, and to Macgillivray's *Natural History of Deeside.* Reference to Sir W. J. Hooker's *British Flora*, to Harvey's *Phycologia Britannica*, to Ralf's *British Desmidieæ*, and to Smith's *British Diatomaceæ*, shows that he contributed valuable information to these works, not only in regard to localities, but also by the discovery of various plants new to Britain, and of some new to science, of which several bear his name.

He also took a warm interest in, and contributed numerous papers to, the Philosophical Society of Aberdeen, and to the Natural History and Philosophical Society of Belfast. His articles in magazines cover a wide range of subjects, but are for the most part morphological or physiological, and several deal with the modes of reproduction in plants. His first article on Algæ appeared in 1844, but thereafter he gave his attention more to Algæ, and latterly almost restricted his studies to that group, and chiefly to the marine species. The results of his labours among Algæ from various parts of the world were published by him for the most part in the *Journal of the Linnean Society.* Among other material of study the

Algæ collected in the "Challenger" expedition, and various collections from the Polar regions, passed through his hands.

Besides botanical papers, he wrote various articles on zoological subjects, chiefly morphological, but some also treating of systematic zoology.

His larger works are—*A Flora of Aberdeen*, published in 1838; *The Botanist's Guide to the Counties of Aberdeen, Banff, and Kincardine*, published in 1860; and *A Flora of Ulster*, published in 1864.

In these works are enumerated the Phanerogams and Vascular Cryptogams of the districts treated of, with localities, and valuable notes on their range in altitude. In the *Botanist's Guide* he included the Cellular Cryptogams, so far as known to him from his own investigations. His knowledge of the Marine Algæ in particular was so thorough, that hardly any species have been added to the flora of the district since the book was published.

In conjunction with Dr M'Cosh, he wrote *Typical Forms and Special Ends in Creation*. The authors indicate the evidences of design in the universe, derived alike from the general principles that can be traced throughout, and from the special adaptations to environments met with, especially in the animal and vegetable kingdoms. Dr Dickie contributed the information in Zoology, in Physiology, in Botany (in part at least), in Geology, and in Physical Geography.

In private life Dr Dickie will be remembered by all who had the pleasure of his acquaintance as a most obliging and kind friend, to whom it seemed always a pleasure to aid with information, or in other way, whomsoever he could. For several years his health almost precluded interviews with strangers, as he was much troubled with deafness; but he kept up his interest in the progress of botanical science to the end of his life, and very shortly before his death completed the examination of a quantity of exotic Algæ.

He was very successful in gaining the respect and esteem of those whom he taught, and delighted in assisting those who devoted themselves to botanical studies, and continued to correspond with and to encourage them after their course as students was at an end. To him not a few of his pupils owe their success in life.

In him Scotland has lost one of her most successful and most widely-known biologists, and one who was admitted to have the most thorough knowledge of Marine Algæ of British botanists. The gap will be difficult to fill, but we hope that in time some will yet do so, following his footsteps, and thus paying the truest and highest tribute to the memory of one who was in all things a true and faithful student of God's works and word.

Richard Parnell, M.D.

Another member of this Society has lately passed away, and for the eminence he attained in scientific research he deserves special notice at this time. Having had little personal intercourse with him, I quote from a notice which appeared after his death in the *Courant*:—

"Richard Parnell, M.D., F.R.S.E., born at Bramford Speke, in Devonshire, in 1810, was the son of John Ratcliffe Parnell, of Bramford Speke, and came to Edinburgh in 1834 to attend the medical classes at the University. There he became a distinguished student, obtaining Professor Graham's gold medal for practical botany, and Professor Lizars' silver medal for practical anatomy. He completed his medical education by studying in London and Paris. He was one of the original members of the Edinburgh Botanical Society, which originated at a meeting held on 8th February 1836, at which he, Professor Edward Forbes, Professor Balfour, and others were present. In 1837 he was elected a Fellow of the Royal Society of Edinburgh. In 1839 he contributed to the Wernerian Natural History Society an elaborate paper (afterwards published) on the fishes inhabiting or frequenting the Firth of Forth. This essay was then stated to be the most valuable contribution which the zoology of Scotland had received for fifty years. He therein showed, what before had not been known, that the whitebait in considerable numbers inhabit the Firth in the summer season. By this invaluable essay he at once placed himself in the foremost ranks of ichthyologists. The published essay is enriched with fully seventy illustrations of the fishes referred to. All the fishes were not only actually collected and drawn by Dr Parnell, but the plates for the work were also engraved by him. He received the Wernerian Society's gold medal for this 'elaborate and scientific' essay. In April 1839 he went to the West

Indies, and thereafter to the United States, and there found in the strange fishes of these seas what deeply interested him. He has left not only elaborate notes on these fishes, but also a series of most exquisite drawings of them, some of these drawings being marvels of colour. In that year he was, by the Boston (Massachusetts) Society of Natural History, elected a corresponding member. In 1842 he published his great work on *The Grasses of Scotland*, which was afterwards enlarged and republished as *The Grasses of Britain*. It is still the standard work on that subject. It is worthy of note that he not only collected the whole of the 124 grasses there illustrated, but also himself engraved the plates. These engravings are extremely fine.

"His note-books of the following year (1843) are filled with notes on the flora of those parts of France, Germany, and Austria which he that year visited in company with the late Misses Walker of Drumsheugh. Of late years he twice visited Egypt, making special study of the fishes of the Nile and Canal, and of the many varieties of bats found in the Egyptian caves and temples. He had previously found one such new to science, and which by the authorities of the British Museum has been named after the discoverer. It is to be hoped that his drawings and great and most interesting collection of stuffed fishes (all prepared by himself) may find their way to our Edinburgh Museum.* Dr Parnell's appearance was very striking—tall and well made, with a large, finely-shaped head, regular features, and a countenance kindly and full of intelligence. He married a daughter of the late James Curle of Evelaw, who survives him.

"The studies of this able, earnest student of nature do not appear to have shaken his faith in the Great Designer. In one of his note-books we find the following note or extract:—'He who does not make himself acquainted with God from the consideration of nature will scarcely acquire knowledge of Him from any other source; for if we have no faith in the things which are seen, how shall we believe those things which are not seen? In short, natural history, or the study of nature, may be reckoned as the parent of natural religion: it teaches us to look from nature up to nature's God.' He

* Since his death the Herbarium at the Botanic Garden has been enriched by the entire collection of plants received from Mrs Parnell.

died 28th October 1882, at 17 Merchiston Avenue, Edinburgh, aged seventy-three."

In the catalogue of scientific papers published by the Royal Society of London there are fourteen memoirs. Twelve are ichthyological and two botanical, which are—

On a New Species of British Grass, and Observations on Some of the more closely allied Species of Grasses found in the Neighbourhood of Edinburgh.—*Proc. Roy. Soc. Edin.*, i. p. 367.

Description of a New Species of Poa.—*Ann. Nat. Hist.*, x., 1842, pp. 121–124.

George H. K. Thwaites, F.R.S.

The third member to whom I have alluded, George Henry Kendrick Thwaites, was perhaps the most illustrious of our colonial botanists. He began life as an accountant, applying himself during the intervals of business to the study of Botany and Entomology. He early attracted notice as a microscopist, and I remember, before I went to India in 1842, Dr Greville saying to me that "Thwaites in Bristol was an acute observer, who would one day make a name for himself." At this time, when Thwaites was pursuing his researches, Cryptogamic Botany was little studied, and the value of his discoveries not at first generally appreciated.

In 1845 he published, in the *Annals of Natural History*, a note "On the Occurrence of Tetraspores in Algæ." This was followed by a series of papers on the structure of the lower Cryptogams, which showed Thwaites' great capacity for careful and original research. One of the most remarkable memoirs was "On the Process of Conjugation in *Diatomaceæ*." In recognition of his work, M. Montaigne dedicated to him the genus *Thwaitesia*.

In 1849 Thwaites was appointed Director of the Botanic Garden, Peradenia, in succession to Dr Gardner, and for thirty-three years he did much conscientious hard work in the interests of science and Ceylon. The chief monuments of his industry and careful research are the *Enumeratio Plantarum Zeylaniæ*, and the extensive list of Ceylon Fungi (1200), published in the *Journal of the Linnean Society* by Messrs Berkeley and Broome. He also assisted greatly in the successful introduction of Cinchona and other useful products into the island, and thus contributed to the welfare of the colony.

He was a vegetarian, and in his jungle excursions his favourite beverage was cold tea. He attained the age of 71, and his funeral was attended by all the European officials and a crowd of natives, showing the respect in which he was held by all around him. A tablet to his memory has been erected in the Botanical Gardens, under the superintendence of his successor, Mr Trimen.

In the catalogue of scientific papers printed by the Royal Society, I find twenty-seven memoirs—five of them were printed in the *Transactions of the Entomological Society*, the rest chiefly related to researches in Cryptogamic Botany. A portrait, accompanied by a short sketch of Thwaites' career, by Dr Masters, appeared in the *Gardeners' Chronicle*, April 4, 1874.

John L. Paterson, M.D., of Bahia, Brazil. By William Craig, M.D., F.R.C.E., F.R.S.E.

John Ligertwood Paterson was the son of the Rev. James Paterson, minister of the Secession Church, Midmar, Aberdeenshire. He was born in 1820, and was the seventh son of a family of nine. At a very early age he entered the Grammar School of Aberdeen, and during his fourth and fifth sessions studied under Dr Melvin. From the Grammar School he passed on to Marischal College, where, at the close of his fourth session, he took the degree of M.A. with credit. He then entered the Faculty of Medicine, and so greatly distinguished himself in anatomy that he was afterwards chosen Demonstrator by Professor Moir. In due time he took the degree of M.D. He next went to London, and was admitted a member of the Royal College of Surgeons. Having now obtained his diplomas, he studied for a time at the medical schools of Vienna and Paris, and returned in the spring of 1842 to Aberdeen. His eldest brother, who had been several years practising in Brazil, obtained for him an opening. In a brief time Dr Paterson succeeded this brother in Bahia, where he continued for nearly a quarter of a century. During this time one deadly epidemic of cholera and three of yellow fever raged in Bahia, when his duties were of the most arduous nature. For his eminent services on two of these occasions he received from the Emperor of Brazil two decorations; but of so little moment did he count such honours that very few outside his own family knew of them. Dr Paterson returned to England in 1867, to secure efficient education for his family. He was previously presented by the English community with a very handsome testimonial as a mark of the esteem in which he was held. After remaining in Edinburgh two or three years he again returned to his work, without which he could not live. In order to make final arrangements for the education of his family, he came a second time to Edinburgh, and till his departure personally superintended their education. In June of 1882 he again sailed for the Brazilian home he loved so well, intending to remain some three or four years more, but on the evening of the 9th December, while at the bedside of a patient, he was suddenly struck down with apoplexy, and died within an hour. The sad tidings fell with overwhelming effect upon the whole community. Nothing could exceed the manifestations all gave of their grief.

Dr Paterson was on intimate terms with all the leading men of the empire, to whom he often suggested reforms which he considered would be beneficial to the town and country, many of which he had the satisfaction of seeing accomplished.

He was a man of a strong mind, and in what he regarded the right course he was unswerving, be the consequences what they might. From this trait in his character, some perhaps were inclined to be rather unfriendly at first, but even they eventually came to honour and respect him as all others did.

His wife, and her family of five sons and one daughter, now mourn him.

Dr Paterson was elected a fellow of this Society 11th July 1872. He was deeply interested in botanical science, and when in this country was a most regular attender at our meetings. He contributed to the Royal Botanical Garden several valuable and rare specimens, and I believe some of these specimens were first cultivated in Britain through his liberality. Through the kindness of Mr Lindsay, I have been furnished with a list of his donations. On

July 1874 he presented to the Garden *three* Wardian cases, containing about forty plants in all, amongst which were *Musa coccinea*, the "flowering banana," *Andina Araroba* (the source of the famous "Goa powder," which is so much used, and is so valuable in the treatment of certain skin diseases), *Lygodium*, *Lycopodium*, &c. On 14th May 1880 he presented a small Wardian case, containing Begonias, Palms, Ferns, *Andropogon* or "Lemon Grass," &c. On 6th January 1882 he presented seeds of the true *Jaborandi*, supposed to be *Pilocarpus pennatifolius;* and on 21st March 1882, seed of a species of Piper, the source of the "Pepper Jaborandi."

John Sadler. By Professor Bayley Balfour.

(Read 12th July 1883.)

John Sadler was born at Gibbleston, Carnbee, Fifeshire, on 3rd February 1837. His parents removed before he was two years of age to Moncrieffe, near Perth, where his father was gardener to the late Sir Thomas Moncrieffe, Bart., and in this district his early years were spent. He received his education partly at the parish school of Dunbarnie, and partly at the Perth Academy, and at both of these seminaries he was a distinguished pupil. After finishing his school education, he assisted his father for some years in the garden at Moncrieffe House, and in 1854 came to Edinburgh and joined the staff of the Royal Botanic Garden. He was employed at first partly in the propagating department of the garden, but his chief work was in the Herbarium in connection with the classes of botany. During the first year of his residence in Edinburgh he had the advantage of attending some of the classes in the University, and he especially devoted himself to zoology under Professor Allman, thereby being enabled to systematise the extensive knowledge of wild animals and their habits which as a Perthshire lad he had acquired. He was a most enthusiastic student of nature, and his diligence in fostering his natural bent, and his numerous rambles made far and near over the country in the prosecution of his studies, find fitting record in the splendid collections in all branches of natural history made by him at this time,—some of them now in the Herbarium of the Royal Botanic Garden in Edinburgh, and others in public collections in different parts of the kingdom. The work of this period of his life bore also plentiful fruit in the extensive knowledge he in after years displayed of the habits and characters of the indigenous plants and animals of this country.

John Sadler soon rendered himself an essential part of the establishment of the Royal Botanic Garden, and was promoted to be assistant to my father, then Professor of Botany. This position he occupied, and faithfully discharged the duties that devolved upon him, during nearly a quarter of a century. To those acquainted with the Royal Botanic Garden during this period, the triumvirate which controlled its affairs—my father in the Chair of Botany, James M'Nab as curator, and John Sadler as assistant—a triumvirate broken up in 1878 by the death of Mr M'Nab, followed by my father's retirement in 1879—will be long remembered.

In 1858 Sadler read his first paper before this Society. It is "A Notice of an Excursion along the line of the Roman Wall from Chollerfield to Wall Town Crags," and since that year hardly a meeting of the Society has taken place without his being present, and no volume of *Transactions* has appeared without some record of his work in it. In that same year he was appointed Assistant-Secretary of the Society, an office he filled until 1879, when pressure of other duties compelled him to sever his long connection with the Society. The satisfactory manner in which he discharged his duties was better emphasised by the Society itself than it can be by any word of mine, when it presented him on his retirement with a handsome testimonial of approval. But I may be allowed to say that, as the success of a Society such as this depends in a very eminent degree upon the efficiency of the secretariat, so a large share in promoting the prosperity which has attended the Botanical Society of Edinburgh may be claimed for John Sadler.

Another Society, in the promotion of which Sadler took a great interest and part, is the Scottish Arboricultural Society. Of it he became Secretary in 1862, and retained the post until 1879, when the same causes which required his resignation of his official connection with this Society compelled a like course being taken with regard to it. His services were handsomely recognised by a presentation from the Society, and he was elected a Vice-President. It is not too much to say of his relation to the Scottish Arboricultural Society, that but for him it would have ceased to exist. I remember well his description of an annual meeting in the early sixties, when he and two others (Mr M'Corquodale of Scone and Mr John Anderson of Perth) were the only members present, and it was a question whether the Society should be carried on or not; but, with his usual energy, the difficulties of the case were faced, and the result is the flourishing Society of the present date.

With several other societies Sadler became associated. He was for long a Councillor of the Royal Caledonian Horticultural Society, which in 1869 awarded him the Neill Prize for eminence as a Scottish botanist. He was an old member of the Royal Physical Society, of the Berwickshire Naturalists' Field Club, and other like societies.

Sadler's intimate connection with the teaching of botany in the University of Edinburgh produced in him the desire to do something in this line on his own account, and not long after his coming to Edinburgh we find him giving popular lectures on botany in many towns through Scotland. In this sphere he excelled. His lively imagination clothed details in an attractive garb, and the apt illustration and appropriate quotation with which he enlivened his discourse, interested and delighted many an audience. When in 1867 the teaching of botany was introduced in the Royal High School, John Sadler was appointed lecturer, and he continued to lecture there until 1879.

On the death of Mr M'Nab in 1878, John Sadler was appointed to succeed him as Curator of the Royal Botanic Garden. It was remarked at the time that the work of this position was out of his line; but his career amply justified his appointment, and the energy with which he carried on the work of the garden, and the success which attended his efforts, are recent history, and in the minds of all members of this Society. Only a year ago he was appointed Curator of the Arboretum, and to the laying out of its grounds he was devoting himself at the time of his decease.

John Sadler was a born naturalist. Gifted with talents of a high order, his early life was well adapted for the development of his natural instincts, and the opportunities he had were not thrown away. In his later life he loved to dwell on his rambles when a boy in the neighbourhood of Bridge of Earn—(of the flora of which he afterwards published an account)—and the love of nature thus early cultivated remained with him through life. As a botanist, Sadler laid claim to be no philosopher. His sphere was not that of abstract morphological or physiological problems,—his education did not fit him in that way. But he was a practical botanist; one who knew plants; one who had a marvellously keen, critical, and diagnostic power; and, having an innate love for plants which had led him in quest of them in their native haunts all over Scotland, his experience and knowledge made him at the time of his death one of the first of Scottish botanists. There are few who possessed so extensive a knowledge of Scottish plants, both flowering and flowerless, as he; for it was one of the features of his acquaintance with plants that it was not limited to one section only of the vegetable kingdom, but mosses, fungi, algæ, lichens, as well as flowering plants, were all equally well known by him. His was a knowledge largely bred of experience, and of a kind no amount of book or laboratory work can create; of a kind, too, that cannot be measured by published records; indeed, on looking over the list of his publications, one cannot but feel a shade of disappointment that so much information, the accumulation of a lifetime, should pass away in one individual leaving so slight a record behind, and the loss that Scottish botanists feel at his death will not be lessened the more remote that event becomes. His discoveries of new stations for plants are numerous, and his name will be perpetuated by several new species, of which perhaps the most notable is the small Scottish willow (*Salix Sadleri*) found by him on the cliffs above Loch Chander.

By his social qualities John Sadler will ever be remembered by those who knew him. Every member of this Society counted him a friend. Genial and good-natured, with a keen sense of humour, his society was welcome everywhere, and no company could be dull of which he was one. Who that has climbed an Alpine crag with him will ever forget the humorous accounts of his adventures with which he relieved the difficulties and monotony of the ascent; or who that has enjoyed an evening with him, at say a meeting of the Scottish Alpine Botanical Club of which he was one of the founders, in some Highland inn, will not remember his outflowing spirits and his stories told with all the gusto of real appreciation? To his intimates he was always the same warm-hearted open friend, and his death, unexpected and sudden, which took place on the 9th December last, has removed in his prime one who will long be remembered by all of us who knew him as a true friend and genial companion.

Note on Rubus Idæus *var.* Leesii, *and Notice of some Plants from Inverness-shire.* By Dr Mactier, St Andrews. Communicated by Dr Cleghorn.

(Read 9th November 1882.)

I beg to bring to the notice of the Botanical Society that the *Rubus Idæus*, var. *Leesii* of Babington, has been found in this neighbourhood. I know of no record of its being previously noted in Scotland. Neither Babington nor Hooker mention it as growing in the north; and the former, in one of the earlier editions of his *Manual*, gives only two or three English stations. I found it in full flower in June, three or four miles south of St Andrews, growing in a thicket of common raspberry and bramble. Six or eight plants were noted, but others would probably have been found had a closer search been made. Its numerous flowers, together with the many small, roundish, simple leaves, and the grey colour of their under-surfaces, were in such marked contrast in the common form of *Rubus Idæus* that it could hardly be overlooked. Indeed, the first plant I found (in an isolated position) was so utterly unlike anything I had before seen, that it at once attracted my attention. I forwarded specimens to Professor Babington at Cambridge, and he writes in reply :—" Your discovery is very interesting, and you have named it correctly. I did formerly consider it as a distinct species, but with some slight doubt, as I believe that it does not ripen seed. I have seen the fruit apparently ripe, but could never find a ripe seed on it, nor indeed do I know that ripe seeds ever have been found. Exactly the same plant is found in Sweden, Germany, and France, and has gone by various names, but all, I believe, posterior to my name of *Leesii*. In the eighth edition of my *Manual* I have placed it as a form under *Idæus*. It is not quite constant in form, although nearly so." It will be noticed that the annual or barren stems differ materially from the flowering ones ; in the former the leaves are all more or less trifid, the petiolules short, and the leaflets rounded ; whereas in the latter the leaves are generally small, simple-rounded, or trilobed, rather than trifid ; but, as Mr Babington remarks, they are not constant in form. These peculiarities are most marked in the upper part of the plant. Being from home during the summer, I was unable to note the appearance of the plants at that season ; but my friend, the Rev. Mark Anderson, tells me that he visited the spot, and found that although the common raspberry was in full fruit, not a single berry was to be found on the *Leesii*.

It may be interesting to record a new station for the *Lysimachia vulgaris*, which in the text-books is stated to be rare in Scotland. I found it in September last on Speyside, between Aviemore and Boat of Garten, and in two separate localities a couple of miles distant from each other. I believe it is quite new to that district, for the Rev. Mr Keith of Forres, who has for many years been engaged on the flora of the province of Moray, writes to me that he is quite unacquainted with it. He suggests, indeed, that it may have been a garden escape. The common garden variety is, if I mistake not, quite a different plant, the *Lysimachia ciliata* (?). I found the *Saxifraga rivularis* on the north face of the Cairngorm range, growing at an elevation of only 2400 feet, by the Ordnance Survey map. This plant, which is considered one of the most alpine of all our Saxifrages, was also new to the district. The *Saussurea alpina* and *Malaxis paludosa* were also interesting finds in the same locality, the latter on low ground near Nethy Bridge.

Note on Proliferous First Fronds of Seedling British Ferns. By Charles T. Druery, London. Communicated by P. Neill Fraser.

(Read 9th November 1882.)

In a batch of young ferns raised from spores provided by Mr P. Neill Fraser, of Edinburgh, two forms of *Athyrium Filix-fœmina* have appeared this season (1882), presenting the following abnormal characteristics. In fig. 1

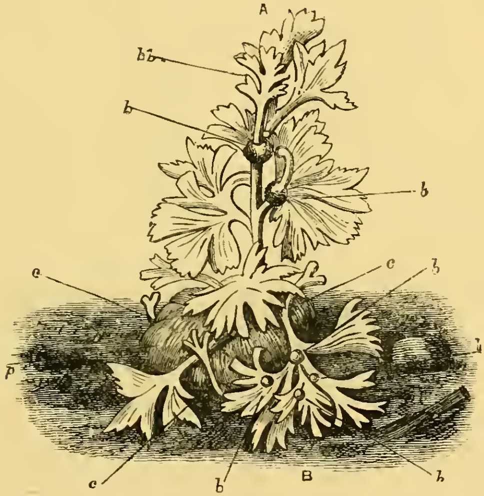


Fig. 1.—Proliferous Fern Sporeling. × 2½ times.
A, first frond; B, second frond; *b*, bulbils; *p*, prothallus; *bb* frond of second generation; *c*, independent ferns developed from same prothallus. The two bulbils on A have sent out aërial roots, reaching and entering soil raised half an inch distant.

the first frond evolved from the prothallus, besides being bipinnate and very foliose, instead of the usual unipalmate form peculiar to seedlings of this family, bore two buds, one in the axil of a pinnule, the other in the axil of a pinnulet; these buds, without any dormant period, developed at once small palmate fronds and aerial roots, the growth being so vigorous that the roots were projected into a mound of soil raised at a distance of half an inch. The second frond produced bears four buds, which are, however, dormant, the growing season being over. In addition to these axillary buds, there is a whitish mass of apparent bud formation in the crown of the caudex at the base of the fronds. The same prothallus has also developed three small independent ferns from its edge; these, however, are seemingly normal, which fact, coupled with the abnormal vigour of the main plant, points to a hybrid origin of the latter. Fig. 2 is an altogether different form,

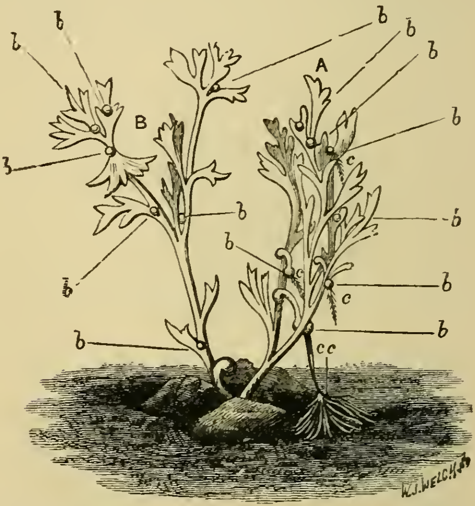


Fig. 2.—Proliferous Fern Sporeling. × 2½ times.
A, first frond; B, second frond; *b*, bulbils; *c*, aerial roots; *cc*, root entering soil.

being very depauperate and ramose; the two fronds of these have developed no less than thirteen buds, of which the majority have evolved aerial roots, one reaching and penetrating the soil. The buds on the first fronds have thrown up small circinate fronds, which have so far not unfolded. The genus of Athyrium, rich as it is in variations, has so far been remarkable for its non-proliferous nature, the exhibitor failing to find any record of a bulbil-bearing form; it is, therefore, singular that two forms so distinct in character, yet so alike in their profuse proliferousness, should have originated simultaneously and within a few inches of each other. Finally, not the least singular feature is the extreme precocity of both forms, since bulbil-bearing ferns, almost without exception, are proliferous only on their ripe fronds, and when much further advanced in development. The formation of axillary buds of this nature is a new link between the filices and the higher forms of vegetation, as, if persistent, a shrub-like development would result.

(The plants were raised by Mr C. T. Druery, Windsor Road, Forrest Gate, Essex, and exhibited by him at the meeting of the Linnean Society, London, in November 1884.)

Sketch Notes of the Flora of Berwickshire. By Charles Stuart, M.D., Chirnside.

(Read 12th April 1883.)

In this paper I intend to give a general sketch of the rarer plants occurring in the county of Berwick, and in doing so I shall endeavour to be as concise and practical as possible. The German Ocean forms its eastern boundary, and the rock-bound coast from Cockburnspath to Berwick-upon-Tweed is unrivalled in its bold scenery. Numerous deans open out at the sea-shore, and are all interesting botanical stations. Dunglass Dean constitutes the northern boundary of the parish of Cockburnspath, and of this part of the county and of Haddington, and is, upon the whole, richer in its flora than any of the others to be afterwards examined. *Chrysosplenium alternifolium*, *Neottia Nidus-avis*, *Vicia sylvatica*, *Pyrola media*, *Anchusa sempervirens*, *Thalictrum flavum*, *Eupatorium cannabinum*, *Melica uniflora* are a few of the flowering plants. *Scolopendrium vulgare* is growing everywhere, and is exceedingly ornamental. *Asplenium Adiantum nigrum*, *Asplenium Trichomanes*, *Polystichum lobatum*, *P. aculeatum*, *P. dilatatum*, and *Polypodium Dryopteris* characterise the ferns; mosses, such as *Hookeria lucens*, *Hypnum undulatum*, *H. alopecurum*, *Bryum hornum*, and many others, are to be found on the moist rocks. The picturesque beauty of the locality cannot be excelled, and the ravine extends towards the hills for about two miles almost from the sea-shore, and may be taken as a type of the character of the other deans lying parallel with it and St Abb's Head. Situated two miles farther south are the Tower and Pease Deans, both excellent botanical stations, and most delightful sylvan retreats. *Polystichum angulare* is the representative plant in the Pease Dean, which was, I believe, the first known Scottish station for it. Associated with it we have *Campanula latifolia*, and many other interesting plants. On the sea-shore, at the outlet of the Pease Burn, and farther along the shore, *Thalictrum minus*, *Glaucium luteum*, *Crambe maritima* (?), *Ligustrum scoticum*, and *Pulmonaria angustifolia* (?) are to be found. *Dianthus deltoides* occurs at St Helen's Chapel, on the sea banks, with *Primula elatior*, and many orchids. The stratification of the Silurian strata is well seen in many places; for by the action of the waves the succession and position of the various strata and rock formations are laid bare. Professor Playfair, Dr Hutton, and Sir James Hall examined the geology of this district thoroughly, and the whole region may be considered geologically classical. At Siccar Point, the junction of the Old Red Sandstone with the Silurian rocks is so remarkable as to attract the attention of persons little acquainted with the science of geology; and its bold rock scenery and caves, full of stalactites, form objects of interest to the scientific observer. Passing along the coast, we arrive at the ruins of Fast Castle, built upon a peninsula of rock high above the sea, one of the most picturesque objects in the county, and from its elevated position affording a magnificent sea view in all directions. *Sedum Rhodiola* grows upon the rocks in abundance, with many ferns—*Asplenium marinum*, and *A. Adiantum nigrum*, being very abundant. *Crambe maritima* (sea-kale) formerly grew on the shore in such abundance that the neighbouring farmer was in the habit of transplanting it into his garden. *Cynoglossum officinale* also grows on the shore (not found lately). Passing by the entrance of Dulaw Dean, another excellent botanical resort, after a few miles walk along the coast, we come to the noble headland of St Abb's, with its lighthouse 300 feet above the sea, and mural precipices on all sides. St Abb's Head is a mass of insulated trap rocks of volcanic origin, the principal of which are felspar, porphyry trap-tufa, and amygdaloid. Towards Pettycurwick, a small inlet on the other side of the valley, to the north, the Silurian rocks are again seen. The plants growing on the two sides of the valley are quite in keeping with the geological character of the ground, *Arenaria verna* growing in great profusion among the unstratified trap rocks of the head; while on the opposite side of the valley not a plant of it is to be seen. The *Hypericum humifusum*, again, is observed on the stratified rocks of the other side of the valley, only a few yards off, but never near the *Arenaria.* The banks at Coldingham Bay, about two miles farther along the coast, are covered in spring with a profusion of *Primula elatior*, *Thalictrum minus*, *Astragalus hypoglottis*, and *Orchis mascula*—sometimes with white flowers. Near Eyemouth, at Gunsgreen, *Scilla verna* still flourishes; and at Ale Mill, in the Whitfield Woods, about two miles from Eyemouth, *Corallorhiza innata;* the coral root is plentiful, growing in a poor, grey, clayey soil, and is a most interesting plant. A mile or two farther south is the picturesque fishing village of Burnmouth, with a steep ravine situated immediately behind it; here we have *Arabis hirsutus*, *Astragalus glycyphyllus*, *Viola hirta*, *Arabis thalianum*, and all along the coast splendid masses of *Vicia sylvatica.* The Silurian rocks cease as we approach Burnmouth, and the lower Carboniferous sandstone, clay ironstone and shale are met with as we approach Berwick.

Berwickshire may be divided into two parts—the higher and the lower. Lammermoor constitutes the higher part of the county, while the Merse will serve us botanically as a designation for the flat or How of Berwickshire. Among the hills, Lammerlaw reaches the height of 1500 feet; Spartleton, which is just over the boundary, is 1600; Sayerslaw, 1500; The Dirringtonlaw, 1145, and many others attain a considerable altitude. The whole region has been but imperfectly examined relative to its botany, and still affords a promising field to any scientific observer. The northern slopes of Lammermoor, which are just outside the boundary, contain deans of the most romantic character as to scenery, and are full of good plants and ferns, such as *Cystopteris fragilis*, which grows in rare beauty, with *Melica* *nutans*, *Asplenium trichomanes*, *Viburnum Opulus*, *Myosotis sylvatica* var. *alba*, *Vicia sylvatica*. Some of these habitats are best reached from Dunbar or Haddington, but are situated for the most part in remote regions, and require the collector to live for a few days near the scene of his work. Specimens of *Rubus Chamæmorus*, the cloudberry, were sent to me last summer from Byrecleugh, near Longformacus, which is a new plant for the county. *Epilobium angustifolium* and *Pyrola media* flourish on the banks of the Dye at Longformacus. On the west side of Dirringtonlaw, *Arctostaphylos Uva-ursi*, the bearberry, grows plentifully with *Vaccinium Vitis-Idæa*; the berries of the bearberry go by the name of Rapper-dandies among the country people of the district.

At Langton-lees Dean, three miles from the town of Duns, the Rev. T. Brown, a former President of the Berwickshire Naturalists' Club, had the distinguished honour of adding *Saxifraga hirculus* to the Scottish flora. This beautiful plant, by far the handsomest of our native Saxifrages, grows there still in considerable abundance, although sheep drains cut through the bog threatened at one time to destroy the station; it grows with a profusion of *Sedum anglicum* and a marsh *Spergula* (*S. nodosa?*), both very attractive plants. This dean contains many good plants,—*Campanula latifolia*, and several good mosses, which fruit there, being conspicuous. It opens into Langton Dean, which is also botanically interesting.

In the moorland part of Berwickshire, however, the locality most prolific of good plants is Gordon Moss, and we will also include Mellerstane Woods and Corsby Bog, all easily reached from Gordon station on the Berwickshire Railway. The *Linnœa borealis* station at Mellerstane Woods, about the 6th of July, when this delightful plant is in full flower, is a sight to behold. The space covered by it is eighty-four yards in circumference, and is situated in a pine wood, due south from a farm named Lightfield, in Gordon Moor. Its long silky roots penetrate into the débris of rotten bark and moss, never into any soil; and it grows here in great luxuriance, close to the ground, so close that any one might easily walk over the top of it without notice—its evergreen leaves, and flowers in pairs, exhaling the most delicious *almondy* smell. Wherever the *Linnæa* grows, *Goodyera repens*, creeping Goodyera, a very curious orchid, is not far off. In the grand old pine woods of Glenmore, near Cairngorm, some members of the Scottish Alpine Botanical Club found the *Linnæa* growing among the heather, and on examining the ground I gathered stately specimens of the *Goodyera* close to it. The same is to be seen at Mellerstane. Where this *Linnæa* grows in the Highlands, it is generally among the heather, which hides its beauty; not so in the south. Chaillu, in his interesting book *The Land of the Midnight Sun*, describes the pleasure he felt, when travelling in Lapland, when he came upon the ground covered with the *Linnæa* and the air perfumed with its sweetness, for whether we examine the beautiful pink-spotted little bells or smell their perfume, they are equally to be desired. *Listera cordata* grows in great profusion at the east end of the Mellerstane Wood, and *Blechnum boreale* grows to a size I have never seen elsewhere, and is most ornamental. *Goodyera* is most plentiful at the east end of the Linnæa wood, seeming to grow on the rotten bark and débris of the pines. In Gordon bogs there is a great feast for the botanist. *Lythrum Salicaria*, purple loose strife, with large spikes of flower, is growing at the side of the moss holes; while *Stellaria glauca*, with its fine large flowers, trails over the sedges and rushes. Numerous Carices and grasses, with creeping willows, are everywhere; and on the dry banks by the side of the railway *Vicia angustifolia* (Roth.), (flowers in pairs), was discovered by Captain Norman, R.N., and myself a few years ago. The moss holes are full of good aquatics, and to do them justice would require to be carefully dredged. *Utricularias*, *Potamogetons*, and *Sparganiums* are to be obtained. But a complete list of the Gordon plants may be seen in the *Proceedings of the Berwickshire Naturalists' Club* for 1880, page 293.

The Merse, or lower part of Berwickshire, may be roughly stated as situated between the Lammermoors and the River Tweed. The county is of a beautifully undulated character, the elevations running as a rule east and west, which is well observed by the character of the roads—those running north and south being very hilly, while the east and west roads are comparatively level and very good. The country is watered by the Tweed, Whitadder, and Blackadder, and the banks of these rivers are among our best botanising ground.

At the mouth of the Whitadder, beds of *Mentha sylvestris* occur for miles up the banks of the river. *Allium Scorodoprasum*, the sand garlic, is also plentiful at the junction of the Whitadder and Tweed, with *Scirpus maritimus*, for we have the tide affecting this part of the river. *Ranunculus arvensis* grows in the fields about this point, and is considered a rare plant in Berwickshire. *Senecio erucifolius* grows in the boundary lane between Berwick bounds and Berwickshire; *Viola hirta* and *Sisymbrium sylvestre* grow at New Mills, farther up. *Scrophularia Ehrharti* grew at one time at Edrington Mill, but has not been seen for some years. From Edrington the banks are well wooded, and many interesting plants are to be met with, the woods being carpeted with primroses and wood anemones in the spring. Hutton Bridge, designed by Sir T. Brown, here spans the river, and the scenery is very pretty, and well worth a visit. The woods are full of *Myosotis sylvatica*, *Valeriana officinalis*, *Vicia sylvatica*, primroses and anemones, *Vicia sylvatica* in great masses, where the crumbling shales give it good roothold. Proceeding up the river for less than a mile, we arrive at a green haugh where *Malva moschata alba* grows in great profusion. Farther on we come to a hanging wood, and beyond to high precipices in the red sandstone opposite Huttonhall Mill. Here grows our best Whitadder plant, the *Lathyrus sylvestris*, narrow-leaved everlasting pea; the great proportion of the plants growing on rocks, is quite inaccessible, which, in these times of wholesale extermination, is fortunate. However, the collector will obtain specimens easily, for in dry weather the seeds, and in wet the plants get dislodged from above, and, rooting into the gravel in the bed of the river, make capital specimens either to grow or preserve. I cultivate these seedling plants in the garden, where they flower and flourish freely. *Lycopsis arvensis* is growing in beds among the rocks, and *Melilotus officinalis* and *M. alba* grow also at the foot of the cliffs. Round a spring there is a patch of many species of mints, which seem to be an attraction to numbers of bright-coloured *Chrysomelæ*, which are crawling about on these plants. A variety of plants grow on both sides of the river here besides those mentioned, especially on seams of a red hue facing Hutton Hall mill-dam. The cliffs opposite Edrington Mill now claim our notice, displaying as they do a good section of the subcarboniferous strata, with the red selenite and white gypsum showing through the shales. The beautiful moss *Hypnum commutatum*, which hangs in masses over the steep rocks, is here petrified by the trickling of the water loaded with calcareous matter percolating through them, eventually becoming as hard as possible. Fine green-coloured masses of this Hypnum are sometimes obtained, preserving the pectinated appearance of the moss, which are very attractive as specimens for the rock garden. For the same purpose, the red selenite and white gypsum are much sought after. Whitehall is the next part of the river bank we have to examine, which is easily known by a wooded eminence 100 feet high, coming sheer down to the river, named Steepleheugh, and well known to artists for its picturesque beauty. Under the planes at the Blue Stone ford, *Viola odorata* grows in profusion. In the woods *Chelidonium majus*, *Arum maculatum*, *Vicia glycyphyllus* (in the sand pit), *Narcissus Pseudo-Narcissus*, *N. biflorus*, *Galanthus nivalis*, &c., are to be found. This is an ancient place. The flowers of both Narcissi growing in the turf assume a greenish tint. In the pastures I have occasionally picked *Orchis pyramidalis*, a true limestone plant. About Allanton, near a spring, many good Carices are to be got, and *Viola odorata*, *Lysimachia Nummularia*, *Ornithogalum nutans*, &c., grow on the lower part of the Blackadder banks. *Mimulus luteus* seems quite wild on all this section of the river up to Prestonhaugh, where it grows broadcast. *Arum maculatum* in the Blanerne Woods, and *Lathræa Squamaria* at Retreat Woods, must close my list for the present of the Whitadder flora. In the summer of 1882, in a dean (Blackburn Rig) near Grant's House, on the North British Railway, I picked *Trientalis europæa*, the only station I know in the county for it, and record it here. *Pyrola media* and *Polypodium Dryopteris*, with *Melica nutans*, are also, with much that is interesting, growing there also.

APPENDIX.

Trientalis europæa.—Rawburn; Langformacus. Specimens received July 1882. Still in Coldingham Moor and moors between Penmanshiel and Old Cambus.

Mentha piperita.—Two stations for this plant near Allanton and Old Cambus Burn; frequent.

Crambe maritima, although plentiful at one time along our coast, is never seen now.

Lithospermum maritimum has also disappeared, from the shifting of the gravel banks.

Cynoglossum officinale has disappeared at Lumsden Dean.

Vaccinium Oxycoccus.—Drone Moor and the Long or Coldingham Moor.

Pyrola media.—Still frequent in fine flower at Penmanshiel Woods and connected deans.

Hieracium umbellatum.—Penmanshiel Woods.

Artemisia maritima.—Confined to one rock of Greywacke, on coast near St Helen's Church.

Utricularia minor.—Gordon Moss.

&c., &c., &c.

Note on Plant Localities in the Seaward District of Berwickshire. By the Rev. George Macfarlane, Coldingham, Associate.

[Read 11th January 1883.]

Vicia orobus, D.C.—This plant has not been found in Berwickshire for many years. It was said to be once found at Houndwood. I have found two new stations for it on the farm of Hillend, which belongs to James S. Mack, Esq.

Silaus pratensis, Bess.—Found on the farms of Fleurs and Hallydown, between Coldingham and Eyemouth.

Adoxa Moschatellina, Linn.—Found on the farm of Bee Edge, near Coldingham.

Cerastium arvense, Linn.—On Northfield farms, and near Coldingham Loch.

Artemisia Absinthium, Linn.—Coldingham Law.

Anchusa sempervirens, Linn.—Near Reston.

Hypericum humifusum, Linn.—St Abb's Head.

Arenaria verna, Linn. Do.

Asplenium marinum, Linn. Do.

Cystopteris fragilis, Bernh. Do.

Sanicula europæa, Linn.—Silver Wells.
Valeriana dioica, Linn. Do.
Listera ovata, Br. Do.
Polypodium Dryopteris, Linn.—Whitefield Wood.
Potentilla reptans, Linn.—Roadside between Coldingham and Milldown.
Geranium pratense, Linn.—Coldingham Shore.
Hypericum quadrangulum, Linn. Do.
Origanum vulgare, Linn. Do.
Carlina vulgaris, Linn. Do.
Erythræa Centaurium, Pers. Do.
Agrimonia Eupatoria, Linn. Do.
Anagallis arvensis, Linn. Do.
Glaucium luteum, Scop.—This beautiful and interesting plant grows in great abundance on the sea-beach near Coldingham.
Viola lutea.—Near Fast Castle, and at Earnsheugh Camp.
Trientalis europæa, Linn.—Grange Wood, and on several parts of Coldingham Moor.
Utricularia minor, Linn.—Coldingham Moor.
Genista anglica, Linn. Do.
Trollius europæus, Linn. Do.
Habenaria bifolia, Br. Do.
Gnaphalium sylvaticum, Linn.
Pyrola media, Swartz.—Lumsdean Ravine.
Gentiana campestris, Linn. Do.
Mertensia maritima, Don. Do.
Ligusticum scoticum, Linn. Do.
Carduus heterophyllus, Linn. Do.
Euonymus europæus, Linn. Do.
Hypericum hirsutum, Linn —Pease Dean, Dunglass.
Cardamine amara, Linn. Do.
Veronica montana, Linn. Do.
Scolopendrium vulgare, Sm. Do.
Circæa lutetiana, Linn. Do.
Sclerochloa rigida, *Bab.*—Near Burnmouth.
Rosa pimpinellifolia, Linn. Do.
Astragalus hypoglottis, Linn. Do.
,, *glycyphyllus*, Linn. Do.
Equisetum hyemale, Linn. Do.

Geranium sanguineum, Linn.—Near Burnmouth.
Hyoscyamus niger, Linn. Do.
Viola hirta, Linn. Do.

On the Affinities of the Genus Pothocites, *Paterson; with the Description of a Specimen from Glencartholm, Eskdale.* By Robert Kidston, F.G.S. (Plates I.–IV.)

(Read 8th March 1883.)

[This paper, which is slightly abridged, appeared in full in the *Annals and Magazine of Natural History*, May 1883, p. 297. It is one of two competing essays for the Botanical Society's Students' Prize, of £10 which was equally divided.]

The genus was founded by Dr Paterson* for the reception of a curious fossil collected by him "in a mass of bituminous shale from the coal strata which are exposed along the coast at Granton, and nearly opposite Professor Hope's residence."

Dr Paterson, in an earlier part of his paper, expresses his opinion that his specimen belonged to the class of parasitic plants.

He also directs special attention "to a slight enlargement of the stem abruptly broken off, very similar, in fact, to what we see in twigs from which the leaves have fallen off, and is evidently to be referred to the remains of a deciduous leaf or spatha" †

In regard to the *stellate bodies*, situated in longitudinal rows on the spike, he further says ‡, "When viewed with a lens, these small bodies are seen crowned with from four to five (generally four) ovoid and obtuse projections, with elevated edges; these assume a quadrangular appearance, and give the idea of a germen or capsule, crowned with four or five obtuse angles. The central depression, to which the flowering part of the plant had been attached, is also distinctly to be seen."

The view held by Dr Paterson that this plant "either

* Paterson, "Description of *Pothocites Grantonii*, a new Fossil Vegetable from the Coal Formation," *Trans. Bot. Edin.*, vol. i. p. 45, pl. iii., 1841.
† *Loc. cit.*, p. 46. ‡ *Ibid.*

belonged to an extinct species of the genus *Pothos*, or to some extinct genus of plants very closely allied to it," was at the time supported by Mr M'Nab of the Botanic Garden, Dr Greville, and many other gentlemen.

Professor Henslow, who also examined the specimen, thought it was probably related to *Potamogeton* or *Pothos*. He conceived that the spadix was continuous and not jointed, the apparent joints being the result of compression. He could not see any evidence of ribs, and was "unable to determine the exact nature of the quadrifarious arrangement, whether the parts are calyx-scales, or seed-valves." *

I believe Dr Paterson has been deceived in some points by certain appearances in his fossil.

This view as to the affinity of *Pothocites* has been accepted by Mr Carruthers, Professor Balfour, and others. †

Professor Williamson, however, has expressed some doubt as to the systematic position of the plant. In a lecture on "Primæval Vegetation in relation to Natural Selection and Evolution," he says—"It is also necessary to state further that the Coal-measures reveal some other remarkable stems, the exact relations of which are not yet fully ascertained." Then in a footnote he adds,—"This is especially in reference to the *Lyginodendra*, *Nœggerathiæ*, and to the curious *Pothocites Grantonii*, which latter is supposed by some botanists to be a monocotyledonous Angiosperm; this, however, appears doubtful. The genus *Antholithes*, from the Coal-measures, was regarded as a dicotyledonous Angiosperm allied to *Orobanche;* but this idea is now abandoned, and the plant is now referred to the group of Gymnospermous exogens. I expect that further research will lead to some similar change in regard to *Pothocites*." ‡

From a detailed examination of five specimens of *Pothocites* § it is shown that the plant possessed a segmented fructifying spike or cone. In the only perfect specimen the

* *Loc. cit.*, p. 52, *note*.

† Carruthers, "On Fossil Plants," delivered to the Geologists' Association as Presidential Address, Nov. 5, 1875; "The Testimony of Fossil Botany in reference to the Doctrine of Evolution," Presidential Address, delivered to the Geologists' Association, Nov. 3, 1876; "Notes on some Fossil Plants," *Geol. Mag.*, vol. ix., 1872; Balfour, *Introduction to the Study of Palæontological Botany*, p. 66 (Edin. 1872); Geikie, *Text-Book of Geology*, p. 732 (1882).

‡ W. C. Williamson, *Essays and Addresses by Professors and Lecturers of Owens College, Manchester*, p. 229, Macmillan, 1874.

§ *Vide* Plates I.-IV., Explanation, p. 37.

fruit consists of eight segments. The segments are formed by a constriction which corresponds in position to the nodes of the axis. On the circumference of each internodal portion of the fruit there have been from ten to fourteen longitudinal elevations which bore sporangia; these in the young state appear externally as quadrate bodies, having their angles rounded and a shallow notch on each side. The sporangia open in a definite manner, by a cleft passing from the apices of the angled corners towards their centre; and by the margins of the split sporangia becoming deflexed the so-called calyx-segments are formed.

The spike is also attached to a stem composed of nodes and internodes, which branched in a more or less equal dichotomous manner, and bore, at the extremities of the dichotomous branches, cones or spikes.

The stem also shows traces of longitudinal furrows.

Verticillate dichotomously formed leaves are given off from the nodes of both spike and stem.

From such important structural evidence it appears no longer possible to regard *Pothocites* as a Monocotyledon, and I am inevitably led to the conclusion that *Pothocites* is not the inflorescence of an Aroid, but the fructification of a Calamitaceous plant.

But from the material before us we can, I think, place the genus *Pothocites* in a much more defined systematic position than merely indicate its nature to have been that of a Calamitaceous plant.

The characters by which we are enabled to show its more particular affinity are the leaves, fruit, and stem.

The foliage is distinctly dichotomous in its structure, as seen in the example from Eskdale.

The furrows on the stem are too indistinct to show whether or not they alternate at the nodes.*

* It is an unsettled point amongst vegetable palæontologists whether the stems of *Calamites*, in their natural condition, possessed a smooth or a furrowed bark. Some contend that the outer surface of the stem was longitudinally furrowed, others that it was quite smooth, and that the furrows have been imparted by external pressure, or even that the fluted casts, which are of so common occurrence, are merely the internal casts of the hollow stems. But it is generally admitted that when *Calamites* occur as mere casts or impressions they almost invariably show a fluted exterior. Hence, in dealing with fossils in this condition (a condition in which all the specimens mentioned in these notes occur), the furrowing of the stem becomes of generic value, whatever structure the outer surface of the stems may have had when growing.

The segments composing the fruit must, however, be regarded as the homologues of the internodes of the stem, so, in all likelihood, the longitudinal ridges of the segments of the fruit represent the furrows of the stem.

In the spike we see that the longitudinal rows of sporangia do not alternate at the nodes, but pass continuously throughout the whole fruit.

In the genus *Bornia*, F. A. Röm. (*Archæocalamites*, Stur), the furrows on the stem do not alternate at the nodes as in ordinary Calamites; and this well-marked character, possessed by no other carboniferous fossil plant, so far as I am aware, gives it an individuality which cannot be mistaken. Likewise in *Pothocites* we find that the longitudinal elevations which bear sporangia do not alternate at the nodes, but pass continuously throughout the whole length of the spike; and these ridges, I believe, are simply a modification of the furrows of the stem.

In the genus *Calamites*, where the furrows on the stem alternate at the nodes, we have no reason to suppose that this character would alter, even were they known to produce a *Pothocites*-like cone. But the fruit of the *Calamites* is well known; and whatever specific differences there may be in the described genera and species of their fructification, they are always of the *Volkmannia* type; hence it is not at all probable that *Pothocites* belongs to this group of the Calamiteæ.

The dichotomous nature of the foliage is not, however, restricted to the genus *Bornia*.

Stur has described a small *Sphenophyllum* (*S. tenerrimum*, Ett. MS) * which also possesses dichotomously divided leaves. But this is easily distinguished from *Bornia radiata*, Brongn., by the leaves being much smaller and less regularly dichotomous. The fruit of this plant has also been described by Stur, and consists of a small *Volkmannia*-like cone.

Even on young branches of *Bornia radiata* the foliage is of considerable size. In the *Pothocites* from Eskdale (Pl. IV. fig. 13) we have apparently only the remains of the leaves, little more, indeed, than to show that leaves

* Stur, *Culm Flora*, plate vii. p. 214.

were given off from the nodal regions of the spike and stem.

For the purpose of comparison I have given three figures of *Sphenophyllum tenerrimum*, Ett. MS. (Plate III. figs. 11, 12, and Plate IV. fig. 18); and as I have been unable to secure good specimens of foliage-branches of *Bornia* (*Archæocalamites*) *radiata*, Brongn., I give a copy of a figure by Feistmantel (see p. 6), which shows both foliage and the fragmentary remains of an undoubted fruit of *Bornia radiata*. This specimen was originally described under the name of *Asterophyllites spaniophyllus*, Feistm.*

Stur figures two other specimens of fruiting branches of *Bornia* (*Archæocalamites*) *radiata*, Brongn.

Both of these are very imperfect, and can only be fully understood from an examination of more perfect specimens.

That on plate iii. fig. 5 † represents a *Pothocites* in a very young state: two entire segments of the fruit are shown, but the upper part is hidden by a tuft of leaves.

The foliage arising from the nodal regions of the two segments shows very beautifully its full size and structure. That figured by the same author (plate iv. fig. 9) is so imperfect that it gives no insight into the nature of the fruit.

To explain more fully the structure of the fruit of *Bornia radiata*, Stur gives two figures (enlarged two diameters) of the fragment of the spike on Feistmantel's original specimen (see p. 7). ‡

His latter figure is a corrected drawing of the former; hence with it only we have to deal.

It is so very imperfectly preserved that the original describer remarked regarding it, "a cone-like structure is attached to the upper end of the present example, which may perhaps belong to it as a fructification; but, owing to its indistinctness, a closer investigation is impracticable." §

Stur gives a very full description of his figure of this fragmentary cone of *B. radiata*, of which the following

* Feistmantel, O.—"Das Kohlenkalkvorkommen bei Rothwaltersdorf in der Grafschaft Glatz und dessen organische Einschlüsse," *Zeitschr. d. deutschen geol. Gesellsch.*, vol. xxv., pl. xiv. fig. 5, p. 498 (1873).

† Stur, *Culm Flora*, Band i. p. 15, fig. 4; Band ii. p. (23) 129, fig. 9 (1875–7).

‡ Stur, *loc. cit.*

§ Feistmantel, *loc. cit.*, p. 498

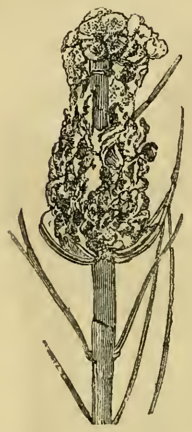
abstract contains the principal points which demand our attention :—

At the base of the spike the remains of a whorl of leaves are shown ; in the whorl of leaves immediately below this, one of the leaves reveals its characteristic dichotomous structure. In the middle of the preserved portion of the cone, the presence of a second leaf-whorl is indicated by a single leaf. At the upper part of the cone portion is a "*receptaculum*," so exposed that one is enabled to see its outer surface. He further states that this "*receptaculum*" appears as if "divided into four slightly elevated lappets ;" and he supposes that each of the "lappets" corresponds to the position of a sporangium attached below.

Branch of *Bornia radiata*, Brongn. (*Asterophyllites spaniophyllus*, Feistm.), showing fragment of a fruit and foliage. (Copied from Feistmantel, *loc. cit.*)

The upper surface of this "*receptaculum*" is unevenly rough. He further points out that the four "lappets" of the shield are only indistinctly separated from each other, being isolated only at the outer edge, but towards their inner grown together. Their dividing line is indicated by a shallow radial furrow; this, he thinks, may perhaps mark the point of the attachment of the "shield" to a stalk.

Stur also thought it very probable that four sporangia hung from the inner surface of the shield, and that, in consequence of pressure, their presence had caused the four slight elevations or "lappets" on the upper surface.



Fruit of *Bornia* (*Archæocalamites*) *radiata* Brongn. (From Stur's *Culm-Flora*, p. 129.)

According to this view, he thought it highly probable that the fruit of *Bornia* included several internodes, and that on the axis, between the leaf-whorls, several whorls of "*receptacula*" were borne; these consisted of a stalked, slightly lappeted shield, bearing on its inner surface four or five sporangia. He also believed the sporangia were (in opposition to recent *Equisetum*) elliptical, flattened, and granulated, about 1·4 mm. long by 0 6 mm. broad. One of the sporangia showed a beak-like projection at one end, which he thought indicated its point of attachment. He goes on to state that the stem, a small portion of which was exposed in the cone, was not jointed.

There are several points in this description which agree entirely with the Scotch specimens. Stur appears, however, to have been misled in some particulars by the imperfection of the example on which his opinions were founded.

We see here again, as in the other figures of this author already cited, the division of the fruit into segments.

The leaf indicating the nodal region, to which reference has already been made, springs from a point a little lower down the axis than the part where the axis is exposed; hence the node is not seen. In plants of this class the presence of a leaf indicates the presence of a node.

In the Eskdale plant this is clearly shown; but one of Stur's figures also shows the same character.*

But the most important structural point of agreement between the Scotch specimens and the plant he so fully describes is afforded by the "*receptaculum*," which he says

* *Loc. cit.*, pl. iii. fig. 5.

is "divided into four slightly elevated lappets," with an unevenly roughened surface.

This agrees in every respect with those shown on the upper portion of the *Pothocites* from Eskdale (Plate IV. fig. 16). Their size also is almost similar.

Whether each of the lobes of the little quadrate bodies represents a sporangium, or the sporangium is four-lobed, I have not sufficient evidence to decide. It is quite possible that the sporangia were arranged in groups of four. It is, however, evident that the "stellate bodies" are formed by an outward radial splitting of the four lappets, the split edges of which eventually become deflexed.

The shield-like structure (quadrate bodies) of Stur is formed by the sporangia (or sporangium), and does not appear to be a peltate expansion to which they were attached, as he supposes.

As already indicated, the sporangia are located on elevated longitudinal rows, which I regard as the equivalents of the furrows on the stem. But it must also be noted that the sporangia of contiguous rows stand opposite to each other.

From this comparison of the structure of the fruit, foliage, and stem of *Pothocites*, with undoubted fruiting specimens of *Bornia radiata*, their agreement is so complete that it appears to me this genus can only be regarded as the fruit of *Bornia* (*Archæocalamites*) *radiata*, Brongn., or of a closely allied species of the same genus.

In the short description which I originally gave of the specimen collected by Mr T. Stock at Glencartholm, it was provisionally named *Pothocites calamitoides*. I have since compared it carefully with the original type, and now find that the points I regarded as of specific value cannot be retained as such.

The chief character which induced me to bestow a specific name upon this specimen was the much greater breadth of the segments in proportion to their length when compared with *Pothocites Grantonii*.

But this diversity is fully explained when we take into consideration the different states of development in which the two specimens occur.

In *P. Grantonii* the fruit appears to have passed maturity and shed all its spores, as indicated by the split sporangia, whereas in the Glencartholm example the lowest segment alone appears to have attained to this degree of ripeness, as only on it the "stellate" sporangia are shown.

In the course of development, we have every reason to believe that during the maturation of the spike the internodes would become elongated; so probably this difference in general outline is only indicative of a different state of development. It agrees with *Pothocites Grantonii* in all other respects.

The absence of nodes on the stem of *P. Grantonii* seems to be entirely due to changes it has undergone during mineralisation. The specimen from Barnton Pavement-stone Quarry has also no indication of nodes on the stem; but, from the evidence afforded by the other specimens, there can remain little doubt as to both it and *P. Grantonii* having originally possessed stems similar in this respect to the other examples.

In regard to *Pothocites Patersoni*, Eth., the chief characters on which this species was founded consisted in the absence of the stellate sporangia and the presence of the "transverse bars." I have already mentioned that there are distinct indications of the stellate-like sporangia, and that the degree of prominence of the transverse bars depends greatly on the physical conditions under which mineralisation has taken place.

In the plant I provisionally named *Pothocites calamitoides* the transverse bars are very distinctly seen, and associated with them we have the stellate sporangia placed upon their little knob-like extremities.

For these reasons, as well as the evidence afforded by the detailed descriptions of the various specimens, I believe that all these fossils are to be referred to *Pothocites Grantonii*, Paterson, and, further, that this plant is not a distinct and separate species, but the fructification of a species of *Bornia*, Röm., probably of *Bornia radiata*, Brongn.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Fruit of *Bornia radiata*, Brongn. (*Pothocites Grantonii*, Paterson). The fruit shows two perfect segments and a portion of a third. Each segment has several longitudinal ridges bearing sporangia which have opened. (Nat. size.) From the Calciferous Sandstone series, shore, at Granton.

Fig. 2. Portion of the uppermost segment of the same specimen, showing the arrangement of the sporangia. (Magnified.)

Fig. 3. An open sporangium composed of five rays, from the same specimen. (Magnified.)

Fig. 4. Another sporangium, with four rays. (Magnified.)

Fig. 5. Diagrammatic section (at right angles to the surface) of one of the rays on *Pothocites Grantonii*, Pat., showing that the apparent "*border*" to the rays is caused by an upward turning of their margins.

Plate II.

Fig. 6. Fruit of *Bornia radiata*, Brongn. (*Pothocites Patersoni*, Eth.), showing the fruit attached to a calamitic stem. The spike shows three segments and a portion of a fourth. From the Calciferous Sandstone series, Raeburn's Pit, near West Calder.

Fig. 7. Impression of the same specimen, which shows more distinctly the transverse bars on the segments of the fruit. This example is imperfect, as indicated by a small portion of the axis extending beyond the uppermost segment preserved in the fossil.

Fig. 8. Fruit of *Bornia radiata*, Brongn., showing two spikes terminating the extremities of a dichotomous branch. From the Calciferous Sandstone series, Barnton Pavement-stone Quarry, Corstorphine Hill, near Edinburgh.

Plate III.

Fig. 9. Fruit of *Bornia radiata*, Brongn. (*Pothocites Patersoni*, Eth.), showing the lowest segment. The fruit is attached to a stem composed of swollen nodes and internodes. The fruit-bearing branch springs from another similar but slightly stouter stem. (Nat. size.) From the Calciferous Sandstone series, Fell's Pit, near West Calder.

Fig. 10. The impression of the last specimen. (Nat. size.)

Fig. 11. *Sphenophyllum tenerrimum* (Ett. MS.), Stur. From the Calciferous Sandstone series, Raw Camps, East Calder.

Fig. 12. The same. From the Calciferous Sandstone series, Burdiehouse. (In the Hugh Miller collection, Museum of Science and Art, Edinburgh. My thanks are due to Professor Archer for permission to figure this specimen.)

PLATE IV.

Fig. 13. Fruit of *Bornia radiata*, Brongn. (*Pothocites calamitoides*, Kidst.), showing a perfect spike composed of eight segments attached to a calamitic stem. Leaves are given off from the nodal regions of both stem and fruit, some of which show the dichotomous nature of the foliage. From the Calciferous Sandstone series, Glencartholm, Eskdale.

Fig. 14. *Bornia radiata*, Brongn. Enlarged sketch of the impression of the basal portion of the fruit of the specimen from Raeburn's Pit, West Calder, showing transverse bars and node on stem.

Fig. 15. Lowest node of the stem of the Eskdale specimen, showing scars from which leaves have fallen. (Enlarged.)

Fig. 16. Two unopened sporangia, from an upper segment of the spike of the same specimen. (Enlarged.)

Fig. 17. One of the open (stellate) sporangia, from the lowest segment of the same example. (Enlarged.)

Fig. 18. *Sphenophyllum tenerrimum* (Ett. MS.), Stur. From the Calciferous Sandstone series, Raw Camps, East Calder.

Figs. 6–11, 14 and 18, are from specimens in the collection of the Geological Survey of Scotland, Edinburgh.

The Multinucleated Condition of the Vegetable Cell, with some special Researches relating to Cell Morphology. By ALLAN E. GRANT. (Plates V. and VI.)

(Read 14th June 1883.)

[This is one of two competing Essays, to which half of the Society's Students' Prize of £10 was adjudicated.]

PART I.—*Previous Researches.*

Professor Schmitz* of Bonn showed that in the cells of *Siphonocladiaceæ* (a family instituted by himself) there is often a great number of nuclei embedded in the layer of chlorophyll, and regularly distributed through it at intervals. Thus, in the genus *Valonia* of this family, there may be several hundred nuclei in each of the larger cells. Division of these takes place, as in Infusoria, &c. The special nucleus gradually assumes an ellipsoidal shape, the proto-

* *SB. Niederrhein. Ges. Natur-u. Heilk*, Bonn, May 5, 1879.

plasm or nucleoplasm becoming at the same time less dense in the middle, and denser at each end, forming the daughter nuclei. Gradually the protoplasm is drawn to each end, until only a thin connecting thread is left, which is finally ruptured.

At a certain period the protoplasm collects round the numerous nuclei, and finally separates into distinct bodies, thus giving rise to zoospores. The nucleus remains during the swarming of the zoospores, and again divides in the same manner in the *unicellular organisms.*

More recently, Professor Schmitz* has demonstrated the presence of numerous nuclei in the cells of *Saprolegnia* and allied forms, as also in *Peronospora*, *Mucor*, &c., which are embedded in the parietal layer of protoplasm.

In some of the larger species of *Conferva* there are two nuclei in each cell, which multiplied by bipartition before the division of the cell, which thus contains four nuclei for the time being. In the *Myxomycetes* he found the nuclei to be present in great numbers in the plasmodia.

As had previously been observed by De Bary, the asci of the *Ascosporeæ* contain eight nuclei, resulting from division of the parent nucleus. In various other plants of low organisation Schmitz has shown the multinucleated condition to be constant.

G. Berthold† has confirmed the observations of Schmitz regarding the plurality of nuclei in the cells of several *Siphoneæ.* In *Codium* he was able to follow the division of the nucleus. After assuming a fusiform shape, it became constricted in the middle, and then swollen out at the ends. Finally, the two daughter nuclei were formed, the threads which joined them being ruptured. In *Deibesia* there were a large number of nuclei in the young sporangia, united by a network of threads. These were gradually replaced by a number of larger nuclei, each of which formed into a zoospore.

Again, M. Maupas‡ notices the occurrence of several nuclei in the animal cell in the cases of *Euchelys gigas*,

* *SB. Niederrhein. Ges. Natur-u. Heilk*, Bonn, August 4, 1879.

† *MT. Zool. Stat. Neapel.*, ii. (1880), pp. 72–78.

‡ *Comptes Rendus*, lxxxix. (1879), p. 250

Opalnia, *Actinosphærium*, the Foraminifera, &c., and records observations on a fungus (*Empusa muscarina*), and several Algæ (three *Cladophora* and one *Vaucheria*).

He mentions that what have usually been considered vacuoles in Empusa, are in reality nuclei. A great number of nuclei were also observed to be present in a freshwater Rhizopod. He finds it difficult to accept Ed. Van Beneden's theory of "fragmentation," since he has seen all the complicated changes usually taking place in the nucleus during "indirect" division.

M. Treub* has lately contributed a most important series of observations on the occurrence of more than one nucleus in the vegetative cells of phanerogams. He has discovered that the multinucleate condition is constant in the vegetative cells of certain plants belonging to the *Asclepiadaceæ*, *Apocynaceæ*, *Euphorbiaceæ*, and *Urticaceæ*. This condition was well seen in the bast fibres of *Humulus Lupulus*, *Urtica dioica*, and *Vinca minor*, and in the laticiferous cells, proved to be simple and branched single cells by De Bary of *Ochrosia coccinea*, *Vinca minor*, *Cyrtosiphonia spectabilis*, *Plumieria alba*, *Hoya*, *Gomphocarpus angustifolius*, *Stapelia ciliata*, and *Melica dioica*.

Ed. van Beneden maintains that in cells with more than one nucleus, fragmentation is the only method of multiplication of the nuclei. Treub, however, asserts that he has traced in the bast fibres of *Humulus Lupulus*, *Vinca minor*, and *Urtica dioica*, and in the laticiferous cells of *Vinca minor*, and *Urtica dioica*, the division of the nuclei by the ordinary method, with formation of nuclear plate, &c. He says that the nuclei in one cell generally divide simultaneously, but that he has seen thirty divide in turn in one cell. Strasbürger observed that the process of free cell formation occurs in the same manner, but we have in addition the aggregation of the protoplasm round the nuclei, new cells being thus formed. Free-cell formation from one point of view may be looked upon as a state of transition between the multinucleated condition and ordinary cell division. Finally, these discoveries tend to exalt the position of the nucleus, and lower that of the protoplasm.

* *Comptes Rendus*, lxxxix. (1879), p. 494.

Hegelmaier* has discovered a plurality of nuclei in the cells of the suspensor of plants belonging to the tribe *Vicieæ* of *Leguminosæ.* Among the species he examined, were *Pisum sativum*, *Lens esculenta*, *Vicia Sepium*, and *V. pisiformis.* The two apical cells of the suspensor have numerous nuclei—it may be twenty or even thirty, usually about twelve—embedded in the parietal layer of protoplasm In the two basal cells the number is still larger, and seems to depend on the size of the cell. The nuclei in the basal cells begin first to divide, and when these have reached a certain number, at least sixteen, those in the upper cells begin to divide. There is never the least trace of a septum between the nuclei in the lower cells, and the formation of a septum between those in the upper cells is extremely rare.

M. Guignard † also describes a plurality of nuclei in the suspensor of plants belonging to the tribe *Vicieæ* of *Leguminosæ*, *e.g.*, in *Orobus angustifolius*, *O. aureus*, *O. niger*, and *O. rosensete*, and *Lathyrus heterophyllus.* The disposition of the nuclei is regular as a rule, but is not always so. They are situated in the layer of parietal protoplasm. They are commonly spherical, but are frequently ovoid, and are easily distinguished from the nuclei of the embryo sac. He is unable to assign a cause for this plurality of nuclei. It is not exclusively the size of the cells, as in some Orchideæ we find cells as large with only one nucleus. It is, he thinks, probably connected with some physiological function.

Johow ‡ describes a plurality of nuclei in the cells of the vegetative system of some Monocotyledons, giving details of the occurrence of the phenomena in the case of *Tradescantia*, *Allium Cepa*, and *Orchis maculata.* The original nucleus of the cell becomes constricted, and then divides into two or more pieces, without any visible change of structure. This takes place in cells of considerable age, but in which the protoplasm is still in circulation, and contains chlorophyll and starch. He prefers to name this phenomenon "direct division," in preference to the term "fragmentation" applied to it by Ed. van Beneden.

* *Bot. Ztg.*, xxxviii. (1880), p. 513.
† *Bull. Soc. Bot France*, xxvii. (1880), pp. 191–193.
‡ *Bot. Ztg.*, xxxviii. (1880), p. 826, Bonn, 1880.

Strasburger * has confirmed the observations of Hegelmaier and Johow in all important points. In the vegetative cells of Dicotyledons fragmentation does not appear to be so common as in those of Monocotyledons. He has seen it occurring, however, in very old cells of the pith of *Tropæolum majus* and in species of *Nicotiana* shortly before disintegration of the nucleus. According to Strasburger, the two phenomena of division and fragmentation of the nucleus are not identical. Division of the nucleus takes place in cells with vital activity, and under the influence of the surrounding protoplasm; fragmentation, on the contrary, is a process belonging to the nucleus only, which does not begin until the influence upon it of the surrounding protoplasm has ceased. The cell may remain for a long time in the multinucleated condition, but in many cases it rapidly leads to disorganisation of the nucleus.

M. Prillieux † describes the multiplication of the nuclei in the cells of the root of a plant grown in soil the temperature of which generally exceeded by about 10° that of the surrounding atmosphere. There were from two to four nuclei in each cell, and they were either isolated or united into a mass, and pressed against one another. They frequently varied in form and size. They multiplied by fragmentation, and often contained a number of nucleoli of various forms and sizes. The hypertrophied nuclei are vesicular, and the protoplasmic mass dense and finely granular, save in the centre, where it is more liquid. The nucleoli are found in the parietal layer. When the nucleus divides there is first formed in its interior a plasmatic portion, then the two halves swell and become isolated by prolongation of the dividing fissure. In some cases the two nuclei remain adpressed.

Part II.—*Special Researches.*

The following examination was by longitudinal sections of the stem or sometimes of the petiole, eosin (a solution in spirit) being the staining fluid commonly used.

* *Bot. Ztg.*, xxxviii. (1880), pp. 845–854 (pl. xii. figs. 1–22).
† *Comptes Rendus*, xcii. (1881), pp. 147–9.

The following plants were examined :—*Polygonum Sieboldii, Acanthus mollis, Podophyllum peltatum, Eschscholtzia californica, Impatiens Noli-me-tangere, Dictamnus fraxinella* —all Dicotyledons; *Lilium pyrenaicum, Polygonatum multiflorum*—both Monocotyledons.

Particular attention was given to *Polygonum Sieboldii* and *Acanthus mollis.*

Polygonum Sieboldii (Plate V. figs. 1–4).

This is a quick-growing herbaceous plant, flowering in the summer time. Its stem is hollow except at the nodes, and has a jointed appearance, the nodes and inter-nodes being distinctly marked. A transverse section of the stem shows it to be something like the burr (*Arctium Lappa*) in structure. Longitudinal sections were cut both radially and tangentially. The latter yielded the best results in this case. Different specimens showed that both the bast cells and the wood cells may be multinucleated, as well as the parenchymatous ground tissue. This condition is best seen, however, in the wood cells and ground tissue, especially in that part of the latter forming the medullary rays. In one specimen almost every cell has several nuclei. In the cells of the wood the nuclei, as a rule, were pointed either at one end or at both, and had frequently a fusiform or falciform appearance. Often they were of great length, and "drawn out," as it were, to extreme tenuity. Sometimes they were roundish or altogether irregular in shape (Plate V. fig. 4). Where there were only two or three in the cell they might be close together, or even adpressed, but frequently they were scattered about in an irregular manner. Some of the fibres were almost filled with nuclei. The nuclear membrane, giving rise to a double contour, was usually more or less distinct. The nucleoplasm was dense and finely granular. The nucleoli were usually placed towards the middle of the nuclei, and varied in number, there being, as a rule, one, two, or three present. Every nucleus contained at least one nucleolus. The endonucleolus could almost always be distinctly made out, and I believe was always present, though, on account of its small size, it might easily be obscured.

In the cells of the parenchyma, including the medullary rays, there was very frequently more than one nucleus. The nuclei were usually circular, or approximately so. It is interesting to note the usual difference in shape between the nuclei generally of the fibres and of the parenchyma or soft bast. The idea suggests itself that the shape and length of the cell, and therefore the difference on the protoplasmic stream, may be the cause of it. The nuclei in the parenchymatous cells are not so numerous as those in the fibres, which may possibly be due to the difference in the size of the cells, as suggested by Hegelmaier, but I do not think this likely. The nuclear membrane is well seen in these nuclei; each nucleus has a nucleolus, and the endo-nucleolus can generally be made out.

In this plant I have been enabled to trace the formation of the multinucleate condition distinctly, and have found it in all cases to be due to "direct division."

The first step is undoubtedly division of the endo-nucleolus, but only in one case (Pl. V. fig. 1*a*) did I see this, though I do not doubt that it could be more carefully made out if carefully looked for. In the case referred to, the endo-nucleolus had become swollen out at each end and constricted in the middle, giving it a dumb-bell-shaped appearance.

The next step, namely, division of the nucleolus, was observed in another cell of the same specimen. It had become dumb-bell-shaped like the endo-nucleolus, and each daughter nucleolus contained an endo-nucleolus (Pl. V. fig. 1*b*). In another cell the third stage was noted. The nucleus had become deeply constricted, and on each side of the constriction was a nucleolus with its contained endo-nucleolus (Pl. V. fig. 1*c*).

I have seen the nucleus constricted in all sorts of ways. Sometimes the constriction begins at one side and gradually extends to the other side, until the nucleus is divided. This would appear to be the commonest method. At other times the constriction begins at both sides, and the two constrictions meet at length. The figures belonging to Strasburger's paper in the *Botanische Zeitung*, before referred to, very closely correspond to what I have observed in this and other plants. Some of them I have copied (Pl. V. fig. 5).

Acanthus mollis (Plate V. figs. 6 and 7).

In this plant the multinucleated condition is well seen in the ground tissue. More remarkable, however, than the occurrence of more than one nucleus in some of the cells, is the fact that most of the nuclei contain several nucleoli, and these in turn may contain several endo-nucleoli. The nuclear membrane was most distinct, and in one specimen the nucleolar membrane could be plainly seen.

The nuclei sometimes exhibited an indistinct, irregular outline, and had the appearance of being about to disintegrate. The tissues examined were those of the petiole, and the plant was past maturity.

As in *Polygonum Sieboldii*, the nucleoplasm was dense and finely granular; but the most noticeable fact in connection with this subject was, that there was sometimes a hyaline layer of protoplasm in the nucleus, in which was placed the nucleolus. This, I fancy, seemed to occur oftenest in large, well-nourished looking nuclei (Pl. V. fig. 7*a*). In such a case as this one cannot fail to see that the nucleolus is a most distinct body, and does not at all resemble a " thickening of the intranuclear network," or the " result of a shrivelling up and intimate fusion of a part of the network." It is worthy of notice that in the cells of this plant, or indeed other plants, where the nucleus contains several nucleoli, there is usually one nucleolus larger than the rest, and which contains several endo-nucleoli instead of one (Pl. V. fig. 7*d*).

Various stages of direct division have been observed in this plant. One case (Pl. V. fig. 6) was especially interesting, and served to illustrate the fact that the nucleolus always takes precedence of the nucleus in division. The nucleus had become constricted at one side; the nucleolus, however, was also constricted, and bent down over the nuclear constriction, so that it must have been divided before division of the nucleus could take place.

Eschscholtzia californica (Plate V. fig. 8).

In longitudinal sections of the stem of this plant the multinucleated condition was chiefly found in the ground tissue. It was of fairly common occurrence. The nuclei were often very large, and contained a good many nucleoli. The nucleoli were also large, and in one the nucleus was the largest I ever saw. The limiting membrane could be most distinctly seen (Pl. V. fig. 8). There were frequently several endo-nucleoli in each nucleolus; usually there were two.

Dictaus fraxinella (Plate VI. fig. 1).

In this plant the multinucleated condition was several times observed in the cells of the parenchyma (Pl. VI. fig. 1). More noticeable than this, however, was the number of nucleoli contained in each nucleus. The number varied from about one to ten.

Podophyllum peltatum (Plate VI. fig. 3)

A plurality of nuclei was observed in most of the cells, both of the ground tissue and of the bundles. In the figure (Plate VI. fig. 3) the cells are from the parenchyma, but the cells of the bundles show the phenomenon fully better. I have drawn a nucleus divided by direct division from one of the cells of a bundle (Pl. VI. fig. 3). Nearly all the nuclei in this plant contained more than one nucleolus.

Impatiens Noli-me-tangere (Plate VI. fig. 2).

A multiplicity of nuclei in the cells of this plant was not very common, but it was observed in some of the cells of the parenchyma (Pl. VI. fig. 2). A good many of the cells in the centre of the stem of this plant contained no nuclei, which would seem, therefore, to have disintegrated, although the plants taken were young. The nuclei, when present, contained several nucleoli as a rule, and the endo-nucleoli were distinct and large.

Lilium pyrenaicum (Plate VI. figs. 4 and 5).

In this monocotyledon many of the cells contained more than one nucleus. The limiting membrane of the nucleus was beautifully seen in many cases. Most of the nuclei were multinucleated. The nucleoli were large (Pl. VI. fig.

5). Direct division was several times seen (Pl. VI. figs 4, 5).

Polygonatum multiflorum (Plate VI. fig. 6).

Many of the cells here contained several nuclei, both in the bundles and ground tissue. The nuclei were very evident, and there were generally several in each nucleus. One case of direct division of the nucleus I have figured (Pl. VI. fig. 6).

The Work of Others in the Field Described.

First, M. Treub asserts that he has traced all the phenomena usually occurring in indirect nuclear division in the cells of phanerogams. I have entirely failed to see these phenomena, though I have carefully sought for them. His opinion is that his researches have tended to lower the position of the protoplasm and exalt that of the nucleus. All recent researches seem to tend to the same point. Hegelmaier notices that division of the nucleus is always preceded by that of the neucleolus. Dr Macfarlane confirmed this; and I have invariably found this to be the case, and also believe with Dr Macfarlane that division of the endo-nucleolus is the first step towards division, whether direct or indirect. Johow finds that no visible change in the structure of the nucleus during direct division, thus differing from Treub and agreeing with myself. He also mentions that the condition of more than one nucleus in the cell occurs in cells of considerable age, but in which the protoplasm is still in circulation. This also I find to be the case. M. Prillieux found that the nuclei divided by ordinary direct division or fragmentation in the cells of the roots of the plants grown in heated soil. The hypertrophied nuclei were vesicular, and the protoplasm dense and finely granular, save in the centre where it was more liquid. This description of the nuclei applies generally to those in multinucleated cells, in so far as I observed them. Strasburger has also found direct division to be the manner of division of the nuclei in the vegetative cells of phanerogams. He says, however, that it is in cells in which the protoplasm has "lost its power upon the nucleus" that this phenomenon occurs, while in cells in which the protoplasm is still "vitally active," *i.e.*, can cause the nucleus to divide, the process of indirect division can still go on, with formation of cell-plate. Now, as before stated, it would appear from recent observations, especially those of Dr Macfarlane, that it is in the nucleus and bodies contained where the process of division begins, in fact that the "generative" force proceeds from within outwards. The protoplasm therefore would not seem to exercise any power over the nucleus which causes it to divide, but rather the nucleus influences the general cell-protoplasm, causing deposition finally of the cell-plate. The expression, "influence of the protoplasm over the nucleus" should be confined to its office of nourishing the nucleus. Since then, in the cells in which the multinucleated condition was observed the protoplasm was still in circulation, the protoplasm may, in this modified sense, be said to have still retained its influence over the nucleus. It will be observed that none of the observers, whose results I have summarised and compared with my own, have advanced any reason for the occurrence of this condition. M. Guiguard, indeed, states that it is not exclusively the size of the cell, but probably is concerned with some physiological condition. He does not, however, suggest what that condition is. Strasburger would seem to be of the idea that it is of pathological significance.

The hypothesis advanced by Dr Macfarlane, in his paper read before the Royal Society of Edinburgh,* seems to be without doubt the correct one, in at all events most cases, viz., that the occurrence of a plurality of nuclei in cells past division is due to a *continued functional activity* of the nucleus, more or less perfect, engendered by an *excess of nutrition*, and by conditions generally favourable to growth. It receives special support from the experiments of M. Prillieux when he produced the condition artificially by superheating the soil in which certain plants were grown. The same cause, namely excess of nutrition, is, I believe, the reason of the multinucleated state of the cells for the absorption of bone, called osteoclasts, in the animal system, as also of those large cells in the spleen which apparently disintegrate and absorb the coloured corpuscles of the blood.

* *Trans. Roy. Soc Edin.*, vol. xxx. p. 585.

The multinucleated condition would be thus produced then in cells in a manner somewhat after this fashion:—In cells that are young and dividing rapidly, the nucleus is then in possession of its full vitality, and can influence the surrounding protoplasm, causing, finally, the formation of a septum. A little later the nucleus has lost some of its vitality or "power of division," and, as a result, is unable longer to influence the general cell-protoplasm. It is still able to divide itself, however, and passes through all the stages of indirect division except the formation of a cell-plate. Such a case would be that in the cells of the suspensor of some *Leguminosæ.* Still later, again, we may imagine the nucleus in a well-nourished plant retaining enough vitality to divide directly without going through the phenomena of indirect division. This is, as it were, the "last functional effort" put forth by the nucleus before retiring into a state of rest. Disintegration may, as noticed by Strasburger, occur immediately, or the cell may continue multinucleated for some time. The presence of several endo-nucleoli in each nucleus, or of several nucleoli in each nucleus, I look upon as simply a modification of the same condition. All these conditions may occur together in one cell, or any one or two may occur. The presence of several nucleoli in one nucleus seems to be the commonest condition.

In plants of low structure, such as *Derbesia*, the multinucleated condition of the cells is not analogous to that in the vegetative cells of phanerogams, as in such a plant the condition is quite normal, and merely occurs in the process of reproduction. In cells, however, such as those of *Chara*, which are past division, the hypothesis of extra nutrition applies, no doubt, equally.

According to Strasburger, fragmentation of the nucleus occurs as a final change before its disintegration in some very old cells of *Tropæolum* and *Nicotiana.* This must be looked on as a senile change, nay, almost a pathological condition. It may be caused by an irritant.

With regard to the comparative frequency of occurrence of this phenomenon among Dicotyledons and Monocotyledons, I believe Strasburger's idea that it is most frequent among the latter to be correct. Six out of the eight plants examined by me were Dicotyledons.

Part III.—*Some Points in the general Morphology of the Cell.*

The older cells do not afford much evidence of the arrangement of the protoplasm in a definite intercellular network, such as is seen in the young actively growing cells. The nearest approach seen to it is the mooring of the nucleus to the cell-wall, sometimes much as in *Spirogyra*. Another point is the difference in shape of the nuclei in the various cells. To this I have alluded before, and stated that I believe it to be due to the difference in shape of the cells, and to the "dragging" of the protoplasm, in the course of its circulation, upon the nucleus. The nuclear membrane was often very distinct indeed, and, in fact, could almost always be made out. I also frequently saw that the nucleolus also was bounded by a distinct limiting membrane.

I have also alluded before to the existence of a curious hyaline circle of protoplasm in the body of the nucleus at times, this being particularly seen in large hypertrophied nuclei.* The independent and important characters of the nucleolus and endo-nucleolus seem now fully established, and there would seem to be no reasonable doubt that division of the endo-nucleolus institutes the act of division, whether direct (as I have observed) or indirect.

One remark as to the production of the multinucleated condition of the cell artificially. I believe that a series of more extensive experiments, conducted somewhat on the lines of M. Prillieux's, would conduce greatly to establishing the hypothesis advanced by Dr Macfarlane.

* With regard to this hyaline circle of protoplasm in the nucleus, the following occurs in the last edition of Quain's *Anatomy* (1882), vol. ii. p. 10:—"Eimer describes a more complicated arrangement as existing in many nuclei, in the form of a clear 'hyaloid' zone, encircling the nucleolus and bounded by a circlet of granules, which are united with the nucleolus by fine radial filaments. It is difficult to avoid thinking that the appearance described by Eimer must be mainly an optical effect produced by reflection of light from the sides of the nucleolus." Although I have not noticed the "fine radial filaments" spoken of, I have often seen the so-called "hyaloid zone," and can only conclude from the latter remark of the editor of Quain that he has never seen the appearance indicated.

EXPLANATION OF PLATES.

Plate V.

Fig. 1. Cells from *Polygonum Sieboldii.*
- *a.* Endo-nucleolus is dividing.
- *b.* Nucleolus is dividing.
- *c.* Nucleus is dividing.

Fig. 2. Cells from *Polygonum Sieboldii.*
- *a.* Nucleolus containing two endo-nucleoli.
- *b.* Nucleus containing two nucleoli, a large and a small one, each with an endo-nucleolus.
- *c.* Nucleus "fragmenting" or "dividing directly."

Fig. 3. Cell from *Polygonum Sieboldii.*
Nucleus dividing directly.

Fig. 4. Variously-shaped nuclei from fibres of *Polygonum Sieboldii.*

Fig. 5. Fragmentation of nuclei copied from Strasburger's paper in the *Botanische Zeitung.*

Fig. 6. Cell from *Acanthus mollis,* from the petiole-nucleus and nucleolus dividing, the nucleolus being so placed as to be divided before the nucleus.

Fig. 7. Nuclei from *Acanthus mollis.*
- *a.* shows the "hyaline" layer of protoplasm.
- *b.* shows three large nucleoli, with their limiting membrane.
- *c.* shows a nucleolus containing two endo-nucleoli.
- *d.* shows two nucleoli, one being larger than the other, and containing a distinct endo-nucleolus.
- *e.* shows a nucleus dividing.
- *f.* shows a nucleus, evidently newly formed, or else where nuclear membrane has been torn across.

Fig. 8. Large nucleus from *Eschscholtzia californica,* containing two nucleoli, one very large, and showing limiting membrane very well.

Plate VI.

Fig. 1. Multinucleated cell from *Dictamnus Fraxinella.*

Fig. 2. Do. do. from *Impatiens Noli-me-tangere.*

Fig. 3. Cells from *Podophyllum peltatum.*
- *a.* Multinucleated cell.
- *b.* Do. do.
- *c.* Do. do.
- *d.* Nucleus dividing.

Fig. 4. Cells from *Lilium pyrenaicum.*

a. Nucleus dividing, and containing several large nucleoli.

b. Multinucleated cell, the two nuclei each containing several nucleoli.

Fig. 5. Cell from *Lilium pyrenaicum.*

Nucleus dividing, and containing several nucleoli.

Fig. 6. Cell from *Polygonatum multiflorum.*

Nucleus very large, and beginning to divide.

Note.—It being of course often, indeed generally, almost impossible to find the same cell again, these figures were drawn on the spot, most of them with a camera lucida (Nachet's), kindly lent me by Professor Dickson.

On the Coal incrusting the large Pinaceous Fossil Stems in front of the Herbarium, Royal Botanic Garden, and its bearings on the question of the Formation of Coal. By Andrew Taylor.

(Read 8th March 1883.)

In view of the great interest taken by visitors to the Garden in these relics of a former vegetation, it may be worth while to recall Sir Robert Christison's elaborate researches into the fossilisation of these trunks, given at great length in the *Transactions of the Edinburgh Royal Society*,* as well as in our own, in which he showed that this coal did not represent the former bark of the trees now fossilised. An hypothesis of the formation of this coal on the trunk, as well as a thin seam found above the former site of the Redhall specimen, may be of far more importance in the light of subsequent investigations than the venerable author seemed disposed to assign it.

In all the trunks mineralogically examined, the encasing material was a bituminous splint coal of a conchoidal fracture, and burning with a dense white smoky flame. The density of this coal in the Redhall specimen is 1·284; giving a hard coke, and leaving 2·95 per cent. of a pale ochre ash, which shows traces of iron to the action of nitric acid. None of the coals from the various trunks examined showed the uniformly vegetable structure demanded by

* *Trans. E. R. S.*, vol. xxxii. p. 203; *Proc.*, vol. viii. p. 377.

some as an essential characteristic of the mineral; but the sections were amorphous, though one out of several exhibited dotted vessels,—a good reason for the palæontologist to classify the trunks as of pinaceous origin. It is clearly not the bark of the tree. But no trace of vegetation or stony matrix remains in the stems, these being clearly examples of fossilisation by replacement. Curiously enough, however, they are not composed of the stone forming the bulk of the quarries, but mostly of a ferruginous dolomite, containing mainly salts of lime and magnesia, together with a small percentage of the carbonate of the protoxide of iron. All the specimens left on analysis a residuum of vegetable charcoal; in the Redhall specimen it amounted to 3·25 per cent.,—this appears to be all that remains of the original wood of the stem. The presence of the dolomite was easily traceable in the pervading sandstones of the quarries, not only in the immediate proximity of the fossil stems, but also here and there, in small patches, all through the beds worked. The small quartz crystals, constituting when segregated more than one of our local sandstones, may have had their origin in hydrothermal agencies. Indeed, in the sandstones at Millerhill, and in the Caulmstone quarry at Salisbury Crags, the crystals are so prominent as to suggest such an origin to a casual observer, rather than being sand-grains of former sea-beaches. If this hydrothermal activity were intermittent, so far as the constituent salts in solution, we would then have all the conditions necessary for the fossilisation of these trunks. Sir Robert claims the action of such alkaline waters for the subtraction of the woody tissues of these trunks; the woody charcoal and the coal is accounted by a process analogous to that when woody matter is charred in close vessels at a low temperature, the woody matter in this case coming either from the interior of the stem or from below the sandstone stratum. So far, then, the matter is dismissed with some doubt as a provisional hypothesis. In a careful analysis of the sedimentary rocks on Salisbury Crags, apparently Sandstones, by external inspection, have exhibited in varying degree the dolomitic constitution of the interior of the fossil trunks.* Many chemical geologists accept

* *Trans. Ed. Geo. Soc.*, vol. iii. p. 289.

such speculations as to the formation of coal. Thus Professor Newberry of America holds that there is neither sharp dividing line nor permanence in the so-called carbon minerals,—that they are all alike probably the product of the decay of animal or vegetable tissue, have no fixity, but are constantly forming; that there appears little call for high heat, time, or pressure in the formation of coal. At the great pitch lake of Trinidad, two kinds of tar, with their solid products, maltha and ozokerite, may be seen simultaneously forming, while not far away may be traced the present formation of lignite. Exhausted oil wells in Pennsylvania are known to be replenished after a few years' rest. It is now thought that petroleum may be there filtering up through the great sandstone deposits lying above immense shale beds. When such matter is thrown into a fissure, and becomes inspissated, coals like the Albertite of Nova Scotia and Virginia are formed. A temperature, then, little if above the ordinary appears sufficient for the changes indicated by Sir R. Christison in these fossils; the heat may have been evolved, and the transformation into coal may have been nearly completed even at the time of deposition. The *Sigillaria* found in the trap rock in the neighbourhood of Binny Craig (*vide Proceedings*, 1856) by Dr Sellar may also have been thus formed. Such internal chemistry going on in the underlying shale may act not only as products of material but as dialysers in the process of bitumenisation. Many years ago, in sinking a pit near Bathville, Armadale, Linlithgowshire, a sandstone bed was cut through, in which round balls of charcoal, externally amorphous, were regularly diffused; as coal beds were above and beneath, it was probably an example of Sir Robert's thesis. So, indeed, are probably certain beds or "fakes" of sandstone shale, with fossils in the state of charcoal, usually above clean freestone beds in sandstone quarries. In some well-known household coal seams at Slamannan and in Fife, thin seams of charred wood, sometimes an inch thick, are found intercalated with the caking coal.

A special point in Sir Robert's hypothesis of the formation of the coal incrusting these trunks is the origination from special centres of the bitumenisation seen in the formation analogous to the chemical action of coprolites, cement stones, and the like. A recent example has been observed in peat-bogs, where at certain depths, as at Screenston, Pennsylvania (*N. Y. Ann. Nat. Sc.*, 1882), anthracite coal is here and there found in conjunction with the unchanged peaty fibre around it. On a larger scale, the "curly" bands in our oil shales, as well as the known facts of certain areas of commercially profitable beds thinning out, and their increasing, as shown at West Calder, far beyond the ordinary yield, point to bitumenisation from specific centres.

On a Divarication of the Common Primrose, with the Calyx divided into Linear Segments. By Charles Howie, Eden Cottage, Largo.

(Read 12th April 1883.)

A few plants with this abnormal calyx were collected growing on the sloping banks of Kiel's Den, Largo, several years ago, within a small area, where the normal form grows in great profusion. The plants, with several Oxlip forms, were placed under cultivation; they had flowers of various colours, from white to orange. From improved forms of flowers from this motley group of plants various selected forms, along with several interesting hybrids from exotic species, were raised; over one hundred selected varieties were enumerated, when in consequence of the wet summers and severe winters, that told severely upon such plants growing in unfavourable conditions, the most valuable as florists' flowers were lost, including a double golden-yellow Primrose. The one exhibited is of no value as a florists' flower. It assumes the Polyanthus form, with a fascicle of flowers retaining the divided form of the abnormal calyx, with the additional peculiarity of the sepals being reflexed upon the peduncle, thus exposing to view the naked tube of the corolla. The present form, originating from seed saved from this group of plants with the divided calyx, is illustrative of certain lines of expansion or contraction of certain parts of their organisation, which is characteristic of some species, as in that of our native Primrose, where the calyx is frequently represented by the form of cauline leaves, and what is known among florists as hose-in-hose or a duplex corolla, which term fails to describe the present divarication.

On an Abnormal Form of Listera cordata, *R. Br.* By Thos. H. Corry, M.A., F.L.S., M.R.I.A., Assistant Curator of the University Herbarium, Cambridge. (Plate VII.)

(Read 7th February 1883.)

A very curious form of this plant has of late come under my notice. In several of the specimens the stem leaves, which in this species are normally two, and sub-opposite, are three in number. Of these the two lower are sub-opposite, and one of the pair is usually smaller and ovate, while the other possesses the usual deltoid ovate form. The third leaf lies at a slightly higher level than the other two, and in shape it resembles the smaller one. In other cases only two leaves are present, but one of them is distinctly bifid for a considerable distance, and possesses two well-marked main veins. This last mentioned leaf, instead of being placed directly opposite the other, has become carried slightly round the stem, thus showing clearly the manner in which the third leaf of the former case originated, viz., by fission.

The lower bracts, instead of being shorter than the pedicels as is usually the case, are much longer, in extreme cases being as much as four times the length of the pedicel. They are broad, ovate with a sub-cordate base, and of a deep green colour; but as they ascend the raceme they become shorter, narrower and more of the normal type.

Professor Babington informs me that he has never seen polyphylly in this plant before, and that the state of the bracts is very peculiar. Dr Boswell Syme, in the ninth volume of the third edition of *English Botany*, mentions that in *Listera ovata*, R. Br., three or even four leaves may occur close together instead of the normal two, but this condition is very rare. I have also seen *L. ovata* several times with three leaves, and am inclined to think that the third leaf is in this case also produced in the same fashion as I have in this paper shown that it is developed in *L. cordata.*

Dr Masters, in his *Vegetable Teratology*, makes no mention of having observed polyphylly in any species of the genus *Listera.*

The specimens of *L. cordata* which I have referred to were sent to me by my freind Mr S. A. Stewart of Belfast, and they were gathered by him in a peat-bog near Donaghadee, co. Down.

On certain Additional Localities for Cornish Plants. By THOS. H. CORRY, M.A., F.L.S., M.R.I.A., Assistant Curator of the University Herbarium, Cambridge.

(Read 10th May 1883).

The only recent printed information to be obtained regarding the plants of Cornwall, is that which is recorded in the *Flora of Devon and Cornwall,* published during the years 1865–71 by J. W. N. Keys of the Plymouth Institution and Devon and Cornwall Natural History Society. Since the appearance of this work Mr J. G. Baker has contributed to the *Journal of Botany* a very valuable list of the plants observed by himself, Messrs T. Archer Briggs, and A. W. Bennett, in the Lizard Peninsula, and one of the latter gentlemen has dealt with those of the extreme south-eastern corner in his *Flora of Plymouth.* The Rev. C. A. Johns also, in his charming book, entitled *A Week at the Lizard*, has given an account of those species which Mr Curmack of Helston and he himself had observed. It is much to be regretted, however, that no complete flora of this most interesting county at present exists, and it is to be sincerely hoped that before long this desideratum will be supplied at the hands of local botanists. Under these circumstances, I offer the following list as a small contribution towards a more complete knowledge of the plants of this county. The plants mentioned from the Lizard district are supplementary to those of Mr Baker's list,* which I found of great value. My visit was made

* "On the Botany of the Lizard Peninsula," *Journal of Botany,* vol. ix. 1871, pp. 353–358, and vol. x. 1872, pp. 14–16 and 35–42.

towards the latter end of August, when many of the most interesting plants had already ceased flowering, so that my list is therefore less numerous than it otherwise would have been.

Ranunculus Flammula, *L.*	Boggy heath at Gurlan, between Land's End and St Just.
Glaucium luteum, *Scop.*	Whitsand Bay, near Land's End.
Mathiola sinuata, *R. Br.*	Sandy shore near Penzance.
Cochlearia danica, *L.*	Rocks near the Signal-Tower, Lizard.
Lepidium Smithii, *Hook.*	Sennan, near Land's End.
Senebiera didyma, *Pers.*	Streets of Helston; near Landewednack; Marazion.
Viola palustris, *L.*	Boggy heath, Gurlan, near Land's End.
Viola hirta, *L.*	Roadside between Helston and Lizard, 7 miles from the last named place, on Devonian strata.
Lepigonum rupicola, *Kindb.*	Land's End.
Lavatera arborea, *L.*	Cadgwith; Kynance Cove.
Hypericum elodes, *L.*	Gurlan, near Land's End.
Geranium molle, *L.*	Cadgwith (flora alba).
Erodium maritimum, *L'Hér.*	Marazion, in the streets.
Radiola millegrana, *Sm.*	Land's End and Gurlan, between it and St Just.
Euonymus europæus, *L.*	Helston.
Medicago sativa, *L.*	Near Penzance.
M. denticulata, *Willd.*	Shore between Penzance and Marazion.
Genista pilosa, *L.*	On the sea bank at Caerthilian, and between it and Kynance Cove.
G. tinctoria, *L.*	Lizard, and between Lizard Point and Kynance, but all of it var. *humifusa*, Dicks. I did not see a single specimen of the type.
G. anglica, *L.*	Between Lizard Point and Kynance Cove, a very remarkable perfectly prostrate plant, with few slender spines, not at all like the usual form.

Trifolium Bocconi, *Savi.*	In both the Cadgwith and Caerthilian Stations.
T. fragiferum, *L.*	Lizard village.
Lotus major, *Scop.*	Sennan; Helston.
L. hispidus, *Desf.*	Cliffs between Landewednack Cove and Cadgwith.
Ornithopus perpusillus, *L.*	Do. do.
Sanguisorba officinalis, *L.*	Copes Pilchim, between Helston and Lizard.
Circæa lutetiana, *L.*	Helston.
Herniaria ciliata, *Bab.*	Between Landewednack Cove and Cadgwith on the cliffs (but only on Serpentine); this is what Mr Baker calls *glabra*, and Rev. C. A. Johns, *glabra* var. *B. subciliata.* Professor Babington recognises in this plant true *H. ciliata.* Babington has only seen *H. glabra* in the district at Ruan Minor.
Sedum anglicum, *Huds.*	Marazion.
S. acre, *L.*	Marazion.
Eryngium maritimum, *L.*	Whitsand Bay, near Land's End.
Helosciadum nodiflorum repens, *R.*	Marsh, Gurlan, near Land's End.
Fœniculum officinale, *All.*	Banks near the sea, at Marazion.
Crithmum maritimum, *L.*	Near Penzance; Whitsand Bay, near Land's End.
Daucus gummifer, *Lam.;* D. maritimus, *With.*, not *Lam.*	Kynance Cove; Lizard; north of Whitsand Bay, near Land's End; Cadgwith.
Rubia peregrina, *L.*	Kynance Cove. Mr Baker did not see it on the Serpentine.
Solidago Virgaurea, *L.*	Penzance.
Anthemis nobilis, *L.*	Gurlan, near Land's End.
Senecio aquaticus, *Huds.*	Marsh at Gurlan, between Land's End and St Just.
Bidens cernua, *L.*, *var.* genuina.	Near Helston.
Serratula tinctoria, *L.*	Between Helston and Lizard, var. *monticola*, a dwarf and monocephalous form on Serpentine Downs, between Lizard and Kynance Cove, and between Lizard and Cadgwith.

Helminthia echioides, *Gaert.*	Roadsides at Lizard.
Hieracium umbellatum, *L.*	Roadsides near Penzance; between Land's End and St Just; Helston.
Wahlenbergia hederacea, *Schrad.*	Gurlan, near Land's End.
Erica Tetralix, *L.*	Land's End.
E. vagans, *L.*	Several places on Devonian strata by the roadside one mile from Helston.
Cicendia filiformis, *Reich.*	Gurlan, near Land's End.
Gentiana campestris, *L.*	Dry grassy ground between Cadgwith and Kennance Dove, beyond the Serpentine works.*
Convolvulus Soldanella, *L.*	Whitsand Bay, near Land's End.
Cuscuta Epithymum, *Murr.*	On *Ulex nanus*, L., near Sennan; on *Thymus Serpyllum*, L., near the Lizard.
Myosotis repens, *Don.*	Boggy heath, Gurlan.
Verbascum Thapsus, *L.*	Sennan, near Land's End.
Linaria Elatine, *Mill.*	Land's End.
Eufrasia viscosa, *Benth.*	Gurlan, near Land's End.
Thymus Serpyllum, *L.*	White flowered, near Helston.
Calamintha nepeta, *Clairv.*	Penzance.
Scutellaria galericulata, *L.*	Helston.
S. minor, *L.*	Gurlan, near Land's End.
Ballota fœtida, *Lam.*	Lizard; Sennan.
Verbena officinalis, *L.*	Sennan, near Land's End.
Narthecium ossifragum, *Huds.*	Gurlan, near Land's End.
Potamogeton natans, *L.*	Sennan.
Osmunda regalis, *L.*	Marshy heath, Gurlan, near Land's End.

Obituary Notice of Thomas Hughes Corry. By Andrew Taylor.

(Read 10th January 1884.)

During our last session we had to welcome a new author in one of our Non-resident Fellows, whose contributions were rich in promise of those which might have been, specially as he had adopted botany as a profession. But

* In Keys' *Flora* the only record given is "one plant in Budock Bottoms, 1856!" Mr Baker says it is "scattered over the Serpentine Downs at Goonhilly and Predannack," and Rev. C. A. Jones has noted it in "fields west of Kynance Cove." These, so far as is known, are at present its only Cornish stations.

on the 9th August 1883, Thomas Hughes Corry was drowned on Lough Gill, Sligo, whilst prosecuting a botanical survey of the district, at the instance of the Royal Irish Academy. He was born in Belfast on the 19th December 1859, and was eldest son of Robert W. Corry, Benvue, Belfast, and nephew of James P. Corry, M.P. for Belfast. This martyr to science was only in his twenty-third year. He has left a wife and child.

Corry was a most distinguished student, whether as a boy at the Royal Academical Institute or subsequently in the Queen's College of his native town, taking his degree of M.A. with honours, in biological science. From 1875 to 1878 he appears in the College lists as first prizeman in mineralogy and geology, practical chemistry, botany, as well as a prizeman in English literature and modern history. He entered Gomville and Caius College, Cambridge, taking an entrance scholarship. He subsequently obtained a foundation scholarship, which he held for four years. He also obtained the Shuttleworth scholarship in connection with the Cambridge University, which he held at the time of his lamented end. He was assistant curator of the Cambridge University Herbarium, and demonstrator of botany. He was a member of the Royal Irish Academy, and also a Fellow of the Linnean Society. Several of his papers recently appeared in the *Linnean Transactions*. He joined our Society in 1876.

A Type Botanic Garden. By PATRICK GEDDES, F.R.S.E. (Plate VIII.)

(Read 14th June 1883.)

A brief account of a small Type Botanic Garden, which I had recently occasion to construct at Grange House School, may be interesting and instructive, as illustrating how much may be made of a little space by judicious grouping and choice of types.

The plot of ground at my disposal, originally the rosetum of the garden, was only about 40 feet by 100 in extent, and even this space included much gravel-walk and turf. The roses being cleared, and only a few yews and a central araucaria left standing, the plot was, with hardly any change, in every way suitable for a useful exhibition of the natural orders. A few beds were set apart for physiological illustration, and experiment trees were planted round two sides in, or as far as possible opposite to, their orders. The higher plants were arranged in the middle.

The method of arrangement will best be seen from the ground plan. At the entrance a large rectangular bed is occupied with Thalamiflorals, indicating at a glance the approximate morphological and generic relations of the included orders. From this row the eye is directed by a notch cut out on the turf from Malvaceæ to Geraniaceæ, while adjoining Cruciferæ lie the Caryophyllaceæ with their degenerate allies. Another notch directs the eye from Rosaceæ, which are united on the one hand through Onagraceæ to Saxifrages and Crassulaceæ and Umbelliferæ, on the other to Leguminosæ. The Calyciforæ form one definite plot. The Corallifiorals form a large plot at the further end; the Compositæ are found in the central oval, and are flanked by a group of orders—Dipsacaceæ, Valerianaceæ, Campanulaceæ, &c.—closely united to one another and to the Compositæ. This relationship is also shown by notches in the grass. The Monocotyledons form a large rectangular bed along one side; the Amentiferæ are similarly grouped along the wall at one end. The trees complete the square. In the bed of Monocotyledons the lilies occupy the central division, and pass off on one hand towards through Iridaceæ to Orchidaceæ, and through Juncaceæ, &c., to grasses. In all cases the orders have been taken in their widest acceptation.

The first advantage claimed for a small type garden of this kind is that it exhibits at the glance the general relationships and divisions of the vegetable kingdom, and thus forms a most useful key to the greater botanic gardens, where a beginner is lost in the maze of numerous beds, and where he too often utterly fails to attain any general scientific conception of the plant world. From its compactness, of course, this further advantage ensues, that even any village school may have its garden. Instead of the dreary wastes of evergreens or blank spaces which we now see, we might have useful, beautiful, and scientific gardens. Every town at least might thus utilise and beautify one or two of those odd half acres which now lie waste or form the shut-up gardens of dismal squares. Already a Board school is not to be reported on as first-rate without a museum, and the present experiment shows how easy and reasonable it would be also to recommend the possession of a garden. The expense of laying out such a garden is only a few pounds.

When taught, as has too often been the case, as a mere matter of nomenclature, and from books and lectures alone, botany probably even exceeds both the most conventional gerund-grinding or the most confused muddle of so-called modern subjects as an agency for the stupefaction of youth; and the disfavour into which the subject has fallen among educationists is therefore little to be wondered at. Reasonably taught, however, by the aid of fresh specimens, it offers a perhaps unique combination of educational advantages. Not only may an intelligent interest in nature be aroused, and the powers of observation be awakened and disciplined, but the reasoning faculties as well; not only too do drawing, painting, and designing become delightful by its aid, but a thorough manipulative dexterity, invaluable in after-life to men and women alike, is thus rapidly and easily acquired; not only too do the other sciences, especially chemistry and physiology, become more interesting and more intelligible, but the study of language and literature to which schools are mainly at present devoted be really helped and not hindered, for surely neither Wordsworth nor Virgil would ever lose a reader who had learned to know asphodels and celandine, and watch the bees come and go in the school botanic garden. From careful experiments, in which the same lesson was given day by day to university students and school children alike, the writer is in a position clearly to assert that it is by the latter that the subject is studied with most ease, most enjoyment, and best average educational result.

To the admirable and energetic natural history societies, which are among the healthiest agencies of progress in modern towns, the project is particularly to be recommended. The writer may perhaps mention that the enterprising Perthshire Society of Natural Science has already had the subject under consideration.

The writer has to record his thanks to Mr and Mrs Nutt, in whose garden at Grange House the experiment was made;

and also very particularly to Mr Lindsay, curator of the Royal Botanic Garden, for his kind counsel and material aid.

Notes of a Meeting of the Scottish Alpine Botanical Club at Loch Awe, in July 1882. By W. B. Boyd, President.

(Read June 14, 1883.)

The first day's excursion, on July 28, was to an outlying portion of Ben Lui, to the west of the actual summit, on which was a rocky corrie facing the east.

On crossing the railway some very large patches of *Narthecium ossifragum* were seen in fine flower, and were carried off by some of the members for the Bog Garden.

On entering the corrie, which was very rocky, steep, and difficult to climb, the following plants were got:—

Botrychium lunaria, Ranunculus acris, alpine var.
Saxifraga oppositifolia.
Bartsia alpina (but not nearly in such quantity as seen on a previous excursion on Ben Lui itself).
Saussurea alpina.
Habenaria viridis.
Saxifraga hypnoides, stellaris, and aizoides.
Sedum Rhodiola.
Arabis petræa (the plant for which the hill is famous); I have only seen it in two other places. A pink-flowered variety got on Ben More, in Mull, is here one of the commonest plants on Ben Lui.
Aspidium spinulosum (alpine form), &c.

On the highest point of Ben Lui were gathered—

Saxifraga nivalis.
Cystopteris montana.
Cystopteris fragilis, forked form.
Pseudathyrium alpestre.
Polystichum Lonchitis.
Tofieldia palustris.
Carduus heterophyllus.
Silene acaulis.
Dryas octopetala.
Rubus Chamæmorus.
Carex rigida, on the summit.

In this corrie *Kobresia caricina*, which grows in considerable quantity on the east side of Ben Lui, could not be found.

On Saturday, July 29, the excursion was to the great corrie on Ben Cruachan. On our way along the foot of the mountain to the entrance of the corrie, the alpine form of *Nephrodium spinulosum* was seen, as well as a most beautiful variegated form of the same Fern, the variegation upon all its leaves which, I have no doubt, it will retain under cultivation; a forked variety of *Asplenium viride;* the alpine form of *Ranunculus acris; Polystichum Lonchitis*, though not in any great quantity; *Dryas octopetala*, and *Pseudathyrium alpestre* and *Allosorus crispus*.

The plants found on the actual summit were *Carex rigida*, *Saxifraga stellaris*, and *Rubus Chamæmorus*.

On Monday, July 31, some of the party got a number of good plants of *Woodsia hyperborea*, which grew on a large boulder on the north side; I believe the first recorded instance of this rare Fern having been gathered on Ben Lui.

On Tuesday morning, August 1, the party took an excursion to Cam à Craig, where, besides the usual plants, a very curious variety of the Holly Fern was found, having the crisped form and appearance of the Holly leaf much more marked than is found in the ordinary typical form of this Fern. *Myosotis alpestris* was seen in the old locality mixed with plants of the white flowered variety. *Woodsia hyperborea* is evidently getting very scarce here; we only saw one or two small morsels on a large boulder. *Gentiana nivalis*, rapidly spreading to the eastward from the place where it was originally discovered, was seen in considerable quantity over a distance of more than 5000 yards along the base of the crags.

The object of going to Killin was to explore the upper part of Glen Lochy and Craig Inhor. On the west side of the corrie on Ben Inhor fine plants of the *Cystopteris montana*, *Draba incana*, *Poa Balfouri*, *Juncus biglumis* and *triglumis*, *Dryas octopetala*, *Bartsia alpina*, *Saxifraga nivalis*, *Carex leporina*, *pallescens* and *capillaris*, and *Crepis paludosa* were obtained; and at the head of the corrie fine specimens of *Juncus castaneus*, some of which were from 18 to 20 inches high.

This excursion cannot be made in one day without making an early start in the morning, and driving for about 10 miles to Mr Willison's farm; from thence it is fully 5 miles into the corrie.

Experiences in the Cultivation of Alpine and other Plants suited for the Rockery, and Herbaceous Plants in the Mixed Border. By W. B. Boyd of Faldonside. The Presidential Address, delivered November 8, 1883.

[In some preliminary remarks on the Society's work during the previous session, Mr Boyd alluded to the publication by the Society of Dr Spruce's work "On the *Hepaticæ* of the Amazon and Andes." The Society had lost during the year Professor Oswald Heer, M.D., Zurich, Honorary Fellow; Dr Robson Scott, Councillor; Mr R. T. Mackintosh and Mr W. T. Thomson, F.R.S.E., Ordinary Fellows; Mr Thomas H. Corry, Non-Resident Fellow; and Mrs Bain, Lady Associate. The new additions to our membership were Rev. Patrick M. Playfair, Edinburgh, and Mr John Stewart, Arbroath, as Ordinary Fellows; Mr George Stabler, Westmoreland, as Non-Resident Fellow; Mrs R. Farquharson, London, as Lady Associate; and Mr Bullen, of the Botanic Gardens, Glasgow, as Associate.]

During the reign of the bedding-out system of gardening the time and energies of the gardener were taken up almost entirely with the propagation and culture of plants which jointly combined to give a great effect of colour during the late autumn and summer months; consequently, many most beautiful alpine and herbaceous plants, not adapted to this system, were allowed to go out of cultivation.

By the bedding-out system a gay effect is produced during a short period of the year, which to an unscientific lover of nature is very pleasing and beautiful; but, except perhaps on a limited scale, in large public gardens, this system is not to be advocated. The species of bedding-out plants are so limited that one tires of them and wishes for something new. On the other hand, in the herbaceous border the plants are, as a rule, perfectly hardy, and thus all lifting and planting in autumn and spring is avoided. The green house, which formerly was filled with bedding-out plants, in a so to speak dormant state, is now utilised for winter flowering plants, and thus a succession of bloom can be obtained all the year round. When I grew bedding-out plants in a border 50 yards long by 2 yards wide, I had two thousand plants, but only six varieties.

Now, however, this is completely altered, as will be seen when I describe my rock borders.

In the rockery at Faldonside a series of beds are raised from 2 to 3 feet high, from 6 to 12 feet across, and I have kept the soil in every division level, so that in watering the plant may get the full benefit, and none run off—an essential precaution where rare alpine plants are to be grown, otherwise, if planted on a slope, they soon die of drought. The natural soil in my garden is a damp heavy clay, quite unsuited for the cultivation of alpine plants. I therefore collect and use large quantities of leaf mould with a mixture of coarse sharp sand, and a small quantity of loam, in the formation of my rockery beds. This answers well for most plants, but a considerable number require special treatment; some want more drainage, others less; some require a mixture of lime rubbish, and others again a little peat and loam. There are also several classes of plants which, by their habit of growth, are well suited for association with others in the alpine garden, that require soil wholly of one kind, such as peat-loving plants and those found growing on the chalk downs. These do not care for the mixture, previously described. The peat-loving plants, of which many of the dwarf American plants may be quoted as examples, require only fibrous peat mixed with a little sharp sand for their healthy growth, and the chalk plants require nothing but chalky soil, in which they luxuriate, and neither of these classes will grow well or long in any other soil. Many of our rarest *Orchideæ* are confined to the chalky downs of England, and they are usually difficult plants to manage in cultivation; but if carefully planted in suitable soil, they can be grown with considerable success. The principal cause of failure with these plants is the excessive moisture to which we are usually subject in this northern climate during the winter. To avoid this, a considerable depth of chalky soil which is of a very porous nature should be used, along with good drainage underneath; thus the accumulation of the moisture round the bulbs at a season when they are at rest is to a considerable extent avoided.

The peat beds should always be placed at the lower part of the rock garden, as the plants of this section all delight in moisture. It is, however, necessary that even these beds should be drained, as few plants can endure stagnant moisture. The chalk beds, on the contrary, should be placed on the higher portions, so that they may be kept as dry as possible during the winter; and during the summer, when the plants are growing, artificial watering can be applied when necessary.

I have used leaf mould largely in the making of my rock beds, because the natural soil in my garden is clay; but where the natural soil is of a lighter nature, it is not necessary to use such a large quantity, as the natural loam from an old pasture, well rotted down, when mixed with a small proportion of leaf mould and sand, is suitable for the growth of most rock plants.

It is well for an amateur, in commencing the culture of rock plants, to confine his attention for some time to those plants that will thrive in such a mixture as has been mentioned, and afterwards, when they are thoroughly at home, he can commence cautiously with those that require more special treatment.

In the summer management of the rockery, the principal matter is watering in dry weather. Those plants which are accustomed on their native hills to a large amount of moisture, supplied principally from the melting snow, during all the summer months must be supplied by artificial means. Great care should be taken by the cultivator to see that this is done thoroughly. A slight sprinkling of water during summer does really more harm than good, as the roots during dry weather are always on the search for moisture, and if they cannot get this at the level of their roots, they naturally turn upwards to get the benefit of the water applied near the surface, where they suffer more from drought (if water be not applied regularly) than they would do when their roots are in their natural position. Giving always as much water as will saturate the soil quite down to the roots, it does not require to be done so frequently. If watering is neglected in dry weather, no real alpine plants can be expected to thrive long. This matter of watering in dry weather, taken in connection with the proper making of the rockery, so as to secure good drainage, constitute essentially the whole matter in the successful growing of alpine plants.

One good rule—and it should be carefully attended to—is, never plant strong-growing and spreading plants in the same bed with small, rare, and delicate species, as the one is sure to outgrow and choke the others. Nothing kills an alpine plant so soon as being shaded or overgrown by its next neighbour. Hence I generally devote one section of the rock work entirely to the cultivation of very small growing plants. The edges, however, of these beds may be planted with dense-growing or overhanging plants, such as *Saxifraga oppositifolia*, *Silene acaulis*, *Hypericum reptans*, or plants of a similar habit, so that they may hang down to the walks, and cover partially the stones supporting the outside edge of the beds; care being taken not to let them encroach into the divisions where the smaller plants are growing. Alpine plants on their native mountains are free from this danger, as no strong-growing species occur at the great elevation where the true alpine plants are found.

Some plants like shade, as the species of *Cyclamen*, *Primula*, &c., and should be planted on the parts suitable for them; others, again, like to grow in the full sun, such as the Gentians, Androsaces, &c.; these, again, should be suited according to their requirements.

Among the first flowers to show in spring are the Snowdrops, of which there are several varieties. The largest flowered is said to be a variety of *Galanthus nivalis* called *Melvillei*, raised from seed by Mr Melville, Dunrobin. A friend of mine flowered it last spring, and he said it was the largest snowdrop he had ever seen. The finest, however, that I have grown is *G. Elwesii*, which Mr Maw was kind enough to send me several years ago, and of which I have two varieties. The most common has large globular flowers, in the other case they are more elongated, but with much darker green markings inside. This is a very handsome species, and should be largely grown. *G. plicatus*, the Crimean snowdrop, is also well worth a place; it has very broad reflexed leaves. *G. imperatorius* has a very fine flower; it seems only a variety of *nivalis*, but the markings of green in the inside are much darker, which give it a rich appearance. *G. latifolia*, or *Redouti*, has only small flowers, but the leaves are very broad, and the glaucous hue common to all the other forms is wanting in this. Early flowering and rare bulbs should if possible be planted in a part of the rockery by themselves, until they become plentiful, as they flower early, and consequently ripen their leaves early in summer. When mixed up with summer flowering plants, the dormant bulbs are very apt to be rotted off when watering the other plants. Bulbs after the leaves are ripened require no water.

Spring Crocuses are also abundant. The finest I have are *Crocus Imperati* and *C. Seiberi*, both easily grown and free flowering plants. *Iris reticulata* is a lovely spring bulb, along with its variety *I. Kreelagi*, which flowers a fortnight earlier than the type. They are both desirable plants, and easily grown in light soil. *Scillas* are very showy, from the bright blue colour of the flowers. And the *Chionodoxa*, recently introduced by Mr Maw, is even more so when well established. Their blue flowers are larger and more saucer-shaped than the *Scillas*. Grape Hyacinths are also showy; there are many sorts of them, and all should find a place on the rockery. I use all these small flowering bulbs for putting into the corners and crevices of the rockwork, as they do not interfere with the plant in its own division; their gay colours set off the rockery at a time when flowers of any kind are much appreciated. *Erythroniums* are beautiful plants, especially the bright yellow *E. americanum*, though not so free in flowering as some of the others. *E. giganteum* is the most stately plant of this genus;

flowers pale yellow, with a branching spike, and free flowering. *E. Dens canis alba* is a beautiful pure white variety, which every one should cultivate. *Eranthis hyemalis*, the common winter aconite, cannot be grown too abundantly; it is not at all particular as to situation, and is one of the first to open its yellow flowers in spring. *Leucojum vernum* blossoms early, about the same time as the snowdrops, and is a handsome plant. Some of the *Anemones* are early in bloom, especially *A. blanda*, which has lovely dark blue flowers, much finer in colour than *A. apennina*, which it much resembles, only flowers about a month earlier. A variety of *A. apennina*, called *atrocœrulea*, a much smaller plant, and with darker blue flowers, is more suited to the rockery than the type, as it does not grow half so high. I have a very fine white-flowered sport from this plant, which comes true, and is very handsome; I consider it quite unique, and intend to propagate it largely. The scarlet *A. fulgens* is a plant that should receive all the attention possible; nothing can be more gorgeous than the bright scarlet when the sun is shining. Many other *Anemones* are well fitted for the rockery, such as *vernalis*, *Robinsoniana*, and *baldensis*. *A. vernalis* is a handsome plant, and where it thrives is a very free flowerer. I had a plant this summer with thirty-six large flowers out at the same time. *A. Robinsoniana*, supposed to be a variety of *A. nemorosa*, with pale blue flowers, quite double the size of the type, and of a very refined quality, should never be overlooked in a collection; as it multiplies very rapidly from the root, it should be largely propagated for the purpose of naturalising in woods. *A. baldensis* is free growing and very desirable; it has, however, a decidedly running habit, and is not very free flowering. *A. palmata* is a neat dwarf plant, but with me it has failed to show flowers, although the plant sends up leaves every summer. The white variety seems more robust, and flowers freely.

The *Ranunculus* family has many small species well fitted for the rockery. *R. alpestris*, though not more than 3 or 4 inches high, is always covered with flowers in its season; and I have seen varieties of it which are continuous bloomers during the whole summer. *R. crenatus*, *R. parnassifolius*, and *R. Troufellneri*, are all dwarf and free flowerers. *R. glacialis*, a beautiful form, should be tried by every one who has a bog garden; but it is no use planting it in the ordinary rockery, as it always grows wild in wet sticky soil at the edge of the melting snow, and is never seen much below 7000 or 8000 feet elevation.

Gentians are also good rock plants. *G. verna* especially is beautiful, but many people find it difficult to manage. It, however, grows well with me in leaf mould and sand; it requires to be firmly planted.

No one will be disappointed when they are able to get it to thrive. I had several plants last spring measuring 6 to 8 inches across, and with as many as forty flowers on each; the brilliancy of the blue is wonderful when the sun is shining. It is no use trying to grow *G. bavarica* in the ordinary rockwork, as it requires bog garden treatment. The flowers are as fine as *G. verna*, but of a slightly darker blue. *G. ornata* is a lovely little gem from the Himalaya, introduced a few years ago to the Botanic Garden. It grows and flowers freely in light soil, and should be in every collection. *Hepaticas* are plants that should be grown by the thousand. They like shady places. All the colours are pretty, but the double blue is the rarest; it, however, grows with me as freely as the others. A few years ago I succeeded in getting a double white sport from this plant, but it was lost from over-nursing. This double white Hepatica is said to have existed more than twenty years ago, and I have met with people who have seen it. It is, however, I think, not in cultivation at present.

Among the *Campanulas* are some fine rock plants. *C. Zoysii* is very distinct from other Campanulas in flower, and well worth growing; it is, however, not easy to keep, being inclined to damp off in winter. It should always be taken into the cool house or cold frame, otherwise we run a risk of losing the whole stock. *C. pulla* and *alpina* are both good; the former a running-rooted plant, and a free flowerer. *C. alpina* is very dwarf, with large flowers for the size of the plant; it is a difficult plant to keep in winter, and should be kept in the cold frame; it grew and flowered well with me this summer. *C. isophylla alba* is perhaps the most beautiful of the whole family; it has large waxy-looking flowers, and grows freely in summer, but requires the shelter of the cold frame in winter. It also requires to be frequently renewed, either from cuttings or from seed, as the plants do not live long.

If you wish to grow some of the finer alpine plants, it is necessary to have a cold frame, to keep them dry during winter, when they are susceptible of moisture. When in their own home they are covered deep with snow, and kept quite dry. *Aubrietias* are good for the steeper parts of the rockery; they cover a large surface, and are very striking when in flower. *A. Hendersoni* is the darkest coloured, but perhaps a little looser in its habit than some of the others.

The family of *Saxifrages* is a large one, and contains valuable plants for winter decoration, for although they flower in summer, when they are exceedingly handsome, they are at their brightest and freshest, as regards the leaves, during the autumn and winter months, so that a collection planted in beds by themselves are at that season most interesting and beautiful objects. This family is divided into numerous sections botanically, but for our purpose it may be arranged into two divisions, viz., the mossy section, of which our native *S. hypnoides* is the type; and the silvery one, of which the alpine *S. Aizoon* may be taken as the most familiar example. The mossy section is a very large one, and I have seen collections numbering more than fifty species, varying even more in the different tints of green during the winter than the flowers of the different species do in summer. The silvery section also show themselves well during the winter, some large and bold, with strap-shaped leaves, margined with distinct white dots, such as *S. pyramidalis*, *Cotyledon*, and *longifolia;* others forming round swelling masses of silvery rosettes, such as *S. cæsia*, *Rochelliana*, and *Burseriana*. They are all easily grown, and only suffer during the spring in dry cold winds or during a great drought in summer, when a little water soon revives them. A friend of mine raised a very beautiful yellow-flowered variety of *S. Burseriana* from seed, and it is quite as free a flowerer as the ordinary white flowered form; he had also a number of crosses between *S. Burseriana* and *Rochelliana*, most of them having the leaf of *Burseriana*, with a numerous branching head of flower, as in *Rochelliana*. Many of the varieties of the *hypnoides* section form nice plants for hanging over bare stones, or as edgings to the beds. A very pretty variety called *S. Macnabiana* raised from seed of *S. pyramidalis* by the late Mr M'Nab, with richly spotted flowers, is grown largely in the Botanic Garden, Edinburgh.

Erodium Richardi, a dwarf geranium-looking plant, never more than about 2 inches high, is well worth growing; it, however, requires to be well looked after in winter, and it will always be well to have a duplicate in the cold frame, in case of the plant being lost outside. *Sedum* is a large group, and many of them are very useful rock plants. The three finest I have are *S. Ewersii*, a rich purple-flowered dwarf variety, *S. cyaneum*, and *S. Beyrichianum*. This last requires to be carefully looked after, as it is apt to flower itself to death. A plant or two should be kept, with the flower stems cut off as they rise during summer; if this is done, the plant is quite hardy, and will stand any winter, but it generally dies after flowering profusely, which it usually does if the flower stems are not nipped off. *S. cyaneum* is not often seen in gardens, but is a very desirable dwarf-growing plant, with pretty pink flowers; it is, however, a slow-growing variety, and rare in collections.

Silene quadridentata is a very elegant dwarf plant with small white flowers, but soon spreads out into a broad tuft when grown in light soil. *Silene pumilio* is a rare species, and very beautiful; this plant does best when planted between flat stones, and few people are able to keep it long unless some precaution of this kind is taken. It has large flowers for the size of the plant, rose-coloured, and never rises more than about 2 inches above the ground. Plants of it should always be kept in reserve in the cold frame, in case of accidents during winter. This is such a little gem that every one should try to possess it. *Silene Elizabethæ* is also a very fine variety, and was got first on the mountains near Lake Como, and has flowers more like a handsome dwarf Clarkia than a Silene. To grow this plant well it must be planted between stones with rich soil. *Ramondia pyrenaica* is a beautiful plant from the Pyrenees, and requires to be placed in the shade, but is rarely seen in this country growing with the same vigour as in its native locality. I once saw it growing very luxuriantly, with flower stems more than a foot high, planted on the side of a gravel walk and shaded by a large stone. The soil was light, but firmly trodden down. It is easily propagated by seed, which it produces freely.

Spreading Plants.—There are many spreading plants which are very useful in the rockery, either for planting along the edge of beds to hang down and partially cover the stones, or on the higher portion of the rockery where other and more delicate plants would not grow; these plants, however, as a rule, are best kept in beds by themselves, as if not carefully watched they are apt to overgrow others near them. Among the best plants for this purpose are *Acæna Nova Zealandia*, *Genista pilosa*, a native plant growing wild on the moors in Cornwall. *Arenaria balearica* is a capital plant for adhering to damp stones. *Dryas integrifolia*, is, I think, the best of this family. Our native *D. octopetala* is also a good plant for the purpose, but is not so free flowering as *D. integrifolia*. *Hippocrepis comosa* is also a nice low-growing and spreading plant, which never fails to produce a profusion of its pretty yellow flowers in the season. This plant grows abundantly on the sugar-loaf limestone in Teesdale. *Alyssum olympicum* is also very dwarf and spreading, of the same character, with white silvery-looking leaves, which contrast well with other plants. These and many others are all showy, and well fitted for this purpose, as they are more easily kept within bounds than the Saxifrages or Sedums, which are also well adapted for covering stones, &c., but require a great deal more attention to keep them from growing too fast, though best seen in very large rockeries.

Many species of *Dianthus* are also well fitted for the rockery. *D. alpinus*, one of the most difficult of the family to grow well, has the bad habit of dying off without any apparent reason. This happens, however, more frequently with plants which are two or three years old. The only way I have found of getting over this difficulty is by sowing seed every year, when the young seedlings are much more vigorous and flower more freely than the older plants. Many other species, however, go on growing and increasing in size for years. *D. neglectus* and *glacialis* are two of the best of these. I have plants of *D. neglectus* in my garden for fifteen years, and which are as vigorous as ever, never failing to bloom well. *D. glacialis* is not quite such a long liver, and will be the better of being renewed from seed occasionally.

Veronica is also a group well worth growing, and I think there is none more handsome than our own wild *V. saxatilis;* the brilliancy of its blue flowers is unsurpassable. A pretty hybrid, raised I believe in the Botanic Garden here between this and *fruticulosa*, called *V. Balfouri*, is also a desirable plant; it has rich brilliant purplish-blue flowers. *V. Daubenyi* is also a pretty variety, with pink flowers. One called *V. Lyalli* is well worth growing; it has, however, a more upright habit, with glossy shining leaves.

Some of the *Hypericums* are good rock plants. *H. nummularia* is a dwarf plant, with yellow flowers about the size of a shilling. *H. ægyptiacum* is also a small growing sort, and rare in collections; these are both well worth looking after. A procumbent variety called *reptans*, with very large flowers, seems almost the counterpart of *H. humifusum*, a native species, but more than twice the size in every way. This makes a capital plant for drooping over rocks and stones, and also as an edging. Most of the plants belonging to this family are large, and many of them are well suited for the herbaceous border. *H. speciosum* is a very floriferous plant with white flowers, but is too large for the rockery. *Bellis rotundifolia cœrulescens*, from Mount Atlas, commonly called the blue daisy, can be depended upon to stand our winters without protection.

Senecio abrotanifolius is not often seen in nurserymen's catalogues, but is well worth looking after, as it is a dwarf-growing plant; the leaves are very much cut and divided almost like parsley, the flowers are bright orange, and it is easily grown. *Geranium argenteum*, nearly allied to *G. cinereum*, but with more silvery white leaves, is a striking plant; it is slow growing, and takes years before it is strong enough for division. *G. cinereum* is more vigorous, and the flowers of this and *G. argenteum* are very much alike, of a pale pink tinged with purple.

Many of the *Linarias* are very small and low-growing, and make capital rock plants. *L. pilosa*, the smallest, does not rise an inch from the ground, but grows very dense and spreading. *L. hepaticifolia* is also a spreading plant, with pretty little purple flowers. *L. pallida* is free growing, spreading, and very handsome when in flower; it is, however, such a running-rooted species that it is not safe to put it into a rockery beside other things, as it soon overgrows everything else. The plant, however, is well worth a place for itself; it is very hardy, requires no attention. *L. alpina* is also good; it will take care of itself, as it seeds freely, and soon becomes a weed. It grows in great abundance on the Albula, and also on the Stelvio Pass.

Erigeron mucronatum, the New Holland daisy, is a continuous bloomer; it has pink daisy-like flowers, which after having been open for a day or two turn white, giving the plant a very varied appearance. From its free habit, it is covered with pink and white flowers from July till late in autumn, when the frost cuts it back. I always find plenty of young seedlings growing round the old plant, so the stock can be kept up in this way without the trouble of sowing.

Brachycome Sinclairi, the New Zealand daisy, is a low-growing Composite, with flowers like a very small daisy, the whole plant never exceeding about three inches high. It is well to keep a plant in reserve in the cold frame, in case it should be killed when left outside; I have, however, had it outside for three or four years without losing it.

Sempervivums are useful for planting in any corners of crevices of the rockwork, as they form pretty little tufts of rosettes, which are always very ornamental, as they vary much in colour from the rich green of *S. montanum* to the dark crimson of *S. triste.* These plants require little attention, and are very hardy.

Polemonium confertum, a rare plant, not often seen in collections, is by far the finest of the family. It has rich blue rounded spikes of flower about ten inches high, and is very striking when in full flower; it is, however, somewhat difficult to cultivate, and must have very light soil for its running root. Many people complain of losing the plant from being eaten by larvæ below ground; it flowered very well with me this summer, having fully three dozen spikes on one plant.

Sedum sempervivoides is a rare beauty, with fine branching spikes of bright crimson flowers. This plant, however, requires to be taken into a dry house or cold frame in winter, being liable to damp off if left outside. It is best raised from seed, as the plants die after flowering. It, however, flowers so late in the autumn that I have been unable as yet to ripen any seed: this can be obtained from the south of England, where it flowers earlier, and seeds freely. This plant is well worth all the trouble required, as it is gorgeous when in flower. It generally flowers the second year from seed.

Erigeron aurantiacum, recently introduced, is a showy orange-coloured Composite, well worth growing, and easy to manage in light soil. Some of the *Colchicum*, or autumn crocus, should be in every garden, especially *Colchicum speciosum* and *maximum*, which are both very large flowered and fine rose-coloured species, particularly the latter. This is, I think, the same plant as sold by the Colchester Bulb Company as *C. speciosum rubrum*, and is by far the finest of this family. The double white variety of *autumnale* is also very fine. The autumn flowering Crocus proper is also well worth growing. *Crocus speciosus* is very free, multiplies rapidly, and is very handsome, with large rich striped blue flowers. *C. nudiflorus* is also a nice species and a free flowerer; it is of a pale lavender colour. These bulbs take up little room, and should be planted in all odd corners.

Arnebia echioides, called the Prophet's flower, because the five purple spots on its yellow petals are supposed to be the impress of Mahomet's fingers; although these spots are not simply on the surface of the petals, but on both sides, they disappear always on the second day after the opening of the flower; it is a difficult plant to raise from cuttings, but grows freely from seed.

I have been devoting my attention, for the last two or three years, to the *Primulaceæ;* many of these require a mixture of loam (which is stiff here) with the leaf mould and sand, especially the smaller sized ones, as I find I cannot get them firmed sufficiently without it; besides, they do not suffer so readily from drought with this mixture. The larger growing sorts, such as *Primula Parryi*, *Stuarti*, *nivalis*, *Turkistanica*, *Cashmeriana*, *longiflora*, *Sikkimensis*, *grandis*, and *luteola*, do well in the leaf mould and sand. In fact, we had flower spikes of *luteola*, *Sikkimensis*, *grandis*, and *Stuarti* nearly 3 feet high this summer; and *P. Stuarti* had whorls of flowers on the stem like *Japonica*, which it never develops unless grown vigorously. I ripened seed of both *Stuarti* and *Parryi*.

Primula vulgaris is one of the sweetest and most beautiful of our spring flowers, and occurs in great profusion in many parts of the country. It loves partial shade like most of the family; and in limestone counties the cowslip *P. veris* takes its place, and is also a pretty spring flower. The oxlip *P. elatior* is much rarer, and occurs wild only in a few places in England; it is, however, rather common in Switzerland. Many of the hybrids between *P. vulgaris* and *veris* have oxlips, but the true oxlip has a trumpet-shaped flower, not flat as in Polyanthus; it has also no thickening at the mouth of the tube, as in *P. vulgaris;* it is a free growing and interesting variety. Our garden *Polyanthus* is a hybrid from *P. vulgaris*, and has no relation with the true *P. elatior*.

When on a tour in the Engadine, two or three years ago, I brought home several plants of *Primula latifolia*, which I saw in splendid flower on the Albula Pass, and also in the Bernina; but they have puzzled me much, not growing with any vigour, and failed to flower them until this summer, when I tried them planted tight between flat stones. So treated, however, they have done much better, and have flowered fairly well. This is a plant which will repay any trouble, as it is one of the most beautiful and showy Primulas we have. I shall never forget the sight of these plants growing out of the crevices of the rock about 6000 feet in the Engadine in August; they were most vigorous and luxuriant, every plant covered with flowers, many of the stems being fully a foot long, with a bunch of drooping rich purple flowers at the top.

All the *P. farinosa* section are free flowerers, from *scotica* to *longiflora*. *P. scotica*, our native Primula, which grows abundantly in Orkney and round the coast of Caithness and Sutherland, is apt to be lost in winter, as it is not a deep rooter, and during frost is thrown out of the ground, when, if not noticed and replanted, it soon dies. It is, however, easily raised from seed, which should always be collected and sown at once, as the plants so raised are always more vigorous than the old plants. Of *P. farinosa*, which is abundant all over the limestone country in Durham and Yorkshire, and also near West Linton on the skirts of the Pentlands, there are a number of different coloured varieties. I have five distinct shades, from pure white to the richest rose colour; and this summer a plant was sent to me from the Dolomite country, in the Tyrol, with striped flowers. *P. auriculata* belongs also to this section, and is a free growing handsome plant; but as far as my experience has gone I do not think it is quite hardy, and it is advisable to keep a duplicate or two in a cold frame during the winter; it also springs freely from seed. I may mention that in sowing seed of all Primulas it is better to do so at the time the seed is gathered, as it germinates more quickly when this is done; if kept over till the spring it will sometimes lie for a year, or perhaps two years before starting.

Primula nivalis Turkistanica, has thriven wonderfully this summer in the leaf mould and sand; the leaves are now nearly a foot long and three inches wide; it has thrown up a strong flower spike about nine inches long with about twenty-four flowers at the top, the flowers all individually small, something in shape like those of *P. erosa*, but of a dark purple colour. The flower stem is thickly covered with farinose powder; there is, however, no powder on the leaves. The flower stem was so late in rising that it set no seed. Of a quantity of imported seed of this plant sold two years ago, none of mine sprang, nor did that of any of my friends. *Primula purpurea* (Royle), a plant somewhat resembling *nivalis Turkistanica* and *Stuarti*, seems to be more difficult to grow. A nice young plant from the Botanic Garden, which Mr Lindsay was kind enough to send me, unfortunately did not live over the winter; and Mr Lindsay told me that none of his plants were thriving. This is a plant, however, worthy of further trial.

The Indian *Primulæ* of the section of *denticulata* are well worthy of cultivation, being free growers. They, however, unfortunately bloom so early in the spring that the flowers are generally spoilt with the frost. *P. cashmeriana*, not so early to flower as *denticulata*, *alba*, and *purpurea*, may be left with less risk outside. *P. rosea* is perhaps the finest introduction that we have had among the *Primulaceæ* for a long time; the colour of the flower is of the richest rose, and the plant itself perfectly hardy; it is a free grower and free flowerer.

P. Monroi, a plant of a perfectly different type, has spoon-shaped leaves and flower stems about a foot high, with a bunch of beautiful white flowers; it dies quite down in winter, but never fails to come again in spring, as it is very hardy, and will grow anywhere in light soil; it is a free flowerer, and should be in every garden. *Primula Balbisiana*, a species from the Dolomite country, is nearly allied to the common *P. auricula;* it has yellow flowers, but the leaves are covered with glandular hairs, and it is as easily grown as the *P. auricula*. *P. integrifolia* is the type of a large section, with smooth strap-shaped leaves, of easy growth, and very hardy. *P. calycina*, *glaucescens*, *Wulfeniana*, *hirsuta*, and *Candolliana*, all belong to this section, and are, as a rule, free flowerers. *P. latifolia* and *P. Dinyana*, belonging to a different class, having long, thick, and strong root stems inclined to rise out of the ground as in the common Auricula, are difficult plants to grow well, but do better when planted between flat stones sunk below the ground. *P. Candolliana* of Nursery Catalogues is not the true plant, but is, I think, only a variety of *Dinyana*. *P. Candolliana*, common in the Engadine, is a free grower and flowerer; whereas the plant sold for it in this country is a shy growing and flowering plant, like *P. latifolia* and *Dinyana*.

Primula carniolica is a fine species from the Tyrol, which, along with its variety *multiceps*, form vigorous, free flowering plants when grown in rich light soil; they die quite down to the ground in winter. I have seen this species growing strong in an ordinary border well enriched. Another interesting section, with round-headed red glandular hairs (like those of a *Drosera*) on the leaves, includes *P. Daconensis* and *piedmontana;* the former grows and flowers well with me, the latter keeps alive, but never makes any progress. *Primula marginata* is another interesting free growing and ornamental plant. Numerous varieties of this plant have the white margin of farinose powder round the edge of the leaf; some have much more cut leaves than the others, such as the Tulloch Castle variety; others again have much darker purple flowers, as in *cœrulea*, and the variety *grandiflora* has much larger flowers than in the type; they are, however, all easily grown, and are desirable.

P. japonica, a plant introduced several years ago with a great character, does not come up to the original drawings and descriptions, from which we expected a plant with from three to five whorls of flowers in bloom at the same time. But the lower whorls die off before the upper ones are expanded; the flower varies from crimson to white, and is often red and white striped. *P. luteola*, a hardy free flowering plant, should be in every garden; it is a strong grower, flower stems about 2 feet long, with an umbel of fine yellow flowers at top. It does well in the ordinary herbaceous borders. *P. grandis*, of comparatively recent introduction, is a strong grower, and dies quite down; it is scarcely worth growing from an ornamental point of view, being more curious than beautiful, having a great number of small insignificant yellow tubular-shaped flowers hanging from the top of a very long flower stem nearly 3 feet high. *P. capitata*, a recent reintroduction of a high order, has a reticulated leaf, the flower stem white with powder, and a round head of purple flowers which open continuously for a long period; the peculiarity of this species is that it flowers in autumn long after all the other Primulas are over.

P. obconica is a new species only introduced last year, which I have not yet flowered; it has, however, been flowered in many places, and grows well out of doors in summer. Mr Brockbank mentions having plants in flower which were only sown in March of this year; he describes it as being very floriferous, and an abundant seeder, having a pale pink flower like *P. sinensis* on its first introduction. *P. floribunda*, nice for planting in the rockery in summer, is not hardy, and requires to be taken into the house in winter; it has pretty yellow flowers, and continues in flower a long time. *P. suffrutescens*, a new species from California, flowered this summer in a friend's garden, and has beautiful rose-coloured flowers, somewhat in appearance like those of *rosea*, with three or four flowers at the top of spike; the leaves are in a whorl, thick and firm, dentate somewhat in the way of *minima* but much more elongate.

P. sapphirina, also a new species, flowered in the Botanic Garden, a beautiful little plant, with reticulated leaves, and pretty dark blue flowers.

Primula Sieboldi, or *P. cortusoides amœna*, a fine showy plant, has sported into various colours, from white, slate, blue, and purple to crimson. It is quite hardy, and flowers generally well outside; it is much used for forcing in spring, and by that means can be had in flower in the greenhouse shortly after the New Year. It should be grown near the glass, as the flower stems have a tendency to get drawn up; if not so placed, grown outside the flower stems rarely exceed nine inches in height; it varies much from seed, some having large flowers with smooth edges, others again being much fringed. This plant has running underground stems, and has no connection with *P. cortusoides*, which is a fibrous-rooting plant, and does not spread like *P. cortusoides amœna*.

P. Parryi, one of the finest species we have, does not thrive well with many people. I have, however, succeeded in growing it strong this summer in leaf mould and sand; and when thus raised it produces freely dark purple flowers from a dozen upwards on the top of flower stem. I also succeeded in saving a small supply of seed which I sent to a friend.

P. viscosa is the most common species in the Alps, about 4000 feet, and has many varieties; some are viscous, and others smooth on the leaves. I gathered a beautiful large-flowered variety on the Riffleberg a few years ago with a large white eye. *P. glutinosa*, confined to the Tyrol, is not nearly such a free growing variety as *viscosa;* it has narrow strap-shaped leaves, and is a shy flowerer. *P. ciliata* is very pretty; and a number of fine hybrids between it and *intermedia* have been raised at the Botanic Garden by Mr Lindsay—two in particular, a bright rose-coloured flower named *Balfouri*, and a rich purple named *Lindsayi*. One of the finest, however, is *ciliata purpurata;* it is bright rosy purple, and should always find a place in every rock garden. *P. minima* is not as a rule a free grower, but I saw a plant this summer in a friend's garden in Berwickshire which was fully six inches across, and in luxuriant health; it was planted against a big stone sunk deep into the soil.

The *Primulaceæ* take up little room, and can be grown by any one, however small the garden. They are tenacious of life, and are not easily killed by a little neglect in watering. Springing out of the ground by forming lengthened root stems, they should be transplanted, and if necessary divided, every spring, and replanted deeper than before, as the best and most vigorous roots start immediately from the neck of the plant. All those growing naturally in crevices of rock should be carefully planted between pieces of flat stone, with rich light soil between and below to a considerable depth, as it is surprising to what a length the roots extend in search of food. I have seen plants with only a small rosette of leaves, not larger than a shilling above ground, push their roots to a distance of a foot to 18 inches in length. This shows the necessity of having the soil deep. Few alpine plants thrive well in shallow soil; being more easily affected by drought, they require double the attention in watering. A few flat stones on the surface round the plant prevent evaporation and keep the roots cooler and the soil moist. These are simple matters, but important if you wish to grow well some of these most beautiful plants. They require and must have plenty of water during the growing season, and be kept comparatively dry during the winter. This is what they have in their native hills, but our moist wet winters tend more to kill the plants of this family than any amount of frost. As they are easily damped off at the period when they are at rest, the beds should be raised considerably above the level of the soil, and a quantity of good drainage laid at the bottom. On the top of the drainage I recommend a mixture of equal quantities of light loam, leaf mould, and coarse river sand, from a foot to 18 inches in depth. Primulas are safe in winter when covered with snow, as this keeps them dry; a bell glass, raised an inch or two above the soil to give air, is also useful for throwing off the superabundant moisture; but where the rare and small varieties are grown, I would advise a duplicate of each species or variety to be kept in a cold frame, in case of any accident happening to those left outside during the winter. See also that the lights of the frame are watertight, as any drip into the inside is very injurious.

The genus *Androsace* belongs to this family and contains interesting plants; though as a rule they are more difficult to keep alive in a thriving state than the Primulas. They mostly grow at very high elevations in the mountains of Europe. A number of species have, however, been introduced of late years from the Himalaya. Some of these are free growers, such as *A. lanuginosa* and *sarmentosa*, but all the species are apt to damp off during winter, without a great deal of care on the part of the cultivator. Those I have succeeded best with outside are *A. Chamæjasme*, *carnea*, *lactea*, *obtusifolia*, and *A. Vitaliana;* and, although they can all be grown on the rockery during summer, it is wise to keep them in a cool house or frame during winter. I had some luxuriant plants of *A. Chamæjasme* this summer, nearly filling the division marked out for them, but they are now sickly owing to wet broken weather.

Aretia Vitaliana, a congener of *Androsace*, and one of the most vigorous, stands the wet weather better than the others. This I always leave outside all winter, and never lose a plant; but among nearly all the others there is a great mortality, if not lifted and put in a dry place. This Aretia has bright yellow flowers, and will spread into patches of a foot square in light sandy soil. It grows abundantly on the Riffleberg, but at a much lower level than *A. glacialis*. *Androsace obtusifolia*, a common plant in Switzerland, is easily managed on the rockery, with a little care. The Pyrenean form of *A. carnea* is the one most grown in gardens on account of its brightly coloured flowers. It has succeeded with me, in patches fully a foot across, planted in light rich soil, well mixed with stones; it is, however, not often seen growing with such vigour.

Androsace lactea, also a free growing variety, does well in the same soil as the last, not requiring to be taken into the cold frame in winter. The flowers are white, upon stalks about four or five inches high. The tufted forms that grow in the crevices of rocks are more difficult to manage, and must be planted between pieces of stone with rich soil, and firmly wedged into their places in the rockery. Otherwise I cannot succeed in growing this section long; those I have been most successful with are *A. helvetica*, *brigantica*, *pyreniaca*, and *Wulfeniana*. Little birds are very troublesome, as they often pull them to pieces in searching for insects among the tufted leaves of the plant. In any case it is always wise to preserve duplicate plants in pots in a cold frame; the greatest danger to be dreaded in winter to the plants outside is the damping off at the neck from excessive moisture. In their native country these plants are kept perfectly dry during winter, being then covered by snow, and are lying in a partially dormant state, ready to start into growth the moment the snow begins to melt. The most lovely *Androsace* I ever saw growing wild was *A. glacialis*, on the Gooner Grat, where it often spreads out on the surface of the soil to the extent of more than a foot square, in a mass covered with hundreds of flowers of an exquisite rose colour. This species is never seen in the Alps at a lower elevation than seven or eight thousand feet; I have many times tried to cultivate it, but with very little success, though several more insignificant species are easily grown in cultivation. *A. Wulfeniana*, a fine species from the Tyrol, has a tufted habit, and is easily managed; but I have only had my plants during this last summer, and they are looking well; the flowers are rosy pink like *ciliata* and *glacialis*. *A. ciliata* is one of the same class with a tufted habit, and grows well with the same attention in planting. *A. villosa* is one with which I have failed, but it does well with a friend of mine.

Androsace may be propagated either by division or by seed. The latter method is, however, much the better way, as you obtain more vigorous and strong growing plants than by division. Division should be resorted to in the spring, when the plant is commencing its growth—at other seasons it requires very great care indeed, and should never be tried late in the year, as the plants will not be established before winter.

Cortusa Matthioli, also a plant belonging to Primulaceæ, is found in the Tyrol, and has a bunch of drooping flowers from the top of a stem about a foot high, of a pretty purple colour. This, along with *C. pubens*, another variety, are both easily grown in moist light soil, and should be in every collection of Alpine plants. It seeds freely with me, and I always find plenty of seedlings growing round the parent plant without the trouble of sowing. This is a very desirable plant, not often seen in gardens.

Cyclamens also belong to this family, and are easily grown in light soil in shady places. *C. Europæum* I have seen in great profusion in Switzerland, and in all the woods in the neighbourhood of Lake Como; it is very sweet scented, and flowers in the autumn. This was a plant difficult to procure from nurserymen until within the last few years, as *C. hederæfolium* was invariably sold for it. *C. Coum*, also a fine species which I have never seen wild, grows well in the rockery in a shady nook, and is easily multiplied by seed; it has bright rose-coloured flowers and green circular leaves, without any of the markings common to most other Cyclamens. *C. ibericum* and *repandum* are both desirable plants, but are not so hardy as those mentioned.

Trientalis europæa and *Anagallis tenella*, both British plants, should find a place in every rock garden, planted in rather moist soil, where they will be found to do well.

Soldanella also belongs to the Primulaceæ, and is considered by many to be the handsomest of all Swiss plants. The species are easily grown in light moist soil, but often fail to flower well. *S. montana*, which occurs in mountain woods, is the easiest to grow, and generally flowers well, but all the others require a damp situation and are in fact bog garden plants. Professor Corèvan of Geneva mentions that they may be easily flowered by watering heavily at the time the flowers begin to rise, for they all set flowers freely, but generally fail to develop from want of sufficient moisture.

Duplicates in cold frames of all the rarer kinds during the winter are absolutely necessary; as even with the greatest care in planting and attention afterwards, plants die, either from excessive moisture or some other cause. These are best potted in small pots and sunk in ashes to prevent worms from intruding. As these are usually the smallest growers, it is astonishing what a number of pots can be put into an ordinary sized frame. Care should be taken, however, that the frame is well glazed, and that there is no drip from the glass, otherwise the plants will not be benefited by the change from the rockery.

As many of these plants do not live long, it is necessary that young ones should be propagated, either by division, cuttings, or seed. Propagation by division should always be done in spring or early summer, when the plant has commenced growing, as at that season there is less risk of losing it by disturbing the roots than at any other. This is a good plan for the stronger growing sorts; but with many plants this system of propagating cannot be adopted without considerable risk; in these it is better to strike young ones from cuttings. This is usually done during summer and autumn, and they should be protected in a cold frame till they make roots; when potted separately and kept in the frame as duplicates during the winter, they can be planted out in the rockery to fill up blanks in the spring, when they have commenced to make growth. But raising from seed is by far the best, as you not only get more plants, but they are of a more healthy and vigorous habit. Thus the grower of alpine plants should never lose the chance of collecting seed.

In preparing for seed sowing it is necessary to have the soil fine, with a good mixture of sharp sand. When the seed is of a rare kind and in small quantity, it is perhaps better to sow in pots in the cold frame; in this case when the pot is filled with light soil, it should be firmed down with the bottom of another pot and the surface made smooth. The seed is then laid on the top and covered by a thin covering of fine soil. Care should be taken not to sow too thickly, as it is troublesome to prick the plants off after they are sufficiently grown for that purpose; no more soil should be laid on the top of the seed than will cover it, as very small seeds are frequently lost by putting on too thick a covering. After all is finished the pots should be carefully watered with a fine rose. For stronger growing plants, where the seed is more abundant, the best way is to prepare a bed of fine soil in a cold frame and sow in rows, care being taken to put tallies to the different kinds. Seed should as a rule be sown in spring, but some sorts, such as Primulas, &c., should be put in whenever the seed is gathered, as it gets dry by keeping till spring, and will sometimes not sprout for a year or longer; if sown, however, at once, when the seed is ripe, it springs readily. But most seeds germinate well when sown the following spring. As soon as the seedlings are large enough to handle they should be pricked off into separate pots or into a prepared bed in a cold frame; these seedlings will last much longer than plants raised from cuttings, and you have always the chance of varieties, besides having many plants to spare for your friends.

I am much troubled with a growth of *Marchantia* on the top of my seed pots, owing to the low and damp situation of my garden; this should be attended to at once, whenever it shows itself, and carefully picked off, otherwise it will smother the plants, and the whole seed be lost. After it has grown for a short time, it cannot be removed without at the same time removing the seed.

The following plants were found in a Swiss excursion with a friend of similar tastes:—*Androsace obtusifolia*, *Saxifraga androsacea*, both little alpines from the Gemmi, which are difficult to cultivate; *Campanula cenisia* and *Saxifraga biflora* grew on wet sticky soil at the edge of melting snow; *Androsace glacialis*, all on the Riffleberg, require more the treatment of the bog garden. I have never succeeded in keeping any of them more than a year. The *Saxifraga biflora* of nursery catalogues is a variety of *S. oppositifolia*, with two flowers to a head instead of one, which is usual in the type. The true *S. biflora* has a looser habit, and the petals are narrower, besides being of a crimson colour, instead of rosy purple, as in all the varieties of *S. oppositifolia*. I see Mr Lindsay at the Botanic Garden has a stock of *Androsace glacialis* from Switzerland, and I hope that he has been successful in growing it; it is a most vigorous plant on its native hills. *Campanula cenisia* has a habit somewhat like *C. Raineri*, but not so compact, and the flower is somewhat similar though smaller, it requires the damp soil of the bog garden to grow it successfully. *Eritrichium nanum* has perplexed cultivators much, and nearly every one who has tried to grow it has failed. This, I think, is perhaps owing to the difficulty of getting the plant taken up with good roots, as it always grows in the crevices of rocks, and the roots penetrate to a great depth in search of moisture. Independent of this the plant requires great skill to keep it alive in this country. It forms a dwarf tuft above ground and has bright blue *Myosotis*-like flowers; the leaves are woolly, and care should be taken not to wet them when watering in summer, and during the winter the plant should be kept quite dry. *Gentiana bavarica*, a strictly bog plant, will not grow in the ordinary rockery unless special means are taken to keep the plant moist. I have seen it well grown in a flower pot planted among sphagnum and a little peat, and the pot sunk in another filled with sphagnum and kept well watered during the growing season, but its real home is in the bog garden. I saw a plant thriving and flowering well this summer in Mr Muirhead's bog garden near Berwick. *Anemone baldensis*, a dwarf plant with rather a running habit and easily grown, has large white flowers about the size of a two-shilling piece, but is not very free in flowering. *Ranunculus glacialis* also requires bog garden treatment; it is a beautiful plant about 8 or 9 inches high, with flowers white on the upper surface, but purple on the under side of the petals. *Pyrola uniflora,* to be found in a fir wood at Comayena near the base of Mont Blanc, is a plant I have never seen in a thriving state in cultivation. Some people fancy it is a parasite, but I am not inclined to think so, and if the proper means were taken it might be grown as readily as any other Pyrola. The variety of *Androsace carnea* found in Switzerland has much paler flowers than the one in the Pyrenees, and is a more difficult plant to grow. I have several times had plants sent to me, but have always after a year failed to succeed with them, whereas the fine rich pink-flowered variety from the Pyrenees thrives with me luxuriantly.

Obituary Notice of the late Professor Oswald Heer. By ANDREW TAYLOR.

(Read 10th January 1884.)

In October 1883 the Society was called to join in mourning the death of Dr OSWALD HEER, the great palæophytologist. Heer was born at Glarus, Switzerland, in 1809, and died on 27th September last at Lausanne, aged 74. Elected one of our Foreign Honorary Fellows in 1874: he had been a Foreign Corresponding Fellow since our foundation.

The Swiss Alps, with their variety of living nature, as well as their marvellous stone tablets of past life, inspire boy naturalists with an unique zeal and enthusiasm, resulting, in more than one instance during the last half century, in their becoming leaders in the van of natural science. Heer's collecting of plants and insects began as a boy. At school he bribed his mates by singing-lessons to add to his finds. Designed for the Church—his father was a Lutheran pastor—he entered the University of Halle in 1828. But so accurate had his knowledge of genera and species, principally of the fossil fishes, insects, and plants of the Tertiary deposits of Œningen become, that he mainly supported himself at the university by selling extensive collections of these fossils for the College Museum of his father's friend, Professor Van Breda, at Haarlem, in Holland. Heer exercised the functions of a village pastor for scarce a year, when he entered on his long career as a professional scientist. The tall, gaunt, narrow-shouldered valetudinarian, with quick eyes and somewhat clerical mien, was henceforth to be pointed out as a celebrity to the Zurich visitant, whilst his friendship was to be prized by the leaders of science.

Heer's life work is marked into two great epochs. The first twelve years of his scientific career were devoted to active observation, and much organising. His latter years were those of a valetudinarian. Though he attained a good age, he battled from a boy with a delicate constitution, which eventually mastered him through the greater part of his manhood. During the first period, living nature, specially in its departments of insects and plants, were studied; palæobotany was the almost exclusive occupation of the closing years.

In 1835 Heer founded the Botanical Garden at Zurich, being its first director. In the following year he became Professor of Botany and Entomology in the University of Zurich. When the Polytechnicon of that city was founded in 1855, his services as Botanical Professor were transferred to it. He founded the Zurich Society of Agriculture and Horticulture in 1845, and was its first president. He had the qualities which combine to make a popular public man, and for twenty years he was a Rathsherr, or member of the Grand Council of his adopted city. Early in this period he published two remarkable essays on the geographic distribution of insects and plants of the Alps in their mutual relations. In these may be traced the germ of his ideas on geographic distribution. The intensity of Heer's method of field study has corroboration in the University collection of insects, one of the scientific sights of Europe. It contains no fewer than 30,000 species of the Coleoptera alone, and took Heer seven years to collect and arrange. He also about this time issued memoirs, mainly on the transformations or distribution of the Swiss Coleoptera, as well as the distribution of Alpine plants.

From 1847 Heer devoted his attention almost exclusively to fossil insects and plants; and now his researches became of wide-world interest. This was the epoch of ponderous volumes, issued latterly at the instance of several Governments, by a solitary student, rarely now seen on the street, except passing from the study to the lecture-room. Heer had no literary collaborateurs, excepting—and that for a year or two—the late M. C. T. Gaudin of Lausanne. But his first great work, *On the Fossil Insects of the Tertiary Deposits of Œningen*, was begun at the earnest instigation, with pecuniary aid, of his life-long friend, Escher von der Linth. Escher possessed a moderate fortune, which was freely spent in aiding Heer's researches. This was done, as far as possible, without the recipient's knowledge, and when that was impossible, in such a way as to make him feel he was conferring an obligation on the donor. The most distinguished scientists in Europe visited the little room in Zurich, piled with books and cabinets, with its solitary sofa, on which Heer reposed after his short but quickly-recurrent spans of work, They have more than once testified to the heroic devotion of the attendant, Heer's only daughter. During the last twelve years, Heer was usually found reclining on a couch, a wooden board stretched along it, on which were fossils, plates, books, or manuscripts he was studying; whilst beside him his daughter waited, ready to change the invalid's weapons of work. Sixteen thick quartos represent some of these labours. Up till 1874 Heer's separated published papers ranked in the Royal Society's Catalogue as 95.

But what of the stability of such extensive work? Heer's conclusions touched many of the most novel points of modern speculative geology, such as a Miocene Atlantis, a uniform warm climate in Tertiary times extending even to the northern Arctic zone. Many scientific writers accept these conclusions as admitted data. What of the verdict of strict classificatory science? The subject is beset with difficulties. The over-multiplication of species in fossil botany, as well as the uncertainty as to the true specific characters of some widely-distributed trees, from which we are accustomed to argue as to recent climatal changes, occur at once to every worker in this field.

Heer's method of determining insects from the wings alone was remarkably successful with so great an entomological specialist. Thus he predicted that a fossil elytra belonged to a living Brazilian form of *Hydrophilus ;* and in a few weeks a complete fossil specimen was discovered, which verified the diagnosis. So, two fruits of fossil plants were discovered which confirmed their previous description worked out from the fossil leaves alone. Heer was soon known to have a power in the field of palæophytology, equalling that of Owen in his special branch of comparative anatomy. His fame was spread abroad through the friendship of Sir Charles Lyell. Besides, the fossils of Œningen were in a very perfect state of preservation. In one locality, along with the insects, were vegetable fossils to the extent of 900 species. So Heer was irresistibly drawn simultaneously into both studies. Both plants and insects had alliances far beyond their present limited area. Plant impressions now peculiar to America and the Azores, such as *Clethra* and *Persea,* were very conspicuous ; along with these were other forms now having their special *habitat* in Asia, Africa, and Australia. Thus the Swiss professor came face to face with absorbing questions of temperature and geographic distribution. The interest was to be enlarged by fresh discoveries amongst the fossil beds of St Gorge, when on a visit to Madeira in 1854–55 for health. Heer visited England in 1861, on the invitation of Sir Charles Lyell, to find at Bovey Tracy, Devonshire, vegetable remains indicative of a still warmer climate prevailing in Eocene times. Further, in 1866, he intimated to the British Association, that when the fossils of North Greenland were living trees, the climate must have been 29° Fahr. warmer than at present. Thus from this solitary study came forth determinations as to climate and temperature on palæophytological grounds, from the Arctic circle down through the greater part of North America and Europe, including the lost Atlantic continent. Heer also began his speculations on progressive development in plant life from Swiss fossils taken from Carboniferous, Jurassic, Cretaceous, and Tertiary localities. His further study of fossils from quarters wide as the globe apart merely broadened his generalisations. This was done by a herbarium student of living forms, of a distinctly poetic temperament, which showed itself on more than one occasion in verse, and was no doubt heightened by his consumptive tendency.

Sir Charles Lyell (*Life and Correspondence*, vol. ii. 246, August 1859), writes to Leonard Horner—

"I perceive that Heer is trying to frame a progressive theory for plants, though he is a good deal put about by finding a Palæoxysis in the coal, one of the Bromeliaceæ. In fact, the monocotyledons do not seem as yet to keep their place in the chronological system, as they should do if they knew their real rank in the order of development. Some of them appear before their time. It is, however, striking to observe that the tendency of geological facts (or opinions) carries a man who is working in a new field, and an independent thinker into the speculation that nature began with cellular, and went on to vascular cryptogams, from lichens and seaweeds to ferns, and slowly got up to coniferæ and cycads, then to different divisions of dicotyledonous, apetalous, polypetalous, and gamopetalous in the order of their perfection. Although Heer is too well aware of the exceptions to his rules, and even of the impossibility of classifying the dicotyledons correctly according to relation, dignity, or perfection, yet the attempt shows how seductive such a generalisation is. So long as it is admitted that man came last, and the idea of progress is cherished as the only way of uniting that fact with palæontological data, I suppose these views will find favour. It seems the only prospect of a complete system of uniting all into one grand whole, the supposed absence of fish in the oldest rocks, with the coming in of the mammalia last of all, and with a parallel series of progressive steps from the algæ to the lilies and the roses. But it might be better if we were rather less ambitious. This eager desire to solve the whole problem may mislead zoologically, botanically, and geologically. I suppose most men prefer a doubtful system which enables them to group together a great many facts, than to have none. I spent three days in Heer's collection. He is continually finding fruits which bear out the generic determinations previously obtained from leaves alone."

Heer's *Primeval World in Switzerland*, which has appeared in English dress, is his only large publication on general geology. Its poetic descriptions of a lost fauna and flora in some instances break out into verse. Heer's other books are classificatory memoirs. A general review of them would be mostly a critique in special on recent additions to Arctic fossil botany. The thorough working out of such an extensive subject implies a knowledge of the living habits and changes as affected by temperature of which we are still far too ignorant. Thus we may bring in evidence the recent papers on half-hardy plants grown in Britain read to this Society. Mr S. Gairdner has reviewed at considerable length Heer's work amongst the Coniferæ (*Nature*, vol. xxiii.). His charges against it are minute-subdivision and an over-multiplication of species, as well as ignorance of the facts that in some species different kinds of leaves are found on the same tree; thereby invalidating one of Heer's favourite methods of classification. Altogether we are too precipitate in forming vast inductions as to the climate of the ancient earth.

"The moral to be drawn from the history of the Sequoias is that we should not place implicit credence in the minimum temperature of the so-called Miocene Greenland, Spitzbergen, Vancouver's Isle, Sitka, Arctic America and Asia, as settled by Heer. Such bold argument, as for instance that because Sequoia now requires such and such a temperature, therefore former but different species must have required the same, is entitled to but little deference, yet Heer's facts and opinions are quoted as axioms by a wide range of workers. When examined they are seen to be disputable, whether taken as physiological, geological, palæontological, or any other data. Provisionally they were of use, but the questions depending on the accuracy of the data are so important and the evidence so intricate that they should not be deemed settled until some greater amount of care has been bestowed on them."—*Nature*, vol. xxiii. p. 414.

Far be it from us by such quotations to depreciate Heer's heroic life of study and suffering. The detailed titles of published works given below are alone his sufficient monument. But, in truth, does it not also testify to the glory and vanity alike of a mere scientific career? The vast field of research opened up on the solitary sick couch at Zurich, has room and scope enough for many other workers to complete its array of laboriously accumulated facts.

List of Oswald Heer's more important Publications.

His larger works, specially on Fossil Arctic Botany, were published in various countries, and by different Governments. They respectively bear imprints of London, Stockholm, St Petersburg, and Zurich.

Heer's first great work was "On the Fossil Insects of Œningen and of Radoboj in Croatia." 1853.

Flora Fossilis Arctica (7 vols. 1300 pages, 399 plates). 1868-83.

Flora Tertiaria Helvetica (8 vols. 3500 pages). 1855.

Flora Fossilis Helvetica (1 vol. 70 plates). 1876.

Urvelt der Schweiz, translated into French by Gaudin in 1865, and into English by J. Heywood in 1876. A new and enlarged edition appeared in 1879.

"Description of the Tertiary Flora of Bovey Tracy," *London Phil. Trans.* 1861.

Professor Allen Thomson, M.D., LL.D., D.C.L., F.R.S. L. & E. By Professor Cleland.

(Read 8th May 1884.)

Among the losses which this Society has sustained during the past year by death, it is our painful duty to record the name of Dr Allen Thomson, who died on the 25th March, at his residence in London, and was buried on the 28th, close beside the remains of his brother, in the Dean Cemetery of Edinburgh.

Dr Thomson became a member of this Society on 9th April 1839.

He was the son of Dr John Thomson, Professor of Military Surgery, and afterwards of Pathology, in the University of Edinburgh, well known as the author of a work on Inflammation, and still better remembered as a notable figure in politics, a trusted adherent of the Whigs, and a powerful wielder of influence in that party. Nor was this circumstance without effects on the life of Allen Thomson, who was named after his father's friend, the well-known John Allen, long resident in Holland House, was brought much in contact with the Bedford family, and was assured, as he would sometimes playfully tell, of the Whig interest to secure for him a regius chair.

Though a member of this Society, and though the chair which he long held in the University of Glasgow was formerly termed the chair of Anatomy and Botany, and he was rather proud of his claim to be called a professor of the latter subject, retaining even a certain number of diagrams and preparations for its illustration, Dr Thomson's attention was devoted principally to the phenomena of animal life.

Immediately after his graduation he became the colleague of Dr Sharpey as a lecturer on Anatomy and Physiology, in Surgeons' Square, and the influence which Sharpey won over him continued until the death of the latter, showing itself not only in the veneration and affection with which Thomson justly regarded him, but even in the unconscious imitation of some of his modes of thought. In 1839 he was appointed to the chair of Anatomy in Aberdeen; in 1841, to the chair of Institutes of Medicine in Edinburgh; and finally, in 1848, to the chair of Anatomy in Glasgow, from which he retired in 1877.

The subject which formed the favourite study of Dr Thomson was Development. He was one of the first in this country systematically and continuously to draw attention to the importance of that study, and to devote himself especially to its details. His inaugural thesis, published in the *Edinburgh New Philosophical Journal*, October 1830 and January 1831, "On the development of the Vascular System in the Fœtus of Vertebrated Animals," gave an account of the researches of Wolff, Pander, Von Bær, Serres, Rathke, and others, and shows a mastery of the whole subject of development, so far as it had been investigated at that time. Having made himself thus familiar at the commencement of his career with embryological literature, he continued to the last to keep himself abreast with its advances, as may be seen by consulting his elaborate chapter on Development in the ninth edition of Quain's *Anatomy*. In the later years of his professoriate his attention was greatly distracted from scientific subjects by the interest which he took in the removal of the site of the University of Glasgow from the High Street to Gilmour Hill; and it will be admitted by all who know about it that he took on himself an amount of labour greater than did any one else in that arduous undertaking, and that it is greatly owing to his energy and perseverance that the New University buildings are what they are, and that the Western Infirmary has been built in their vicinity.

In 1876 Dr Thomson was president of the British Association, and opened the proceedings of the meeting at Plymouth with an elaborate address "On the Development of the Forms of Animal Life," in which the facts of vegetable embryology were also referred to in illustration. His argument was in favour of evolution; but although he showed distinctly enough that his own inclination was to believe that for the explanation of the phenomena of life no order of things was required additional to those which are recognised in the inorganic world, he exhibited abundantly his habitual care not to commit himself to any dogmatic expression of speculative views in detail.

Perhaps it is owing to the circumstance that the bent of his mind was more in the direction of criticism than of independent exploration, that Dr Thomson has not left behind him any great monument of original work or discovery; but a more thoroughly accomplished man, versed and interested in the progress of all branches of biology, is not often met with. His habitually urbane and gentle manner, his diplomatic tact, and, most of all, the exceedingly winning character of his smile, and the joyous expression which lit him up when he was more than usually pleased, will linger long in the memory of those who have experienced their wonderful influence.

Dr James Robson Scott, M.D. By F. Douglas, M.D., Kelso.

(Read 13th March 1884.)

Dr Robson Scott was the eldest son of Mr John Robson, tenant in Belford on Bowmont Water, and grandson of James Robson, Esq. of Samieston, whose name has long been held in grateful remembrance by Border farmers and stock-breeders as the first great improver in the breed of Cheviot sheep by crossing with the Leicester blood. Dr Scott was born at Belford in 1814, and, after a home education, entered the literary classes of Edinburgh University. He chose the study of medicine as a profession, and, after graduating in 1836, proceeded to India as an assistant-surgeon on the Madras Establishment of the East India Company. After serving some years in that Presidency, he accompanied his regiment to Singapore, and subsequently to China, towards the conclusion of the war with that country in 1844. On returning to Madras he served at Vellore, and afterwards for two years had medical charge of the Nilghiri Hills Sanitarium. Thence he took furlough to England, and, on his return to India, was appointed to a cavalry regiment, which he retained until he finally left the service in 1858. By his brother officers

Dr Scott was highly esteemed, and he was, from his geniality of temper and disposition, a general favourite with all classes in the public service and with his numerous friends.

On the death of a maternal uncle he inherited the estate of Ashtrees in Roxburghshire, and took the additional name of Scott. He was a Commissioner of Supply and Justice of Peace for the county; and, being fond of archæological pursuits, was associated with Sir Walter Elliot of Wolfelee in the investigation of old county records. Dr Scott had from his youth an ardent attachment to natural history, especially to botany and ornithology. In 1858 he became a member of the Berwickshire Naturalists' Club, and to its *Transactions* he occasionally contributed. In 1873 he was appointed its President, and delivered the Annual Address at Kelso in the following year.

Dr Robson Scott was elected a member of the Scottish Meteorological Society in 1865, and was for many years an active member of the Council of that Society. He joined our Society in 1875, and was a member of Council at his decease.

He died, after a very brief illness, at his brother's house, Newton, near Jedburgh, on the 22nd of September 1883, and was buried in Hownam Churchyard, where many of his forefathers sleep. Dr Scott is survived by his widow, two married daughters, and one son, an officer in the 3rd Hussars.

Rev. John Gibson Macvicar, LL.D., D.D., Minister of Moffat. By the Rev. John M'Murtrie, M.A.

(Read 12th June 1884.)

It is fitting that notice should be here taken of a member of this Society, who, throughout a long and useful life, devoted much of his attention to scientific pursuits—the late Dr Macvicar, who died in the Manse of Moffat on 12th February 1884. He was the second son of Dr Patrick Macvicar, minister of St Paul's, Dundee, and was born in March 1801, so that at the time of his death he had nearly completed his 83rd year. He was educated at the grammar school, Dundee, and it is on record that from the age of twelve he showed the bent of his mind, for "as soon as school hours were over he was always in some workshop or other, constructing some kind of philosophical instrument."* He took his Arts course at St Andrews University, and graduated M.A. The remainder of his course was taken in the University of Edinburgh, where he not only attended the usual classes in the Divinity Hall, but studied with enthusiasm in the classes of chemistry, anatomy, physiology (taught extra-murally by Dr Knox), and especially natural history under Professor Jameson. His first essay on a botanical subject appears to have been a paper "On the Germination of Ferns," which appeared in MS. in vol. x. of the *Transactions of the Philosophical Society of Edinburgh,* now in the library of the Royal Physical Society. To this time belongs an anecdote which we have from his son-in-law, the Rev. Mr Weir of Dumfries. His old friend, Dr W. A. F. Browne, tells how Dr Macvicar, then a young man, announced that he would lecture on botany in Edinburgh. There was, however, no demand for what he had to supply, and at the opening lecture there were present only two students—Dr Browne and the late Professor Balfour. But thus began a friendship of the three men which was always afterwards kept up.

Another who appreciated his qualifications to lecture on science was Dr Chalmers, then Professor of Moral Philosophy in the University of St Andrews. He proposed and carried a motion for instituting in that university a lectureship on Natural History, and Mr Macvicar, in 1827, was the first appointed to the lectureship. He lectured there for several years on a wide range of scientific subjects, and at the same time aided in founding the Museum of Natural History in St Andrews. In intervals of leisure he visited Northern Germany and Denmark, forming at Copenhagen an intimacy with Hans C. Oersted, the Danish physicist. At a later period he was much in France and Italy, studying art as well as science, and he also made a tour in Canada and the United States.

* Quoted in *Moffat Times* of 16th February 1884, from a manuscript sketch of his life, written (we believe) by Mr Samuel Neil, ex-rector of Moffat Academy.

In his native town of Dundee he promoted the founding of the Watt Institution, where he was a most popular lecturer. We have before us a Report of that Institution for 1838–39, containing a list of twenty-one lectures delivered by him to an average attendance of 500. They include not only (1) Vegetable Anatomy and Physiology, (2) Systematic Botany, (3) Geographical Distribution and Economic Uses of Plants, but also Mollusca, the Solar System, the Steam-Engine, the Chemical Constitution of the Atmosphere, and many other subjects.

In regard to Dr Macvicar's original investigations in chemistry, to which he himself attached considerable importance, the present compiler does not feel competent to form an opinion. But Dr Macvicar's old friend Sir Lyon Playfair has written to his widow a letter which we are permitted to quote. In this letter, after speaking of the Doctor as one of those who first turned his thoughts to science, Sir Lyon remarks that his views on Chemistry, published many years ago, are now much more in accordance with what is commonly received than they were when first promulgated.

It may here be added, that so early as 1828 he edited the *Quarterly Journal of Agriculture*, and in 1866 he received a silver medal from the Scottish Arboricultural Society for an essay on the "Philosophy of Arboriculture."

A complete list of Dr Macvicar's publications, and contributions to Journals and the Transactions of Societies, would be long, and would display unusual variety as to subjects. The *Edinburgh Medical Journal*, for which he often wrote, has in its number for March 1884 the titles of his principal papers. Among his larger publications are *An Inquiry into Human Nature*, and a treatise on the *Philosophy of the Beautiful*, which was first delivered as a lecture to the Edinburgh Philosophical Institution.

We have before us a paper on Vegetable Morphology, which was communicated to our Society on 12th July 1860, and appears in the *Transactions* for that year. In this paper he argues that the hollow sphere is the form towards which vegetable growth tends. In a large work published by him in parts (Part IV., was published in 1874) and which under the title *A Sketch of a Philo-*

sophy, contained his mature speculations, we find this article reprinted and commented on.

This is not the place to deal with Dr Macvicar's career as a clergyman, further than to say that probably his scientific tastes and attainments delayed for a time his professional advancement. And this not merely because he found congenial work elsewhere—for he was a gifted and earnest preacher; but also because during his early manhood the ecclesiastical atmosphere of Scotland was hot and stormy. A deeply religious man, his spirit was calmed and strengthened by scientific pursuits; and he felt little disposed to engage on either side in that partisan warfare which was to a great extent the road to ecclesiastical or even (in the case of a clergyman) academical preferment. His best contribution to the religious necessities of those times was a treatise intended to be an Eirenikon, and entitled *The Catholic Spirit of True Religion.* He gave it to the Church, as he was about to sail to Ceylon in 1839, as the ordained minister of the Scotch Church there. Returning in 1852, he was inducted to Moffat in 1853, where, amidst universal esteem and regret he has now ended a long and beautiful life of faithful service.

He would doubtless have enhanced his scientific reputation, and might have done more for some particular department of knowledge, in these days of subdivision of labour, if he had concentrated his energies on a narrower field. But in that case he would, not unlikely, have been a less complete man, and his life might have been less full and happy. As it is, his aid to scientific progress was of the nature of a general impulse. His theories, always ingenious and beautiful, often show a remarkable power of intuition. Some of his speculations have been superseded; but in others he was in advance of his time, anticipating subsequent discovery and the recent course of scientific thought.

He married in 1840 Miss Jessie R. Macdonald of Kinloch Moidart, a grand-daughter of Dr Robertson the historian, and is survived by her and by eight of their children. Originally a member of the Wernerian Natural History, he became one of our members at its amalgamation with the Botanical Society.

Statistics of the Topographical Botany of Scotland, with Suggestions as to further Work. By SYMINGTON GRIEVE.

(Read 8th May 1884.)

With the object of showing what is the state of our present knowledge regarding the distribution of plants throughout Scotland, we have prepared the following lists from the most recent work on the subject—the second edition of *Topographical Botany*, by the late Mr H. C. Watson. Mr Watson divided Scotland into 6 provinces, 13 sub-provinces, and 40 districts, which are mostly counties, but sometimes he divided counties into artificial divisions of his own, which he called Vice-counties, and those that are not familiar with these divisions should study a Watsonian map, which is to be found in most of the books with which Mr Watson's name is associated. The number given to those counties and vice-counties in the *Topographical Botany of Great Britain*, that belong to Scotland, begin at number 72 in the southern borders, and run northwards to 112. We give the plant statistics of these districts in rotation. Both species and sub-species are included. We sometimes add a plant to the lists as certain where Mr Watson has put it down as *doubtful.*

72. *Dumfries.*—This is a large county, with the highest hills in the south of Scotland, yet only 471 plants have been noted in it.

73. *Kirkcudbright.*—This is another large county with elevations of upwards of 2000 feet, but only 491 plants have been noted.

74. *Wigtown*—Very little has been done to record the flora of this county, as only a hundred plants have been noted, and many of the commonest species are not included in this list. The part of Wigtownshire named the Rhinns, is one of the points where Scotland approaches most closely to Ireland; and possibly at this place there may at one time have been a land connection with Ireland. But if, as some authorities suppose, there has always been in post-glacial times a deep depression filled with water between the coast and Ireland, while there was a land connection between Britain and that country both north and south of

this locality, it is possible that here we may discover traces of the earliest migration of plants from what is now the European Continent.

75. *Ayr.*—In the list of the flora of this large and interesting county 645 plants have been recorded.

76. *Renfrew.*—In this county, a district less than one-third the area of Ayrshire, 597 plants are recorded.

77. *Lanark.*—This is a large county, with elevations ranging from sea-level to over 2400 feet, and the plants that have been noted number 648.

78. *Peebles.*—Ten years ago hardly a plant was noted in this county, now we have 321 recorded, but this is only a beginning. The highest elevation appears to be a little over 2450 feet.

79. *Selkirk.*—Another interesting county, with high hills, that has been little worked, for only 447 plants have been recorded.

80. *Roxburgh.*—This large border county, with considerable elevations, has been better worked than some others, as 607 plants have been noted.

81. *Berwick.*—This county is less in size than Roxburgh, and no elevations are above 1540 feet, but the record of its flora shows that it has been better worked, as Mr Watson gives 716 plants.

82. *Haddington.*—Another maritime county near our doors which needs attention, as only 581 plants have been recorded. The highest hill in this county appears to have a height of 1732 feet.

83. *Edinburgh.*—The flora of our home county has been well worked, with the result that we have recorded in it 766 plants. The highest elevation is about 1890 feet.

84. *Linlithgow.*—This is a small county, without any great elevations, but certain districts have a rich flora. However, only 466 plants have been noted.

85. *Fife and Kinross.*—These two counties, which Mr Watson has formed into one vice-county, have been well examined for plants, with the result that 785 have been recorded. The highest elevation in this district is the West Lomond Hill, with a height of 1713 feet.

86. *Stirling.*—This is a county, with elevations from the sea-level up to 3192 feet, and we would expect to find a

very extensive flora, but only 543 plants are given in *Topographical Botany.*

87. *West Perth, with Clackmannan.*—This vice-county has elevations of over 3800 feet, and has an interesting flora; 615 plants have been noted. This and the three following districts, viz., 88–89–90, contain the richest Arctic-Alpine flora in Britain, among which are some of our rarest plants.

88. *Mid Perth.*—This is a most celebrated botanical district, and comprises Ben Lawers, with a height of 3984 feet, but with its gigantic cairn, it claims an elevation of 4000 feet. There are also a number of other mountains that rise considerably over 3000 feet above sea-level. The number of plants recorded in this vice-county is 667.

89. *East Perth.*—This Watsonian district contains some high elevations, a number of them over 3000 feet, but the highest appears to be Cairn Gowar, 3671 feet. The number of plants that have been noted is 599. This vice-county comprises a smaller area than Mid Perth.

Perthshire as a County.—During 1882 Dr Buchanan White published in the *Scottish Naturalist* a list of the plants of the county of Perth, and the total he gives, including sub-species, is 876; but we have not co-related it with the artificial vice-counties by Mr Watson.

90. *Forfar.*—This county may be considered the principal field of George Don's work, and 801, the record of its plant life, as given by Mr Watson, shows how well it has been explored. No other Watsonian district in Scotland has such a numerous list. The fringe of mountains that forms the northern border of this county has a number of elevations that vary from 3000 up to 3500 feet.

91. *Kincardine.*—The greatest elevation in this county appears to be about 2555 feet, so we may expect to find some of the Arctic-Alpine plants absent. The area covered by this county is small compared with some others. The number of plants on record is 601.

92. *South Aberdeen.*—With the exception of Westerness, there is no other district in Scotland where such a number of zones of vegetation are to be found as South Aberdeen,

for you have the sea-level along the east coast, and an elevation of 4296 feet on the top of Ben Macdhui. The district appears to have been well explored from a botanical point of view, as 705 plants have been noted.

93. *North Aberdeen.*—There are no elevations above 2368 feet, so we naturally expect to find the Arctic-Alpine flora absent; but only 472 plants are recorded.

94. *Banff.*—Another maritime county, with all elevations from the sea-level up to 4095 feet; the number of plants that have been noted is 524.

95. *Elgin.*—This maritime county has no great elevations, and is more limited in its area than some others. The number of plants recorded in it is 573.

96. *Easterness.*—This extensive Watsonian vice-county comprises within its limits the county of Nairn. It has a rich littoral, bleak moorlands, deep glens, and rugged mountains. The highest elevation is 4000 feet. The botanist will find here an extensive field for work, especially among the more remote portions. The plants on record number 552.

97. *Westerness.*—Is a maritime vice-county, which extends south as far as the northern shore of Loch Etive, and to the west comprises the districts of Lochiel, Ardgower, Ardnamurchan, and Morven in Argyllshire, and stretches up the west coast of the mainland of Inverness-shire to Glenelg. Within its limits is Ben Nevis, the highest mountain in the British Isles, with an elevation of 4406 feet. This district has therefore the greatest number of zones of vegetation, as it extends from the sea-level up to the summit of Ben Nevis. There are many rare plants, and this vice-county has not been worked as it ought; only 289 have yet been noted.

98. *Argyll.*—This is Mr Watson's name for a vice-county which is bounded on the north by a line drawn from Loch Luydan to the head of Loch Etive, and along its southern shore to Loch Linnhe. It extends southwards to the isthmus that separates East and West Loch Tarbert. On the east it is bounded by the Kyles of Bute, the Cowal shore of the Firth of Clyde, Loch Long, and northwards by the boundary of the county of Argyll. It extends westwards to the Sound of Jura and the Firth of

Lorn. This should prove a rich field for the botanist, as it has an extensive littoral, and also great elevations. The highest mountain in this district is Ben Cruachan, with a height of 3670 feet, but there are other peaks with an elevation of over 3000. The Arctic-Alpines are largely represented on the high mountains that border Perthshire where the mica schist rocks are met with. Only 331 plants are recorded.

99. *Dumbarton.*—This is a comparatively small county, but extends from the sea-level up to 3091 feet, the height of Ben Vorlich. The number of plants noted is 468.

100. *Clyde Isles.*—This vice-county comprises Bute, Arran, Cumbrae, and other isles in the Firth of Clyde between Cantire and the coast of Ayr. The highest mountain in this district is Goat Fell, in Arran, with an elevation of 2863 feet. The area covered by these islands is very restricted compared with some vice-counties we have referred to, but 604 plants have been observed.

101. *Cantire.*—This vice-county is the long promontory that forms part of the county of Argyll, and stretches southwards from the isthmus that separates East and West Loch Tarbet to the Mull of Cantire. It covers a comparatively small area, but has at least one elevation of 2000 feet. The number of plants recorded is 418.

102. *South Ebudes.*—The islands comprised in this district are Islay, Jura, Gigha, Scarba, Colonsay, and Oronsay, with the smaller islands adjoining. The highest mountain is Beinn-an-Oir, one of the Paps of Jura, with an elevation of 2565 feet. The plants recorded number 462.

103. *Mid Ebudes.*—The islands that compose this vice-county are Mull,* Coll, and Tiree, with the islands that adjoin them. There are high mountains in Mull, but only one exceeds 3000 feet in height, viz., Ben More, with an altitude of 3185 feet. The number of plants noted is 414.

104. *North Ebudes.*—The group of islands that form this

* *Trans. Bot. Soc. Ed.*, vol. xiii. p. 234, "George Ross, on the Flora of Mull."

Watsonian district are Skye, South Rona, Raasay, Scalpa, Eigg, Muck, Rum, Canna, and the smaller isles in their vicinity. In the south of Skye is one of the most remarkable mountainous regions in Scotland. Within a narrow radius there are nine peaks over 3000 feet in height, the highest having an elevation of 3261 feet. To the south of Skye there is the island of Rona and another remarkable group of mountains, the highest of which rises 2667 feet above sea-level. The number of plants recorded in this vice-county is 385.

105. *West Ross.*—This is an extensive district, but with the exception of Wigtown and East Sutherland, has a smaller number of plants recorded than any vice-county in Scotland; the number given by Mr Watson is 185. Here is a field for botanists that will well repay exploration. The scenery is grand in the extreme, and some of the finest parts are quite beyond the reach of ordinary tourists, and could not be satisfactorily worked without a camp. There is an extensive littoral, and elevations up to 4000 feet, the height of Ben Slioch.

106. *East Ross.*—Another large vice-county, with high mountains, the greatest elevation is Ben Wyvis, with a height of 3422 feet. The plants recorded number 458. The county of Cromarty is included in West and East Ross according to the situations of its detached portions.

107. *East Sutherland.*—This is an extensive vice-county that has been little explored by the botanist. We have only a list of 184 plants that have been observed. This is next to Wigtown the vice-county with the smallest number of plants recorded. The highest elevation is Ben Klibreck, with a height of 3164 feet.

108. *West Sutherland.*—This wild district of the north-west of Scotland, the region of moor and loch, has many high mountains, two of which have elevations of over 3000 feet, the highest is Ben More, Assynt, with an altitude of 3281 feet. The deep indentations of the coast, the many islets, and the bold sea cliffs, all tend to make this an interesting district to the visitor. The number of plants that have been observed is only 373.

109. *Caithness.*—This district is more accessible than that we have just referred to, but has no elevations higher

than Morven, with an altitude of 2313 feet. The plants recorded number 449.

110. *Hebrides.*—This vice-county is the Long Island or Outer Hebrides. The highest mountain is Clesham, in Harris, with an altitude of 2662 feet. The plants that have been noted number 311.

111. *Orkney.*—This group of islands has been well explored, though only 429 plants are given in *Topographical Botany*, but Mr W. Irvine Fortescue, in a list he has recently published of the flora of these islands, makes considerable additions. The highest elevation is Wart Hill, on Hoy, with a height of 1559 feet.

112. *Shetland.*—Comprises the islands of the same name. They have no great elevations, and the number of plants recorded number 338

The numbers of plants recorded are approximately, but not categorically, correct, as no one, unless they attempt it, can realise the amount of labour entailed in examining lists that give between twenty and thirty thousand localities for Scottish plants.

[Mr Grieve then pleaded that the Society purchase a camp equipage for the botanical exploration of the more remote regions; and submitted a scheme for the working of the same.]

Growth of Half-Hardy Plants on the East Coast of Arran.

By the Rev. D. Landsborough, Kilmarnock.*

(Read 8th November 1883.)

The east coast of Arran is more favourable for half-hardy plants than any place in Scotland, and as favourable as any in Britain. Without enumerating all the exotic plants that grow there, I shall mention such as call for special notice.

Eucalypts.—The peppermint tree (*Eucalyptus amygdalina*) of Tasmania, the tallest tree in the world, grows at two places in Arran; the specimen at Cromla, Corrie, is 22 feet in height, and $9\frac{3}{8}$ inches in girth. The blue gum (*E.*

* The measurements are given at 5 feet from the ground, unless otherwise mentioned.

globulus), at Captain Brown's, Lamlash, a well-shaped tree, is now 1 foot 7 inches in girth. The white gum (*E. coriacea*), and the cider gum (*E. Gunnii*, synonym *E. polyanthemos*) also grow freely at the same place.

Arborescent Lily.—I saw lately a beautiful photograph, entitled "The Palm Avenue, Botanic Gardens, Ballarat." This so-called Victorian Palm grows luxuriantly at Cromla, under the names of—*Cordyline indivisa*, *C. australis*, and *C. Veitchii.*

Tree Ferns.—Arran is the only place in Britain where the tree ferns of Australia grow in the open air without protection in winter. In a sheltered spot the great bush tree fern (*Dicksonia antarctica*) grows in the utmost luxuriance. This year it sent forth a magnificent crown of eighteen fronds, each averaging 6 feet in length by 2 in breadth. The girth of the stem is 2 feet 4 inches, height 1 foot 9½ inches. The fronds of *Dicksonia squarrosa* are 2 feet 9 inches in length and 13 inches in breadth, girth 9½ inches.

Among the ferns of lower degree that grow at Cromla are *Todea superba*, *T. hymenophylloides*, *Pteris scaberula*, and *Trichomanes radicans.*

Camellia.—During the whole of April and part of May the front of Cromla was rendered gay by a plant of *Camellia reticulata*, which bloomed abundantly. *Camellia japonica* grows freely, but rarely blooms.

Acacia.—One of the most valuable of the timber trees of Australia, the Black Wood (*Acacia melanoxylon*) is growing well at Cromla, Corrie. The very beautiful Feather-leaf or Black Wattle (*A. decurrens*), grows luxuriantly at Captain Brown's, Lamlash, as does also the Silver Wattle (*A. dealbata*).

Broad-leaved China Fir.—After much inquiry it has at length been satisfactorily determined that this tree, planted in Brodick Castle High Garden about the year 1858, is *Cunninghamia sinensis*, or the Chinese broad-leaved Fir. In general appearance and habit it much resembles *Araucaria brasiliana*, but the leaves are more light in texture. Were it to bear cones it would be readily distinguished.

Norfolk Island Pine.—Two young plants of this beautiful tree (*Araucaria excelsa*) were last summer placed in Captain Brown's garden at Lamlash. The captain was told they would not stand the winter, but he was determined that they should. Procuring pieces of thick glass he placed them round the plants, and put another piece over them, so as to admit air in mild weather. The trees remained in excellent health during the whole of the winter, and would have been so still had they not been transplanted in spring. They are now recovering.

Miscellaneous Trees and Shrubs.—The Cork tree (*Quercus suber*), 2 feet 3 inches in girth 4 feet from the ground, grows freely in the Castle grounds, Brodick. The She Oak or Beef Wood (*Casuarina equisetifolia*), 13 feet in height, grows freely in the Castle High Garden. In a side border of the same garden a beautiful white Heath was in one mass of bloom during the whole of the month of April. It is 7½ feet in height, and 15 feet in circumference, and well becomes its name—*Erica arborea*. *Escallonia rubra albiflora* also flowers abundantly. A beautiful white Sikkim Rhododendron, 14½ feet in height, flowers in the garden at Cromla, Corrie, but did not bloom till it was thirty years of age. A plant of the holly-like *Desfontainea spinosa*, 7 feet 3 inches in height, comes into bloom at Cromla in the beginning of July, and continues in bloom till December. A standard Myrtle (*Myrtus communis*), 11 feet in height, here blooms abundantly every year. There are also plants of *Elæagnus reflexa variegata, Photinia serrulata, Coccoloba vespertilionis, Azalea amœna* (blooms abundantly), *Euonymus latifolia aurea*, &c. *Pittosporum Ralfii* grows at Captain Brown's, Lamlash. A plant of *Buddleia globosa*, 19 feet in height and 7 inches in girth, at Whitehouse, Lamlash, was, during the months of June and July, most attractive, being covered with its sweet-scented orange-coloured bloom. The early blooming scarlet Rhododendrons at Whitehouse, as also in the Brodick Castle grounds, are yearly most gorgeous. Those who have only seen these magnificent shrubs in the neighbourhood of towns, or in places where they are exposed to much frost, have no idea of what they are in Arran, where there are many plants of thirty or forty years' growth in perfect health, without which there cannot be richness of colour. I doubt if even in their native Indian mountains they are more gorgeously magnificent.

On Phyto-Phenological Observation. By W. C. Crawford.

(Read 8th May 1884.)

(*Abstract.*)

The number of observations on the budding and flowering of plants, the ripening of fruits and the like, in relation to climate and weather, yearly increases; and an attempt is being made in Germany to co-ordinate them and give them a scientific value.* Phenological maps, with lines in the fashion of isothermal lines to indicate the places where vegetation is equally advanced at certain dates, have also been published; but little new knowledge, apart from that indicated on an ordinary physical map, was thus indicated.† Attention was directed to some very careful researches of Professor Hoffmann of Giessen on the flowering of plants, in which he analyses the phenomenon into its separate factors, such as the mean temperature of the air, sunshine, rainfall, temperature of the soil, &c. He shows that the most important of these is underground temperature.‡ To give these researches a local application, the accompanying diagram has been constructed. In it a graphic curve gives averages of the times of flowering of forty plants in the Royal Botanic Garden, originally chosen for observation by the late James M'Nab, and continued records of which have been accumulated by his successors for ten years. II. 9, under 1882, means the 9th February, that being the mean of all the dates for the year, when the first blossoms expanded. The other curve is that of the mean underground temperature as given in the Registrar General's reports for the same period. The two curves run exactly parallel. Apparently, then, the present methods of taking large averages from selected plants, or general observations and records of the annual progress of vegetation, are of little value, and afford no

* *Beitræge zur Phænologie*, Hoffmann und Ihne, Giessen, 1884.

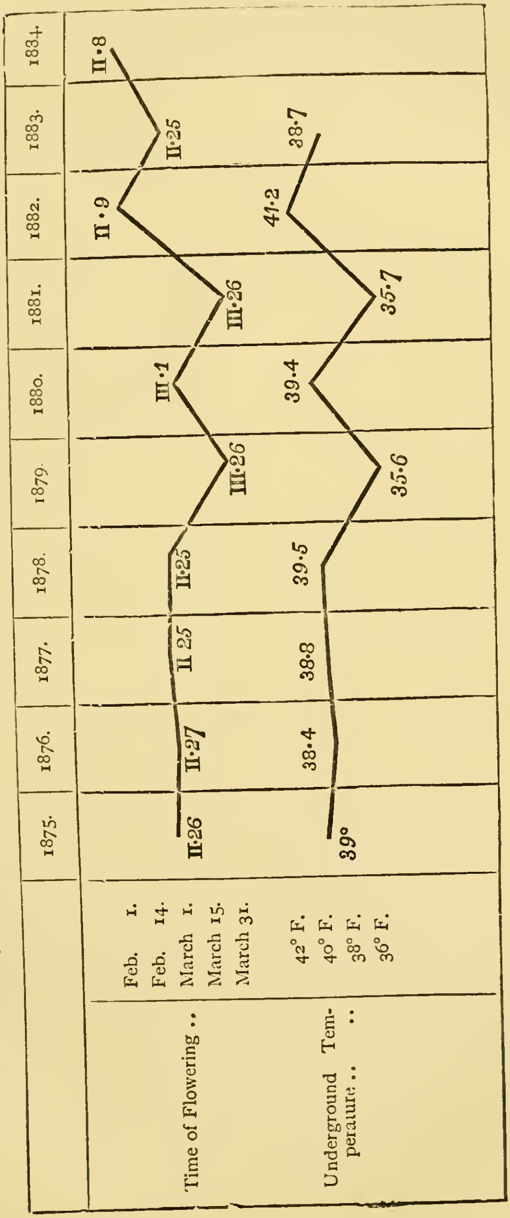
† Petermann, *Mitth.*, 1881, i.; 1382, ix.

‡ *Gartenflora*, 1882.

information which ordinary meteorological reports do not contain.

ANNUAL AVERAGES OF THE TIME OF FLOWERING OF FORTY PLANTS,

Observed at the Royal Botanic Gardens, Edinburgh: compared with the Mean Temperature of the Soil 3 inches deep.



Excursion of the Scottish Alpine Botanical Club to the Braemar Highlands, with the Ascents of Lochnagar, Corry Ceann-mohr, and Ben Macdhui, in August 1883. By Charles Stuart, M.D. Edin. Communicated by W. B. Boyd, Esq.

(Read 12th June 1884.)

(*Abstract.*)

Excursion to Lochnagar, August 3, 1883.—At Glen Callater Lodge we got ourselves into light marching order, and ordered the conveyances to meet the party at 6.30 P.M. The Lochnagar range extends for 15 miles from Glen Cluny to Ballater, farther down the Dee. It comprises Glen Maol, 3502; Cairn Taggart, 3560; Lochnagar, 3789, and many other heights, the whole being second in altitude to the Cairngorm range. There is a track from the keeper's cottage to the summit of Lochnagar; but as this path is obscure in some parts, and as the summit is not visible from our starting-point, we now take our bearings. Climbing the grassy bank above the cottage, we found *Meum athamanticum* (Bald-Money), an umbelliferous plant of an aromatic character, much used by the Highlanders for chewing. By the side of the path, the bear-berry, *Arbutus Uva-ursi*, was in profusion, with its small pink bells. We gathered an alpine form of *Lotus corniculatus*, which differed somewhat from lowland specimens, *Carex aquatilis* and *C. pauciflora.* The Dwarf Birch, *Betula nana,* a desirable plant, disclosed itself in boggy ground among the heather. A little higher up, we picked several of the downy alpine willows *Salix Lapponum*, *S. myrsinites*, *S. arbuscula*, the small tree willow which sometimes will grow on the rock border, when carefully transplanted. Proceeding upwards, the trailing *Azalea* [*Loiseleuria procumbens* of some] was creeping among the crumbling granite, but flowerless. This plant is never found under 2000 feet, so our elevation was considerable. Our route now skirted the shoulder of Cairn Taggart, and brought us into a valley, where we crossed a brawling burn which flows into Loch Muic. Here were great beds of *Trientalis europæa*, European chickweed, winter green, in beautiful flower. This pretty plant grows everywhere about Braemar, but was long out of flower in the lower regions. In the mountains the beautiful white corollas were tinged with pink, and were very attractive. Beside it the low wheat *Melampyrum pratense* var. *montanum*, was carpeting the ground. After passing over a table-land of some size, a steepish slope had to be surmounted, leading to the Sappers' Cairn. This is said to be the highest point, but a confused heap of boulders, a little more to the south-east, seems higher, so we cross over, and clamber on to the highest boulder. Here we are on the summit of dark Lochnagar, which Byron climbed, dreamed, and sang of in strains worthy of its glory. The view from the summit was charming; the atmosphere to the north-east and west being perfectly clear. To the south there was heat haze. Looking to the north-east, the Moray Firth was glistening in the sun, Ben Wyvis being distinctly visible. Ben Nevis was seen in the far west, Ben-y-Gloe in Athole, and the Braemar range proper came out very distinctly. Indeed, Ben Macdhui, Ben Avon, Ben a-Bourd were clear to their summits. At our feet the mural precipices, constituting the eastern Corry of Lochnagar, extended for 1200 feet sheer down, to the inky tarn of Loch Muic. These precipices are intersected by several ravines with a very steep inclination, where the snow was lying many feet deep about their upper opening. The first ravine next the Sappers' Cairn may be traversed for about 200 yards, when a perpendicular rock bars farther progress. The best of the Alpines can be gathered here at the risk of your neck. The second ravine is a more feasible region, and can be traversed right down to the lake, if you are a light, sure-footed cragsman. Here grow *Saxifraga rivularis*, Alpine Brook Saxifrage, the blue sow thistle, *Mulgedium alpinum*, *Carex leporina*, the hare's foot sedge, *Alopecurus alpinus* and *Phleum alpinum*, mountain fox-tail and cat's-tail grasses. *Saxifraga rivularis* wa found in abundance, but sparingly in flower, the season being a late one, and few of the specimens had the luxuriance of growth I have observed on former occasions. The only living animals seen were ptarmigan or white grouse, and several swifts, probably the Alpine species. On the previous year I observed a pair near the summit of Ben Lawers. After scrambling about for some time, a muster was made at the Cairn, and the descent commenced, which was made in safety and comfort, the weather being perfect. The weather broke shortly after we left Braemar, and in such circumstances it is very rash to make this ascent singly. Two fatal accidents occurred about this time, both arising from inexperience. In fine weather the ascent of Lochnagar is perfectly safe, and something to remember. If your pedestrian powers are not equal to the exertion, there are plenty of hill ponies and guides at Braemar, ready to go with you.

Ascent of Corry Ceann-mohr, 4th August 1883.—Returning by the same route to Loch Callater Lodge, the next day, we on this occasion took the right hand side of the lake, from which we gathered, with the crook of an alpen stock, the European quillwort, *Isoetes lacustris* and its var. *I. echinospora*, *Lobelia Dortmanni*, water

Lobelia. The *Lobelia* sends its comparatively large flower right on to the surface of the water. The hard fern *Blechnum boreale*, was growing in profusion by the sides of the small rivulets running into the lake, many of its fronds being bifid and trifid. At the break-neck waterfall, a celebrated botanical station, *Carex rupestris*, rock sedge, was obtained—a great rarity, but a very poor plant to look at. *Carex vaginata*, *C. atrata*, and many other species, were also gathered.

In Crombie's delightful little book on Braemar,* it is stated that *Saxifraga oppositifolia* is scarce here. He can hardly have said so from personal experience, as it was found above the loch, not high on the slope, the whole turf full of it, mixed with *Thalictrum alpinum*. The other mountain Saxifrages, *S. aizoides*, *stellaris*, and *hypnoides*, were growing everywhere. We started away over the face, and gradually ascended the slope by a steep watercourse, where I could see the rough crack in the precipice, where the blue sow thistle, *Mulgedium alpinum*, grows in great profusion, secure as yet from all collectors.

The Scottish asphodel, *Tofieldia palustris*, in beautiful flower, with the Greenlandic scurvy grass, *Cochlearia alpina*, were everywhere in fine state. The starry Saxifrage, *S. stellaris*, has to be seen here, with its drooping crimson-spotted corolla, to form any idea what a gem it is, nestled at the margin of some oozy spring. Here it was growing in the wet moss principally, as well as close to the edge of the stream. What delighted me most, however, was a profusion of mossy Saxifrage, *Saxifraga hypnoides*, with petals of the most delicate pink, which I dug away at for a long time. Alas ! their corollas fade, and my dried specimens give a faint idea of the beauty of the originals growing on their native soil, and bathed in the dews of Cairn Glasshie. The alpine willows festooned the rocks with a hoary coronal. The woolly-leaved *Salix lanata* was perhaps the most uncommon, but it was gathered in plenty, and grows on my rock border in Berwickshire, luxuriantly bearing in spring its long golden catkins. A charming rock plant, *Salix Sadleri*, was sparingly gathered. A minute, silky-round leaved species was also obtained, considered to be a hybrid between *S. Sadleri* and *S. Lapponum*.

Ben Macdhui, 6th August 1883.—The ascent of the Ben is generally made from Glen Derry, but as some of our men wished to go to the Wells of Dee, and ascend the Ben from that point, a course was taken to the left by the back of the keeper's house for the Dee, and thence up Glen Dee. About six miles distant a few diminutive specimens of *Arabis petræa*, alpine rock cress, occurred in granitic débris, with small crenulated leaves, very different in

* *Braemar: its Topography and Natural History*, by Rev. James Crombie, M.A. Edin.: W. Blackwood & Sons, 1861 (now out of print).

appearance to the plant growing on the mica schist at Ben Laoich. The walking was most monotonous. However, the mountain views are grand. Ben-y-Geol, in Athole, is seen to great advantage on our left, and its huge bulk must give it a great mileage circumference. It is said to contain twenty-three corries, which are a celebrated resort of the red deer. Of course, it is diligently watched so that no mountain prowlers or "herb gatherers" can ever get leave to penetrate its recesses. No country in Europe but Scotland, with all its boasted character for freedom, shuts up its mountains from the public. It will soon be as difficult to get access to our most romantic regions as to reach the Wilderness of Sinai in Palestine. It is proper now to show you the tracks through that forest, where no one can turn or interfere with the pedestrian, to enable you to get out of it. Route 1st is up Glen Luig and the Derry to Spey Side and Abernethy; 2nd, a branch from Glen Lui and Glen Lui Beg, round the base of Cairnaveim and into the Larig Rhu to Aviemore; 3rd, up Glen Dee and over the Geldy by Carnageldy to Glen Feshie and Kingussie; 4th, a branch from this near Dee and Geldy, up Glen Dee, till it joins road No. 2, and so leads through the Pass of Larig Rhu. There is properly no road to the top of Ben Macdhui, but no objections are ever made to persons going up by the Sappers' track to the Derry and Corry Ettachan, or to their returning by the Ben Macdhui Burn to the Glen Lui Beg road, provided they call at Mar Lodge, and mention their wish to do so. And of course there is no objection to their descending the west face to the Larig Rhu, if they choose to risk their necks, as all the upper part of the Larig is beyond the deer ground. This description of routes was written by the late Duke of Leeds, when lessee of Mar Forest, in answer to a letter written to him at the time on the subject, and is authentic.

To return from this digression. We approached a black conical mountain, which shoots itself right up into space on our left, named the Devil's Point. Look how it is scarred and bared by the howling winter storm, to which it is exposed, and its whole appearance is repulsive in the extreme. A little beyond and behind it is Cairntoul, really the finest mountain in the Highlands. From whatever side you look at it, the fine conical peak stands out pre-eminent. The height is 4200 feet. I can well recollect when ascending Braeriach a few years ago, how much I admired this mountain; and now looking from Glen Dee or Glen Lui Beg, upon its noble form and fine corries, makes one wish to be more intimately acquainted with it. We are sorry to observe a wooden hut, erected this year at its base to keep wanderers off. It is the latest "detective station" in Glen Dee.

Our lost guide put in an appearance at the cairn, in no very agreeable frame of mind. Facing round towards the north-east he led us to the skirts of an extensive snow field, 10 feet deep at least, where we had some snow-balling, and descended. The margin of a spring issuing from the snow consisted of oozy fringes of moss and *Jungermannia*, amongst which we noticed *Cephalozia albescens* and *Anthelia julacea*, large purple patches of *Scapania uliginosa* and *Nardia compressa*, and light green, dark orange and purple beds of *Sphagna ;* while by the banks and among the stones we saw dark patches of *Andrœa nivalis* and the lurid green and purple beds of *Bryum Duvalli*. Gaining a sort of poacher's path among the huge boulders scattered around, we got to the *Shelter Stone* or Clach Dian, which seems to have fallen from the precipice above, and rests on several large rocks : itself as big as a house, and under its roof capable of sheltering 15 men, more or less. This shelter, rough as it is, has been a welcome sight to many a weary traveller, overtaken by the storm in this desolate region. Most visitors to Loch Avon, Wells of Dee, Ben Macdhui and Cairngorm, spend the night here. As we preferred to get home if possible, we did not do so, but all entering drank to the health of our Venerable President, Professor Balfour [" now gone over to the majority"], who in former years spent the night here, and made tea for his companions in a big kettle. Botanically, this is classic ground, for most of our great scientific men have been here in the pursuit of their favourite science. Having descended thousands of feet to the Shelter Stone, the guide pointing up the side of Ben-a-main, showed me the slack on the plateau to make for. On the table-land above the loch 1800 feet, the ground was carpeted with the trailing mountain Azalea in beautiful flower, which one only on the Cairngorm range sees in perfection. We at length caught sight of Loch Ettachan, a black mountain tarn, out of which issues the Derry from its southern extremity. The guide now informs us that we have 10 miles hard tramp to Glen Derry Lodge. I am inclined to state the miles traversed at 30. Our route by Glen Lui Beg was no easy way to Ben Macdhui, and the ground was the roughest in Scotland. The vegetation on the summit of the Ben was hardly worth mentioning—*Luzula arcuata* and *spicata*, *Carex rigida*, and *Salix herbacea.* Mr Boyd gathered *Pyrola secunda* near Glen Derry, and *Carex filiformis* in a pool in the wood near Glen Derry Lodge ; also *Drosera anglica* var. *obovata* near base of mountain. *Cerastium trigynum* was sent to me by my Liverpool friend from Wells of Dee, where *Cerastium latifolium* is also got. *Dryas octopetala* and *Saussurea alpina* are also obtained on the mountain.

Tuesday, 7th August.—Another excursion to *Corry Ceann-mohr* was made by the most of the party. Capt. Norman and myself, being rather stiff, botanised Morrone Wood, getting splendid specimens of *Hypnum crista-castrensis*, *Melica nutans*, *Pyrola media*, but failed to find *Linnæa borealis*, which grows there, as we could not venture high enough, owing to the deer-forest restrictions.

I am indebted to Mr Arthur Evans, M.A., Cambridge, one of our members, for the complete list of Carices obtained on Lochnagar and Corry Ceann-mohr.

Carex pauciflora,	Lochnagar.	*Carex atrata*,	Corry Ceann-mohr.
alpicola,	do.	*rigida*,	do.
aquatilis,	do.	*glauca*,	do.
vulgaris,	do.	*capillaris*,	do.
distans,	do.	*vaginata*,	do.
fulva,	do.	*pallescens*,	do.
binervis,	do.	*panicea*,	do.
dioica,	Corry Ceann-mohr,	*pilulifera*,	do.
pulicaris,	do.	*filiformis*,	do.
rupestris,	do.	*flava*,	do.
ovalis,	do.	*frigida* (new), discovered by the late Mr Sadler.	
stellulata,	do.		
curta,	do.		

Mr Evans picked another Salix in Corry Ceann-mohr, differing in some respects from one which I mentioned, as probably a hybrid between *S. Sadleri* and *S. Lapponum*, and which as yet has not been critically examined.

The May Island; its Archæology; its Algoid Flora; its Phanerogams and Higher Cryptogams. By JOHN RATTRAY, M.A., B.Sc., Marine Station, Granton, Edinburgh.

(Read 10th July 1884.)

The island of May, according to Government survey, has an area of about 143 square acres, and, although its breadth nowhere exceeds one-third of a mile, it is upwards of a mile in length.

The word "May" is probably to be referred to a Gothic root signifying "verdure," although others have attributed it to a Celtic root found in the name of an ancient tribe of Midlanders called the Mæotæ, said to have occupied this and the southern part of Scotland between the walls of Hadrian on the south and Antonine on the north; others say the Danish invaders called the isle Mö ("The Maid"), which is pronounced like "May." In the reign of King Constantine (864–882) various missionaries arrived in Scotland for the purpose of introducing Christianity into its pagan domains; St Adrian—who was popularly believed to have come from Hungary, but who may not improbably have been of Irish extraction—was one of their chiefs, and selected the island of May as a place for retirement and private devotion. During the Danish invasion he was cruelly slaughtered in the year 872, and was buried on the island, where his stone coffin is still to be seen.

About the middle of the twelfth century, David I., influenced, it would seem, chiefly by the memory and sufferings of St Adrian, founded a monastery on this island, and handed it over to the care of the Abbey of Reading. Besides local power of taxing, the monks received grants of lands in Fifeshire, Clackmannan, Perthshire, and Berwick from several successive Scottish monarchs and from many nobles. It may be asked, Did the necessary interchange of visitors influence the introduction of plants then and afterwards? In the year 1269 this Priory was sold by Robert de Burghgate, who was then Abbot of Reading, to William Wishart, Bishop of St Andrews, for a sum of 1100 merks. After several years of international disquietude, from 1292 onwards, the monastery was fully transferred, in the year 1318, to the Canons of St Andrews. Subsequent to this, no historical reference of importance is made to the May until the summer of 1449, when a vessel conveying Mary of Gueldres, who was about to become queen of James II., anchored near the island, on which Mary is reported to have landed, and to have paid her devotions before proceeding to Leith. During the years 1503, 1505, 1506, 1507, and 1508, repeated visits were made by James to the same spot, not only for purposes of devotion, but also, as old records have it, "to schut fowlis with the culveryn."

During the first half of the sixteenth century many of the lands that had been presented to the monks by the Scottish kings and nobles became alienated, and in 1549 the island of May itself was feued to Patrick Learmonth of Dairsay, Provost of St Andrews, on account of its insular situation, its liability to seizure by an enemy in times of hostilities, and the devastated condition in which it had been recently left by English invaders. Soon afterwards the monks took up their principal residence at Pittenweem, on the adjoining coast of Fife, and in deeds belonging to the period the Priory of May is styled the "Priory of Pittenweem, otherwise Isle of May," or the "Priory of May and Pittenweem."

On December 21, 1551, the May was acquired by Andrew Balfour of Mountquhanie; and on May 12, 1558, by John Forret. It subsequently passed into the possession of Allan Lamont, and afterwards of Alexander Cunningham of Barns. This proprietor will long be remembered as being the first to erect, by permission of King Charles I., a lighthouse on the island in the year 1635. This lighthouse was the first to be built on the east coast of Scotland, and it consisted of a square tower about 40 feet high, provided with a flat roof, on which, about the beginning of the present century, upwards of 380 tons of coal were annually consumed. This primitive lighthouse still exists, and stands to the east of the modern building. The May next fell into the possession of the Balcomie family, from whom it was purchased in 1816 by the Commissioners of the Northern Lights, who erected a beacon at a height of 240 feet above sea-level. At first a system of oil-lamps and reflectors was used in this modern lighthouse, but in 1843 these were exchanged for the argand lamp and dioptric system of Sir David Brewster. During 1843–1844 a second and smaller lighthouse was erected, for the purpose of affording mariners a convenient landmark to enable them to avoid the Carr Rock.

The ruins of an old chapel, the only other stone erection on the island, may be seen to the south of the larger lighthouse. This chapel has been dedicated to St Adrian; it is rectangular in shape, being about 32 feet in length by 16 feet wide, and its windows are indicative of thirteenth century architecture. Its walls have been recently pointed under the careful supervision of the authorities of Her Majesty's Office of Works.

The island is composed of dolerite, which on its western side rises vertically from the sea to a height of 150 feet. Its eastern margin, though in a few places capable of accommodating boats, is in several localities rugged and uneven, presenting in its many indentions rich crops of various species of Algæ. Although the development of a columnar structure in this dolerite is less marked than in some parts of the mainland on the shores of the Forth, yet an incipient structure of this type is to be found in the south-west corner of the island.

The water in the vicinity is of a clear green shade of colour and contrasts very markedly with its muddy character further up the Firth, the river having purified itself during its subsequent seaward course, partly by the deposition of heavier sedimentary matter, and partly, too, by the oxygenation of many complex decomposable organic compounds into simpler chemical unions. As evidence of the purity of the water, it may be mentioned that on one occasion a white disc, having a diameter of 2 feet, was lowered by a sounding-lead from the bow of the steam-yacht "Medusa," and was gradually sunk to a depth of 9½ fathoms before it became invisible. The depth of the water in the immediate vicinity of the island varies from 9 to 20 fathoms.

The waters round the May have long been regarded as good fishing ground, and although at present the only inhabitants on the island are people connected with the lighthouse, historians record that formerly fifteen fishermen's families lived there, and that "the want of these families is a considerable loss to the general interests of the fishery in the Firth, for, placed as sentinels at its entrance, they were enabled to descry and follow every shoal of herrings or other fish that came in from the ocean." Again, the wool and fur of the sheep and the rabbits are said formerly to have been of superfine quality —"the fleeces of the coarsest wooled sheep from the worst pastures in Scotland, when put on the island of May, becoming in course of one season as fine as satin;" but this is no longer so—on the contrary, the wool and fur of these animals are just like other wool and fur. Ants, too, were in former years very abundant. Some years ago, however, the Commissioners of the Northern Lights tried in vain to exterminate them, and at present they are very abundant, although no ant-hills are to be seen. Sea-birds, such as skarts, dunters, gulls, and kittiewakes, are very common, the egg of the skart, which is green, and dotted over with black spots, being much prized by collectors.

Fresh water for the lighthouse employées is now brought from the village of Crail, on the Fifeshire coast, about 6½ miles distant, no permanent supply being found on the island.

Meteorological.—Mr Alexander Buchan, of the Scottish

Meteorological Office, has kindly furnished the following statistics bearing on the climatology of the May :—

1. *Rainfall.*—This has been computed from the averages of two places, whose mean annual rainfall is equal to that of the May, and the computations, which extend over a considerable number of years, are as follows :—

January,	2·33 inches approx.	July,	2·63 inches approx.
February,	1·70 ,,	August,	3·03 ,,
March,	1·50 ,,	September,	2·68 ,,
April,	1·68 ,,	October,	2·80 ,,
May,	1·72 ,,	November,	2·46 ,,
June,	1·80 ,,	December,	2·31 ,,

2. *Mean Atmospheric Pressure.*—This table represents the average of a period of thirteen years :—

January,	29·788 inches approx.	August,	29·866 inches approx.
February,	29·830 ,,	September,	29·848 ,,
March,	29·810 ,,	October,	29·802 ,,
April,	29·895 ,,	November,	29·838 ,,
May,	29·946 ,,	December,	29·806 ,,
June,	29·924 ,,	Average for the year,	29·853 ,,
July,	29·886 ,,		

3. *Temperature.*—An average, again taken for a period of thirteen years, gives the following figures :—

January,	39°·1 approx.	August,	57°·3 approx.
February,	39°·4 ,,	September,	54°·4 ,,
March,	40°·0 ,,	October,	48°·7 ,,
April,	43°·7 ,,	November,	42°·6 ,,
May,	48°·4 ,,	December,	40°·7 ,,
June,	54°·4 ,,	Average for the year,	47°·1 ,,
July,	57°·1 ,,		

It will thus be seen that in this area August is remarkable as being the month of maximum rainfall and maximum temperature ; (2) that the minimum of pressure and temperature occur in January, the maximum pressure being in May, and minimum rainfall in March ; and (3) that while the average range of pressure for the year is only 0·158 inches, the range of temperature amounts to 18°·2 Fahr.—figures far below what we find in continental regions, the climate being insular, and consequently far more equable than in the former areas.

As regards the flora, the only account which we possess of it is one by Mr Sadler, late Curator of the Botanic Garden, Edinburgh, and published in the *Transactions of the Botanical Society* for 1873, vol. xi. p. 390. In addition to the plants enumerated in Mr Sadler's list, we record the following:—

ROSACEÆ.

Potentilla tormentilla.

COMPOSITÆ.

Anthemis arvensis.
Arctium Lappa.

CARYOPHYLLACEÆ.

Cerastium triviale.

PLANTAGINACEÆ.

Plantago media.

JUNCACEÆ.

Juncus bufonius.
Luzula campestris.

POLYGONACEÆ.

Rumex crispus.
„ Acetosa.

CHENOPODIACEÆ.

Atriplex patula.

PORTULACEÆ.

Montia fontana.

GRAMINEÆ.

Festuca arenaria.
Glyceria loliacea.
Anthoxanthum odoratum.
Poa cæsia.

CYPERACEÆ.

Carex vulgaris.
„ distans.
„ fulva.
Eleocharis palustris.

FILICES.

Lastrea Filix-fœmina.

MARCHANTIEÆ.

Fegatella conica.

MUSCI.

Schistidium maritimum.
Hypnum chrysophyllum.
„ confertum.
„ prælongum.
Orthotrichum (sp.?)

LICHENES.

Ramalina scopulorum.
Parmelia aquila.
„ sinuosa.
Lichina pygmæa.

One Jungermanniaceous plant was found, but the species remained undetermined.

ALGÆ.

Enteromorpha compressa.
„ intestinalis.
Ulva linza.
„ latissima.
Porphyra amethystea.
„ vulgaris.
„ laciniata.
Ceramium acanthonotum.
„ rubrum.
diaphanum.
Chylocladia articulata.
Polysiphonia Brodiæi.
„ urceolata.
„ fastigiata.
„ nigrescens.
Dumontia filiformis.
Delesseria sinuosa.
Delesseria alata.
Cystoclonium purpurascens
Rhodymenia palmata.
„ laciniata.
Cladophora arcta.
„ rupestris.
„ laetevirens.
„ uncialis.
Conferva melagonium.
Ptilota elegans.
Elachistea fucicola.
Punctaria plantaginea.
Corallina officinalis.
Plocamium coccineum.
Chorda lomentaria.
Alaria esculenta.
Laminaria saccharina.
„ digitata.

Laurencia pinnatifida.
„ hybrida.
Leathesia tuberiformis.
Callithamnion polyspermum.
„ arbuscula.
Ectocarpus tomentosus.
„ littoralis.
„ siliculosus.
„ sphærophorus.
Fucus vesiculosus.
„ serratus.
„ nodosus.
„ platycarpus.
„ canaliculatus.
Halidrys siliquosus.
Himanthalia lorea (two varieties).
Desmarestia aculeata.
Gigartina mammillosa.
Chondrus crispus.
Furcellaria fastigiata.
Polyides rotundus.
Odonthalia dentata.
Ralfsia deusta.
Petrocelis cruenta.
Melobesia pustulata.
„ calcarea.
Hildenbrandtia rubra.

The more noteworthy points connected with the flora appear to be the following:—

1. The entire absence of trees, whose roots play so important a part in aiding in the disruption of rocks and the formation of soils, and whose leafy branches prevent at once rapid radiation and excessive warmth while they harbour many insects, and modify the conditions of exposure as regards wind currents.

2. The occurrence of *Porphyra* and young *Ectocarpi* parasitically on *Desmarestia aculeata*—the former being attached to the aculei of that plant.

3. The occurrence of a large growth of *Enteromorpha intestinalis* in a pool above the limit of high spring tides, and so furnished with saline matter exclusively by the agency of spray—a fact which is to be correlated with the usual mode of occurrence of this species in places where fresh water streams enter the sea.

4. The localisation of *Punctaria plantaginea*, which was found only at the level of high tide on the south-east, seaward, side of the island.

5. The very large vegetative development of *Cladophora arcta* and *C. uncialis*.

6. The abundance of *Plocamium coccineum*, of which, however, no specimen was found growing, and which must have come as drift from deep water.

The inaccessible character of the rocks on the west side of the island rendered the collection of Algæ impossible over a considerable area of this margin.

On the Algæ of Granton Quarry. By JOHN RATTRAY, M.A., B.Sc., Marine Station, Granton, Edinburgh.

(Read July 10th 1884.)

In this quarry a well marked division of the tidal belt into zones, each bearing a preponderance of certain species, is to be observed. We may enumerate these zones as follows:—

1. The upper tidal zone, characterised by its abundant growth of *Enteromorpha compressa* and *E. intestinalis*—both of which species are especially common on the landward side of the quarry, although very rare on the seaward side, which has an exposure to the south.

2. The median tidal zone, in which very few *Chlorosperms* are to be found, but which is marked out by a great development of Fuci, especially *Fucus platycarpus* and *F. nodosus*, as well as by the occurrence of many *Rhodospermic Ceramiums.*

3. The lower tidal zone, in which we again find a very great development of *Enteromorpha compressa* with *Ulva linza* growing around its lower margin.

4. The aqueous zone, which is always under water, and where one finds a few delicate *Callithamnia*, *Ectocarpi*, and *Laminaria saccharina.**

While the various belts thus pointed out are very readily distinguishable from one another, probably the fact of greatest immediate interest is the disappearance of *Laminaria saccharina*, which has occurred consequent on a lowering of the low water-level of the quarry, which was affected some time ago, in order to allow the steam-yacht connected with the marine station to enter the quarry from the river at high tide. A passage was cut through a bar of shingle and boulders to a depth of several feet, and the result has been that the large leaf-like thalli of the Laminaria have fallen from their attachment wherever that attachment was effected in the zone which is now periodically exposed to the air, but which was formerly invariably under water. It is to be noted, however, that this species of Laminaria has not entirely disappeared from the quarry; it is still to be found on the rocks which are not exposed to the air at every low tide, and also on cages which are buoyed in the quarry, and in which zoological specimens are kept alive.

* *Mém. de l'Acad. d. Sci.*, 1845, Bd. 337 *ff.*

It may further be remarked, that although *Laminaria saccharina* seems incapable of resisting for a prolonged period exposure to the air, *Laminaria digitata* does not appear to be affected in a similar manner, as we have recently seen it growing in places exposed at every ebb-tide, near Lamlash, in the island of Arran. Probably the greater succulency of the tissues of the latter plant, as compared with the former, may account for this curious physiological difference. A similar disappearance of Laminaria was noted in the lake of Stennis, Orkney, by the late Hugh Miller.

Observations on the Oil Bodies of the Jungermannieæ. By JOHN RATTRAY, M.A., B.Sc., Marine Station, Granton, Edinburgh.

(Read 13th March 1884.)

Gottsche (in his "Researches on *Haplomitrium Hookeri*, 1843,") first called attention to the remarkable structures now being considered, naming them "cell bodies" (Zellen Körper), in 1857 Holle changed the name to "cell vesicles," and in 1874 Pfeffer designated them "oil bodies," chiefly on account of their fatty nature. Similar bodies were noted by Mirbel in 1835 in the Marchantieæ.

The main results at which Pfeffer has arrived may be stated as follows:—

1. Oil bodies may be classified under two heads, according to the appearance they present—(1) *non-emulsiform, or homogeneous oil-like oil bodies*, which may be simple or compound, the latter being made up of a limited number of component parts, as in *Nardia scalaris*, *Blepharostoma trichophylla*, *Kantia trichomanis*, or of more numerous, but more minute portions, as in *Lophocolea bidentata*, *Trichocolea tomentella*, and others, membrane-like walls, either straight or curvilinear, existing between these components; (2) *emulsion-like or heterogeneous* oil bodies, in which rounded oily droplets, it may be of different sizes, are embedded in a medium of different refractive index, as in *Radula complanata*, *Frullania tamarisci*, &c.

2. The largest non-emulsion oil bodies occur in *Nardia scalaris*. Their form is cylindrical, and their greatest diameter $= 0{\cdot}02$ mm., only a small number (3 to 6) occurring in one cell. The largest emulsiform oil bodies are found in *Radula complanata*, their form being ovoid and their greatest diameter $= 0{\cdot}02$ mm., and they appear either singly in the cells, or several of different sizes in one cell.

It may be added that some of the oil bodies of *Aneura multifida* and *Frullania tamarisci* approximate those of *Radula* in size. In consistence the oil bodies are semifluid, changing their form under slight pressure, and resuming their original outline when the pressure is removed; when broken, round droplets of fatty oil escape.

3. The localities where oil bodies are found in these plants are various, such as in (1) foliage leaves; (2) coats of the reproductive organs, *i.e.*, of the *antheridia* and *archegonia*, as in *Radula complanata*, *Mastigobryum trilobatum*, &c.; (3) stem—the oil bodies in the stem cells being smaller than those in the leaf cells, and at the same time larger and more numerous in the peripheric than in the central stem cells, as in *Trichocolea tomentella;* (4) root hairs, as in *Lophocolea bidentata;* (5) walls of antheridia and archegonia, as in *Blepharostoma trichophylla;* (6) sporogonium stalk, as in *Blepharostoma trichophylla* and *Nardia scalaris*.

4. According to Pfeffer, oil bodies are absent in *Jungermannia bicuspidata*, *Pellia epiphylla*, *Metzgeria furcata*, and, according to Gottsche, in *Jungermannia setacea*, *J. connivens*, and *J. divaricata*.

5. Four views have been held regarding the composition of the oil bodies:—

(1) Gottsche* believed them to be resinous or waxy, and Hofmeister † also thought them resinous.

(2) Holle ‡ maintained that they were a mixture of oil and resin.

(3) Schacht § said they were composed of inulin. It may here be noted, that treatment with alcohol produces angular crystals in the cells of Hepaticæ, which dissolve on addition of water. These crystals are distinct from the oil bodies.

(4) Pfeffer regards them as chiefly composed of fatty oil, although traces of wax, resin, gum or ethereal oil may be present, as well as very minute quantities of water and albuminous or proteinaceous substances. These results rest on the following considerations:—

(*a*) Dilute alcohol, spirits of wine, benzole, turpentine, ether, and carbon bisulphide cause the droplets to fuse, a fine limiting membrane alone persisting and retaining approximately the size and form of the original oil body. A second membrane may be seen in *Nardia scalaris*, &c., after the action of absolute alcohol.

(*b*) Boiling with weak potash for a quarter of an hour does not cause the drops to vanish, and stronger solutions only act with difficulty.

(*c*) Wax or resin is solid at the ordinary temperature, but the oil bodies are semifluid, and yet traces of wax or resin may be present dissolved in the fatty oil.

(*d*) Ethereal oils are not present in large quantity, inasmuch as boiling in water would remove them, and the oil bodies would change

* *Loc. cit.*, p. 289. † *Pflanzenzellen*, p. 396. ‡ *Loc. cit.*, p. 18.

§ *Lehrbuch der Anatomie u. Physiologie*, 1856, 1 Thiel, p. 60.

greatly in appearance, yet after such treatment they are found to persist in the liquid state.

(*e*) The oil bodies are not a balsam, because on removal of the ethereal oil a solid resin would remain which is not found.

(*f*) Pfeffer has extracted fatty oil from *Mastigobryum trilobatum.*

(*g*) Treatment with sugar solution or glycerine causes the volume to lessen and the outline to become wavy. By again adding water these changes are reversed, *e.g.*, in *Nardia scalaris.*

(*h*) The membranes left behind after solution of the fat are albuminous, being insoluble in dilute alkalis, acids, and in boiling water. The oil body too is not entirely made up of pure oil, inasmuch as a small amount of insoluble residue remains after the action of alcohol containing corrosive sublimate, an insoluble Hg-compound being formed. Similarly the divisional walls in compound oil bodies also contain proteinaceous matter.

The slight divergences to be seen on treatment of different oil bodies with the same reagent are due either to a variability in the quantity of albumen present, or to a difference in the nature of the fat.

The form of the oily droplets occurring inside such oil bodies as those of Radula is rounded, but the oil bodies as a whole may be ellipsoid or oval, their form being due primarily to the shape of the cell lumen in which they appear, and secondarily to the proteinaceous envelope that invests them, this envelope being of sufficient resistance to retain the original form of the oil body, even after the droplets have been removed by ether or other reagents; adhesion to the plastic protoplasm of the cell also tends to modify their general outline.

Again potassium-phosphate is a solvent for albuminous substances, and according as it is present in greater or less amount, the oil bodies are more or less speedily acted on by other reagents.

(*i*) The result of the action of potash on *Mastigobryum* or *Nardia* indicates the fact that these oil bodies are not composed of pure fat. This reagent produces vacuolation and dimness in the oil drops, a result attributable to the swelling and solution of foreign constituents present in the oil bodies.

(*k*) If specimens be dried, the oil bodies diminish in size, if again moistened they resume their original magnitude. Herbarium specimens may be kept for several years (7–10), and still show traces of these oil bodies; after a time they are absorbed by cell wall and cell contents, their long preservation proving their small volatility.

6. No trace of tannic acid is to be detected in the oil bodies of *Radula* or *Nardia.*

7. They are not doubly refractive.

In Marchantieæ* the following leading points are to be noted :—

* Pfeffer, *loc. cit.*

1. Oil bodies occur in isolated cells of the thallus and in cells of the gemmæ. They are emulsiform in character, and their colour is brown in *Marchantia polymorpha* or brownish-red in *Lunularia vulgaris*.

2. The reactions shown are generally similar to those found in *Radula complanata*, although dilute potash acts differently on the oil bodies of Marchantia and on those of Lunularia; in the former the droplets fuse slowly, in the latter the oil bodies suddenly disappear, unless the very dilute potash be slowly drawn under the cover glass, an oil droplet inside a limiting membrane being then formed. In this latter case the fat is in a finely divided state, and easily saponified.

3. Tannic acid occurs in the oil bodies of Fegatella, Lunularia, and Marchantia in small quantities; it appears in oil bodies just formed no less than in older oil bodies, and proteinaceous substances are also present in minute traces. As regards the tannic acid, ferrous sulphate, with slight pressure, causes a deep "black-blue" colour, which disappears after application of hydrochloric acid.

Potassium bichromate, again, does not alter the reddish-brown colour of the oil bodies, but instead of being, as previously, soluble in alcohol, they become insoluble, a similar reaction being found in the case of the tannic acid drops in the joints of *Mimosa pudica*.*

With reference to the development of oil bodies, it is to be noted—

1. That the oily droplets appear in the cell sap, though they may lean against protoplasmic strings.

2. That emulsiform or non-emulsiform bodies are formed according to the amount of fusion that is effected between these droplets; in the latter fusion is most complete.

3. That the oil droplets appear either after cell divisions are completed, and the chlorophyll bodies are formed, as in *Nardia scalaris*, or while the cells are dividing, and prior to the complete formation of chlorophyll, as in *Mastigobryum tribolatum*.

In the case of *Radula complanata*, a dim mass of droplets occupy the entire lumen of young cells, a membrane forms around this; as the cell grows this dim oil body, not increasing in size, is surrounded by a clear area; but in basal cells of adult leaves, I have repeatedly observed emulsiform oil bodies filling the cell lumen entirely, and in such cells the chlorophyll bodies had the same shade of colour as in other adjoining cells less oleiferous. These solitary oil bodies may have resulted from fusion of several smaller ones by mutual pressure, although no traces of the faint membrane surrounding each constituent body could be detected. Moreover, if two or more oil bodies be present in a cell, they are to be found in the youngest stages; that is, oil bodies once formed do not divide. In *Nardia*

* Pfeffer, *Physiolg. Untersuchungen*, 1873, p. 12 *ff.*

scalaris, *Plagiochila asplenioides*, *Mastigobryum trilobatum*, and *Radula complanata*, the oil-like droplets, according to Pfeffer, appear first at the leaf apex, and are formed later towards the leaf base, but after dissecting numerous apical buds of Radula with needles in water, I have failed to observe any such sharp distinction between the apical and basal regions of the leaf as has thus been indicated; on the other hand, the dimness which ultimately results in an oil body seems of fairly uniform intensity in both these localities.

In addition to the above, the following points are noteworthy :—

1. The oil bodies of *Radula complanata* often exhibit very active movements in their interior, somewhat like those in salivary corpuscles, as was first pointed out by Dr Archibald Dickson, Edinburgh.

2. Very dilute acetic acid when applied accelerates this movement. Turpentine and benzole, a short time after application, increase the rapidity of the movements, but prolonged exposure to these reagents results in fusion of the oil droplets.

3. The colour of the non-emulsiform compound oil bodies of *Kantia trichomanis* is of a beautiful azure-blue shade, and this causes the leaves to assume a delicate bluish-green tint, which becomes more marked if specimens are mounted for some time in very dilute acetic acid.

Regarding the physiological significance of these oil bodies, the results arrived at by Pfeffer may be stated as under :—

1. They are not assimilation products, because they occur in cells that never contained chlorophyll, *e.g.*, in hairs or young leaves before the formation of chlorophyll, as in *Mastigobryum trilobatum*; and again, since the oil droplets appear in cells at the tips of the leaves before developing in basal leaf cells, the fatty matter cannot wander from the stalk to the leaves.

2. The material out of which the oil bodies are formed, may be glucose or some allied substance, although no reduction of cupric oxide, except faintly in *Lepidozea reptans*, is seen, there being no storing of glucose; that is, it becomes transformed into oil as rapidly as it is formed. Similarly starch becomes oil in the seeds of Pæony.* Fat may be present in a fine state of division in the protoplasm, yet the oily droplets occur only in the cell sap.

3. The oil bodies of Hepaticæ once formed, behave as "excretory" matter, having no latent assimilative value like starch or glucose. Thus the cell sap in the cells of the sporogonium stalk of *Diplophyllum albicans* gets dim before the sporogonium emerges from the perichaetium, when it emerges the oil bodies are already

* Pfeffer, *Untersuchungen über Proteinkörner u. s. w. Jahr. f. wiss. Bot.*, Bd. viii. p. 507.

formed. The sporogonial cells now elongate, but the oil bodies do not change in form or number, although the starch disappears entirely at elongation. This also happens in *Blepharostoma trichophylla*, &c.

4. Plants of *Mastigobryum trilobatum*, *Plagiochila asplenioides*, *Fegatella conica*, &c., kept in darkness for three months, were found to have oil bodies present in their leaves that had formed in the darkness, and previously formed oil bodies still persisted.

With reference to these positions it may be noted—

1. That if these oil bodies be formed out of glucose, they have an indirect relation to protoplasm itself, inasmuch as glucose can only exist where a protoplasmic basis has previously been, and that they are accordingly ultimately protoplasmic products.

2. That their persistence in the cells of a developing sporogonium stalk is to be expected, as sufficient starch which has not undergone fatty transformation (assuming that glucose does become converted into oil bodies) is present for purposes of growth without drawing on the oily reserve.

3. That the great numbers and large volume of some of these oil bodies, such as those of *Radula complanata*, is *a priori* opposed to the idea that they represent so many excretory calculi of no assimilative value to the plant.

4. That the early appearance of so many oil droplets in the cells, as opposed to a late casual appearance in but a few cells, is, as has been suggested by Professor Dickson, also opposed to the view that they are excretory, no less than the fact that in some of the emulsiform oil bodies rapid movements are to be found.

5. That their occurrence in leaves formed in darkness may be accounted for by reserve assimilative materials stored up in the cells previous to exposure to this condition, and probably subjection to starvation, such as impoverished soil or lack of water, would result in proving that before death supervened these oil bodies would be used up as reserve food supplies.

6. That the hyphæ of a fungus were often observed in specimens of *Kantia trichomanis* examined from the Moss House of the Botanic Garden; and, in close proximity to these hyphæ, I have noted that some of the bluish oil bodies were found in a broken-up condition, as if they had been partially removed by the adjoining hypha—minute oily droplets being at the same time found in these fungoid filaments.

Bibliography.—*Anatomisch. Physiolog. Untersuchungen über Haplomitrium Hookeri in Verhdlg. d. Leopold. Carolin. Akad.*, 1843, Bd. xii. Abth. i. p. 286 *ff.*; *Ueber die Zellenbläschen der Lebermoose*, 1857, p. 11; *Die Oelkörper der Lebermoose, Flora oder allgeméine botanische Zeitung herausgegeben von der Königl. Bayer. botanischen Gesellschaft in Regensburg*, 1874.

On the Germination of Podophyllum Emodi. By Professor Alexander Dickson, M.D. (Plate IX. fig. A.)

(Read 9th November 1882.)

Observations have been made by botanists, from time to time, on a peculiarity in the germination of certain plants belonging to various natural orders where the bases of the cotyledons are connate into a narrow tube of greater or less length. The tube being too narrow to allow the upward passage through it of the developing plumule, this last breaks its way out through its base. The above-mentioned anomalous condition has been observed in the following orders:—

Ranunculaceæ. Delphinium fissum. „ ochroleucum.	Bernhardi; *Linnæa*, vol. vii., 1832.
„ nudicaule.	Asa Gray, Silliman's *Journal*, quoted in *Journal of Botany* for Dec. 1871; and note thereon by myself, in *Journal of Botany*, 1872, p. 45.
Anemone coronaria, and various other species. Eranthis hyemalis.	Irmisch, *Bot. Zeitung*, 1865.
Berberidaceæ. Leontice altaica. „ vesicaria. Cruciferæ. Dentaria. Umbelliferæ. Bunium luteum. Prangos ferulacea. Ferulago.	Bernhardi, *loc. cit.*
Cucurbitaceæ. Megarrhiza californica.	Asa Gray, *Bot. Text Book*, 6th edit., 1880.
Primulaceæ. Dodecatheon Meadia.	Bernhardi, *loc. cit.*

To this list has now to be added another Berberidaceous plant,—*Podophyllum Emodi*,—the germination of which has been observed in connection with seeds from Thibet, recently presented to the Royal Botanic Garden, Edinburgh, by Mr Elwes. The cotyledonary tube here is of considerable length (about 3 inches), and in most cases it would appear that the plumule remains over winter in a comparatively undeveloped condition, in this respect resembling *Leontice*, as described by Bernhardi, where only the cotyledons and a small tuber appear the first season, the development of the plumule occurring in the second. In the one I have figured, however, the plumule had developed sufficiently to break through the base of the cotyledonary tube, just as in *Delphinium* or any of the other cases mentioned. The cotyledonary laminæ are expanded and leaf-like; and in several specimens I observed the remarkable peculiarity of the development of an adventitious root from the cotyledonary tube a little above its base.

Explanation of Plate IX. Fig. A.

Fig. A.—Outline sketch of seedling of *Podophyllum Emodi*.
- *lc* = Blades of the cotyledons.
- *tc* = Cotyledonary tube; formed by connation of the stalks of the cotyledons.
- *f* = First leaf of plumule, which has broken out through the base of the cotyledonary tube.
- *ar* = Adventitious root, springing from the lower part of the cotyledonary tube.

On the Occurrence of Foliage-leaves in Ruscus (Semele) androgynus; *with some Structural and Morphological Observations.* By Professor Alexander Dickson, M.D. (Plates IX., X., and XI.)

(Read 12th July 1883.)

For many years I have had, in my greenhouse at Hartree, a plant of *Ruscus androgynus*, grown in a large flower-pot. The plant has thriven fairly well; but the aërial stems are less strongly developed than when the plant is not so confined,—nor has it as yet flowered. Lately, however, my attention was attracted by certain leaves, with long petioles and ovate or lanceolate-ovate blades, springing from the soil on the side of the plant next the light. At first I thought that these leaves must belong to some plant accidentally introduced along with the *Ruscus*; but on closer examination, when having the plant divided for the purpose of propagation, I found that the leaves in question really belonged to the *Ruscus*. In ordinary descriptive language, they would be termed "radical" (Plate IX. figs. 1 and 2).

The occurrence of foliage-leaves in a plant so highly specialised as *Ruscus*, where the leaf-functions are in ordinary circumstances performed exclusively by expanded cladodes, is of great interest; and it can hardly be doubted that if the development from seed were examined we should find foliage-leaves constantly present, just as in some other highly specialised forms we see a more generalised or ordinary development in the young state. For example, the development of bipinnate leaves in the seedlings of phyllodineous Acacias, where in later life the leaves are all developed as phyllodia; of ternately compound leaves in the seedling Furze (*Ulex*), where in later life the leaves are simple and much reduced, the leaf-function being mainly performed by the green branch-thorns; and of a few genuine foliage-leaves succeeding the cotyledons in *Sciadopitys*, where in later life the leaf-organs are all reduced to scales and the leaf-function is performed by cladodial needles. To an evolutionist all such cases are invested with what may be called an archæological interest, as affording indications of the kind of ancestor from which the more specialised form may be supposed to have derived its origin. But, however that may be, the traces here and there of the more generalised structure alongside of the more specialised are most important as links in the morphological series. In the present case, I am inclined to consider the immediate cause of the production of foliage-leaves to have been the confinement of the plant in a flower-pot, with consequent weakening of the aërial stems; and, from the propagation experiments I have made, I think that foliage-leaves may almost always be expected from feeble rhizome-cuttings.

In these foliage-leaves, the blade is, as just mentioned, ovate or lanceolate-ovate, and is somewhat acuminate. In my largest example, the lamina is about 6 inches in length, by about $3\frac{1}{2}$ inches at its greatest breadth. In colour, smooth surface, and dry leathery consistence, this lamina closely resembles the cladodial expansion. A considerable number of longitudinal veins run nearly parallel to one another from base to apex, towards both of which they converge. One of these veins occupies the middle line, is considerably stronger than the others, and constitutes a distinct midrib projecting somewhat on the lower leaf-surface. It is to be noted that, as we pass from the midrib outwards, every fourth vein is considerably stronger than the three intervening ones. Of the stronger longitudinal veins, there are from 5 to 9 on each side of the middle line. Between the longitudinal veins, small transverse veinlets extend, forming a somewhat rectangular net-work. The upper surface of the blade is of darker colour than the lower. The upper epidermis is almost wholly destitute of stomata, while the lower is well supplied with them. The stomatic guard-cells contain numerous well-coloured chlorophyll-bodies, and are for the most part so placed that the slit is parallel to the long axis of the leaf. The chlorophyll-parenchyma towards the upper leaf-surface consists of about four layers of somewhat closely packed cells, which, instead of exhibiting the ordinary pallisade-form, are slightly flattened parallel to the surface. That towards the lower surface is somewhat thinner, consisting of about three layers of cells, rather more loosely arranged. Between the upper and lower chlorophyll-parenchyma, there are (just as in the *cladodes* of this and other species of *Ruscus*) about two layers of somewhat irregularly shaped cells destitute of chlorophyll, and with rather firm walls. The fibro-vascular bundles exhibit a well-marked sclerenchymatous sheath, and the position of the phloëm and xylem elements is normal; *i.e.*, the xylem is towards the upper, and the phloëm towards the lower leaf-surface. The petiole is about 5 inches long, and is somewhat flattened where it passes rather gradually into the lamina. About its middle, it is nearly semi-cylindrical (Plate IX. fig. 3); convex externally or below, and nearly plane internally or above. Lower down, the inner face becomes concave; and it is more and more channeled as it is traced towards the base, which is expanded and sheathing, with somewhat scarious margins. Between these foliage-leaves and the—in this plant—much more familiar leaf-scales, transition forms are to be seen, where the sheathing base is more marked, while the petiole is shortened and the lamina much reduced.

When these foliage-leaves are compared with the cladodes (developed on the aërial stem), the following striking differences may be noted.

1. In vernation the foliage-leaf is convolute, while the cladode—if I may speak of "vernation" in this connection—is perfectly flat.

2. The foliage-leaf is provided with a long stalk, while the cladode is nearly sessile.

3. The foliage-leaf exhibits a distinct midrib, while the cladode does not. They resemble each other, however, in the longitudinal disposition of the veins, of which every fourth one is stronger than the intermediate ones.

4. In the foliage-leaf, the non-stomatic surface is the upper, and the stomatic the lower,—as in ordinary leaves. In the cladode, on the other hand, the non-stomatic surface is morphologically the lower, while the stomatic surface is morphologically the upper (Plate X.); these surfaces, however, becoming inverted by a twist at the base of the cladode, whereby the stomatic surface is directed downwards and the non-stomatic upwards. In this arrangement, *R. androgynus* resembles *R.* (*Danäe*) *racemosus*, and differs from *R. aculeatus*, where the stomata are equally disposed on both surfaces of the cladode, which is twisted only so far as to direct its edges upwards and downwards.* In the allied *Myrsiphyllum asparagoides*, the stomata are developed exclusively on the morphological lower surface of the cladode, which is not twisted at all.

The almost exclusive development of the stomata on the morphological upper surface of the cladode, and the inversion of the surfaces by a twist, in *R. androgynus* and *R. racemosus*, is, in many respects, of great interest. A precisely similar phenomenon is to be noted in the leaves of the

* Goebel (Schenk's *Handb. d. Botanik*, iii. 1, p. 269) refers to *R. racemosus* and *R. aculeatus* as both having their cladodes twisted about 90°, so as to direct their edges, instead of their surfaces, upwards and downwards, like the phyllodia of New Holland Acacias; a statement correct as regards *R. aculeatus*, but not so as regards *R. racemosus*. In *R. androgynus*, the amount of twisting varies with the position of the branch supporting the cladode, being just sufficient to effect the downward direction of the stomatic surface,—or, rather, its direction away from the light. In *R. Hypoglossum*, although the stomata are equally distributed over both surfaces, there is practically no twisting of the cladode.

Chilian Amaryllids *Alstrœmeria*, *Bomarea*, and *Leontochir*, and of the Liliaceous genera (curiously enough, also Chilian) *Callixene* and *Luzuriaga*, where the stomata are developed exclusively on the morphological upper leaf-surface, which ultimately becomes directed downwards by a twist; and various authors have noted the occurrence of a similar condition in species of *Allium*, of *Gramineæ*, &c.

The physiological problem afforded by these twisted cladodes or twisted leaves is one of considerable difficulty. At first sight we are disposed to wonder at an arrangement where the stomata appear to be developed—so to speak—on the wrong surface, to be set right afterwards by a twist.* Of course, given a pale stomatic surface on the morphological upper side, the twisting of the organ might naturally be expected to occur: just as ordinary leaves tend to right themselves by a twist, when their surfaces are reversed artificially, by inversion of the plant or branch; or as in the familiar case of a plant grown at a window, where the leaves so adjust themselves that the stomatic surface is directed away from the light. But why should the stomata have been developed on the morphological upper surface, instead of on the lower? It may be assumed that such a curious arrangement must be of some use to the plant; and, this premised, the question arises as to whether it is the shifting of the stomata to the morphological upper side, or the twisting of the organ on itself, that is the matter of primary physiological importance. As regards the actual sequence of phenomena in the development of the plant, there is no doubt that the formation of the stomata on the morphological upper side precedes the twisting of the organ, which only takes place when the parts are set free by unfolding of the bud; but I think we may at once set aside the idea that the shifting of the stomata to the morphological upper side is the matter of primary importance, since it is scarcely conceivable how such a shifting can of itself be of any service to a plant, except, of course, in the case of one with its leaves floating on the surface of the water. If, however, we look

* An apparent paradox almost as great as that exhibited by the flower of *Malaxis paludosa*, pointed out by Darwin, in which the labellum, instead of becoming inferior by a half-twist of the ovary, as in ordinary Orchids, is restored to its original superior position by a whole twist.

to the twisting of the organ upon itself as the primary physiological object, I would suggest that such twisting may be an arrangement whereby water (as rain) falling upon the exposed surface would, instead of lodging in the axil of the organ, either be thrown off before reaching the base, or be conducted to the under surface of the base, thence to run down the stem to the root.

In the cladodineous plants above mentioned, we have an interesting morphological series: from *Myrsiphyllum*, with stomata on the morphological under side of the cladode, which is not twisted; through *Ruscus aculeatus*, with stomata equally distributed on both sides of the cladode, which is twisted a quarter-turn, so as to stand vertically; to *Ruscus androgynus* and *R. racemosus*, where the stomata are on the morphological upper side of the cladode, which is twisted a half-turn, so as to become inverted-horizontal. An evolutionist might imagine a gradually progressive shifting of the stomata from the morphological lower to the morphological upper side, the stomata tending in the first place to become distributed equally on both sides, and ultimately to be accumulated—so to speak—on the morphological upper side, and that such shifting of the stomata was accompanied, *pari passu*, by a progressive twisting of the organ, first into the vertical position, and then into the inverted-horizontal. The difficulty here, however, is to conceive of any external conditions sufficient, under natural selection, to effect, in a terrestrial plant, the fixation, from time to time, of small variations in stomatic distribution, leading ultimately to the accumulation of the stomata on the morphological upper side. In an aquatic plant with floating leaves, it is easy enough to imagine such a shifting of the stomata to the morphological upper side; since it is evident that the smaller the number of stomata in contact with the water the better the plant would fare in the struggle for existence, and therefore that the variations in stomatic distribution that would be fixed by natural selection would all be in one direction, viz., towards the accumulation of the stomata on the upper side. But, as regards terrestrial plants, the advantage of any small variations in stomatic distribution can scarcely be appreciable, and seem very unlikely to have become fixed and accumulated by natural selection. To enter further on this subject, however, would lead me beyond the scope of the present paper; and I would leave the matter in the hands of those who may occupy less of the position of an agnostic towards the doctrine of evolution, or who may entertain greater hopes that the question of the "origin of species" can ever be settled, than I do.*

5. In the foliage-leaf of *Ruscus androgynus*, the elements

* It may not, however, be out of place for me here briefly to refer to the case of heterophyllous aquatics, and to the very interesting observations and experiments of Hildebrand on certain aquatic and amphibious plants, as having an important bearing on this question of stomatic distribution.

As regards heterophyllous aquatics, it is well known that in some (*e.g.*, certain Batrachian *Ranunculi*, and *Cabomba*) there are two forms of leaves: the submerged, which are destitute of stomata, and the floating, which have stomata only on their upper surface. In others, again, (*e.g.*, *Hippuris*) there are two forms of leaves, the submerged and the aërial. While in a third category there is a plant, *Sagittaria sagittifolia*, in which Hildebrand (*Bot. Zeitung*, 1870, p. 17) has pointed out that all three forms may be produced; the leaves formed at the beginning of the season being submerged, those formed a little later being floating ones, while the last developed are of the ordinary aërial type. In connection with the floating leaves, he further made the interesting observation that while the earlier developed ones are almost quite destitute of stomata on the under side, those developed later exhibit a distinct approximation in structure to the aërial leaves, the stomata on the under side being almost as numerous as they are in these leaves.

Of perhaps still greater interest are the so-called amphibious plants, such as *Polygonum amphibium* and *Marsilea*, which may appear in two forms: the one terrestrial, with aërial leaves, and the other aquatic, with floating ones. In connection with these amphibious plants Hildebrand has made some important observations (*loc. cit.*, p. 1). In *Marsilea*, he made the discovery of floating leaves in a plant of *M. quadrifolia* which happened to be growing from the bottom of a tank. These floating leaves had the stomata exclusively on the upper leaf-surface, while in the ordinary aërial leaves they are nearly equally distributed over both surfaces. He further experimented with other species,—*M. elata* and *M. pubescens*,—and found that these also, when planted under water, produced floating leaves. In the case of *Polygonum amphibium*, he took plants of the terrestrial form, with preponderating development of stomata on the under leaf-surface, and sunk them in a tank in 3 feet of water, with the result that the growth of the aërial shoots was arrested, their leaves decaying away, while from the rhizome other shoots were produced, which in a few weeks reached the surface, and spread themselves out with their leaves, now developed as floating ones.

Such facts are certainly very striking. The transition forms between the floating and the aërial leaves in *Sagittaria* might fairly be used in illustration of the steps of a supposed evolution of the one leaf-type from the other—the floating from the aërial, or *vice versâ*. The case of the amphibious *Marsileas* and *Polygonum*, however, seems a very extraordinary one; inasmuch as here we have the sudden production of floating leaves accompanying a change in the external conditions: so extraordinary, indeed, as to have led Hildebrand to hazard the conjecture that in such cases the aquatic form was the original one; that the terrestrial form was slowly evolved under natural selection; and that the sudden production of floating leaves depends on the retention by these plants of a capacity for reversion, under suitable conditions, to the ancestral type.

of the fibro-vascular bundles are disposed as in ordinary leaves; *i.e.*, the phloëm portion of the bundle is placed towards the lower surface, and the xylem portion towards the upper surface. In the cladode of that plant, on the other hand, the position of these elements is reversed; the phloëm being towards the morphological upper surface, the xylem towards the morphological lower surface (Plate X. fig. 1). In the cladodes of *R. racemosus* and *Myrsiphyllum asparagoides*, I have found the same arrangement. In the barren cladodes of *R. Hypoglossum*, the same is also usually to be seen; but sometimes there seems a tendency in the middle bundle to be multiple, with the elements variously directed,—in evident connection with the possibilty of the emergence of an inflorescence in the middle line. In the barren cladodes of *R. aculeatus*, the position of the fibro-vascular elements does not seem to be very constant: usually the phloëm is directed towards the morphological upper surface, as in the other cases; but sometimes—especially in the smaller veins—the phloëm and xylem are placed obliquely to the surfaces of the cladode, or may even have an altogether reversed direction.

The direction of the phloëm elements of the fibro-vascular bundles towards the morphological upper surface, to be seen in these cladodes, and most clearly in those forms where the leaf-like specialisation of the cladode is greatest, as in *R. racemosus*, *R. androgynus*, and *Myrsiphyllum asparagoides*, is very interesting, and is, it seems to me, of great importance from a morphological point of view,* especially in connection with the vexed questions of the constitution of the *squama fructifera* of Conifers and of the "needle" of *Sciadopitys*,—questions on which I would take this opportunity to make some remarks.

A. As to the *squama fructifera*, Schleiden was the first to question the accuracy of Robert Brown's idea that it

* At first sight, one is tempted to inquire whether the position of the fibro-vascular elements may not have some relation to the development of the stomata on one or other surface. That, however, there is no such relation, and that the position of these elements has a morphological rather than a physiological significance, is proved by the fact that in the twisted leaves of *Alstrœmeria*, *Bomarea*, and *Luzuriaga*, the position of these elements is the same as in ordinary leaves (viz., the xylem to the morphological upper, the phloëm to the morphological lower surface); while in the cladodes under consideration these elements have the reverse position, whether the cladodes are twisted, as in *R. androgynus*, or not, as in *Myrsiphyllum asparagoides*.

represented an open carpel. He pointed out its position in the axil of a bract, and argued that it must therefore be axial in its nature. At the same time, however, he adopted Brown's hypothesis of the ovular nature of the female reproductive structure ; and accordingly looked upon it as a placenta,—a view that, curiously enough, has in recent years been revived, though in somewhat modified form, by Professors Sachs and Eichler.

In 1853, Alexander Braun,* on teratological evidence afforded by Larch cones, in which the axis was prolonged through the cone as a leafy branch (*durchwachsene Zapfen*), asserted that the *squama* was formed by the growing together of two leaves. His view, as afterwards more clearly explained by Caspary, who adopted it,† being that the cone-scale consists of two carpels which are connate and are the first leaves of a scarcely developed shoot springing from the axil of the bract.

In 1860, Baillon‡ showed that the *squama* originates as a mammilla in the axil of the bract, after the manner of an axillary shoot ; and it may, I think, be looked on as almost certain that a secondary axis does enter into its constitution, if, indeed, it does not form the whole of it. Baillon viewed the *squama* as representing an expanded shoot or cladode ; and in this opinion I am strongly disposed to concur.

In 1869, Van Tieghem§ made a most important histological contribution to the subject, by showing that the fibro-vascular bundles of the *squama* are so arranged that their phloëm elements are directed towards the upper, and their xylem towards the lower surface. He suggested that here we had an arrested axis giving origin to one carpel or possibly two carpels (the number he left an open question). If there was only one carpel, then it was supposed to spring from the posterior aspect of the secondary shoot ; and if there were two, then these were

* "Das Individuum der Pflanze, &c.," *Abhandl. der k. Akad. d. Wissensch. zu Berlin*, 1853, p. 81, note.

† Caspary, *De Abietinearum Carr. floris feminei structura morphologica*, Königsberg, 1861, p. 4.

‡ Baillon, *Recherches organogéniques sur la fleur femelle des Conifères*, Paris, 1860, p. 6.

§ Van Tieghem, "Anatomie de la fleur des Gymnospermes," *Ann. des Sc. Nat.*, 5e Sér., Botanique, x. (1869) p. 274, note.

supposed to have become united to each other by their posterior margins: in either case the superior position of the phloëm elements would thus be accounted for. The latter of these alternatives was adopted in 1872 by Von Mohl.*

In 1868, Sachs † advanced the opinion that the female cone represents a single female flower with a spike-like arrangement of open carpels (the *bracts* of authors), each with a placental excrescence or appendage from the inner surface of its base, this placenta being flatly expanded to form the *squama fructifera* of authors. Sachs's view has been adopted and elaborated by Eichler,‡ who relegates the placental appendage to the category of *ligular* formations, to which belong the *scales* on the inner face of the petals in *Lychnis* and *Silene,* the *corona* of *Narcissus*, the *stamens* on the inner face of the petals in *Primulaceæ*, &c., in all of which there appears to be the same remarkable arrangement of the fibro-vascular elements, with the phloëm directed superiorly or internally, and the xylem inferiorly or externally.§ Such a hypothesis would, no doubt, account for the arrangement of the fibro-vascular elements in the *squama;* and it has the further recommendation of correlating, as homologically equivalent, the female cone with the so-called " male cone," which is undoubtedly a single flower. It is to be borne in mind, however, that it is a hypothesis based upon another hypothesis, viz., that the female reproductive structures are naked ovules,—one which I still hold to be destitute of any solid foundation ; and, furthermore, it appears to me that the idea of the *squama* being merely a ligular appendage to the bract is wholly at variance with what may be seen in cones exhibiting " retrograde metamorphosis " into the ordinary branch form, where the not unfrequent formation of an axillary bud is very manifestly part of the metamorphosis of the *squama*.

B. As to the " needles " of *Sciadopitys*. The " needles "

* *Bot. Zeitung*, 1872, p. 23.

† Sachs, *Lehrbuch der Botanik*, 1868, p. 427.

‡ Eichler, " Uber die Weiblichen Blüthen der Coniferen," *Abhandl. der k. Akad. d. Wissensch. zu Berlin*, 24 Nov. 1881.

§ See Van Tieghem, "Structure du Pistil des Primulacées et des Théophrastées," *Ann. des Sc. Nat.*, 5e Sér. xii. (1869) p. 329.

in this remarkable conifer were regarded simply as leaves until, in 1866, I pointed out that they were placed in the axils of scale-leaves, and that they differed essentially from the few foliage-leaves which occur in the young plant, in having two vascular bundles, one on either side of the middle line, instead of the single mesial bundle or midrib exhibited by the foliage-leaves. I concluded that these "needles" should be referred to the category of phylloid shoots or cladodes.*

In 1868, Dr Engelmann propounded the view that the "needle" of *Sciadopitys* consisted of an abortive axillary shoot, developing two leaves which had become fused together.† According to this view, the structure would be comparable to the bifoliar spur or fascicle in *Pinus sylvestris*, with connation of the two leaves.

In the same year, M. Carrière ‡ described monstrous *Sciadopitys* "needles" where the slightly bifid character of the extremity of the ordinary "needle" had become much pronounced, and where a bud was developed from the interval between the two points.

In 1871, Von Mohl published an elaborate and admirable investigation of the structure of these "needles."§ He discovered that in the two fibro-vascular bundles the arrangement of the elements was such that the phloëm was directed towards the upper and the xylem towards the lower surface of the "needle;" and, taking this in connection with what was previously known regarding the *squama fructifera*, he came to the conclusion that in the *Sciadopitys* "needle," just as in the *squama fructifera*, we had to deal with an abortive secondary shoot developing two leaves which become united by their posterior margins, and thus have their morphological lower surfaces directed upwards.

In 1872, Strasburger described the development of the

* "On the Phylloid Shoots of *Sciadopitys verticillata*," *Report of Internat. Horticult. Exhibition and Botanical Congress*, London, 1866. Also in *Journal of Botany*, iv. (1866) p. 224.

† Engelmann, *Sitzungsberichte d. Naturforsch. Freunde*, Berlin, 1868, p. 14. Also in *Bot. Zeitung*, 1868, p. 484.

‡ *Revue Horticole*, 1868; as referred to in *Gardeners' Chronicle*, May 2 1868, and March 1, 1884.

§ H. v. Mohl, "Morphologische Betrachtung der Blätter von *Sciadopitys*," *Bot. Zeitung*, 1871, p. 1.

"needles" of *Sciadopitys* to the following effect:—The needle makes its appearance within a short distance of the growing point of the main axis; but not until the axillant scale-leaf is somewhat advanced in its development, and is beginning to form its single mesial vascular bundle. In its earliest stage, the needle is a uniformly rounded elevation from the axis, somewhat flatly compressed, but "otherwise exactly like an ordinary axillary bud." Very soon, however, it exhibits an evident cleft at the apex, followed shortly afterwards by a slightly-marked furrow on the under side. Beyond this first stage, apical growth of the organ is no longer to be observed. Its further rapid increase in length is only by intercalary cell-divisions, especially at the base. The cleft at the apex is much more striking in the young needle than in the older one; since the apex remains almost unchanged, while the needle increases notably in length. At a later period, the furrow on the under side becomes more pronounced, while a shallower one appears opposite to it on the upper side. The formation of the two vascular bundles commences when the needle measures about 0·65 mm. in length. From each of the two nearest stem-bundles, above the insertion of the axillant scale-leaf, a bundle is given off; and these are pretty quickly differentiated from below upwards in the needle. Strasburger concludes that we have here to do with an axillary bud, and that, moreover, the development shows that the union of the two leaves of this bud reaches back (*zurückgreift*) to the first stages of their development, so that at no time thereafter is it possible to observe a *punctum vegetationis* between them.* It will be seen from the foregoing, that Strasburger's view closely approximates to that of Von Mohl. Only, that Strasburger (as I understand him) holds the two leaves to be united by their inner (upper) faces, the abortive *punctum vegetationis* being buried and lost between their bases; while on Von Mohl's hypothesis the abortive *punctum* would, I presume, be external on the anterior aspect of the bases of the two leaves supposed to be united by their posterior margins. With regard to the developmental evidence, however, there seems to be nothing whatever to prove that the arrested

* Strasburger, *Die Coniferen und die Gnetaceen*, Jena, 1872, pp. 385–86.

punctum vegetationis is not at the apex of the organ, between the two small projecting points; and if it be at the apex then the organ must be regarded as a cladode. I am quite prepared to recognise in the aforesaid projecting points two rudimentary leaves; but it seems to me that M. Carrière's monstrosity proves the *punctum vegetationis* to be at the *apex*, and not at the base of the organ, where according to the views of Von Mohl and Strasburger it ought to be.

In attempting to controvert the opinion that the *squama fructifera* is cladodial, Eichler makes a statement which would, indeed, furnish a strong argument against that opinion, and tell similarly against my view of the *Sciadopitys* "needle," if only it were of universal applicability. "No cladodium," says he, "not even the most leaf-like, has the vascular bundles in a plane, and all with their xylem on the same side; but in all Cladodia (I examined *Ruscus, Xylophylla, Carmichaelia, Phyllocladus, Mühlenbeckia*, and others) the vascular bundles (either all of them, or at least those in the middle of the organ) are arranged around a common centre, with their xylem internal, as in an ordinary stem."* I would not dispute the accuracy of Professor Eichler's observations as regards the cladodes of *Xylophylla, Carmichaelia, Phyllocladus*, and *Mühlenbeckia;* but with regard to *Ruscus* his statement must be received with due limitations. The only species of *Ruscus* where such an arrangement can be seen in the cladodial expansion are those in which an inflorescence springs from the middle of the organ; and I would surmise that the cladodes examined by him were only of the commoner species, *R. aculeatus* or *R. Hypoglossum*, in which there is this complication of a mesial inflorescence either *in esse* or *in posse*. In the cladodes of *R. androgynus, R. racemosus*, and *Myrsiphyllum asparagoides*, however, the case is very different. In these, where there is the highest and most leaf-like specialisation of the cladodial structure, we have no such complication. *In these, there is no mid-*

* Von Mohl (*loc. cit.*, p. 19), making use of the same argument in support of his contention that in the needle of *Sciadopitys*, we have to do with a foliar structure and not with a cladode, refers to the absence of "any indication of the circular arrangement of the vascular bundles around a central pith, such as is found in the cladode of *Phyllocladus.*"

rib ; the fibro-vascular bundles are always arranged in one plane ; and the fibro-vascular elements are so disposed that the phloëm is directed towards the morphological upper surface, the xylem towards the lower: all as in the squama fructifera, or in the Sciadopitys "needle."*

On the whole question, I must still adhere to the view I have long held (in spite of the adverse opinion of deservedly high authority), viz., that both the *squama fructifera* and the *Sciadopitys* "needle" are cladodial; and it seems to me that the hypotheses, ligular and foliar, to which I have above referred, are wholly unnecessary.

In conclusion, I shall very briefly advert to a few points connected with the structure of other parts of *Ruscus androgynus* which seem worthy of notice.

1. The *aërial stem.*—This affords a very beautiful and typical example of Monocotyledonous structure. As in most climbing plants, the xylem ducts are of large size.

2. The *roots.*—These vary considerably in thickness, and are very sparingly branched. The stronger ones measure from $\frac{1}{5}$ to $\frac{1}{4}$ of an inch in diameter. Externally we have the *Epidermis*, numerous cells of which are prolonged on their free surface into unicellular root-hairs. Subjacent to the epidermis, there is a moderately developed *Corky Layer*, some four or five cells thick. Then we come to the *Cortical Parenchyma* proper, which forms a zone of considerable thickness (from $\frac{1}{16}$ to $\frac{1}{11}$ of an inch), the cells of which exhibit a certain amount of collenchymatous thickening, especially at their angles. The innermost portion of the cortex is differentiated to form the *Endodermis*, or sheath of the vascular cylinder. The endodermis, in this plant, is very remarkable. Instead of the ordinary single layer, it consists of at least two, and sometimes of three layers of cells, with the characteristic U-like thicken-

* The diversity in the venation of the cladodes exhibited by *Ruscus* and *Myrsiphyllum* cannot fail to strike the observer. It is referred to by Clos ("Cladodes et axes ailés," *Mémoires de l'Acad. de Toulouse*, 5^e Sér., t. v., 1861), as follows:—"Les cladodes curvinerves et stériles du *Danäe* [*Ruscus racemosus*] et des *Myrsiphyllum* ont toutes leurs nervures semblables et de même grosseur, tandis que les organes de même nom ont chez les *Ruscus aculeatus* et *R. Hypoglossum* leur nervure médiane (florifère), et chez le *R. androgynus* L. (*Semele androgyna* Kth.) les deux nervures latérales (florifères) beaucoup plus prononcées que les autres."

ing. As seen in the transverse sections figured in Plate XI., the cells of the innermost of these three layers—that corresponding to the endodermis of ordinary roots—are relatively small; those of the middle layer are about twice as large; while those of the outer layer (which is sometimes imperfect or almost absent) are of intermediate size. Next comes the *Pericambium*; and then the *Fibro-vascular Zone*. The fibro-vascular zone towards its periphery consists of from 28 to 68 phloëm tracts,* with the spoke-like radiations of the xylem passing between them. Internally, the xylem forms a continuous zone of mingled prosenchyma and ducts. The xylem ducts are of largest size towards the interior, and are smaller the nearer they are to the periphery. The larger ducts exhibit scalariform or dotted markings; while the smaller ones, towards the extremities of the xylem spokes, exhibit reticulated or spiral markings. The centre of the root is occupied by a rather large cylinder of thin-walled *Medullary Parenchyma*. As regards the general character of the root-structure, it will be seen that, with exception of the very remarkable development of the endodermis and the somewhat collenchymatous character of the cortical parenchyma, it corresponds with the ordinary type of Monocotyledonous roots.

In the course of my investigation, I was much struck with the great dissimilarity in structural detail between the roots from the plant in my own garden and those from the plant in the Edinburgh Botanic Garden; and this induced me to apply to other establishments for further root-specimens. The examination of these has led me to recognise three types,—possibly of varietal importance,—which are illustrated by the figures in Plate XI., drawn to one scale, by help of the *camera lucida*.

In Plate XI. fig. 1, is represented the transverse section of a portion of a root from the plant in my own garden. The tissue elements are of small size. The endodermis and xylem prosenchyma are relatively much indurated, especially the endodermis, in which the cell cavities are much reduced; and even the pericambium shares in the

* These figures indicate the smallest and largest numbers of phloëm tract that I have counted.

general induration. The third and outermost layer of the endodermis is usually well marked. The xylem ducts are comparatively small, and are not very numerous.—Specimens from the Glasgow Botanic Garden exhibit almost exactly the same characters.*

In Plate XI. fig. 2, is represented a similar section from a plant in the garden of Miss Hope at Wardie, Edinburgh. Here the tissue elements are not so numerous, but are of considerably larger size, and are relatively much less indurated. The third and outermost layer of the endodermis is almost completely undeveloped, as will be seen from the figure, where only one cell of this layer is to be seen.—Specimens from Trinity College Botanic Garden, Dublin, correspond with this type.

In Plate XI. fig. 3, is represented a section from the plant in the Royal Botanic Garden, Edinburgh. The roots here are altogether a good deal larger than in either of the preceding forms. The endodermis exhibits all the three layers distinctly developed, but with only a moderate amount of induration. The xylem prosenchyma is less indurated than in my plant, but more so than in Miss Hope's one. Perhaps the most striking peculiarity of this third form is to be seen in the xylem ducts, which are numerous and of great size.—Specimens from the Royal Gardens, Kew, which I owe to the kindness of Sir J. D. Hooker, correspond with this type.

The figures I have drawn will give a much better idea of these remarkable variations in root structure than any further description. They may possibly be found to be correlated with other varietal differences; or they may to a certain extent depend on circumstances affecting the general vigour of the plant. But for the present I must leave such questions unsolved.

Postscript.—April 1885.

The substance of the foregoing paper was communicated to the Society in July 1883; and a short abstract was published soon afterwards in the *Gardeners' Chronicle*, July 28, 1883. In various respects, I have considerably expanded

* Unfortunately, I cannot remember whence I obtained my own plant of *Ruscus androgynus*. It seemed not improbable that I had got it from Glasgow; but Mr Bullen, the Curator of the Garden there, thinks this impossible, as he has never until quite recently attempted to propagate his plant.

my remarks; but a comparison with the abstract will show that the essence of the communication has been adhered to.

Since bringing the subject before the Society, I have had my attention drawn to the fact that Foliage-leaves similar to those I have described in *Ruscus androgynus* had been observed by Askenasy in *R. racemosus;* and, furthermore, I have had opportunity of examining, in our Botanic Garden, the germination of *Ruscus androgynus*, *R. racemosus*, *R. aculeatus*, *Myrsiphyllum asparagoides*, *Asparagus davuricus*, and *A. capsicus*.*

1. As to Foliage-leaves in *Ruscus racemosus*, Askenasy, in 1872, recorded his observation of "a remarkable anomaly" sometimes occurring in this plant, viz, the development from the aërial stem, after the rather large sheathing leaves with green tips which are found at its lower part, "of a few leaves with long petiole and ovate green blade, somewhat resembling the leaves of *Convallaria*".† It will be noted that these must almost exactly resemble the Foliage-leaves in *R. androgynus;* and this is the more interesting, when we recall how remarkably the cladodes of the two species in some respects resemble each other,—in having no midrib, in having the stomata developed on the morphological upper surface, and in being twisted a half-turn upon themselves.

2. As to the germination of the plants I have named. To this I shall only briefly refer. The plants are still under observation, and I hope to give a more detailed account of them at a future period.

As to *Ruscus androgynus*, my anticipation of the occurrence of Foliage-leaves in the seedling has been fully justified. These make their appearance after the production of some half-dozen scale-leaves immediately succeeding the hypogeal cotyledon. In the specimens I have at present under observation, from 1 to 3 Foliage-leaves have already appeared, besides leaf-forms intermediate between these and the scale-leaves. It is a very remarkable cir-

* Our Botanic Garden is indebted for the seeds of *Ruscus androgynus* to Mrs A. Kingsmill, Eastcott, Pinner, who kindly obtained them for me from a correspondent in Madeira; for those of *R. aculeatus* to G. E. Frere, Esq., F.R.S., of Roydon Hall, Norfolk; and for those of the two species of *Asparagus* to Professor Todaro, Director of the Botanic Garden, Palermo.

† Askenasy, *Botanisch-morphologische Studien, Beiträge zur Kenntniss der flachen Stämme*, p. 22. Frankfurt a. M., 1872. For reference to this paper, I am indebted to my friend Mr F. O Bower.

cumstance that these Foliage-leaves in the seedling do not form a continuous series, but are intermingled with scale-leaves; and the same appears sometimes to hold good when Foliage-leaves occur in the adult plant. The seedlings have not as yet produced aërial stems.

In *Ruscus racemosus*, the seedlings exhibit a number of distichous green scale-leaves forming a rather flat pectinate arrangement. As yet no Foliage-leaves have appeared, nor any aërial stem.

The seedlings of *Ruscus aculeatus*, *Myrsiphyllum*, and *Asparagus* have already produced aërial stems, without exhibiting any trace of Foliage-leaves. After the hypogeal cotyledon, a few barren scale-leaves appear in the first place; and these are followed by scale-leaves from the axils of which the characteristic cladodes are produced. It may be that the remote ancestors of these plants possessed Foliage-leaves; but, if so, these have been completely lost by their descendants.

In connection with the question of the morphological constitution of the *Sciadopitys* "needle," and especially with Strasburger's account of its development, above referred to, I must here draw attention to Mr F. O. Bower's recent observation of the development of the cladode of *Ruscus androgynus*, as of great importance and significance. "In *Ruscus*," he says, "the apical part of the phylloclade soon lost its meristematic activity, and the further growth was localised in the basal part of the organ, both in a longitudinal and transverse direction.* From this it will be seen that in an undoubted cladode, such as that of *Ruscus*, we may have the same early apical arrest, and subsequent intercalary growth towards the base, as in the *Sciadopitys* "needle."

I would here acknowledge my obligations to my demonstrator, Dr J. M. Macfarlane, and to Mr A. D. Richardson of the Royal Botanic Garden, for much valuable help in the cutting and preparing of the numerous sections required for this investigation.

* F. O. Bower, "On the Comparative Morphology of the Leaf in the Vascular Cryptogams and Gymnosperms." *Phil. Trans. Roy. Soc.*, part ii. 1884, p. 601.

EXPLANATION OF PLATES.

Plate IX. (figs. 1, 2, and 3).

Fig. 1. Photo-lithograph * of small plant (from rhizome-division) of *Ruscus androgynus;* showing "radical" Foliage-leaves *(fl.)*, and weak aërial stem (*as*) bearing Cladodes (*cl*).

Fig. 2. Outline figure of a similar plant. From a photograph.

Fig. 3. Outline figure of transverse section from about the middle of the petiole of the Foliage-leaf, showing arrangement of the vascular bundles, and disposition of the fibro-vascular elements. In each bundle are to be noted : (1) the *Phloëm* (*ph*), indicated by dotted shading, and (2) the *Xylem* (*x*) ; the whole being surrounded by a *Bundle-sheath* of indurated prosenchyma (*bs*). *m* = *Ground tissue*, or *Matrix*. *ep* = *Epidermis.* The mesial bundle at the lower part of the figure is continued up into the lamina as the midrib ; while the others spread themselves out and subdivide, to run in the lateral halves of the lamina, where they so adjust themselves to its surfaces as to have their *Xylem* directed upwards. At each of the upper corners of the section, is a rudimentary bundle, wholly fibrous.

Plate X.

Fig. 1. Section of Cladode of *Ruscus androgynus*, at right angles to the surface, and across one of the stronger longitudinal veins.

se = Morphologically-upper epidermis, in which two stomata are to be noted.
sp = Morphologically-upper chlorophyll-parenchyma.
mp = Middle layer of colourless parenchyma.
ip = Morphologically-lower chlorophyll-parenchyma.
ie = Morphologically-lower epidermis, destitute of stomata.
bs = Bundle-sheath of indurated prosenchyma.
ph = Phloëm (here consisting of soft-bast), directed towards the morphologically-*upper* surface of the Cladode.
x = Xylem, directed towards the morphologically-*lower* surface of the Cladode.

Fig. 2. Portion of epidermis from morphologically-upper surface of Cladode, showing numerous stomata.

Fig. 3. Portion of epidermis from morphologically-lower surface of Cladode, destitute of stomata. In this and in the last figure, the direction of the long axis of the Cladode is across the plate.

* I may here draw attention to the methods of production of the figures in these plates.

In Plate IX., fig. 1 is not a drawing, but is a photo-lithograph from the plant direct. The "grain" in the lithograph is obtained by interposition of a "stippled" transparent film between the photographic "negative" and the "transfer."

In Plate IX., fig. 2 is a photo-lithograph from an outline-drawing obtained from a photograph, by a process which I have elsewhere described, but which it may be useful for me again to refer to. A paper-print is taken from the "negative ;" the outlines on this print are carefully gone over with a fine pen and Indian ink or other black paint ; the photograph is then obliterated by washing with cyanide of potassium solution, leaving the black outline on the now white paper ; and from this outline-figure, after any necessary "touching-up," a photo-lithograph is made to the desired scale.

In Plate IX., fig. 3, and in Plates X. and XI. all the figures, are photo-lithographic reductions from pen and ink drawings made with help of *camera lucida.*

PLATE XI.

The figures here, drawn to one scale, are from transverse sections of roots of *Ruscus androgynus*: (1) from my own garden at Hartree; (2) from Miss Hope's garden at Wardie; and (3) from the Royal Botanic Garden, Edinburgh. In each figure, a small portion of the section is represented, including part of the inner *cortical parenchyma*, with *endodermis;* of the *pericambium;* of the *fibro-vascular zone;* and of the *medullary parenchyma.*

cp = Cortical parenchyma.	*xd = Xylem ducts.*
end = Endodermis.	*xp = Xylem prosenchyma.*
pc = Pericambium.	*mp = Medullary parenchyma.*
ph = Phloëm tracts.	

Fig. 1.—From Hartree Garden. Showing the small size of the tissue-elements; the relatively great induration of *endodermis, pericambium,* and *xylem prosenchyma;* and the three distinct layers of the *endodermis.*

Fig. 2.—From Wardie Garden. Showing the larger size of the tissue-elements; the relatively smaller amount of induration of these elements; and the almost complete absence of the third, outermost, layer of the *endodermis,* of which layer only a single cell (towards the left side) is to be seen in the section.

Fig. 3.—From Royal Botanic Garden, Edinburgh. Showing the moderate amount of induration of the *endodermis,* of which, however, all three layers are distinctly developed; the great size and number of the *xylem ducts,* &c. The structure here is the most beautiful of any of the forms I have examined; and a well-prepared section is an exquisite microscopic object.

Report on Temperatures and Open-Air Vegetation at the Royal Botanic Garden, Edinburgh, from October 1882 *to June* 1884. *With Register of flowering of Selected Plants, compiled from Reports read at the Monthly Meetings of the Society.* By the late JOHN SADLER, and ROBERT LINDSAY, Curator of the Garden.

October 1882.—There was rain during nineteen of the thirty-one days of this month. On the 26th of the month there was frost, which nipped all the tender Dahlias, of which there was a good show. At that date the thermometer stood at 27° F.; next morning it was at 30° F.

November.—At the middle of the month the rock garden exhibited a wonderful display of blossoms, including different species and varieties of autumn Crocus, &c. On the 9th inst. the thermometer stood at 32° F.

December.—The thermometer, on the night of the 12th inst., fell to 7° F. A severe snow storm began on the 4th, continuing till the 9th inst. At Dalkeith Gardens 40 inches of snow fell, while in the open the average fall was 25 inches. In the garden itself, the ground was covered from 18 inches to 2 feet, protecting outdoor vegetation effectively, though much difficulty was experienced in keeping up a sufficient heat in the plant houses, owing to the cold north-east winds. On the 15th, when the thermometer stood at 3° F., a gradual thaw set in, but the ground was covered with snow till the 23rd.

Considerable damage was done to evergreen trees and shrubs by the continued weight of snow bending and breaking their branches. Unripened shoots of Golden Queen Holly were slightly browned, and some plants left out in the rock garden, which survive during mild winters only, were cut to the ground, as *Cordyline australis*, *Eucalyptus globulus*, and *E. viminalis;* these were tall plants uncovered by snow, while the New Zealand *Veronica Andersonii* and its varieties, which with us are usually killed in severe weather, were safe, by having been protected by snow.

January 1883.—The thermometer was at or below the freezing-point on fifteen occasions, as against twelve during January 1882. The following plants were in flower in the open air on the first day of the year:—*Geum aureum*, *Hepatica triloba alba*, *Erica herbacea alba*, *Helleborus grandiflorus*, and different coloured varieties of the common Primrose.

February.—The thermometer was at or below the freezing-point on nine occasions. The lowest readings were registered on the 1st, 29°; 11th, 31°; 12th, 32°; 16th, 32°; 19th, 28°; 28th, 31°. The highest morning readings were on the 5th, 46°; 14th, 49°; 20th, 45°; 21st, 50°; 24th, 47°; 25th, 46°. Little rain and no snow fell. South and south-west winds were prevalent, bright sunshine being of frequent occurrence during the early part of most days. So mild a month of February has only occurred once during the last thirty years; this was in February 1869, when 2° less were recorded. In consequence of this mild and genial weather vegetation made rapid progress. Leaf and flower buds are well forward on many deciduous trees and shrubs, such as Thorns, Lilacs, Roses, and *Ribes sanguineum*, the latter being also in flower. Herbaceous plants, such as *Fritillaria*, *Hemero-*

callis, *Symphytum*, *Ferula*, and the like, made growths of from 12 to 14 inches in length. The early-flowering *Rhododendron atrovirens*, *dahuricum*, *præcox*, and *Nobleanum*, have been particularly fine this season. On the rock garden forty-three species and varieties of plants came into flower for the month, as against forty-eight in the same month last year.

March.—During the month there were twenty-three frosty nights, as compared with seven in March 1882. The lowest readings registered were on the mornings of the 12th, 27° 13th, 26°; 15th, 24°; 17th, 25°; 28th, 24°; 29th, 25°; while the highest morning readings at 9 o'clock were on the 2nd, 44°; 5th, 43°; 24th, 42°; 30th, 48°; and 31st, 41°. Vegetation, having been forced on by the unusual mildness of the previous month, suffered a severe check. The small amount of rainfall experienced along with these low temperatures tended in a great measure to protect early-flowering plants from injury. Roses (tea and hybrid perpetual) were slightly injured. Rhododendrons, which were in bloom during the early part of the month, had their flowers destroyed, but later developed buds were in full flower. Scillas and other spring-flowering bulbous plants had their period of flowering somewhat shortened, but otherwise they were as good as usual. Only twenty-eight species and varieties of plants came into flower in the rock garden during the month, while in March last year ninety-three species came into bloom. The retarding nature of the weather during the month may have a beneficial effect on the fruit crop this season.

April.—Towards the beginning of the month, when westerly winds were prevalent, vegetation made considerable progress. Many deciduous trees and shrubs, such as Larch, Poplar, Elder, Amelanchier, Thorns, and Lilacs, had their leaves nearly expanded. Elms and Ashes were literally covered with flowers. The following plants trained on south walls were finely in flower, viz.:—*Prunus triloba*, *fl. pl.*, *Magnolia conspicua*, *M. purpurea*, and *Cydonia japonica*. But a succession of cold east and north-east winds, together with little rainfall, prevailing after the 19th inst., materially checked outdoor vegetation. On the rock garden 108 species and varieties of alpine and dwarf herbaceous plants came into flower during the month, making a total of 193 since January 1, while at the same date—the end of April—last year, 286 species were recorded as having flowered. The lowest temperatures were registered on the mornings of the 2nd, 31°; 4th, 30°; 6th, 30°; 7th, 31°; and the 26th, 29°. The highest readings at 9 A.M. were on the 9th, 50°; 11th, 52°; 12th, 50°; 15th, 50°; and 26th, 51°. During the early part of the month vegetation made fairly good progress; westerly winds were prevalent until the 19th.

May.—Towards the commencement of this month, on the 6th, 7th, 9th, and 12th, the thermometer was at or below the freezing-point. East winds and occasional showers of hail and sleet also left their marks on many plants. Those which have suffered most were Roses, Dielytra, Astilbe, *Spiræa palmata.* The young fronds of Osmunda and Athyrium, which were well advanced, completely blackened and destroyed; even some species of thorns had their leaves browned. The lowest readings occurred on the 6th, 25°; 7th, 30°; 8th, 34°; 9th, 32°; 12th, 32°; 17th, 33°. The highest morning readings were on the 13th, 57°; 14th, 57°; 22nd, 58°; 24th, 56°; 25th, 60°; 29th, 58°. On the rock garden 243 species and varieties of alpine and dwarf herbaceous plants came into flower during the month, making a total of 446 for the season, while at the same date—the end of May—last year 492 were recorded as having flowered.

The show of hardy spring plants, though late, was very fine, and well-developed foliage and abundance of flowers were characteristic features of deciduous trees and shrubs despite the unpromising spring.

June.—The lowest readings of the thermometer during the month were—on the 4th, 40°; 5th, 39°; 8th, 35°; 16th, 40°; 17th, 38°; 21st, 38°; while the highest morning readings were—on the 3rd, 80°; 15th, 60°; 23rd, 60°; 28th, 62°; 29th, 60°; 30th, 62°. The foliage of deciduous trees, such as Plane, Lime, Oak, Service, Spanish and Horse Chestnut, &c., were thoroughly developed and remarkably clean and perfect, owing greatly to the scarcity of the usual insect pests, such as aphis, caterpillars, red-spider. Even Roses, which are peculiarly subject to attacks of aphis, are, so far, almost free from this enemy; probably owing to the lateness and dryness of the spring. Amongst plants which have flowered unusually well this season *Rhododendron hirsutum* and *R. ferrugineum* (the Swiss alpine Rhododendrons) may be mentioned; large bushes 4 to 5 feet wide have been completely covered with bloom. On the rock garden 255 species and varieties of plants came into flower during the month, as compared with 173 for the corresponding month last year, making a total of 701 for the season, as against 666 at the same date last year.

August.—During the month of August the weather, though mild and pleasant generally, was more favourable in the development of wood and leaves than ripening and maturing of fruit and seed. The lowest readings of the thermometer were on the 10th, 47°; 12th, 45°; 13th, 46°; 20th, 45°; 23rd, 42°; while the highest morning readings were on the 4th, 60°; 14th, 61°; 20th, 65°; 24th, 64°; 25th, 64°. West and south-west winds were prevalent. Rain fell in slight showers nearly every day throughout the month, in consequence of which many kinds of seeds have ripened badly, particularly those of herbaceous plants, which this year are a poor crop.

Seventy species and varieties of plants came into flower on the Rock Garden for the month, making a total of 938 for the season.

September.—September was also mild and pleasant throughout. North-west winds were frequent until the latter part of the month, when north-east winds prevailed, accompanied by rain, which, however, was not so frequent as on the previous month. The lowest temperatures occurred on the 1st, 41°; 5th, 41°; 12th, 32°; 11th, 41°; 22nd, 34°; while the highest morning readings were on the 3rd, 58°; 16th, 57°; 17th, 58°; 22nd, 56°; 25th, 60°. The first frost experienced since the 12th of May last was thus on the 12th of the month, when the thermometer fell to freezing-point. The first frost recorded last season was also on the 12th of September, when the same amount, viz., 32°, was registered. From the 12th till the end of the month the weather was again mild and bright, which tended to ripen and mature the wood of various trees and shrubs. Autumn tints began to appear on sugar maple and *Pavia flava*, which at the close of the month were very beautiful.

Thirty species of plants came into flower on the Rock Garden, making for the season 968. These included *Gladiolus Saundersii*, *Kniphofia Uvaria*, *Rudbeckia purpurea*, *Aster longifolius*, *Crocus speciosus*, *C. medius*, and *C. vitellinus*.

October.—October was remarkable for the fine, dry, almost summer-like weather which prevailed throughout the entire month; frost occurred only once, viz., on the 22nd, when 3° were registered. In consequence of the mildness, deciduous trees parted with their foliage most reluctantly; many, which in October are usually stripped bare of their leaves, were still covered with foliage. The most beautiful were *Acer saccharinum*, *A. rubrum*, *A. monspessulanum*, *A. Lobbii*, and the varieties of *A. pseudoplatanus*; *Quercus rubra*, *Q. coccinea*, and *Q. conferta*; *Pyrus Aria* and *P. vestita*; *Salisburia*, Beech, Thorns, and Tulip tree; Ampelopsis, Azaleas, Cornus, Mahonias, and Weigelas, &c. Among herbaceous plants *Saxifraga purpurascens* and *Funkia Sieboldi* were most striking. A few evergreens also showed rich colouring, and contrasted favourably with the more beautiful, but shorter lived, deciduous coloured leaves; amongst such may be mentioned *Cryptomeria elegans*, *Thuia elegantissima* and *aurea*, Golden and Silver Hollies, and the various Japanese Retinosporas. The season, though favourable for the development of foliage, was apparently most unfavourable in developing flower-buds for next year. Rhododendrons, Azaleas, and other "American" plants, which are usually lifted about the end of the month for forcing purposes, were deficient in flower-buds. Yew, Holly, and Cotoneaster had a fair crop of well-coloured berries. The lowest temperatures occurred on the 2nd, 32°; 12th, 34°; 22nd, 29°; 23rd, 35°; 30th, 35°; while the highest morning readings were on the 4th, 50°; 7th, 52°; 8th, 52°; 9th, 60°; and 14th, 51°. On the rock garden thirteen species of plants came into bloom, making a total for the season of no less than 981, being the largest number yet recorded as having flowered in one season, and 107 more than flowered last year; this result was not due to the season, but simply to the fact that new plants are constantly being added to the collection from various quarters, many of which flower, and are recorded.

November.—During November the thermometer was at or below the freezing-point on fourteen occasions. The lowest readings were on the 7th, 28°; 8th, 29°; 11th, 28°; 12th, 22°; 13th, 27°; 14th, 29°. The highest morning readings were on the 1st, 47°; 2nd, 45°; 3rd, 46°; 25th, 46°; 29th, 51°.

The month began with eight days of mild spring-like weather. On the 9th and 10th a severe storm of wind, rain, and snow occurred, which swept off (with few exceptions) what leaves were remaining on deciduous trees. The latter portion of the month was remarkable for an extraordinary series of most brilliant sunrise and sunset phenomena, which attracted general attention. On the evening of the 28th, when the sunset was perhaps most striking, the thermometer registered 50° as the minimum. On the rock garden the following plants came into flower during the month:—*Aster Reevesii*, *Crocus* sp. (from Asia Minor); *Erica herbacea alba*, *Hepatica triloba alba*, *Iberis stylosa*, *Helleborus purpurascens* var., and *Geum aureum.*

A number of herbaceous and alpine plants which came into flower during previous months remained in fine flower, the finest of all being *Helleborus altifolius*, which began to flower this year about the beginning of September. Amongst others, *Arabis procurrens, Veronica rupestris, Schizostylis coccinea*, *Lithospermum prostratum*, *Aubrietia*, *Erica vagans*, &c. In other parts of the garden plants were in flower of *Jasminum nudiflorum*, *Hamamelis virginica, Erica ciliaris,* China Roses, Wallflowers, Stocks, Primroses (double and single), Pansies, &c.

December.—The month of December 1883 will be long remembered as one of the mildest on record. During the month the thermometer was twelve times at or below the freezing-point being in marked contrast with December 1882, when twenty-two frosty nights occurred. The lowest readings occurred on the 5th, 28°; 7th, 26°; 8th, 29°; 16th, 30°; 17th, 33°; while the highest morning readings were on the 9th, 45°; 13th, 49°; 24th, 49°; 25th, 48°; 29th, 49°.

The lowest reading which has yet been registered at the garden this winter was 22° which occurred on November 12th last.

The mildness of this month was only paralleled by that of December 1868, the mildest season recorded for thirty years, when Pelargoniums, Calceolarias, and other bedding-out plants remained throughout unprotected in the open. Of the forty plants whose dates of flowering are annually recorded, *Tussilago fragrans* and *Dondia Epipactis* appeared twice this year in flower.

The effects of the mildness of the season are very conspicuous in the case of the Cherry-Laurel, which has flower-buds already advanced, the usual time of flowering being April and May; also *Ribes sanguineum* with much swollen leaf-buds; Roses with young shoots 2 to 4 inches in length. Amongst herbaceous plants, Ferulas, Heracleum, Orobus, and Sisyrinchium are well started into growth.

The severe storm of wind of December 11 and 12, which did so much damage throughout the country, passed over fortunately without doing the slightest damage in the garden.

January 1884.—In January there were unprecedentedly high night readings of the thermometer, along with the lowest barometric reading ever recorded in Britain, that of the 12th being 27·333 inches accompanied by gales causing great destruction to life and property. In the garden the effects of the storm were most conspicuous on the hard rigid leaves of *Yucca gloriosa*, of which there are a large number in the rock garden, those in exposed situations having had their leaves bruised and broken off, thus rendering them unsightly for a time. Of the forty plants whose dates of flowering are annually recorded, fourteen came into bloom during the month, while three only were in flower at the same date last year. The lowest readings occurred on the 4th, 23°; 24th, 30°; 26th, 29°; 27th, 30°; 28th, 30°. The highest morning readings were on the 6th, 47°; 9th, 50°; 18th, 47°; 19th, 48°; 20th, 47°. On the 22nd and 23rd there was heavy rain, accompanied by high winds from the west and north-west. On the 24th and 25th a considerable fall of snow took place.

February.—During February the mild character of the previous month was well maintained. The lowest readings of the thermometer occurred on the 2nd, 30°; 3rd, 28°; 8th, 25°; 19th, 30°; 29th, 25°. The highest morning readings were on the 4th, 49°; 5th, 48°; 9th, 47°; 12th, 48°; 13th, 48°. Comparatively little rain or snow fell, and the weather was favourable throughout for gardening work. On the morning of the 21st another severe storm of wind from the south-west occurred, rivalling that of the previous month in the amount of damage done throughout the country. Fortunately, the Botanic Garden again escaped almost unscathed. The mild and open nature of the season throughout brought vegetation very rapidly forward, both foliage and flower being in advance of that of recent years: *Nuttallia cerasiformis* was in flower on the 10th, *Ribes sanguineum* on the 21st, being fully a month later than last season. Forty-one species and varieties of plants came into flower on the rock garden during the month. By the end of the month no less than ninety different species were in flower, including those which opened on previous months, thus giving quite a showy appearance to the rock garden much earlier than usual. Of the forty plants whose dates of flowering are annually recorded seventeen came into flower during the month of February.

March.—The month of March has been very mild compared with that of last year, still it has been the most severe of any month during this unprecedentedly mild season. The thermometer was at or below the freezing-point on twelve nights. The lowest readings occurred on the 3rd, 28°; 11th, 27°; 22nd, 29°; 24th, 28°; 26th, 27°; the highest morning readings ranging from 47° to 53°. Thorns were in full leaf at the end of the month; Poplar, Lilac, Horse Chestnut and Maple being far advanced. *Magnolia conspicua* and *purpurea*, which last year at this date were in full flower, are not yet expanded. These plants are trained on south walls. Their lateness in flowering can only be accounted for by their wood being insufficiently ripened last summer and autumn. To the same cause may be attributed the lateness and poor condition of several other flowering plants on walls, notably *Prunus triloba*. Of the forty spring-flowering plants whose dates of flowering are annually recorded, six came into flower, completing the list. The winter of 1868-69 compares in mildness with the present season.

April.—Throughout the month of April there were generally low night temperatures, with bright sunshine during the day. The cold easterly or north-easterly drying winds which prevailed almost continuously throughout the month, and the absence of anything like drenching rain, together with a succession of frosty nights at the end of the month, seriously retarded vegetation. The thermometer was below the freezing-point ten times. The lowest readings occurred on the 1st, 28°; 21st, 27°; 23rd, 27°; 25th, 26°; 27th, 27°; 28th, 28°. April has thus been the most severe month of the season. Owing to the advanced condition of vegetation these low temperatures did great injury to fruit trees and bushes in many parts of the country; much more damage, however, appears to have been sustained in the south than in the north. Almost the only plants damaged in the garden are Astilbe and Dielytra; young leaves of Horse Chestnut and Roses are also slightly damaged. On the rock garden 103 species and varieties came into bloom for the month as against 108 for the same month last year, making a total of 225 since January 1, as compared with 210 for the same period last year.

May.—No frost was registered, and once only did the glass fall to the freezing-point, while last May the thermometer was at or below freezing-point on four occasions. From the 1st till the 20th of the month rain fell more or less daily, after which a succession of dry, parching, easterly winds with bright sunshine throughout the day prevailed until the end of the month. Most deciduous trees have developed fine healthy foliage, and a few, owing to the absence of frost, have flowered better than usual, such as Horse Chestnut, Hollies, and *Pavia flava*. Laburnum and Thorns, both single and double, also promised well; but others, particularly Lilacs, double and single Cherries, and most species of Pyrus and Prunus, have not flowered so abundantly as usual. Although no actual frost was registered the average temperature was not high. The lowest readings of the thermometer occurred on the 2nd, 34°; 4th, 34°; 5th, 32°; 7th, 33°; 19th, 34°. The highest morning readings were on the 12th, 57°; 22nd, 59°; 23rd, 62°; 25th, 62°; 31st, 58°. In the rock garden 228 species of alpine and herbaceous plants came into flower during the month, as against 243 for the same month last year, making a total of 455 since January 1st, as compared with 446 for the same period last year. A large proportion of those which began to flower in March and April continued to flower during May, thus rendering the garden very attractive.

June.—During the past month outdoor vegetation was much retarded, owing to the extreme drought which prevailed. There were twenty-three dry days. Slight showers of rain fell on seven days, viz., the 5th, 6th, 13th, 22nd, 23rd, 24th, and 29th. The lowest night temperature for June was 42°, on the nights of the 7th and 9th; the highest, 58°, on the 29th. The lowest day temperature was 56°, which occurred on the 5th; and the highest, 80°, on the 28th. In consequence of the want of rain, along with the mildness of the past winter, aphides, caterpillars, and other insect pests were very numerous and destructive, especially on Beeches, Elm, Holly, Gooseberry, and Currant; Roses, however, were tolerably clean and well budded. Late varieties of Rhododendron and Azalea were inferior. All late transplanted trees and shrubs suffered severely from drought. Most coniferous plants—Piceas, Abies, and Cedrus in particular—developed fine healthy shoots. The golden variegated forms of *Biota*, *Retinospora*, *Cupressus*, and *Taxus* coloured extremely well. On the rock garden 346 species and varieties of dwarf-growing herbaceous and alpine plants came into flower during the month, making a total of 798 for the season, as compared with 701 at corresponding date last year.

[TABLE

Table of Flowering Plants at the Royal Botanic Garden, Edinburgh, from February 1880 *till April* 1884.

		1880.	1881.	1882.	1883.	1884.
1	Adonis vernalis . . .	Apr. 20	May 11	May 1	Apr. 8	Mar. 26
2	Arabis albida . . .	Mar. 3	Mar. 20	Jan. 24	Feb. 19	Jan. 23
3	Aubrietia grandiflora . .	Mar. 4	Mar. 12	Feb. 16	Feb. 15	Feb. 10
4	Bulbocodium vernum . .	Mar. 1	Mar. 5	Feb. 2	Feb. 6	Jan. 26
5	Corydalis solida . . .	Mar. 16	Apr. 1	Feb. 26	Mar. 30	Mar. 13
6	Corylus avellana . . .	Feb. 11	Mar. 1	Feb. 3	Jan. 26	Jan. 14
7	Crocus susianus . . .	Feb. 12	Mar. 8	Feb. 2	Feb. 9	Jan. 19
8	Crocus vernus . . .	Feb. 20	Mar. 12	Feb. 9	Feb. 17	Jan. 28
9	Daphne Mezereum . . .	Feb. 28	Mar. 2	Dec. 28	Feb. 10	Jan. 20
10	Dondia Epipactis . . .	Feb. 2	Feb. 28	Dec. 26	Feb. 6	Dec. 29 (1883)
11	Draba aizoides . . .	Feb. 15	Feb. 26	Feb. 1	Mar. 12	Feb. 12
12	Eranthis hyemalis . . .	Feb. 8	Mar. 4	Feb. 1	Jan. 27	Jan. 22
13	Erythronium Dens-canis . .	Mar. 11	Mar. 29	Feb. 20	Mar. 24	Mar. 12
14	Fritillaria imperialis . .	Apr. 12	May 6	Apr. 10	Apr. 9	Mar. 27
15	Galanthus nivalis . . .	Feb. 7	Mar. 2	Jan. 24	Jan. 25	Jan. 19
16	Galanthus plicatus . . .	Feb. 8	Mar. 1	Feb. 1	Feb. 6	Jan. 26
17	Iberis gibraltarica . . .	Killed	...	...	Apr. 3	Mar. 20
18	Iris reticulata . . .	Mar. 10	Mar. 28	Feb. 21	Mar. 2	Feb. 28
19	Leucoium vernum . . .	Feb. 9	Mar. 4	Feb. 1	Feb. 4	Jan. 26
20	Mandragora officinalis . .	Mar. 15	Apr. 2	Feb. 24	Feb. 20	Feb. 9
21	Narcissus Pseudo-Narcissus .	Mar. 19	Apr. 20	Mar. 4	Apr. 2	Mar. 18
22	Narcissus pumilus . . .	Mar. 9	Mar. 18	Feb. 2	Mar. 12	Feb. 28
23	Nordmannia cordifolia . .	Feb. 20	Feb. 25	Jan. 26	Feb. 20	Feb. 15
24	Omphalodes verna . . .	...	...	...	Mar. 14.	Feb. 12
25	Orobus vernus . . .	Mar. 8	Mar. 20	Feb. 4	Mar. 30	Feb. 9
26	Rhododendron atrovirens . .	Feb. 5	Mar. 6	Dec. 27	Feb. 10	Jan. 10
27	Rhododendron Nobleanum . .	Mar. 5	Mar. 15	Feb. 26	Feb. 22	Feb. 2
28	Ribes sanguineum . . .	Mar. 17	Mar. 24	Feb. 3	Mar. 28	Feb. 20
29	Scilla bifolia	Mar. 6	Mar. 9	Feb. 8	Feb. 20	Feb. 14
30	Scilla bifolia alba . . .	Mar. 7	Mar. 20	Feb. 15	Mar. 3	Feb. 21
31	Scilla præcox . . .	Feb. 25	Mar. 10	Jan. 28	Feb. 7	Jan. 20
32	Scilla sibirica . . .	Feb. 26	Mar. 12	Feb. 3	Feb. 16	Jan. 30
33	Scilla taurica . . .	Mar. 10	Mar. 21	Feb. 8	Mar. 3	Feb. 24
34	Sisyrinchium grandiflorum . .	Feb. 24	Mar. 18	Feb. 20	Feb. 22	Feb. 14
35	Sisyrinchium grandiflorum album .	Feb. 24	Mar. 8	Jan. 26	Feb. 22	Feb. 12
36	Symphytum caucasicum . .	Mar. 16	Mar. 24	Feb. 23	Apr. 10	Feb. 15
37	Symplocarpus fœtidus . .	Mar. 11	Mar. 14	Feb. 9	Feb. 8	Feb.
38	Tussilago alba . . .	Feb. 10	Mar. 8	Feb. 3	Feb. 6	Jan. 1
39	Tussilago fragrans . . .	Feb. 12	Mar. 4	Feb. 2	Jan. 15	Dec. 26 (1883)
40	Tussilago nivea . . .	Mar. 8	Mar. 9	Feb. 2	Apr. 1	Feb. 14

MISCELLANEOUS CONTRIBUTIONS AND EXHIBITIONS.

SESSION 1882-83.

November 9, 1882.

Exhibition of *Hoya stenophylla*, by Mr M. Dunn, Dalkeith; and of a hybrid *Sarracenia*, from Dr Paterson, Bridge of Allan.

Exhibition from the Royal Botanic Garden, by Mr Sadler, of *Durio zibethinus* (Durian or Duryon fruit), *Alsodeia Welwitschi*, *Colletia Bictoniensis*, *Malpighia urens*, and *Parochetus communis*, in flower.

"Note on Cross-Fertilisation," by Rev. J. A. Paton, M.A., B.Sc., Inch.—In experiments in cross-fertilising different varieties of potato in my garden last summer with a view to raise new, and, if possible, improved seedlings, the number of flowers upon the potatoes was very great, and the fruit was very abundant, bunches being on nearly every plant. This year, however, though the flowers were equally abundant, the only "plums" in all the rows were those arising from flowers marked as having been cross-fertilised. Certainly the damp could not be the cause, as it acted equally on crossed and uncrossed flowers.

January 11, 1883.

Exhibition of a spike of *Hedychium Gardnerianum* (Wall.), in fruit, showing a bright red aril, from stove of the Royal Botanic Garden, by Professor Dickson.

Seedling Primrose, whose colour showed the nearest approach to blue amongst the common Primroses, from Mr P. Neill Fraser, grown in a cold frame, but had also done well in the open air.

February 24.

"On some Abnormal Cones of *Pinus Pinaster*," by Professor Dickson.

Dr Cleghorn exhibited a collection of European woods prepared by Herr Wilmersdorff, and gave an interesting account of the manufacture of these thin shavings of wood for such technological purposes as room decoration and bookbinding. The value of the thin sections of various woods exhibited for educational purposes, *i.e.*, in teaching vegetable physiology, was specially insisted on.

Mr W. B. Boyd showed, in flower, *Saxifraga ciliata* (Royle), a native of the Himalaya, grown at Faldonside, Melrose; also *Calceolaria deflexa*, and a hybrid between it and *C. Lord Raglan*, as well as an abnormal Cyclamen recently sent to the Museum at Edinburgh.

A specimen of Foxglove, 8 feet 10 inches high, and of Wallflower, 8 feet 1 inch high, were shown from Dr Paterson, Bridge of Allan; and a specimen of Foxglove, 10 feet high, from Mr Girdwood, Tanfield.

A portion of the stem of *Eucalyptus globulus*, from Colintraive, Kyles of Bute (*Trans.*, vol. xiv., p. lxvi.), which had succumbed during the winter of 1881, after growing upwards of 47 feet high, sent by Colonel Campbell.

A section of the wood of the same tree, from New Zealand, grown in the cold conservatory at Carlowrie, Linlithgowshire, by Mr R. Hutchison. It was planted some years ago, and had grown at the rate of 4 feet in a year, though twice beheaded to prevent the breakage of the glass roof; it was then 25 feet high.

April 12.

Exhibition of Lichens, chiefly from Ayrshire, by Mr Archibald Gray. These included a series of forms of the genus *Sphaerophoron*, Pers.; also *Parmelia sinuosa*, Sm., from Mulloch Hill, Dailly; and *P. caperata*, L., from the Water of Doon, at Hollybush, Dalrymple. Collected by the exhibitor in March 1883.

Professor Dickson exhibited specimens of an *Epacris* (Lady Panmure), sent by Mr Charles S. France, from his greenhouse at Balboughty, near Perth, showing median prolification of the flowers, from which leafy shoots of considerable length extended themselves. This form of abnormality has already been noticed as occurring in Epacris by Dr Masters in his *Vegetable Teratology*, p. 137.

Mr Symington Grieve exhibited a small branch of dead birch wood from the island of Colonsay, on which had grown intermixed the two mosses *Ulota crispa*, Hedw., and *Ulota phyllantha*, Bud.—the former being in fruit, and the latter, whose fruit is unknown, being in its usual barren state, but having gemmæ at the apex of the leaves. The branch was exhibited to show in what close association these two mosses may at times grow; and as their foliage is somewhat similar in appearance to the eye, unless examined microscopically, to warn botanists from concluding they have found the fruit of *Ulota phyllantha* until they have examined the areolation and base of the leaf. In *Ulota crispa* the large diaphanous cells at the base of the leaf are in three to five rows, whereas in *Ulota phyllantha* there is a single row. Again, the last-named moss has gemmæ usually at the apex of the leaves, while in *Ulota crispa* they are absent, and the leaves of this moss are of a dilated ovoid form at the base, which is not the case with those of *Ulota phyllantha*. Both these mosses are widely distributed throughout Britain, growing on trees, and also sometimes on rocks, and appear at one time to have been confounded with each other, and were then both known under the designation of *Orthotrichum crispum* Hedw.

Mr Archibald Constable exhibited as a specimen of binding in wood a curious work he had lately acquired, of which he supplied the following account:—" *The History of the Five Indian Nations depending on the Province of New York in America.* Printed and sold by William Bradford in New York, 1727.—This, the first edition of a well-known book, is a small 12mo of 119 pages. It differs from the after-editions in having a Dedication to Governor Burnet of six pages, with the name of the author, 'Cadwallader Colden,' at the end of it. When the book came into my possession last July the wooden boards were somewhat loose, and eight pages of Leed's *American Almanack* for 1727, printed by Andrew Bradford in Philadelphia, which were bound in at the end of the book, were rather imperfect (the *Almanack* itself is incomplete after April). I sent the volume to Messrs Birdsall, the Northampton bookbinders, to be put to rights, and to have a case made for it. It interested me to hear from them that the wood of which the boards are made, and the leather that covers them, were both of a kind they had not seen before. I have not been able to find out the nature of the leather; but from a study of American woods, kindly permitted me by Dr Cleghorn, it would seem that the boards are of American walnut. The volume is not without its interest to American book collectors, as I find from a reference to Mr J. Carter Brown's *Bibliotheca Americana*, printed at Providence, Rhode Island, in 1870, that at that time only four copies of it were known to exist in the United States.

Mr P. N. Fraser exhibited a bundle of Orchids in beautiful condition, just received by post from Algiers

May 10.

Mr P. N. Fraser presented to the Herbarium a large collection, principally *Gramineæ* and *Cyperaceæ*, collected by the Rev. John Buchanan in 1875–76, chiefly during a long waggon journey of some 1200 miles from Natal Free State, Basuto Diamond Fields, and Cape Colony. Many of the grasses had been named by the late General Munro.

Mr Anderson-Henry sent for exhibition the following new plants raised by him from seeds:—

Androsace foliosa.—This plant was submitted early last summer to Sir Joseph Hooker, and was figured by him, *Bot. Mag.*, Tab. 6661, and named *A. foliosa.* It is found on the Western Himalaya, at an elevation of 8000 to 12,000 feet. Sir Joseph observes that this is by far the largest known species of *Androsace.* It flowered first on May 18, last year, and continued in full bloom till September, throwing out flower after flower during all that time. Sir Joseph observes—"Mr Anderson-Henry farther informs me that he has raised young plants of what appear to be the same species, but with shorter and broader leaves." This last form is also submitted, as well as a new *Androsace* raised by me from seeds from the Sikkim ranges of the Himalaya. I submit also *Geranium Traversii*, a New Zealand novelty, now shown, I believe, for the first time in this country. See *New Zealand Flora*, p. 726. I also lay on the table *Veronica*, nova species from New Zealand, with variegated foliage.

The President laid on the table a number of cut blooms from the open air at Faldonside, consisting of various species of *Primula, Narcissus, Polemonium confertum*, &c.

Miss Owen, Knockmullen, Gorey, sent a selection of abnormal Primroses; one variety of "Jack in the Green," having an enormous development of calyx, attracted attention.

June 14.

Mr Irvine, of Drum Castle, Aberdeenshire, intimated that *Rheum nobile* was now flowering there. The flower-stem was 37 inches high. The seed whence this plant has sprung was sown at least six years ago. This is the second instance of this Himalayan plant flowering in Britain; it did so two years ago in the Edinburgh Royal Botanic Garden. (Bot. Soc. Trans. xiv. p. 88.)

Mr Isaac Anderson-Henry sent for exhibition the following plants, grown at Hay Lodge, Trinity :—

1. *Monochætum sulphureum*, which is being figured for the *Botanical Magazine*, and which Sir Joseph Hooker writes me is wholly new to Europe.

2. *Primula sp.*, No. 12 of seeds liberally distributed by Mr Elwes among his friends.

3. *Erigeron multiradiatus*, from the upper valley of the Ganges. Quite hardy.

4. *Ophelia species*, from mountains near Murree—a present to the Botanic Garden.

5. *Cortusa species*, No. 34 of Mr Elwes' seeds.

6. *Veronica Lyalli* × *V. diosmæfolia.*

7. *Veronica*, own hybrid, *V. Lyalli* × *V. angustifolia. Note.*—I have another cross of *V. angustifolia* of New Zealand, which is a tall growing species, and this cross grows flat on the ground; very hardy, and standing all the winter in the open.

8. A composite from Tibet, being the top of the plant cut off merely to show the coming flower. There is a great traffic carried on from Kashmir to China, &c.; but the only account I find of it in our books is under the head '*Aplotaxis*' in the *Treasury of Botany.* The roots are the subject of traffic, something like dahlia tubers. It is used to protect from the attacks of moths, and in China as an aphrodisiac. The seeds were sent to me by the traveller (Dr Bellew) on the expedition to Yarkand in 1873, and were sown by me in November that year. It has been grown in the open ground, and never till now has it shown flower.

Mr Boyd exhibited a number of cut flowers from his garden at Faldonside. These included *Primula grandis, P Stuarti, P. sikkimensis*, with flower-stalks 18 inches long, and *Cypripedium spectabile.*

Mr W. Evans, M.A., exhibited a specimen of *Viola stagnina*, new to Britain, from the Cambridgeshire Fens.

July 12.

Mr Boyd mentioned that he had in his garden a large tuft of *Rubus arcticus*, L., which was producing dozens of ripe fruit, about the size of a small raspberry, yellowish-white in colour, but tinged with pink. The flavour was excellent, having a slight after-taste of vanilla.

Mr P. N. Fraser showed a plant of *Polystichum Lonchitis,* found by him in 1879. At the time it struck him as being a peculiar variety, with fronds perfectly smooth, which character it still retains, but this year all the fronds are beautifully crested. A plant of it which he presented to the Edinburgh Botanic Garden was also shown, with the fronds crested in the same manner, after having remained for four years with fronds undivided. Both plants are very healthy, and it is curious how they should become so finely crested at the same time. He also showed a specimen of *Trillium erectum* var. *declinatum*, about 3 feet high; and *Primula luteola,* the same height, having the stem slightly fasciated.

SESSION 1883–84.

November 10, 1883.

"Note, with a flowering stem of *Phormium tenax* with seed capsules ripened in the open air at North Ronaldshay, Orkney," by Wm. Traill, M.D., of Woodwick. The specimen, about 6 feet high, with other plants of the same New Zealand exotic, had flowered and ripened seeds three times in the open air. The first year of such ripening was in 1879, and the next in 1881. On both occasions many young plants were raised from the seed, as has also been done during the present year of ripening. The young plants of 1883 look fully better matured, perhaps because the flowering occurred in the beginning of July, instead of the beginning of August, in 1879. The date of the second flowering was not recorded. Thus far they have flowered in Orkney every second year, whereas in New Zealand, it is said, they mostly flower every third year. Mr Lindsay exhibited a young healthy plant of New Zealand flax from the Royal Botanic Garden, which had been raised from some of the seeds of 1881.

"Note on a variegated form of *Asplenium Adiantum-nigrum* found at Pitlochrie," by Mr Robert Lindsay.—This was a fine variegated form of *Asplenium Adiantum-nigrum*, which was presented to the Garden by P. H. Rooke, Esq., Weybridge, who obtained it near Pitlochrie in the autumn. The variegation was more marked than usually found in such forms of this species.

January 10, 1884.

"On the Common Lupin as a Fodder Plant in Orkney," by William Traill, Esq., M.D., of Woodwick. The following letter from Dr Traill was read :—

"When taking a walk last September, about a mile to the eastward of the Manse of Sandwick, in the west mainland of Orkney, I was a good deal surprised to come upon a large quantity of the common blue Lupin of our gardens—*Lupinus perennis*, I believe; about 3 acres of ground were thickly covered with it, but scattered plants extended to a much greater distance; the plants were 2 or 3 feet high, and most of them were covered with ripe seeds; the soil they grew in appeared a thin yellowish loam, mixed with small angular pieces of flagstone, and partially covered with tufts of heather. On inquiry, I found that it was known that the plant had escaped from a garden in the neighbourhood a good many years ago. I observed that in parts where it had been long growing, the tufts of heather had disappeared, and were replaced by a thin covering of grass. I understand that cattle are partial to this plant, and I observed a cow eagerly cropping it while I was there. I believe this is not the only instance of the Lupin becoming naturalised in Scotland, but it appeared to me to be sufficiently interesting to bring to the notice of the Society, more especially as it seems to be a useful kind of fodder to introduce on waste ground, where hardly anything else will grow."

Professor Dickson gave a microscopic demonstration of the structure of the pitcher in the seedling of *Nepenthes* as compared with that in the adult plant.

Mr Patrick Geddes, on behalf of A. G. More, Esq., Dublin, presented to the Royal Botanic Garden a living plant of *Selaginella lepidophylla.*

Mr George L. Brown exhibited a flower of *Triteleia uniflora*, obtained that day from his garden, Millburn House, Morningside.

Mr A. B. Herbert sent a living plant of a fine dark form of *Primula acaulis.*

February 14.

Meeting adjourned in consequence of death of Professor Balfour.

March 13.

At this meeting, which had been adjourned in consequence of the death of Professor J. H. Balfour, W. B. Boyd, Esq., President, expressed regret at the irreparable loss which the Society had sustained in the death of Professor Balfour. He was the founder of the Society; it was in his house in Dundas Street, in 1836, that the Society took form; and ever since it had gone on increasing in usefulness, very much of this success being due to the untiring energy of Professor Balfour. Professor Dickson had undertaken to prepare an obituary notice for the *Transactions.* On the motion of the Chairman, the following minute of the Council was unanimously adopted, and a copy of it was ordered to be sent to the family of Professor Balfour :—"It is with profound regret that the Council has to record the loss of Emeritus Professor John Hutton Balfour, the honoured founder of this Society, who had from the commencement till a very recent period taken the deepest interest in its welfare, and may be described as having been its mainspring. Of Professor Balfour's services to botanical science and education it is impossible to speak too highly. His earnest devotion to botany and his inexhaustible energy have borne abundant fruit, not only in the direct scientific result of his labour, but in the vast number of pupils dispersed over the globe who have attained important positions in connection with botany pure or applied. Professor Balfour's death will be deeply deplored by all who have had the privilege of studying under him, and who will retain lively and affectionate remembrance of his enthusiasm, and of those personal qualities which endeared him to all with whom he came in contact."

Exhibition of an abnormal form of *Dryas octopetala*, gathered by Ben. Peach, H.M.G.S., in Sutherlandshire.

Notice by Dr Cleghorn of *Sorghum vulgare*, raised at Monteviot, Jedburgh, by the Marquis of Lothian, from a seed found in a fleece brought from Africa.

May 8.

"On a variation of *Asplenium germanicum*," by Mr W. B. Boyd. He noticed several stations where this and *A. septentrionale* were found together, but it never associated with *A. ruta-muraria*.

Mr Boyd exhibited a fine specimen of *Pinguicula alpina* in flower, also cut flowers of *Primula Sieboldi*, and varieties of several species of Narcissus from his garden at Faldonside, Melrose.

Mr Milne, Kevock Tower, Lasswade, sent species of Laurustinus in fine fruit.

June 12.

Mr R. Lindsay exhibited a spray of *Elæocarpus cyaneus*, from a plant now 30 feet high, covered with flowers in one of the hothouses of the Botanic Garden.

Isaac Anderson-Henry, Esq., sent pots from Hay Lodge, Trinity, containing the following Indian and New Zealand plants in bloom:—*Morina*, new species; *Myosotis antarctica* from New Zealand, new; *Cathcartia villosa; Pimelea*, from 4000 feet, in New Zealand; *Pratia*, sp., New Zealand.

July 10.

Mr Taylor exhibited a sample bag of coffee grown on Mount Zomba, East Africa, by Mr John Buchanan. An expert pronounces it very good, resembling mountain Jamaica coffee. It represented a crop of ten acres. Three years ago a single plant was sent from the Edinburgh Royal Botanic Garden to the Blantyre Mission Station, and now there were upwards of 23,000 plants in that district. Vines also, similarly transmitted, were growing well, though as yet the tea plant had not given so favourable results.

Dr Sanderson, treasurer of the Scottish Meteorological Society, sent, through Mr Buchan, a fine specimen of *Saxifraga stellaris*, transmitted by Mr Miller, second assistant at the Ben Nevis Observatory, who had picked it, along with a large full-grown moth, at the top of the Ben on the 6th July.

Mr Boyd showed ripe fruits of *Rubus antarcticus*, of the form which never fails to produce fruit in abundance, from his garden at Faldonside, Melrose.

OFFICE-BEARERS.

At the General Meeting held on Thursday, 14th December 1882, the following Office-Bearers for 1882–83 were elected:—

PRESIDENT.

William B. Boyd, Esq. of Faldonside.

VICE-PRESIDENTS.

Isaac Anderson Henry, F.L.S., F.R.S.E.
Professor Thomas R. Fraser, M.D., F.R.S.E.
Professor Douglas Maclagan, M.D., F.R.S.E.
Professor Bayley Balfour, Sc.D., M.B., C.M.

COUNCILLORS.

Robert Gray, F.R.S.E.
William Craig, M.D., C.M., F.R.C.S.E., F.R.S.E.
Malcolm Dunn.
Thomas Alexander Goldie Balfour, M.D., F.R.C.P.E., F.R.C.S.
James Robson Scott, M.D.
James Buchanan.
Charles Jenner, F.R.S.E.
Alexander Buchan, A.M., F.R.S.E.
Hugh Cleghorn, M.D., F.R.S.E.
Andrew Peebles Aitken, Sc.D., F.R.S.E.

Honorary Secretary—Emeritus Professor Balfour, M.D., F.R.SS. L. & E.
Honorary Curator—The Professor of Botany.
Foreign Secretary—Professor Dickson, M.D., F.R.S.E.
Treasurer—Patrick Neill Fraser.
Assistant Secretary—Andrew Taylor, F.C.S.

LOCAL SECRETARIES.

Aberdeen—Stephen A. Wilson of North Kinmundy.
Berwick—Philip W. Maclagan, M.D.
Birmingham—George A. Panton, F.R.S.E., 95 Colmore Row.
Calcutta—John Anderson, M.D., F.L.S.
,, George King, M.D., Botanic Garden.
Cambridge—Charles C. Babington, M.A., F.R.S., Professor of Botany.
Dublin—W. R. M'Nab, M.D., F.L.S., Professor of Botany, Roy. Col. Science.
Dumfries—James Gilchrist, M.D.
Exeter—Thomas Shapter, M.D.
Fife—J. T. Boswell, LL.D., F.L.S., of Balmuto, Kirkcaldy.
Georgetown, Demerara—W. H. Campbell, LL.D.
Glasgow—Professor Bayley Balfour.
Greenock—Donald M'Raild, M.D.
Kilbarchan—Rev. G. Alison.
London—William Carruthers, F.R.S., F.L.S., British Museum.
London, Brixton—John Archibald, M.B., C.M., F.R.C.S.E.
Manchester—Benjamin Carrington, M.D., Eccles.
Melbourne, Australia—Baron Ferdinand von Mueller, M.D.
Nairn—William Alex. Stables.
Norfolk—John Lowe, M.D., King's Lynn.
Nova Scotia—George Lawson, LL.D., Dalhousie.
Ottawa, Ontario—W. R. Riddell, B.Sc., B.A., Prov. Normal School.

Perth—F. B. White, M.D., F.L.S.
Saharunpore, India—J. F. Duthie, B.A., F.L.S., Botanic Garden.
Shrewsbury—Rev. W. A. Leighton, B.A., F.L.S.
Silloth—John Leitch, M.B., C.M.
Wellington, New Zealand—James Hector, M.D., F.R.SS. L. & E.
Wolverhampton—John Fraser, M.A., M.D.
Zanzibar—Sir John Kirk, M.D., F.L.S.

Fellows elected, Session 1882-83.

1882.
Nov. 9. Rev. John M. Robertson, M.A., Edinburgh—*Res. Fellow.*
William Brown, Earlsmill, Forres—*Non-Res. Fellow.*
Dec. 14. Emeritus Prof. John Hutton Balfour, Edinburgh—*Hon. Fellow.*
Prof. Oliver, Kew—*Hon. Fellow.*
1883.
Jan. 11. Edward Chamberlayne, Edinburgh—*Res. Fellow.*
Arthur Evans, M.A., Cambridge—*Res. Fellow.*
March 8. George L. Brown, Edinburgh—*Res. Fellow.*
Alexander Milne, Edinburgh—*Res. Fellow.*
April 12. Rev. David Paul, Roxburgh Manse, Kelso—*Res. Fellow.*
Robert Lindsay, Edinburgh—*Res. Fellow.*
May 10. Mrs Ridley Farquharson—*Lady Associate.*
Rev. Patrick M. Playfair, Edinburgh—*Res. Fellow.*
July 12. John Stewart, Arbroath—*Res. Fellow.*

At the General Meeting held on Thursday, 13th December 1883, the following Office-Bearers for 1883–84 were elected:—

PRESIDENT.

William B. Boyd, Esq. of Faldonside.

VICE-PRESIDENTS.

Professor Douglas Maclagan, M.D., F.R.S.E.
Professor Bayley Balfour, Sc.D., M.D.
Robert Gray, F.R.S.E.
William Craig, M.D., F.R.S.E.

COUNCILLORS.

Malcolm Dunn.
Thomas Alexander Goldie Balfour, M.D., F.R.C.P.E., F.R.S.E.
James Buchanan.
Charles Jenner, F.R.S.E.
Alex. Buchan, A.M., F.R.S.E.
Hugh Cleghorn, M.D., LL.D.
Andrew Peebles Aitken, Sc.D.
Isaac Anderson Henry, F.L.S., F.R.S.E.
Rev. John Macmurtrie, M.A.
Robert Lindsay.

Honorary Secretary—Emeritus Professor Balfour, M.D., F.R.SS. L. & E.
Honorary Curator—The Professor of Botany.
Foreign Secretary—Professor Dickson, M.D., F.R.S.E.
Treasurer—Patrick Neill Fraser.
Assistant-Secretary—Andrew Taylor, F.C.S.

LOCAL SECRETARIES.

Aberdeen—Stephen A. Wilson of North Kinmundy.
Berwick—Philip W. Maclagan, M.D.
Birmingham—George A. Panton, F.R.S.E., 95 Colmore Row.
Calcutta—John Anderson, M.D., F.L.S.
,, George King, M.D., Botanic Garden.
Cambridge—Charles C. Babington, M.A., F.R.S., Professor of Botany.
Dublin—W. R. M'Nab, M.D., F.L.S., Professor of Botany, Roy. Col. Science.
Dumfries—James Gilchrist, M.D.
Exeter—Thomas Shapter, M.D.
Fife—J. T. Boswell, LL.D., F.L.S., of Balmuto, Kirkcaldy.
Glasgow—Professor Bayley Balfour.
Greenock—Donald M'Raild, M.D.
Kilbarchan—Rev. G. Alison.
London—William Carruthers, F.R.S., F.L.S., British Museum.
London, Brixton—John Archibald, M.B., C.M., F.R.C.S.E.
Manchester—Benjamin Carrington, M.D., Eccles.
Melbourne, Australia—Baron Ferdinard von Mueller, M.D.
Nairn—William Alex. Stables.
Norfolk—John Lowe, M.D., King's Lynn.
Nova Scotia—George Lawson, LL.D., Dalhousie.
Ottawa, Ontario—W. R. Riddell, B.Sc., B.A., Prov. Normal School.
Perth—F. B. White, M.D., F.L.S.
Sarahunpore, India—J. F. Duthie, B.A., F.L.S., Botanic Garden.
Shrewsbury—Rev. W. A. Leighton, B.A., F.L.S.
Silloth—John Leitch, M.B., C.M.
Wellington, New Zealand—James Hector, M.D., F.R.SS. L. & E.
Wolverhampton—John Fraser, M.A., M.D.
Zanzibar—Sir John Kirk, M.D., F.L.S.

Fellows elected, Session 1883–84.

1883.
Nov. 8. George Stabler, Levens, Milnthorpe, Westmoreland—*Non-Res. Fellow.*

1884.
April 10. William Smith, Arbroath—*Res. Fellow.*
W. B. Bashford, Portobello—*Res. Fellow.*
May 9. William Murray, Edinburgh—*Res. Fellow.*
P. W. Fairgrieve, Dunkeld—*Res. Fellow.*
July 10. John Rattray, M.A., Edinburgh—*Res. Fellow.*
Alexander Waddell, Jedburgh—*Res. Fellow.*
Charles Stuart, M.D., Chirnside—*Res. Fellow.*
Dr Watson, Liberton—*Res. Fellow.*

ADDITIONS

TO THE

LIBRARY, HERBARIUM, AND MUSEUM,

AT THE

ROYAL BOTANIC GARDEN, EDINBURGH,

From 1st October 1882 to 1st October 1884.

I.—LIBRARY.

BOOKS.

Bentham and Hooker. Genera Plantarum. 3 vols.—*Purchased.*

Brown, James. The Forester. 4th Edition.—*Purchased.*

Cooke, M. C. British Freshwater Algæ. 2 vols.—*Purchased.*

Duthie, J. F., B.A., F.L.S., and J. B. Fuller. Field and Garden Crops of the N.W. Provinces and Oudh.—*From the Authors.*

Dutton, Clarence E. Tertiary History of Grand Cañon District.—*From the Survey Director.*

Griesbach, Dr. Flora of British West Indian Islands.—*Purchased.*

Grigor, H. Arboriculture.—*Purchased.*

Harvey, Will. H., and O. W. Sonder. Flora Capensis. 3 vols.—*Purchased.*

Hector, J., M.D., C.M.G., F.R.S. Reports of Geological Explorations, New Zealand.—*From the Director.*

Hooker, Sir J. D. Flora of British India. Vol. IV. Parts 1 and 2.—*From India Office.*

Hutton, F. W., F.G.S., C.M.Z.S. Catalogue of New Zealand Diptera, &c.—*From the Director.*

Jolly, William, F.R.S.E. Life of John Duncan.—*Purchased.*

Linnæus, C. Hortus Upsaliensis. Amsterdam, 1748.—*From Mr Thomas Walker, Carluke.*

Loudon, J. C. Trees and Shrubs of Great Britain.—*Purchased.*

Mueller, Prof. H. Fertilisation of Flowers. Eng. Trans.—*Purchased.*

Mueller, Baron F. von, M.D., Ph.D., K.C.M.G. Census of Australian Plants. Part I. Vasculares.

——— Eucalyptographia. Ninth decade.—*From the Author.*

Ormerod, Eleanor A. Report of Injurious Insects during 1881.—*From the Authoress.*

Pallas, P. S. Elenchus Zoophytorum. Hague, 1766.—*From Mr Thomas Walker, Carluke.*

Parnell, Richard, M.D., F.R.S.E. British Grasses.—*From the Author's Trustees.*

Pickering, Charles, M.D. Chronological History of Plants, 1879.—*From Mrs Pickering.*

Ray, John. History of Quadrupeds. — *From Mr Thomas Walker, Carluke.*

Seboth, Joseph. Alpine Plants. 3 vols.—*Purchased.*

Smiles, Samuel. Life of Robert Dick.—*Purchased.*

Warner, R. Select Orchidaceous Plants. Parts 4, 5, and 6.—*Purchased.*

Westhoff, Fr. von. Die Küfer Westfalens. Bonn, 1882. II. Abth.—*From the Author.*

PAMPHLETS, REPRINTS FROM SCIENTIFIC PUBLICATIONS, &c.

Baden-Powell, B. H. Manual of Land Revenue Systems and Land Tenure of British India. Calcutta, 1882.—*Presented by Home Department.*

Beyse, G. Untersuch. über den Anat. der Gattung *Impatiens.* Halle, 1881.—*From the Author.*

Boeddicker, Dr Otto. Notes on Physical Appearance of Planet Jupiter during 1880–81. (From Proc. Roy. Dublin Soc. 1882.)—*From the Author.*

Clos, M. D. Des organes intermediaires entre la racine et la feuille, et de l'appareil vegetalif des Utriculaires.—*From the Author.*

Craig, Dr William. The late Mr John Sadler. (From Proc. Berwickshire Nat. Soc.)—*From the Author.*

Drude, Dr Oscar. Die stossweisen Wachsthum sanderungen in der Blattentwicklung von *Victoria regia.* Halle, 1881.—*From the Author.*

Duthie, J. F. A List of Grasses of North-Western India.—*From the Author.*

Dyer, W. T. T. A New Species of *Cycas.* (From the Linnean Trans. 1883.)—*From the Author.*

Engelhardt, Herman. Ueber die fossilen Pflanzen von Tschernowitz. Dresden, 1877.

——— Ueber die fossilen Pflanzen von Grasseth. Halle, 1881.—*From the Author.*

Gray, Asa. Memorials of George Engelmann and of Oswald Heer.

——— A Revision of the North American Species of the Genus *Oxytropis.*

——— Gender of Names of Varieties.

——— Characteristics of the North American Flora.—*From the Author.*

Harkness, H. W. Footprints found at the Carson State Prison. (From Proc. of Californian Acad of Sciences, 1882.)

Hartley, W. A. Photographs of the Spark Spectra of Twenty-one Elementary Substances. (From Proc. Roy. Dublin Soc.) 1882. —*From the Author.*

Hunter, James. Permanent Pasture Grasses and their Adulteration. —*From the Author.*

James, Joseph F. A Revision of the Genus *Clematis* of the United States. (From Cincinnati Society of Natural History, 1883.)—*From the Author.*

Lindberg, S. O. Kritish Granskning af Mossorna uti Dillenii Historia Muscorum, 1741. Helsingfors, 1883.—*From the Author.*

Mueller, Baron F. von. Address on Development of Rural Industries.

——— Plants of Shark's Bay.—*From the Author.*

Netto, Dr L. Aperçu sur la Theorie de l'Evolution. Rio de Janeiro 1883.—*From the Author.*

Parish, S. B. & W. F. Supplementary List of Plants of South California.

Pringsheim, N. Untersuchungen über das Chlorophyll. Berlin, 1881.—*From the Author.*

Radlkofer, L. Ein Beitrag zur Africanischen Flora. (From Abhand. des Natur. Vereines in Bremen.)

——— Ueber den Systematischen Werth der Pollenbeschaffenheit bei den Acanthaceen. (From Litz. der Acad. der Wiss. Bd. XIII.)—*From the Author.*

Reinke, J. Entwick. Untersuch. über die Dictyotaceen des Golfs von Neapel. Dresden, 1878.

——— Entwick. Untersuch. über die Cutleriaceen des Golfs von Neapel. Dresden, 1878.—*From the Author.*

Rodrigues, J. Barbosa. On *Esenbeckia fasciculata* (Rutaceæ.)—*From the Author.*

Saint-Lager, Dr. Catalogue des Plantes vasculaires de la Flore du Bassin du Rhone, 1883.—*From the Author.*

Schlich, Dr W. Suggestions Regarding the Demarcation and Management of the Forests in Kulu. Calcutta, 1882.—*From Forest Branch of Home Department.*

Schomburg, Dr R. Report on Botanic Garden and Government Plantations. Adelaide, 1883.—*From the Author.*

Senoner, A. Cenni Bibliografici.—*From the Author.*

Sodiro, P. A. Recensio Cryptogamarum Vascularum Provinciæ Quitensis. Quito, 1883.—*From the Author.*

Spruce, Dr R. On *Anomoclada*, a new genus of Hepaticæ, and on its Allied Genera.—*From the Author.*

——— On *Cephalozia*, a genus of Hepaticæ.—*From the Author.*

Strasburger, Dr E. Uber den Befruchtungsvorgang. 1882.—*From the Author.*

Zopf, Dr W. Zur Entwickelungsgeschichte der Ascomyceten. Halle, 1881.—*From the Author.*

TRANSACTIONS, &c., OF LEARNED SOCIETIES, AND KINDRED INSTITUTIONS.

ADELAIDE.—Botanic Garden and Government Plantations.
Report of Progress and Condition during 1882.—*From Dr R. Schomburg, Director.*

AUCH.—Société Français de Botanique. Bulletin Mensuel. Tome II. Parts 11–24.—*From the Society.*

BELFAST.—Natural and Philosophical Society.
Proceedings for Sessions 1881–82, 1882–1883, and 1883–84.—*From the Society.*

——— Naturalists' Field Club.
Proceedings. Vol. II. Part 2.—*From the Club.*

BERLIN.—Botanischen Verein fur die Provinz Brandenburg.
Verhandlungen. No. XXIV.—*From the Society.*

BERNE.—Société Helvétique des Sciences Naturelles.
Mittheilungen. Heft I., II. 1883.—*From the Society.*

BERWICK.—Berwickshire Naturalists' Club.
Proceedings. Vol. X. Nos. 1 and 2.—*From the Club.*

BONN.—Naturhistorischer Vereine der Preussischen, Rheinlande, und Westfalens.
Verhand. Jahrgang. XXXIX. 1 and 2; XL. 1. 1881.—*From the Society.*

BOSTON.—Massachusetts Horticultural Society.
Transactions. 1882 and 1883. Parts 1 and 2.—*From the Society.*

——— Society of Natural History.
Proceedings. Vol. XX. Part 4; Vol. XXI.; Vol. XXII. Part 1.
Memoirs. Vol. III. Nos. 4–7.—*From the Society.*

BREMEN.—Naturwissenschaftlicher Verein.
Abhandlungen. Band VIII. Heft 1, 2; IX. Heft 1.—*From the Society.*

BRISBANE.—Royal Society of Queensland.
Proceedings. Vol. I. Part 1.—*From the Society.*

BRISTOL.—Bristol Naturalists' Society.
Proceedings. New Series. Vol. IV. Parts 1, 2.—*From the Society.*

BRUSSELS.—L'Académie Royale des Sciences de Belgique.
Bulletins de l'Académie. Ser. III. Tomes I., II., III., IV., V. Annuaires. 1882, 1883.—*From the Academy.*
Société Royale de Botanique de Belgique.
Bulletin XXI. and XXII.—*From the Society.*

CINCINNATI.—Society of Natural History.
Journal. Vols. IV., V., VI.; Vol. VII. Nos. 1–3.—*From the Society.*

COPENHAGEN.—Botaniske Forening i Kobenhavn.
Botaniske Tidsskrift (Journal de Botanique). Series III. Vol. XIII. Liv. 3 and 4; Vol. XIV. Liv. 1 and 2.—*From the Society.*

DAVENPORT.—Academy of Natural Sciences.
Proceedings. Vol. III. Parts 2 and 3.—*From the Academy.*

DUBLIN.—Royal Society.
Transactions. Vol. I. Parts 20–25; Vol. II.; Vol. III. Parts 1–3.
Proceedings. Vol. III. Parts 5–7; Vol. IV. Parts 1–4.—*From the Society.*

EDINBURGH.—Botanical Society.
Transactions and Proceedings. Vol. XIV. Part 2; Vol. XV. Part 1.
Geological Society.
Transactions. Vol. IV. Part 2.—*From the Society.*
Royal Society.
Transactions. Vol. XXX. Parts 2 and 3; Vol. XXXI. Part 1.
Proceedings. Sessions 1881–82, 1882-83.—*From the Society.*
Royal Physical Society.
Proceedings. Sessions 1874–75, 1878–79, 1881–82, 1882–83.—*From the Society.*
Royal Scottish Society of Arts.
Transactions. Vol. X. Part 5; Vol. XI. Part 1.—*From the Society.*

EPPING FOREST and County of Essex Naturalists' Field Club. Vol. III. Parts 7 and 8. Appendix I. of Vol. IV.—*From the Club.*

ERLANGEN.—Physikalisch Medicinischen Societät zu Erlangen. Heft 14. and 15. 1882–83.—*From the Society.*

GIESSEN.—Oberhessische Gesellschaft.
22nd and 23rd Bericht.—*From the Society.*

GLASGOW.—Natural History Society.
Proceedings. Vol. V. Part 1.—*From the Society.*
Philosophical Society.
Proceedings. Vol. XV.—*From the Society.*

HAARLEM.—Bevordering van Nijverheid.
Tijdschrift. 4e Reeks, Deel VII. and VIII.—*From the Society.*
Musée Teyler.—Archives. Series II. Repertorium Annuum. Vol. VII.; Vol. VIII. Part 1.—*From the Corporation.*

HALIFAX.—Nova Scotia Institute of Natural Science.
Proceedings. Vol. VI. Part 1.—*From the Institute.*

HALLE.—Kais. Leop. Carol. Deutsche Akad. der Naturforscher.
Nova Acta. Band XXXIX. No. 7; XLII. No. 5; XLIII. No. 2, 3, 4.
Leopoldina. Parts 12–19.—*From the Society.*

HERTFORD.—Natural History Society and Field Club.
Transactions. Vol. II. Parts 1–9; Vol. III. Parts 1, 2.—*From the Society.*

INDIANAPOLIS.—Botanical Gazette. Vol. IX. Nos. 1–12.—*From the Editor.*

KÖNIGSBERG.—Physikal. Ökonom. Gesell. zu Königsberg.
Schriften. Part 2, 1880; Parts 1 and 2, 1881; do. 1883.—*From the Society.*

LIEGE.—La Belgique Horticole Annales de Botanique et d'Horticulture. Par Dr Edouard Morren, 1882.—*From the Editor.*
Bulletin de la Federation, 1882. Correspondence Botanique, 1884. —*From the Editor.*

Liverpool.—Literary and Philosophical Society of Liverpool.
Proceedings. Nos. 35, 36, 37.—*From the Society.*

London.—India Office—Forest Department.
Reports for 1880–83.
Reviews of the Forest Administration of the several Provinces under the Government of India for the years 1881–84.—*From the India Office.*

Linnean Society.
Journal. Nos. 122–135.
Transactions. Second Series. Vol. II. Parts 2–7.—*From the Society.*

Pharmaceutical Society.
Journal and Transactions. Nos. 646–746.
Calendar, 1883, 1884.—*From the Society.*

Quekett Microscopical Club.
Journal. Ser. II. Vol. I. Nos. 4–7; Vol. II. Nos. 8–10.—*From the Club.*

Luxembourg.—Soc. Bot. du Grand-Duché de Luxembourg.
Mémoires. Nos. 6–8.—*From the Society.*

Lyons.—Société Botanique de Lyons.
Annales. No. 1, 1881–82.—*From the Society.*

Manchester.—The Botanical Record Club.
Phanerogamic and Cryptogamic Report for the years 1882–83.—*From the Club.*

Literary and Philosophical Society.
Proceedings. Vols. XX., XXI., XXII.—*From the Society.*

Melbourne.—Royal Society of Victoria.
Transactions. Vols. XV. and XVIII.—*From the Society.*

Montreal.—Geolog. and Nat. Hist. Survey of Canada.
Report of Progress, 1880–82, with maps.—*From the Director.*

Horticultural Society.
Eighth and Ninth Report.—*From the Society.*

New York.—Lyceum of Natural History.
Annals. Vol. II. Nos. 7–9.
Transactions. Vol. I. Nos. 4–8.—*From the Lyceum.*

American Museum of Natural History.
Bulletin. Vol. I. Nos. 2–5.
Annual Reports, 1882–84.

Torrey Botanical Club.
Bulletin. Vol. XI. Parts 1–10.—*From the Club.*

Academy of Sciences.
Transactions. Vol. II. Nos. 1, 5–8.
Annals. Vol. II. No. 13; Vol. III. Nos. 1 and 2.—*From the Academy.*

Norwich.—Norfolk and Norwich Naturalists' Society.
Transactions. Vol. III. Parts 4 and 5.—*From the Society.*

Paris.—Société Botanique de France.
Bulletin. Revue Bibliographique. Tom. XXIX., XXX., XXXI. A. B. C.
Comptes rendus. Tom. XXX. 5; XXXI. 1–5.
Session extraordinaire á Bayonne, 1880.—*From the Society.*

PERTH.—Perthshire Society of Natural Science.
Proceedings. Vol. II. Part 3.—*From the Society.*

PETERSBURG, ST.—Hortus Imp. Bot. Petropolitanus.
Acta. Tom. VIII.—*From the Director.*

PHILADELPHIA.—Academy of Natural Sciences.
Proceedings. Parts 1–3, 1882; Parts 1 and 2, 1883; Parts 1 and 3, 1884.—*From the Academy.*

PLYMOUTH.—Plymouth Institution and Devon and Cornwall Natural History Society.
Transactions. Vol. VIII. Part 3.—*From the Society.*

RIO DE JANEIRO.—Archivos de Museu Nacional do Rio de Janeiro.
Vol. IV. 1, 2, 3, et 4 Trimestrés, 1879; Vol. V., 1, 2, 3, et 4 Trimestrés, 1880.—*From the Director.*

SYDNEY, AUSTRALIA.—Royal Society of New South Wales.
Journal and Proceedings. Vols. XV. and XVI.—*From the Society.*

TORONTO.—Canadian Institute. The Canadian Journal of Science, Literature, and History. New Series. Vol. I. Nos. 3–5; Vol. II. Nos. 1–3.—*From the Society.*

UPSALA.—Société Royale des Sciences. Nova Acta, Vol. XI. Fasc. 2; Vol. XII. Fasc. 1.—*From the Society.*

WASHINGTON.—Smithsonian Institution.
Report of the Board of Regents, 1857, 1865, 1866, 1869, 1882.
Congressional Directory, 1883.—*From the Institution.*
U.S. Geological and Geographical Survey of the Territories. Bulletin, Second Series No. 1.—*From Dr F. R. Hayden.*
Mineral Resources of the United States. By A. Williams, jun.—*From the Survey Office.*

WELLINGTON.—New Zealand Institute.
Transactions and Proceedings. Vols. XV. XVI.—*From the Institute.*
Colonial Museum and Geological Survey Department.
Meteorological Report, 1883.
Reports of Geological Explorations, 1882; 1883–84.
Handbook of New Zealand (3rd edit.), 1883.
Report of Col. Museum and Laboratory, 17th and 18th.—*From the Director.*

YORK.—Yorkshire Naturalists' Union.
Transactions. Vol. I. Parts 4–7.—*From the Society.*

PERIODICALS.

The Garden. Vols. XXII., XXIII., XXIV.—*Purchased.*

The Gardeners' Chronicle. New Series. Vols. XIX., XX.—*Purchased.*

Nature.—*From the Editor.*

Curtis's Botanical Magazine. Vols. XXXIX., XL. 3rd Ser.—*Purchased.*

The Journal of Forestry.—*From the Proprietors.*

The Scottish Naturalist. New Ser. Vol I. Nos. 1–6.—*From the Proprietors.*

DONATIONS TO THE HERBARIUM.

Aitchison, J. E. T., F.L.S., Surgeon-Major H.M. Bengal Army. A collection of Afghan Plants.

Coles, F. R. Six dried specimens of rare British Plants from Kirkcudbrightshire.

Dickson, Prof. Alex., M.D., LL.D., F.R.S.E. Specimens of two species of *Utricularia* from Gordon Moss.

Fowler, J., Kingston, Ontario. About 300 species of North American Plants.—*By Exchange.*

Gibson, Alex. H., Kirkcaldy. Collection of Plants from Edinburgh neighbourhood, for which Gold Medal was awarded, Session 1883.

Kew Herbarium. Socotra Plants, gathered by Prof. I. B. Balfour, M.D., D.Sc., F.R.S.

Lauder-Lindsay, W., M.D., F.R.S.E., F.L.S. A large and very fine collection of Lichens.

——— A complete set of British Flowering Plants and Ferns.

——— A collection of New Zealand Plants.—*Presented by direction of the Relatives.*

Norman, Captain F., R.N. Specimen of *Callitriche verna* from Skye.

Parnell, Richard, M.D., F.R.S.E. Entire collection of Grasses and other Flowering Plants, Ferns, and other Cryptogams gathered by him.—*Presented by the Trustees.*

Richardson, A. D., Royal Botanic Garden. Dried specimens of four British Plants.

DONATIONS TO THE MUSEUM.

British Guiana Collection (Directors of), Forestry Exhibition. Collection of Fungi.

Cape of Good Hope Collection (Directors of), Forestry Exhibition. Specimen of *Welwitschia mirabilis.*

Cleghorn, Dr H., F.R.S.E., F.L.S. Specimen of *Sorghum vulgare.*

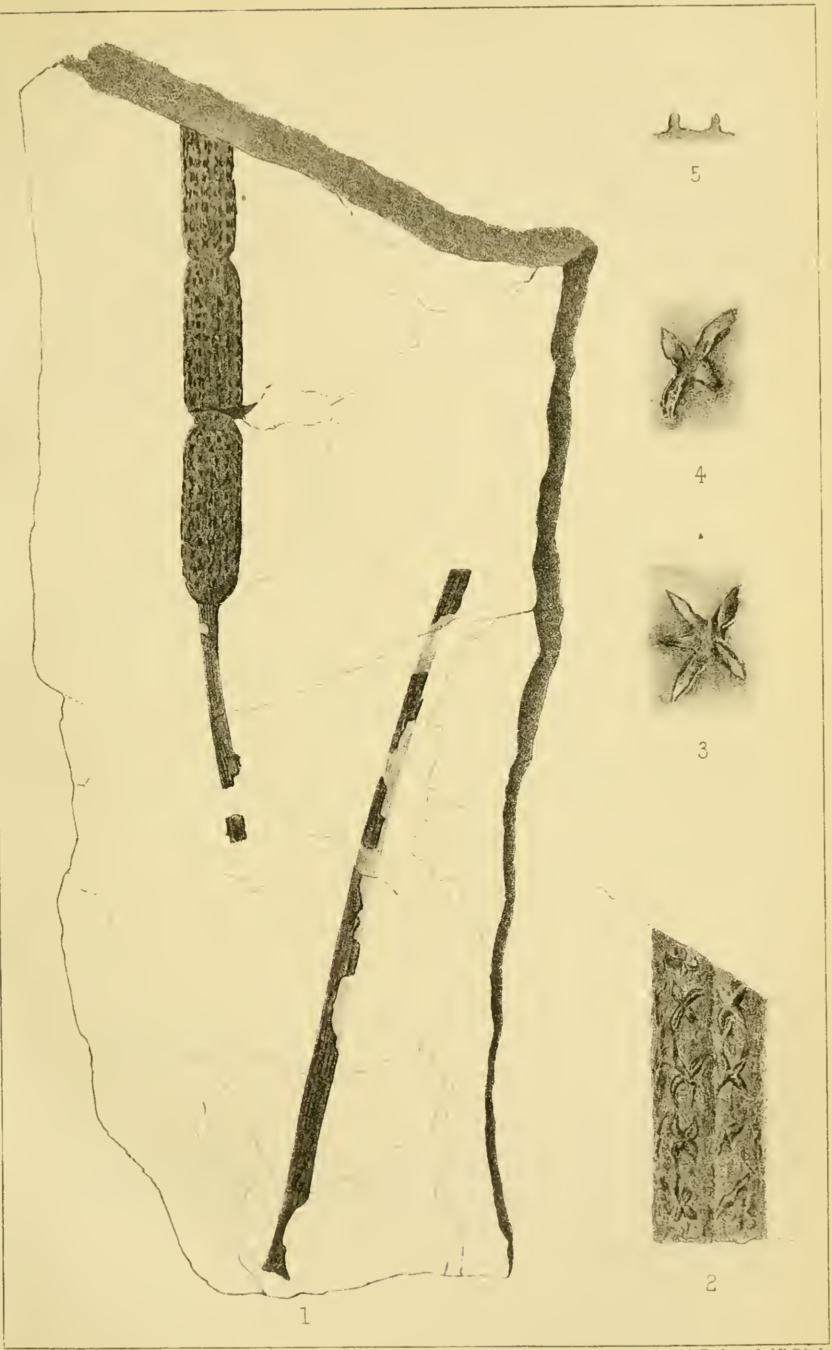
——— Midribs of Palm leaves (*Raphia*) from Zanzibar.

Japanese Collection (Directors of), Forestry Exhibition. Large collection of Japanese Seeds.

Michael, Colonel, Commissioner from India, Forestry Exhibition. Stem of Bamboo.

——— Three sections of Dicotyledonous Wood.

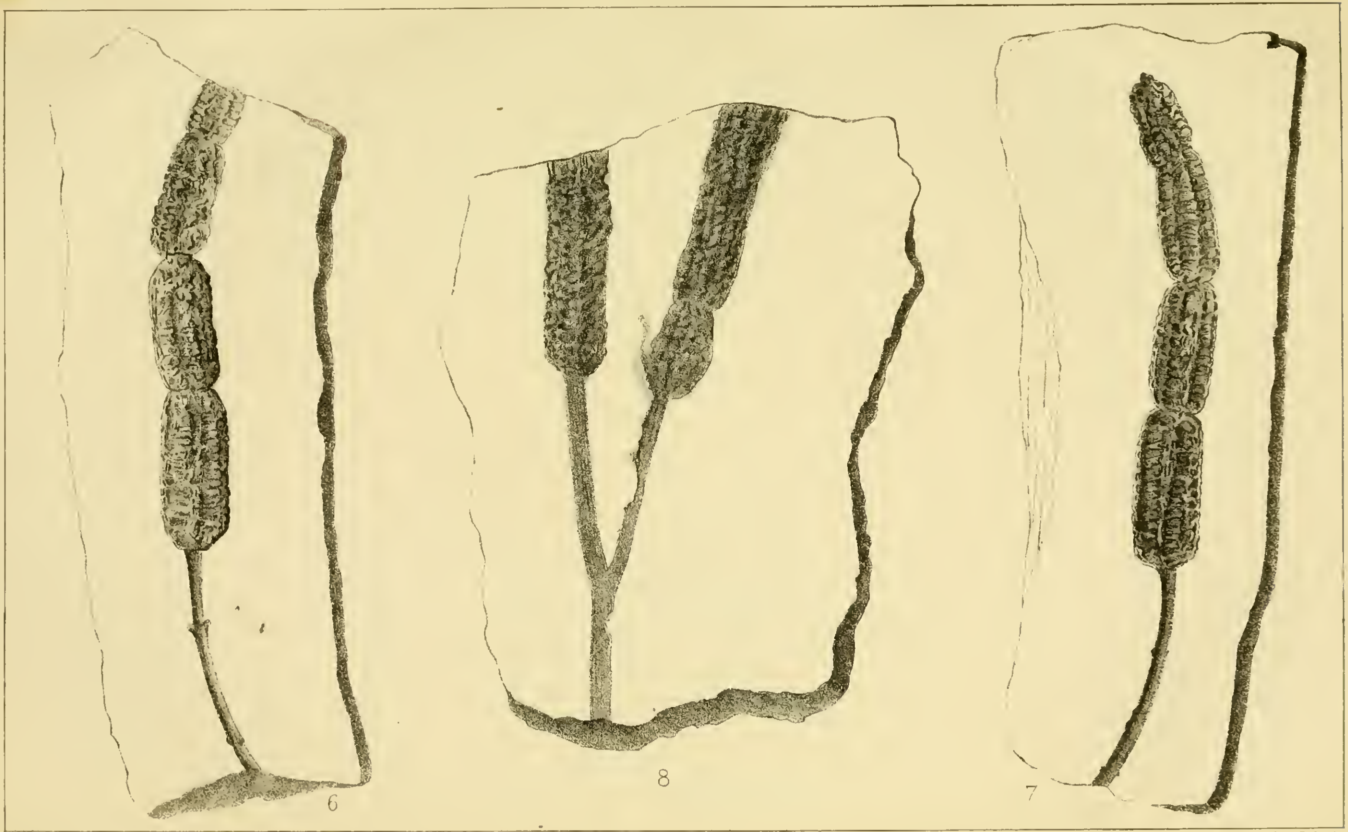
Sidey, Dr. Cone of Silver Tree (*Leucodendron argenteum*).



Robt Kidston, del.

McFarlane & Erskine, Lithrs Edinr

FRUIT OF BORNIA. *Roem.*



Robt Kidston, del

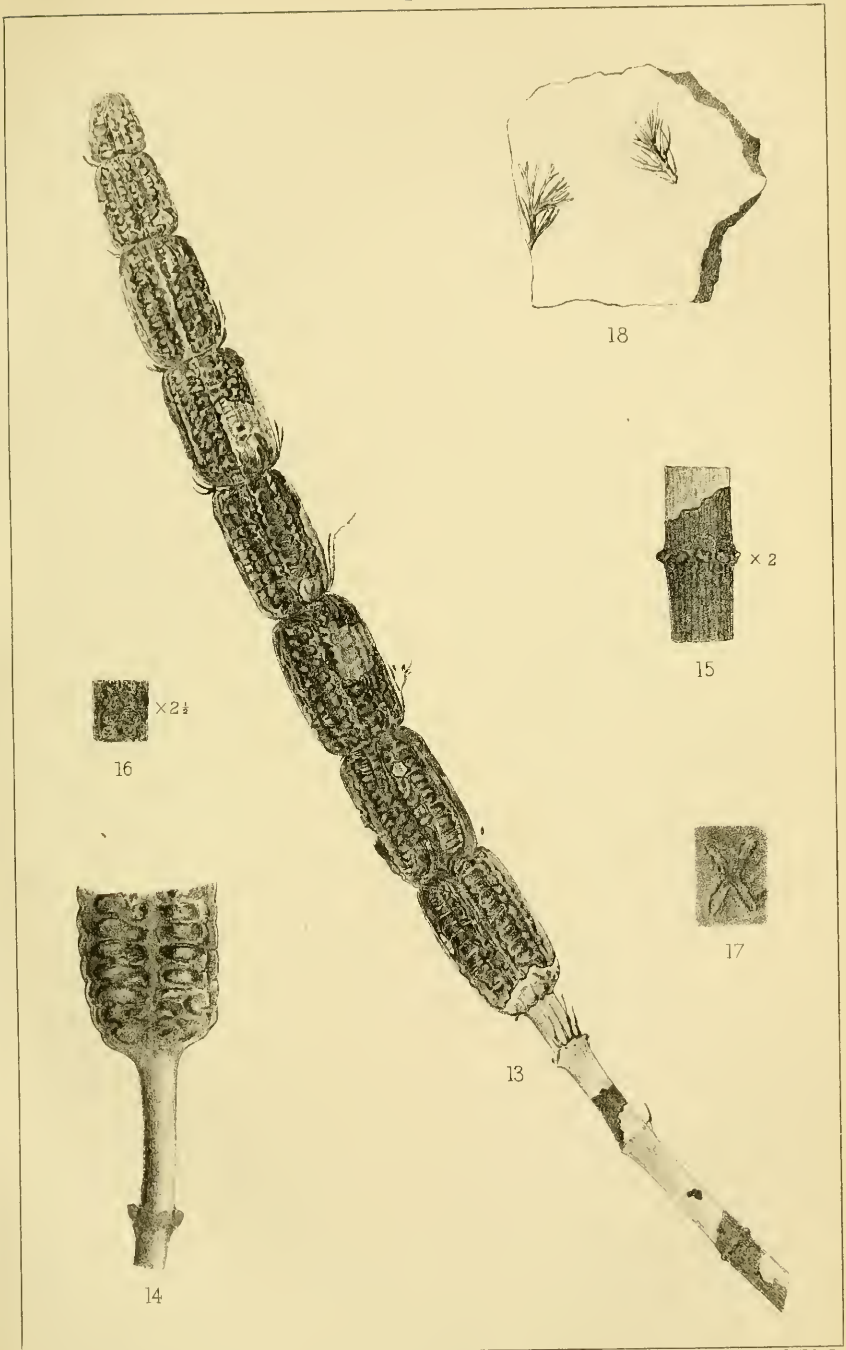
McFarlane & Erskine, Lithrs Edinr

FRUIT OF BORNIA. *Roem*

Robt. Kidston, del.

McFarlane & Erskine, Lithrs. Edinr.

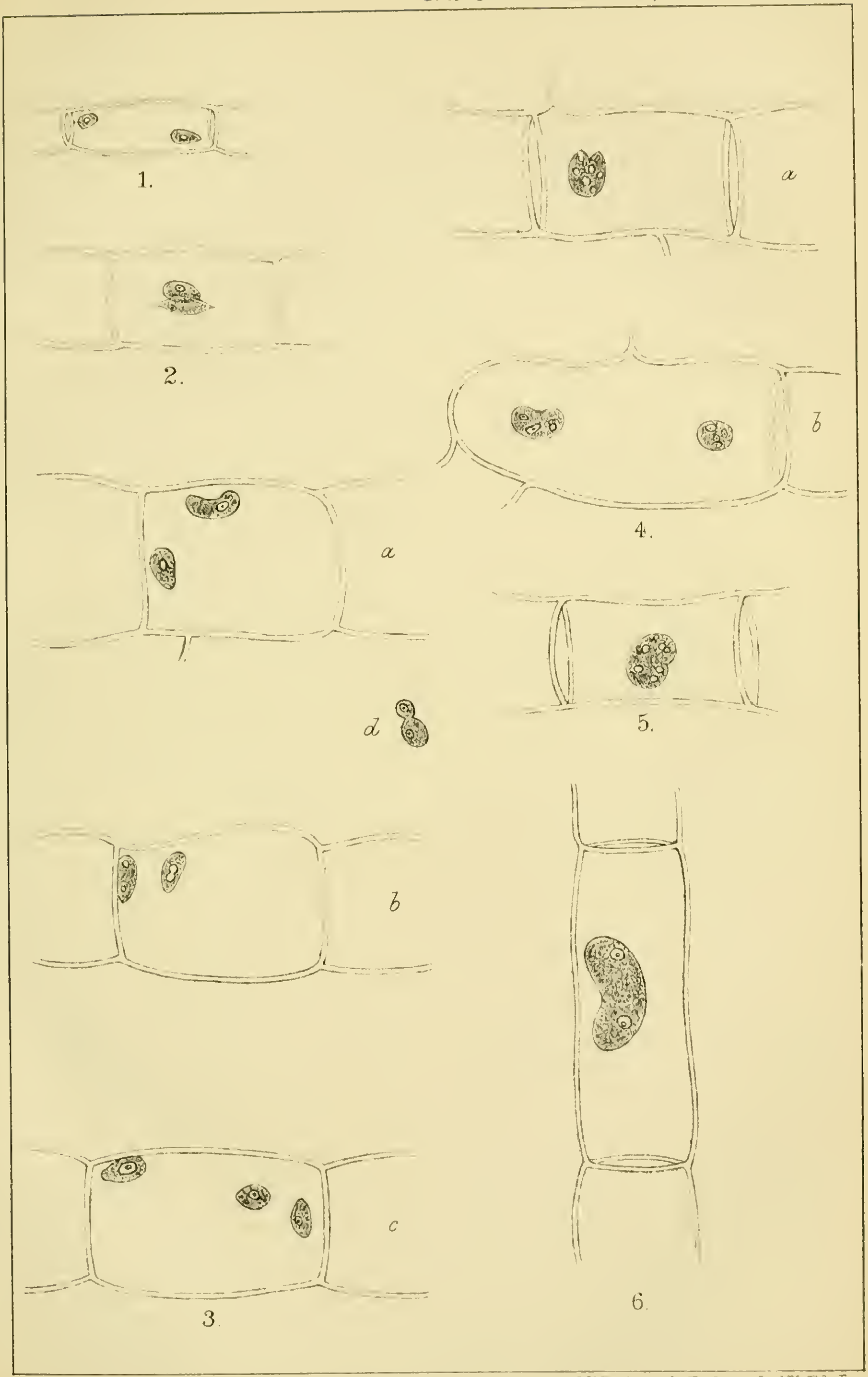
9-10. FRUIT OF BORNIA. *Roem.*



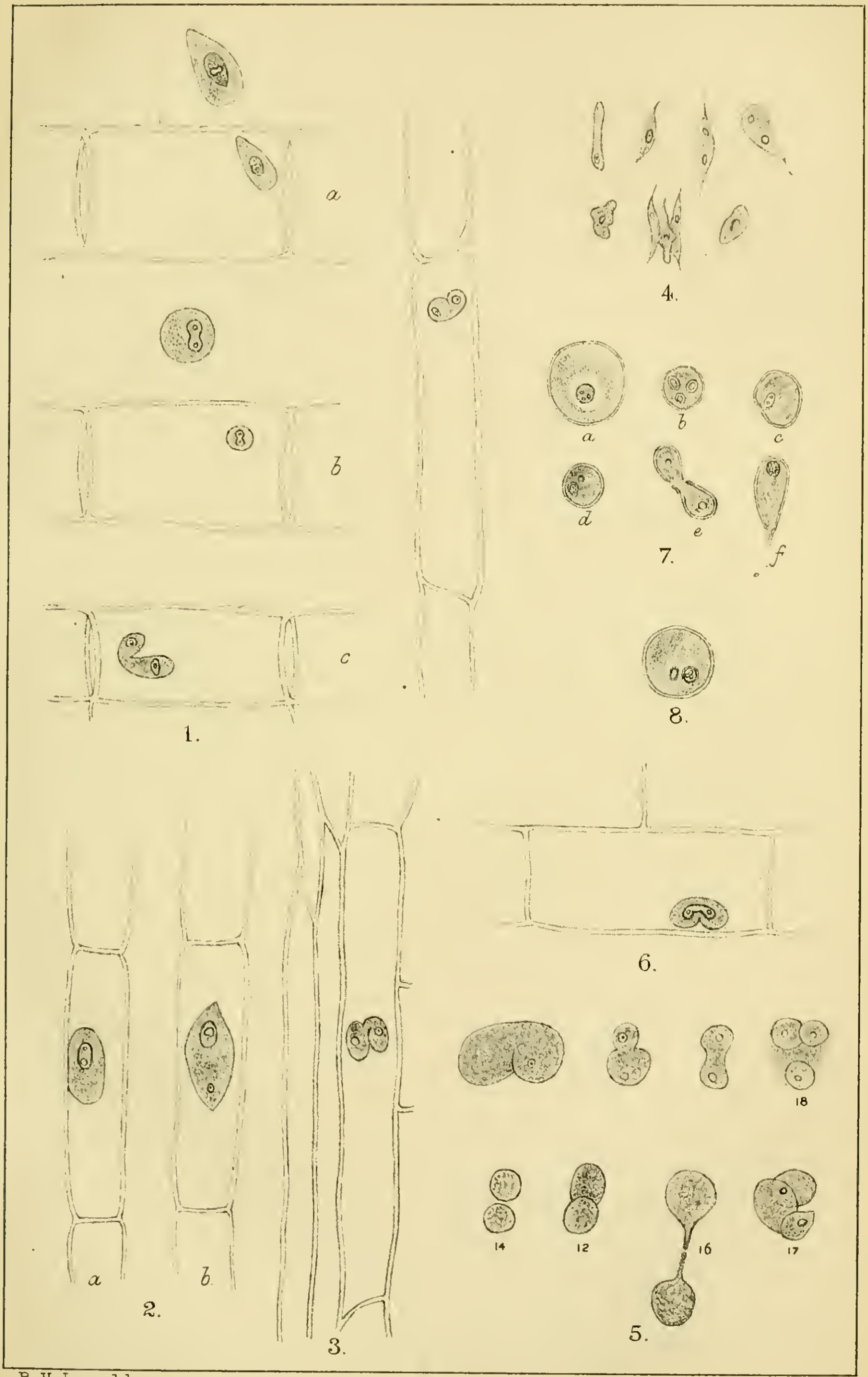
Robt Kidston, del

McFarlane & Erskine, Lithrs Edinr

13-17. FRUIT OF BORNIA *Roem.*
18. SPHENOPHYLLUM TENERRIMUM. *Ett*

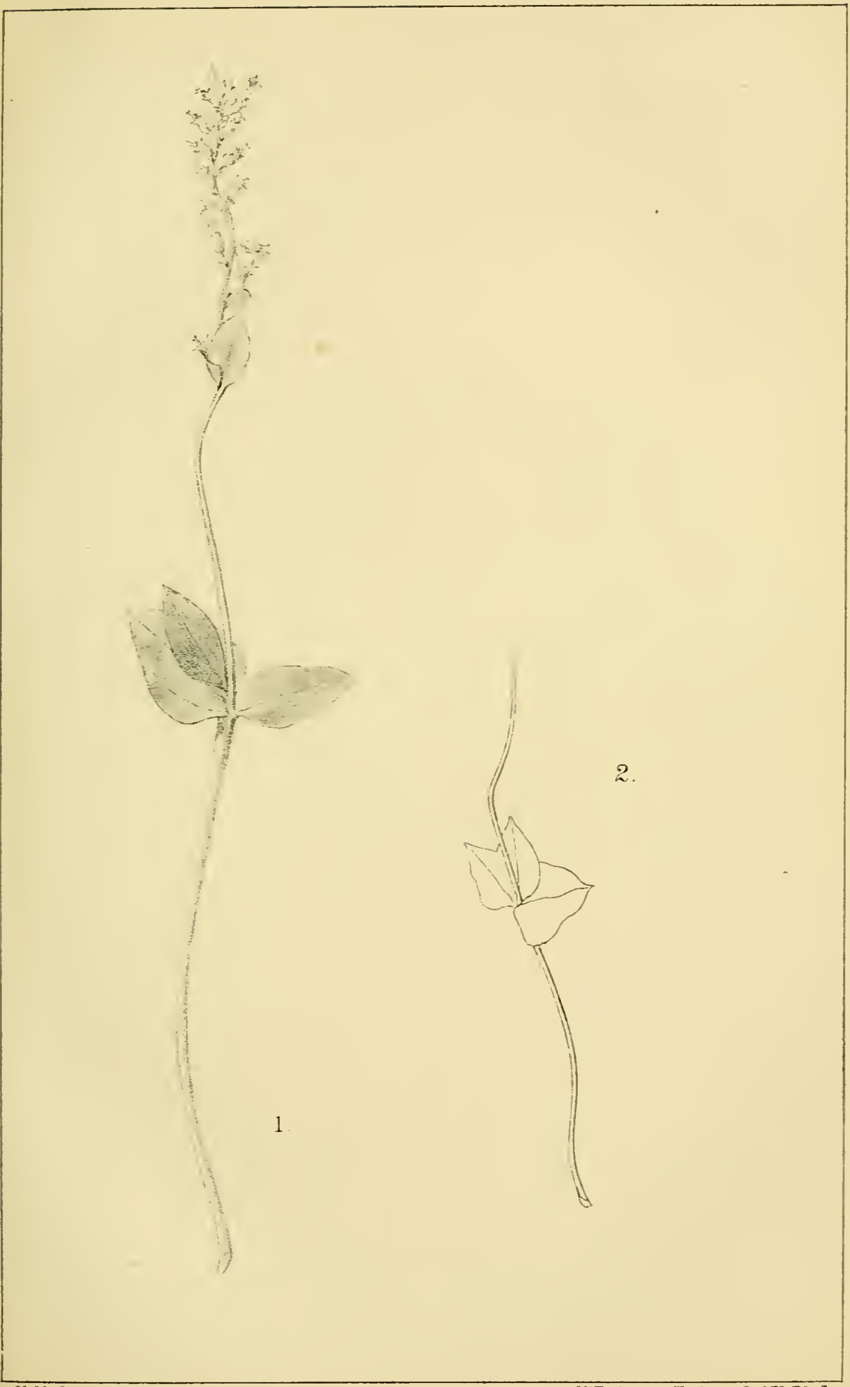


R. H. Lucy, del.   McFarlane & Erskine Lith.rs Edin.r



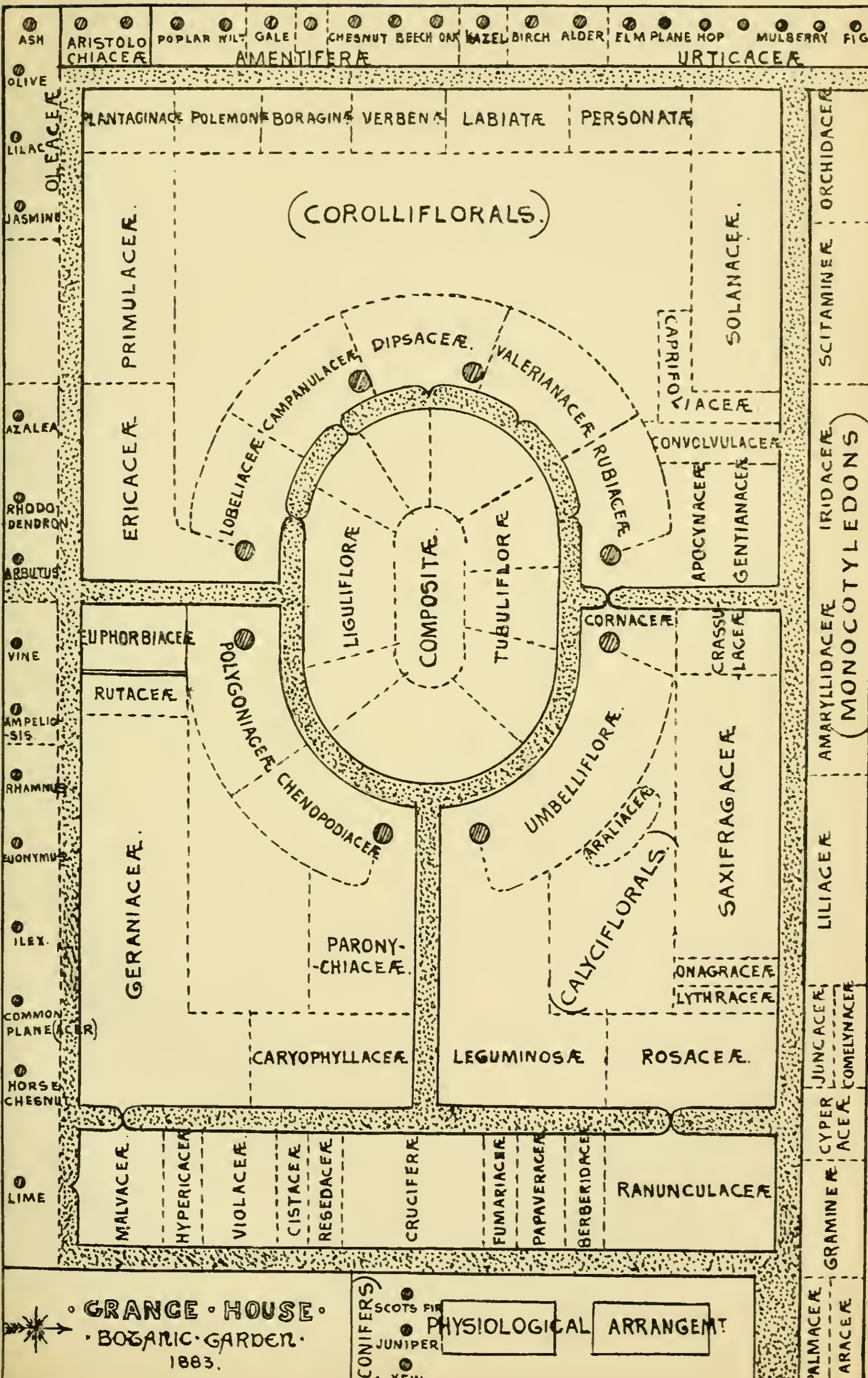
R. H. Lucy, del.

McFarlane & Erskine, Lithrs, Edinr.



H. M. Corry. del. ad. nat.   McFarlane & Erskine, Lith.rs Edin.r

LISTERA CORDATA, *R. Br.*


ASH
ARISTOLOCHIACEÆ
POPLAR
WILLOW
GALE
CHESNUT
BEECH
OAK
HAZEL
BIRCH
ALDER
AMENTIFERÆ
ELM
PLANE
HOP
MULBERRY
FIG
URTICACEÆ
OLIVE
LILAC
JASMINE
OLEACEÆ
PLANTAGINACEÆ
POLEMONIACEÆ
BORAGINEÆ
VERBENACEÆ
LABIATÆ
PERSONATÆ
(COROLLIFLORALS.)
PRIMULACEÆ
SOLANACEÆ
CAPRIFOLIACEÆ
ORCHIDACEÆ
SCITAMINEÆ
DIPSACEÆ
CAMPANULACEÆ
VALERIANACEÆ
LOBELIACEÆ
RUBIACEÆ
CONVOLVULACEÆ
APOCYNACEÆ
GENTIANACEÆ
AZALEA
RHODODENDRON
ARBUTUS
ERICACEÆ
LIGULIFLORÆ
COMPOSITÆ
TUBULIFLORÆ
IRIDACEÆ
MONOCOTYLEDONS
AMARYLLIDACEÆ
VINE
EUPHORBIACEÆ
RUTACEÆ
AMPELIC-SIS
POLYGONIACEÆ
CHENOPODIACEÆ
CORNACEÆ
CRASSULACEÆ
UMBELLIFLORÆ
ARALIACEÆ
SAXIFRAGACEÆ
CALYCIFLORALS.
RHAMNUS
EUONYMUS
ILEX.
GERANIACEÆ
PARONYCHIACEÆ.
LILIACEÆ
ONAGRACEÆ
LYTHRACEÆ
COMMON PLANE (ACER)
HORSE CHESNUT
CARYOPHYLLACEÆ
LEGUMINOSÆ
ROSACEÆ.
JUNCACEÆ
COMELYNACEÆ
CYPERACEÆ
LIME
MALVACEÆ
HYPERICACEÆ
VIOLACEÆ
CISTACEÆ
RESEDACEÆ
CRUCIFERÆ
FUMARIACEÆ
PAPAVERACEÆ
BERBERIDACEÆ
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· GRANGE · HOUSE ·
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1883.
CONIFERS
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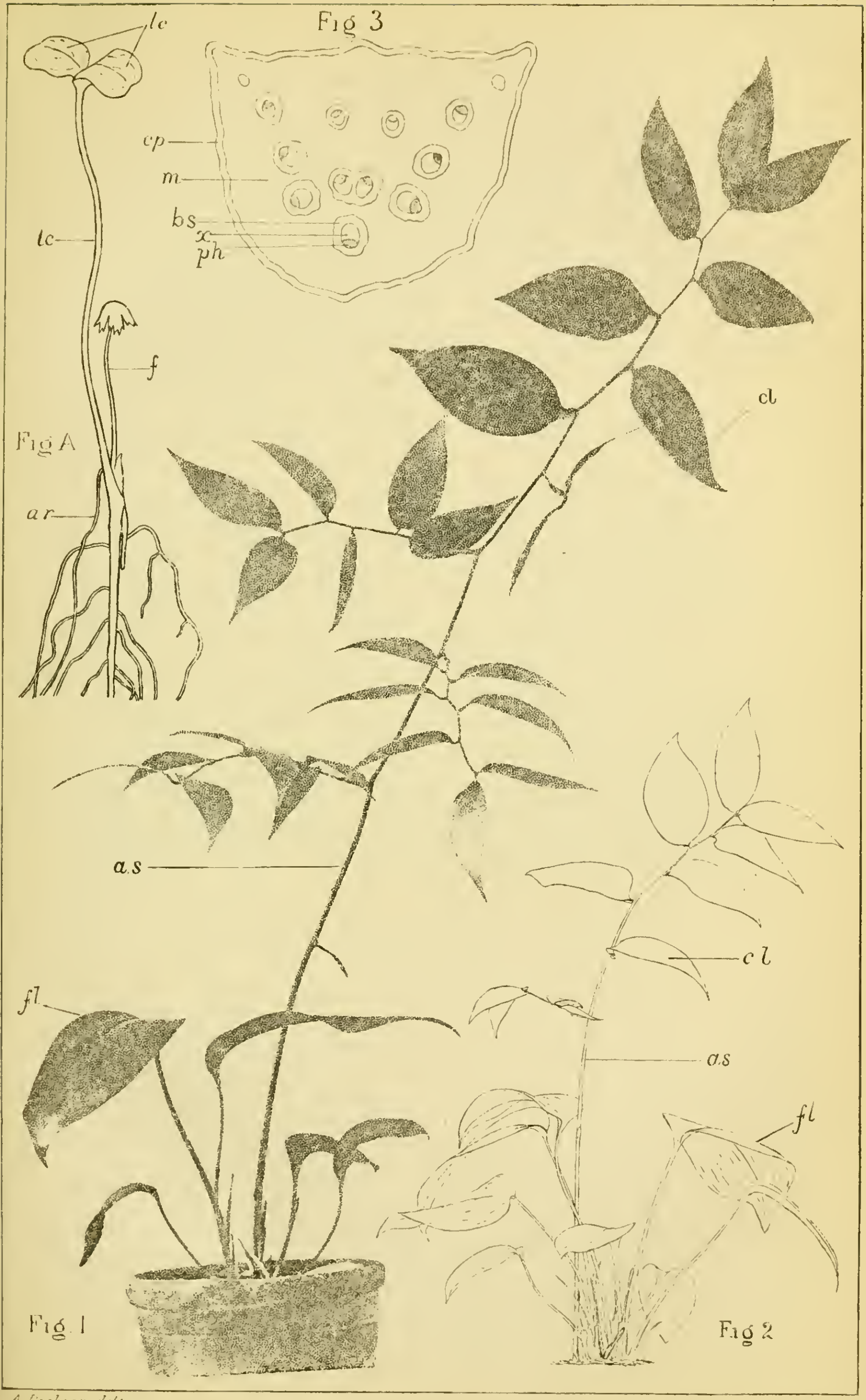
PHYSIOLOGICAL ARRANGEMENT
PALMACEÆ
ARACEÆ

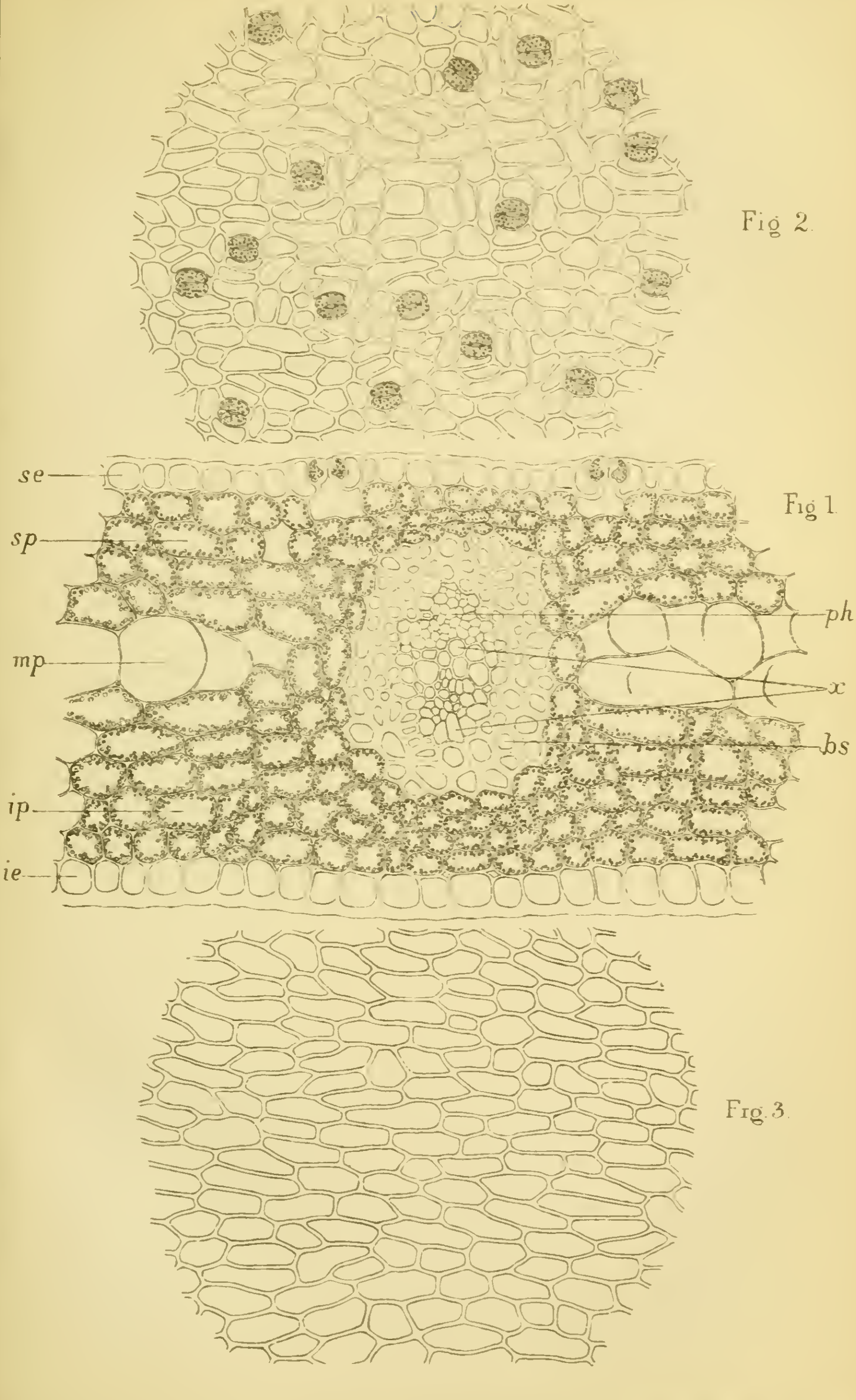


A. Dickson delt.

J. Waterston & Son. Photo Lith.

Fig A. PODOPHYLLUM EMODI.

Figs 1. 2. & 3 RUSCUS ANDROGYNUS.



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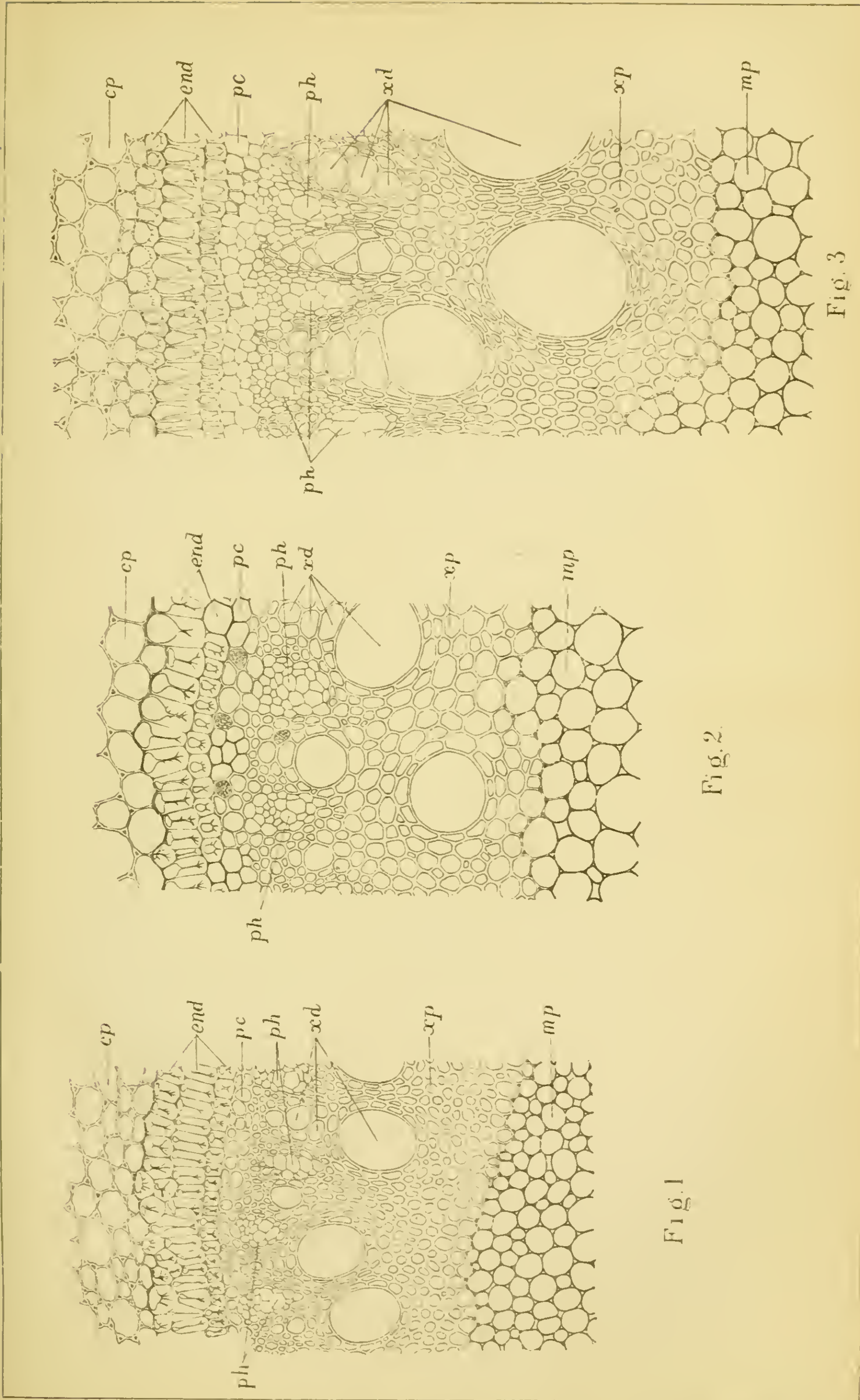

A Dickson, del^t

RUSCUS ANDROGYNUS

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OF THE

BOTANICAL SOCIETY.

VOL. XVI.—PART II.

EDINBURGH:

PRINTED FOR THE BOTANICAL SOCIETY.

MDCCCLXXXVI.

A complete copy of the Transactions, to Vol. XV. inclusive, can be had from the Assistant Secretary.

Odd Parts may also be had to complete sets, with the exception of a few nearly out of print.

TRANSACTIONS

OF THE

BOTANICAL SOCIETY.

SESSION XLIX.

November 1884.—William B. Boyd, Esq. of Faldonside, President, in the Chair.

The President, after thanking the Society for the courtesy extended to him during the two years he had been in office, stated that he intended to devote his Valedictory Address to

Some Remarks on the Study of Mosses.

These tiny members of the vegetable kingdom, recognised by Linnæus as servants, plants of the winter, crowding in numbers into the spaces relinquished by the higher tribes, though perhaps below the iodine-yielding seaweeds, or the mushrooms, designated by the same naturalist as vagabonds of the vegetable kingdom, and barbarous naked, putrescent, are not without their economic value. But their beauty has attracted, at no time more than the present, the study of the philosophic botanist, the poet painter, or the horticultural connoisseur.

Even by the naked eye, Mosses, with a few exceptions, may be distinguished from Hepaticæ, the other of the twin group of Muscales, even in the absence of fruit. For the leaves are not only regular in outline, but there is far more variety in their spiral arrangement, and even in those cases where they are distichous and filmy, there is a peculiar indefinable aspect about them which is seldo deceptive.

If the determination is easy at first sight in the absence of fruit, the facility is greatly increased when it is present. Though occasionally in some genera the leaves when exposed to the sun, especially where abundant moisture is present, acquire red, brown, or other tints, they are by no means so subject to assume abnormal tints as the Jungermannieæ. The earliest condition of Mosses is that of a green mass of jointed threads, much resembling Algæ, which in fact has been confounded with them; this state is usually called the protonema. Buds originate on parts of the protonema, and form by their growth the ascending axis; at the same time, radicular fibres strike downwards from the bud. Soon after the true plant is formed, the protonema withers and disappears, having fulfilled its function of supplying the young plant with nutritious fluids. In the Ephemeræ, however, which are plants of very rapid growth, the protonema is persistent during the life of the plant, which appears to nestle in it.

Mosses are generally composed of the following parts:—The stem, which is sometimes upright with roots at the base, or is creeping and rooting at intervals. The structure is a cellular tissue without vessels, but indications of a spiral deposit are seen in the cells of a few species. In some cases the stem grows to the length of several inches or even feet, while in *Buxbaumia* it is so reduced as to be obsolete. The methods of branching are easily reducible to two kinds in British plants, viz., *Acrocarpi*, or terminal fruiting Mosses, which usually produce branches in pairs below the flowers; and *Pleurocarpi*, or lateral fruit bearers, in which the fruit is produced on a very short branch. The ramification of pleurocarpous Mosses is very varied, being either irregular, pinnate, bipinnate, fasciculate, or dendroid, besides other modes which scarcely admit of a verbal description. In addition to these two kinds, there is another variety of fruiting called *Cladocarpi*. This latter is sparingly found in Britain, but in tropical and southern countries abounds and verges so completely into the Pleurocarpi that it is impossible to draw a line of demarcation. In acrocarpous Mosses the branch formed under the inflorescence is frequently much elongated during the growth of the fruit, and therefore the fruit seems to be of lateral growth; this is well shown in *Archidium alternifolium.*

The stem and branches are generally more or less leafy, seldom scaly (as in the Hepaticæ), the leaves vary much in their form, and also somewhat in their structure. They generally consist of but one layer of cells similar in structure, sometimes, though rarely, of two kinds of cells, different in form, as in *Sphagnum.* The leaves of Mosses are generally inserted at right angles to the stem, very seldom parallel with it. Their outline is generally more symmetrical than the leaves of Hepaticæ, besides which they are more frequently furnished with one or two nerves, which are rare in Hepaticæ. On the other hand, the genera *Bryum* and *Mnium* approach in their areolation to the Hepaticæ. The cells of the leaves vary much in size, shape, and amount of chlorophyll, of which great advantage is taken in natural arrangements. In *Leucobryum*, and a few others, the green cells are embedded between two layers of colourless cells, thus causing the peculiar glaucous hue which pertains to these plants. The leaves are variable in the presence or absence of a nerve, which may be more or less wide, forked, or absent; sometimes being produced into a more or less excurrent point, which is frequently devoid of chlorophyll, giving the plant a hoary aspect, as in many *Racomitræ* and *Tortulæ.* In *Hypnum illecebrum* the nerve is sometimes excurrent about halfway up the leaf, like the awns of some grasses. The nerves of *Pogonata* and others are covered by small laminæ, and in some *Polytricha* and *Tortulæ* the upper surface of the leaf is partly covered by cellular filaments. In *Potia cavifolia* the pagina appears to be double or even triple; there being, in fact, two or three laminal appendages growing from the nerve. The margin of some leaves, as *Diphyscium* and *Hedwigia*, are laciniate; and in others the margin is variously convolute or revolute. A remarkable modification of the pagina is that called equitant, as in *Fissidens,* the leaves being in two ranks, and the neutral part being double, and sheathing the next leaf. The stems of many Mosses are clothed with variously branched villi, which have been thought to defend them from great heat, but are most probably rudimentary plants.

The reproduction of Mosses is effected in various ways; the principal being by the co-operation of the male and female flowers; the true function of which was first established by Hedwig. Mosses are either monœcious, diœcious, synœcious, or hermaphrodite; the diœcious species being in consequence rarely in fruit. The male flowers are enclosed in a bud or dish-shaped perigone; the essential organs consist of an oval sac called the antheridium. This is filled with a rather dense liquid, containing an immense number of antherozoids, each consisting of a thread-like body with biciliate spirals. These when free, move rapidly in fluid, and thus penetrate the female organ or archegonium. This body is contained in a circle or cluster of leaves called the perigynium, and is flask-shaped, and like the antheridium is generally surrounded by jointed threads. These are supposed to supply fluid to the sacs, thus preventing them from being parched by great heat.

During growth a central cavity is formed in the archegon with a cell at the bottom, fixed only from below. After impregnation this cell swells, and becomes the young fruit, by enlarging into a conical form, and elongating into a stalk, and eventually tears through the middle of the archegon, the upper part of which is carried up as the calyptra, the lower portion remaining as a tube called the vaginula, on which are often seen shrunk-up archegonia.

The fruit when perfect consists of a capsule with its calyptra; the centre of the capsule being generally occupied by the columella, round which is the spore sac, in which the spores are formed by septate division.

The capsule usually dehisces by a lid called the operculum, but in some species it bursts irregularly, while in the Andreæceæ it splits into four valves, which, unlike the Hepaticæ, do not separate at the tips. At the base of the lid is a ring of highly hygrometric cells called the *annulus*, which probably assists in the throwing off of the lid. When the lid is removed, the spores are, in gymnostomous Mosses exposed; but in others they are more or less covered by a thin membrane, or by one or two rows of hygrometric teeth, called peristomes. These beautiful organs have been supposed to be modifications of petals, but they have never been transformed into leaves, nor are they arranged spirally round the axis. It has also been suggested that the capsule consists of modified leaves; but the fact of stomata occurring on it when they never occur on the leaves, disproves the theory. These stomata are easily seen on the points of *Polytrichum* and *Funaria.*

The peristomes are formed by cell thickenings, the outer peristome being composed of four, or a multiple of four, " teeth or processes," and consists of three layers of cells, the outer generally coloured or sculptured, the inner hyaline. The inner peristome consists below of a ring of 80 cells, splitting up above into 16 teeth, which are frequently perforated; and two or three ciliolæ often occur between the teeth. In *Bartramia* the teeth of the inner peristome are divided to the base into two segments; while in some plants, as *Diphyscium* and *Buxbaumia*, the inner peristome is reduced to a membrane. The forms of peristome are subject to great variation; at times there is only one row of teeth, at others there are two or three. Owing to irregular thickenings in the cell walls, the peristome of *Barbula* is beautifully twisted, while in others the teeth are placed round the mouth in pairs or fours. Sometimes, as in *Tetraphis*, true teeth are not formed, but four conical masses or pseudo-teeth take their place, while in *Cosinodon* a perforated membrane breaks up with irregular teeth. The teeth are sometimes entire as in *Hypnum*, divided to the middle, as in *Dicranum;* or to the base, as in *Racomitrium.* The outer surface is frequently smooth, papillose, articulate, or covered with transverse bars called trabeculæ. In some plants the tips of the teeth are united into a cone, as in *Conostomum;* a hemisphere, as in *Funaria*, or into a flat disk. In *Cinclidium* the inner teeth unite into a beautiful dome, and in *Fontinalis* into a cone, while in others the teeth spread outwards on the removal of the lid. The office of the peristome appears to be the dispersion of the spores, at the proper time, being thus analagous to the action of the elaters of Hepaticæ; the latter are, however, not found in Mosses. Thus the fruit spores are seen to be the result of the sexual co-operation of the antheridia and archegonia, without which true fruit is never produced. The formation of the fruit is, strictly speaking, the second generation of the Moss, the first being completed when the flowers are formed, by the co-operation of which the primary mother cell of the second generation is formed, which becomes the fruit rudiment, and eventually the capsule and peduncle.

It is worthy of remark that in Ferns Mosses, and Hepaticæ, all cell thickenings occur in the second generation ; in fact, what we understand by the word Fern is the second or spore-bearing generation, but in Mosses and Scale Mosses the sporophore is a capsule containing a multitude of free cells, analogous to Fern spores. There are other modes of reproduction, however, besides fruiting in Mosses, the most important of which is by gemmæ. The gemmæ are very various in form, and invariably precede the fruiting time in capsule-bearing species. Among others may be mentioned *Didymodon gemmascius*, the leaves of which have an excurrent nerve, and the tips are crowded with gemmæ. In *Tetraphis pellucida* the gemmæ are in pedicellate clusters in little leaf cups on proper stems (called *pseudopodia*). In *Webera annotina* the gemmæ assume the form of buds in the axils of barren branches, and in *Bryum erythrocarpum* there are mulberry-shaped bulbs in the axils of the leaves, that fall off when ripe. On the nerve and pagina of *Orthotrichum Lyelli* grow strings of cells, these were supposed to be of a confervoid nature, hence they were named *Conferva castanea* and *C. orthotrici*. Bridel thought them glands which secreted a peculiar substance ; but Schimper has demonstrated the life history of this pretended Conferva, and has clearly shown the gradual development into a young plant. In *Aulacomnium* powdery masses of gemmæ are sometimes formed ; and the leaf points of *Ulota phyllantha* are thickly covered with septate gemmæ, while a very similar form is found on the apices of *Syrrhopodon*. These gemmæ are analagous to those found on the perichætial leaves of *Radula complanata* and *Jungermannia exsecta*, British specimens of which always have bilocular gemmæ on thin apices. Besides these, there are other propagating organs, as the radicles on leaf apices of *Leucobryum*, and the stems of various *Dicrana*, also the branched villæ on *Thuidium Blandovii* and other hypnoid Mosses. It is stated by Dr

Schimper that in every case a protonemoid growth is first formed from these gemmæ, as in the true generation from spores. In fact, every part of a Moss appears to be endowed with great vitality; for Hofmeister has grown plants from single leaf cells, and Mees from antheridia.

The Society is well advised in promoting the publication of such works as that of Dr Spruce on the Hepaticæ of the Amazon and Andes, which is to form volume xv. of our *Transactions.* Students of special subjects may thus be furnished with proper text books on special branches, otherwise beyond their reach; and competent observers will thus be multiplied.

The following are the Obituary Notices for the year:—

Professor BALFOUR was born in Edinburgh on the 15th September 1808. After going through the usual course of six years at the High School, under Dr Carson and Dr Pillans, he matriculated at the University of Edinburgh. After a three years arts curriculum there, he went for a year to the University of St Andrews, where he attended the lectures of Dr Chalmers, whose fame had at this time attracted a large number of students to that university.

John Hutton Balfour's studies had up to this time been directed with a view to his entering the ministry of the Church of Scotland; but Professor Jackson strongly recommended the medical profession as being more congenial to his turn of mind, and this he ultimately resolved upon.

During the summer of 1826 he made his first start in the study of botany by attending the class of Professor Graham, and from this time botany became his special study. After taking his degree of M.D. in 1832, a short time was spent on the Continent, attending specially the hospitals of Paris. On his return to Edinburgh in 1834, he settled at 15 Dundas Street, and continued for five years as assistant to Sir George Ballingall, at the same time prosecuting his favourite study. His autumn holidays were always devoted to examining the flora of different districts, most frequently in the Highlands of Scotland.

Professor Balfour was instrumental, along with ten others, in establishing the Botanical Society of Edinburgh. The first meeting took place in his house 15 Dundas Street, on the 8th February 1836, and from this small beginning, nearly fifty years ago, this Society, which now occupies so prominent a position among scientific institutions, originated. In 1840 Professor Balfour became a lecturer on Botany in Surgeon Square; and in 1841 he succeeded Sir William Hooker (who was translated to Kew) as Professor of Botany in Glasgow. In 1845, on the death of Professor Graham, he obtained the vacant chair of Botany in Edinburgh, and at the same time was by the Government appointed Regius Keeper of the Botanic Garden and Queen's Botanist for Scotland. He continued active class work till 1879, when he retired from the chair, owing to severe illness, and was succeeded by his friend and pupil Professor Alexander Dickson, then Professor in Glasgow.

The progress of the Edinburgh University Botanical Class is but an index of the progress of that medical school of which it forms an important part. In 1846 there were 160 pupils, and in 1878 the number had increased to 400. The manner in which the late Professor performed the conjoined duties of Regius Keeper of the Royal Botanic Garden and Queen's Botanist for Scotland can be best appreciated by old Edinburgh residents. The addition of new ground to the Garden, the building of the Palm House, and other erections, to be capped by the active exertions in promoting the allied Arboretum, was the work of busy years, and too long for narration at this time. In fact, the Garden and the Arboretum, as they stand, are the floral memorials of the energy and perseverance of John Hutton Balfour and James M'Nab.

The admirable system of practical instruction, whether in plant diagnosis, or vegetable histology, was a marked feature in Professor Balfour's teaching, appreciated and copied by other universities. So too were the weekly class excursions, and more than one narrator has given to the reading public a glimpse of the joys and hardships of those long botanical rambles, made to the alpine districts of Braemar, Clova, and Breadalbane, the highlands of

Connemara, the Cumberland and Welsh mountains, or the Swiss Alps. Professor Balfour was also the founder of the Botanical Club and the Scottish Alpine Botanical Club, in both of which institutions he always took a most active interest, and was till nearly the last a most regular attender. Many were the happy days which the latter club spent among the Breadalbane mountains in his society, and much of the work done in searching for new plants in new localities was due to his untiring energy and perseverance.

By personal effort and published manuals, he endeavoured to encourage the study of botany among all classes. Of his different works on botany, some were intended for university students, others for secondary and also for primary schools. He was also a considerable contributor to the Royal Society's *Transactions.* In our own, are many of his original papers; and he was editor for many years. He also supplied the article "Botany" to the *Encyclopædia Britannica.* Professor Balfour was for nearly thirty years Dean of the Medical Faculty; and for upwards of ten years Secretary of the Royal Society of Edinburgh, of which he became a member in 1835.

He was elected a Fellow of the Linnean Society in 1844, and of the Royal Society of London in 1856. The degree of LL.D. was conferred on him by the Universities of St Andrews, Glasgow, and Edinburgh.

In the death of Mr Isaac Anderson-Henry the Society has lost one of its most distinguished and industrious members.

Mr Anderson-Henry was a gentleman well known to most of the members of this Society as a famous horticulturist and hybridiser. He died at Hay Lodge, Trinity, on the 21st September last, at the ripe age of 85. He was educated for the law, and for a number of years he practised in Edinburgh as a Solicitor to the Supreme Courts. Although well known as a judicious and able man of business, Mr Henry never took very kindly to the dry details of law, and as soon as circumstances permitted, gladly renounced them.

His fame as a horticulturist was made, however, while fully occupied with his professional pursuits; and his researches and observations were conducted in the morning and evening, when he escaped from the office in town to his pleasant home in the environs of Edinburgh. His taste for natural science was first developed about 1836 from having for his nearest neighbour a most ardent amateur horticulturist and grower of plants, in whose society he spent much of his leisure time, and gradually acquired a love for the same objects. So when once embarked in the study, his advancement was exceedingly rapid. It was about the year 1840 that he first commenced experiments in hybridisation, and the results of these are published in our *Transactions* (vol. ix.). Time does not permit me to enter into details on the subject, but I must say that the care and determination with which Mr Henry wrought at this, his favourite study, resulted in the production of a large number of most interesting crosses; and more than that, many of them are most showy and beautiful garden and greenhouse plants. I am glad to say that I have frequently had the pleasure of paying visits to Mr Henry's garden, and a greater treat no one at all interested in this subject could enjoy. His enthusiasm was so great, that he never tired of talking of all the interesting experiments he had tried—many which were failures at first, resulted in success in the end, as the result of his indomitable perseverance. His kind and genial manner impressed every one with whom he came in contact, and it will be long before his pleasant and happy face will be forgotten by those who attend the meetings of this Society.

Mr Henry was a President of this Society; and has served frequently on the Council, when he always took a most warm and hearty interest in all the business.

The late Mr George Bentham died on the 10th September last, at the great age of 84. Much of Mr Bentham's early life was spent on the Continent with his parents, both in St Petersburg and Paris, where he had the opportunity of acquiring an almost matchless knowledge of European languages. The story of his first start in the study of botany is interesting. During the extended travels of the Benthams, the lad one morning took up a copy of De Candolle's French Flora, which his mother, herself a remarkable woman, daughter of Dr Fordyce and friend of Aiton of Kew, had purchased. He marched off at once into the back yard of the inn, where they were staying, and plucked the first plant he found, and spent the morning in determining its species by the aid of his new guide. It was a sufficiently difficult task for a beginner, the species being a *Salvia*, but it was successfully accomplished, and thenceforward the lad worked out every flower he came across without any tuition, but simply as a pleasant recreation. Thus began in 1817 the life work which only ended sixty-six years afterwards, when the great *Genera Plantarum* of Bentham and Hooker was completed. Few are aware that the Horticultural Society grew into prosperity under Bentham's management from 1829 to 1840, with Lindley as assistant secretary. Bentham started and carried to perfect success the Exhibitions which became famous as the Chiswick fêtes, and established the Society in a financial position, which it has not maintained in late years. At that time the Society was doing good service by sending out collectors to different countries, and introducing, publishing, and drawing the new plants they brought home. In the work of description Bentham took his full share, and especially described and illustrated the plants brought home by Douglas and Hartwig. When at Kew, in connection with Sir W. J. Hooker, and later with Sir Joseph Hooker, he took a distinguished part in preparing the series of colonial Floras (initiated by Sir William Hooker). The Flora of Hongkong, and that of the Niger, together with his extended labours in connection with the Brazilian Flora, were the prelude to Mr Bentham's engagement for about twenty years in elaborating the enormous Flora of Australia, on the completion of which Mr Bentham received in 1878 the companionship of the Order of St Michael and St George. No sooner, however, was the Australian Flora, with its 2000 species, well started than a vaster work was urged upon him in conjunction with Sir Joseph Hooker, viz., the examination and revision of the generic characters, and their limits in the whole domain of flowering plants. This was a work of great labour and research. A new and thoroughly reliable determination of everything connected with the groups into which species are arranged, and their geographical distribution, was what was undertaken, and its results are given in a condensed Latin form in the *Genera Plantarum*, in three volumes, completed in 1883. Year by year the mighty work progressed, Mr Bentham taking the larger share, but at last, at the age of eighty-three, Mr Bentham, with almost undiminished vigour, saw his work completed, a work which is likely to fix the main lines of systematic botany and flowering plants for generations. Of Mr Bentham's long presidency of the Linnean Society, of his masterly addresses and memoirs on philosophic botany, of his well known and most useful Handbook of the British Flora, as well as of his many excellent personal qualities, I have not time to speak. His strength gradually failed, when his life work was done, and he died literally of old age. His name will rank with the most famous botanists, as Linnæus and Jussieu.

Henrich Robert Goeppert, M.D., Director of the Botanic Garden, and Professor in the University of Breslau, one of the earliest writers on Fossil Botany, aged 85 years.

John Ballantine, Birkmere, Windermere, formerly a nurseryman near Dalkeith, on the 23rd June last.

C. H. Millar, F.R.S.E., 5 Palmerston Place, on 15th October last. He was also a member of the Royal Society, and for some years a member of the Council of the Botanical Society.

Rev. George Macfarlane, Coldingham, Berwick, was an associate of this Society. He contributed numerous specimens to the Herbarium, and in the forthcoming volume of the *Transactions* will appear his list of the plants in the neighbourhood of Coldingham. He was an enthusiastic botanist, and a great friend of the late Professor Balfour.

Mr Thomas Greig of Glencarse zealously attended our meetings when in Edinburgh, and contributed more than one paper.

Mr Boyd referred, in conclusion, to the International Exhibition of Forestry just closed, which had been inaugurated mainly through the offices of the Scottish Arboricultural Society. Such an Exhibition should convince us of our insular ignorance and apathy regarding this branch of botanical study. The Japanese Court alone was a proof that this strange people were ahead of us in a national forestry scheme. The forests of this country do not amount to so much as 4 per cent. of the total acreage, not so much as one-tenth of the proportion of forests in Sweden ; but those who are best informed in those matters say that the acreage of woods in Scotland should be increased fivefold at least. An ameliorating effect would thus be produced upon the climate and the conditions of agriculture, so as to raise permanently the value of arable land in many counties by at least 5s. per acre. But India and the colonies are the great fields in which our foresters must work. May one of the fruits of this Exhibition in Edinburgh be the supply of the great national want of a School of Forestry, where our sons may be trained for such appointments. A large share of the good that has been effected in forest conservancy in these dependencies of our Crown has been done by Scotchmen educated in our Edinburgh Botanical School. In Edinburgh in 1850, at the meeting of the British Association, the public were first warned of the dangers of an indiscriminate forest denudation, and of the disastrous effects which it had produced in India. It was shown that the destruction of forests, and the occurrence of drought and famine, were related to each other as cause and effect. Edinburgh, with its great botanical school, its splendid botanic garden, and its arboretum acquired by the city at a cost of £20,000, its Chair of Agriculture, and its Botanical and Arboricultural Societies, is exceptionally well fitted to be the home of a national school of forestry.

Through the liberality of many of the exhibitors at the recent Exhibition, an important nucleus of an Arboricultural Museum has been formed, and is waiting for a suitable home. The members of this Society, many of whom have laboured so well for the Exhibition, should not rest satisfied until they have established and equipped a School of Forestry in this city, so as to secure the continued progress of forest science.

Report on Australian and New Zealand Plants grown on the East Coast of Arran. By the Rev. D. LANDSBOROUGH, Kilmarnock.

(Read November 13, 1884.)

The island of Arran enjoys a climate in which the severity of winter is as little felt as in any part of Britain. The east coast is specially mild, as here cold frosty winds are tempered by crossing the sea, while their force is destroyed by the high mountains of the Goatfell range rising immediately from the coast to a height of 2866 feet, which so lift up the wind, that trees along the coast, instead of being scourged, actually in full luxuriance overhang the sea at high tide. I have therefore confined the experiments which I have been kindly permitted to make, to this side of the island. The measurements were taken in the beginning of August, and unless otherwise mentioned, were made 5 feet from the ground.

Gum Trees.—The first place is due to the Gums, as these are the loftiest trees in the world. Fortunately my list includes two of the most notable species—the Blue Gum, growing to the height of 330 feet, and famous for its sanitary properties: and the Almond-leaved Gum, which grows in Australia to the height of 430 feet.

Eucalyptus globulus (Blue Gum), at Lamlash.—Girth, 1 foot 7½ inches; height, about 30 feet. Another at Strabane, Brodick, was planted this spring.

Eucalyptus amygdalina, Corrie, (Almond-leaved Gum), 25 feet high, 11 inches in girth.

Eucalyptus coriacea (White Gum), Lamlash.—The seed of this tree was received in the spring of 1879. The tree is now 14 feet 6½ inches in height, with a girth of 4½ inches.

Eucalyptus Gunnii (Mountain White Gum), Lamlash, 3 feet 10 inches in height.

Eucalyptus alpina (Alpine Gum), Corrie, 3 feet in height.

With the exception of the blue and the alpine, these species are also growing at the Rev. Dr Story's, Rosenenth; Mr Scoular's, Tighnabruaich; and at Ballinakill, Kintyre. Their hardihood will thus be further tested. In Arran not a leaf of the White Gum (*E. coriacea*) was even browned in the severe winter of 1879–80. This year at the Forestry Exhibition I saw branches of these and other species from Antibes, in the south-west coast of France. They were not a whit more luxuriant than similar branches in Arran, though the rate of growth at Antibes is three or four times greater.

Cabbage Trees.—The Cordylines are favourite plants in Australia, avenues being formed of them, as at Ballarat Botanic Garden. They grow in Arran in the utmost luxuriance, and have never been even browned by frost.

Cordyline indivisa, 12 feet 10 inches high (including leaves), 1 foot 5 inches girth 18 inches from the ground; leaves 3 feet 10 inches in length, 2 inches in breadth.

Cordyline Veitchii, 9 feet 11 inches high, 1 foot 4 inches girth at 12 inches from the ground; leaves 2 feet 11 inches in length by $1\frac{3}{4}$ inch broad.

Cordyline australis, 9 feet 7 inches high, 11 inches girth at 12 inches from the ground; leaves 3 feet 7 inches long and $1\frac{1}{4}$ inch broad.

As these Cordylines are in perfect health and growing rapidly, it may be expected that they will bloom ere long. The specimen of *C. indivisa* was sown in 1872; the others were received from a friend at a later date.

Tree Ferns.—So far as I am aware, the island of Arran is the only place in Britain where Tree Ferns, altogether unprotected, grow luxuriantly in the open air. Three species have been tried. *Cyathea dealbata* stood a winter, but was stolen the following summer. The two growing at present are *Dicksonia antarctica*, 1 foot 11 inches high, girth 2 feet 3 inches; its crown consists of sixteen fronds, each about $5\frac{1}{2}$ feet in length by 1 foot inches in breadth. *Dicksonia squarrosa*, 7 inches high, 10 inches in girth, fronds 2 feet 8 inches in length by 1 foot 3 inches in breadth. *Dicksonia antarctica* was planted in 1867, when it was very small—about the size of a plant of *Cystopteris fragilis*. It was ten years before the stem began to grow in height, having in this time acquired its full girth. *Dicksonia squarrosa* was planted in 1877, and had then a stem about 4 inches in height. It is in a colder situation than *D. antarctica*, and was accidently much injured a summer ago.

Todea superba and *Todea hymenophylloides* both grow well.

Beefwoods.—*Casuarina equisetifolia* (He-Oak), 10 feet 10½ inches in height, was planted in 1882, when it was 8½ feet high. I hope by another year to try *C. quadrivalvis* (She-Oak), and *C. suberosa* (Cork Oak), of both of which I have specimens.

Pittosporums.—*Pittosporum tenuifolium*, planted this year in Brodick Castle High Garden.

Brambles.—*Rubus australis*, planted this year in the High Garden, Brodick Castle, on a north wall, where it is growing admirably, and has a more tropical appearance than any plant in the garden, its leaves being even finer than those of *Aralia Veitchii*, and much more curious, as they are studded over with little white prickles. They would form a beautiful fringe to a bouquet. If abundant in Australia, its innumerable prickles must render it a perfect torment in the bush, for they are sharp and turned back, and will catch and hold and tear.

Wattles.—*Acacia melanoxylon* (the Black-wood of Australia). This tree, so valuable as an ornamental timber in Australia, had not a leaf browned by the severe winters four or five years ago. It grew most luxuriantly, which proved its destruction, as it was blown over by the storms of last winter. *A. pycnantha* (Golden or Broad-leaf Wattle), a young plant in Captain Brown's garden, Lamlash, is uninjured. *A. decurrens* (Green or Feather-leaf Wattle), 5 feet in height, in Captain Brown's garden, Lamlash. This is a most beautiful plant.

The Bottle Tree (*Brachychiton diversifolium*).—This curious plant receives its name from the stem at the base swelling into the shape of a bottle. I have the promise of one of these Australian Bottles for Arran.

The Grass Tree (*Xanthorrhœa arborea*).—This very remarkable plant (see Balfour's *Class-Book of Botany*, pp. 92 and 930) is very rare in this country, though well known in the plains of Australia. Through the kindness of a friend, its leaves are now waving in front of his house, enjoying the great heat of our present weather (August 11). Soon I hope to see them waving in a favourable situation in Arran. I might mention that I saw, in the possession of James Wilson, Esq., Kilmarnock, a walking-stick of Grass-tree wood. It had been shown at the Dunedin Industrial Exhibition.

Miscellaneous Plants, not Australian.—Camellia (blooms freely), Myrtle (blooms abundantly), *Buddleia globosa* (in bloom, very beautiful); *Desfontainea spinosa*, 7 feet 6 inches high, and covered with flowers; *Photinia serrulata*, *Elœagnus reflexa variegata*, *Euonymus latifolius aureus*, 4 feet 9 inches high; *Coccoloba vespertilionis*; *Platanus orientalis*, 3 feet 8 inches in girth; *Schizostylis coccinea*, blooms most abundantly every year; *Cunninghamia sinensis* (Chinese broad-leaved Fir), planted about 1858 by the late Mr Townley.

Notes on some of the larger Palms in the Palm-Stove of the Royal Botanic Garden, Edinburgh. By Robert Lindsay, Curator.

(Read January 8, 1885.)

On the completion of the new Palm-house at the Royal Botanic Garden in 1858, the late Professor Balfour gave, in our *Transactions* (vol. vi. p. 128), a detailed account of this fine structure, including a description of some of the larger Palms then growing, and their respective heights. The late Mr M'Nab also communicated to the Society from time to time much information regarding them. The object at present is to record the progress that has been made during the last twenty-seven years by those plants which still exist, and also to give some information regarding younger plants, several of which give indications of erelong outstripping the older ones. Of the old Palms the largest is a fine specimen of *Livistona chinensis.* The height of this tree in 1858 was 42 feet; in 1875, 45 feet; and it is now 49 feet high, showing an increase of 7 feet in twenty-seven years. The circumference of the stem at the base was 6 feet in 1875; it is now 6 feet 3 inches. It has a clear upright stem, 33 feet in height up to where the lowermost leaf is given off, and is in vigorous health for so old a plant. Of *Seaforthia elegans* there are two plants, now nearly equal in every respect. In 1858 the taller one measured 26 feet in height; both plants are now 47 feet 6 inches in height (an increase of 21 feet 6 inches in twenty-seven years). They have clear stems 30 feet high, and their circumference at the base is 3 feet 3 inches. For the latter measurements there exist no data for comparison. There are eleven fully-developed leaves on each plant, averaging 14 feet in length. These two fine trees are in vigorous health, and are likely to go on improving for years to come. *Corypha australis* in 1858 measured 23 feet in height; it is now 41 feet. It has a clear stem of 20 feet 4 inches, and measures 3 feet 3 inches at the base. *Phœnix reclinata* in 1858 was 20 feet high; it is now 30 feet 4 inches, with a clear stem of 14 feet, the circumference at the base being 1 foot 7 inches. The leaves are 11 feet 6 inches in length, mostly curved downwards, and forming a fine canopy of foliage. The most remarkable of the older Palms is the well-known example of *Sabal umbraculifera*, the Bull Palm of the West Indies. This grand tree was 30 feet high in 1858, and it is now 36 feet 4 inches. In 1858 the circumference of the stem at the base was said to be 5 feet 6 inches; ten years later 5 feet 4 inches is given; it is now 5 feet 3 inches; it seems difficult to explain how this has happened. In 1874 it had a clear stem of 14 feet, and the circumference below where the lowermost leaf is given off was 3 feet. It has now 17 feet 4 inches of a clear stem, and the circumference at the top is 3 feet 1 inch. The greatest difference occurs in the length of the leaves, which was then 16 feet, the leaf-stalk being 10 feet, and the blade 6 feet long by 5 feet 6 inches broad; now the leaves measure 12 feet 6 inches, viz., 7 feet of leafstalk, and 5 feet 6 inches of blade; there is an increase, however, in the breadth, which is now 6 feet

8 inches. The smaller size of the leaves made now may probably be an indication of diminishing vigour, owing to the great age of the tree; otherwise it appears to be perfectly healthy, and is developing numerous young leaves and abundance of flowers and fruit. The latter is produced in such quantity that it requires to be cut off occasionally to prevent the tree from exhausting itself. Ten years ago it was moved to its present position in the centre of what was formerly the old Palm-house, and was grown until last spring in a wooden box 7 feet 10 inches square by 5 feet deep, and rested on the floor of the house, which formed the bottom. Owing to the heat and moisture the box had become very much decayed, showing the roots of the plant protruding in several places; it therefore required to be furnished with a new box. As the tree was resting on the floor, and in the best possible position, in the centre of the house, where it gets the light all round, no advantage was to be gained by moving it. Instead of the usual wooden tub, it was thought advisable to have a permanent structure built round it. When the square boards were removed to allow of this being done, a dense mass of roots was disclosed. The corners were carefully forked out, and any old soil that could be got at taken away. The whole ball was then covered with mats, and soaked with water. A stone tub or wall 34 feet 6 inches in circumference, 18 inches thick at bottom, tapering off to 12 inches at top, and 5 feet deep, was then built round it; openings were left at the bottom for drainage, and spaces round the sides for Ferns and other plants to grow in when the building was finished, and additional drainage material and fresh soil were inserted; Ferns, *Ficus stipularis*, and other plants, were planted round the sides and margin so as to cover the stonework. Being circular it takes up less room than formerly, and has also a much better appearance. Regarding the age of this tree, the late Mr M'Nab gave some interesting facts in a communication to this Society in 1874.* He says:—" This tree cannot be less than sixty years old. It was removed from the stove of the old Botanic Garden at Leith Walk, in 1822, and was kept in a lean-to house in the present garden

* *Trans. Bot. Soc.*, vol. xii. p. 221.

for thirteen years. This house being only 18 feet high at back and 7 feet in front, it was greatly hampered." Assuming the Palm to have been only 16 feet high when removed from this lean-to house in 1835, it has thus made 20 feet 4 inches in fifty years, to attain its present height of 36 feet 4 inches. This is equal to an increase of nearly 5 inches per annum. If the same ratio be applied to the 16 feet formed previous to 1835, that would give the age of our tree as being over eighty-eight years. We know, however, that while young this species of Sabal makes very slow progress. For the first eight or ten years it produces long, simple, undivided leaves, after which it assumes the more or less divided palmate leaves characteristic of the adult plant. The seeds are consequently not in demand by nurserymen and others who require plants that will have a showy appearance quickly. Many species of Palms, *Livistona*, *Seaforthia*, *Chamædorea*, and others, assume their characteristic adult foliage, though in miniature, in three to four years from the time of sowing the seed, and then make useful plants for decorative purposes, whereas *Sabal umbraculifera* requires from sixteen to twenty years to become in any way effective.

A seedling from our Bull Palm, raised certainly not less than eighteen years ago, is now 6 feet high, measured to the tip of the leaf, and has 7 inches of stem. This is the largest of our young plants, and has thus increased at the rate of 4 inches per annum. Assuming that the old plant increased at the same rate while forming its first 6 feet of growth, and allowing the remaining 10 feet to have increased at the same rate which the plant has made during the last fifty years, viz., 5 inches per annum, this would give ninety-two years as the lowest approximate age of our tree.

Regarding some of the younger Palms which have not been measured hitherto, the largest is a fine plant of *Euterpe edulis*. It is now 47 feet 6 inches in height. It has a clear stem of 34 feet 9 inches, and the circumference at the base is 1 foot 10½ inches. This plant has made very rapid progress. It was removed from the east range of houses fifteen years ago, and was from 12 to 13 feet high at that time. It was then growing in an earthenware pot 16 inches wide, and is now in a tub 5 feet wide, by 3 feet 10 inches deep.

Cocos plumosa is 44 feet 9 inches high, and has 30 feet of a clear stem. The circumference at the base is 4 feet 8 inches, and it is about thirty years of age.

Caryota excelsa measures 37 feet 7 inches in height. It has a clear stem of 18 feet, and the circumference at the base is 3 feet 1 inch.

A young vigorous plant of *Cocos Romanzoffiana* is 34 feet 4 inches high, and it has a clear stem of 22 feet 8 inches, the circumference at the base being 3 feet 10 inches. This plant was received from the nurseries of Louis van Houtte, at Ghent, in 1865, and is now about twenty-six years old. These large Palms, with the exception of *Sabal umbraculifera*, already mentioned, are all growing in round tubs, made of oak, and placed on rollers. The principal advantage of this system of having the plants in tubs, instead of their being planted out in the ground of the house, is the comparative ease by which they may be removed to other parts of the house, when they become crowded. Five years ago most of the larger plants were re-tubbed and arranged. Several of them have already become so crowded that rearrangement will be again necessary. Another important advantage is, that we are thus enabled, by occasionally turning the plants round, to assist them materially in keeping their stems upright. In certain portions of the house, when they remain too long in one situation, the leaves become drawn to the position of most light, which ultimately causes their stems to become bent.

On the Occurrence of Carex salina, *Wahlnbg.*, *β* Kattegatensis, *Fries, in Scotland.* By Arthur W. Bennett, F.L.S., Croydon.

(Read February 12, 1885.)

In placing on record the discovery of this interesting addition to the Scotch flora, it may be well to state how it was made, as showing how easy it is to pass over a "good find." In August 1883, Mr Grant sent me a specimen from Caithness, labelled "*C. riparia?*" At this time of the year one is botanically busy, and I, merely glancing at the plant and seeing the aristate glumes, wrote "*C. paludosa* v. *Kochiana.*" So it remained until the early part of last December; but having occasion to go through my Carices for our proposed Flora of Surrey, which my friend Mr Beeby is engaged on, this specimen came under careful examination, with the result, after comparison with foreign specimens, that it was a form of *C. salina*. Being at Kew a few days after, I showed the specimen to Professor Oliver and Mr J. G. Baker, but neither seemed inclined to say it was *salina*, or was not; and as I myself hesitated under what subspecies or variety of this variable species to place it, I felt afraid of a mistake. On my return home I again subjected it to careful examination, and felt convinced it was *salina*. To make sure, I enclosed it in a letter to Dr Almquist (who wrote the account of this section of the genus for Hartmann's *Scandinavian Flora*, 11th ed.); he returned it named as above, naturally using his own nomenclature; Nyman, in his *Conspectus Floræ Europeæ*, places it as a subspecies under *C. hæmatolepis*, Dreyer. It is of course not the place here to discuss the limits of the species or subspecies that are placed under or near *salina;* to those interested I would refer to able remarks by Dr J. Lange, in his *Conspectus Floræ Grœnlandicæ*, 1880; to Dr Almquist, *l.c.;* and to Blytt in his *Norges Flora*. I give the distribution of the species and the variety, and a short description :—

Carex salina, Wahlnbg., in Fl. Lapp. and Vet. Ak., 1803.

It should here be said, that under this name I take a very broad view of the species, on purpose to better show its distribution.

Iceland! Faroe Isles, Spitzbergen, N. Zembla, Arctic Russia, Lapland! Norway! Sweden! Greenland! British North America, United States.

Of *β Kattegatensis*—

Norway! Sweden, provinces of Bohnslän! and Halland. Scotland—Wick, River Caithness.

Stems in Caithness specimen 18 inches high, with broad membranous sheaths to the lower part of the leaves; leaves $\frac{3}{8}$ inch wide, with the central nerve whitish, prominent, and very conspicuous. Female spikes 2–3, 2 inches long the lower glumes with long aristate points, and usuall 3-nerved (but exceedingly variable), much longer than the fruit. Male spikes 2–4, the lowest usually with female flowers at the base; glumes narrow, semi-truncate, or obtusely rounded at the apex; perigynia short, 1½ lines long, nearly without veins, but variable (nut withered and immature).

Habit of slender forms of *paludosa*, but characters near *aquatilis* v. *Watsoni*, but the young spike richly coloured with purplish-brown.

My herbarium contains specimens from the countries followed by the usual sign !

Report on the Excursion of the Scottish Alpine Botanical Club to Teesdale and Kirkby Lonsdale in 1884. By William Craig, M.D., F.R.S.E., F.R.C.S. Ed.

(Read February 12, 1885.)

The annual excursion of the Scottish Alpine Botanical Club last autumn was to Upper Teesdale in England, a district interesting alike to the botanist and geologist. The members of the club took up their quarters, and were comfortably entertained, at the Cross Keys Hotel, Middleton-in-Teesdale.

The members of the Club present were Professor Dickson, Mr W. B. Boyd, Rev. George Alison, Dr A. P. Aitken, Dr H. M. Church, and Dr W. Craig.

At the business meeting of the Club the following office-bearers were elected:—President, Professor A. Dickson; Vice-President, Mr W. B. Boyd; Chaplain, Rev. George Alison; Minstrel, Dr A. P. Aitken; Secretary and Treasurer, Dr W. Craig.

The newly elected President referred to the great loss which the Club had sustained since its last meeting by the death of our venerable President, Emeritus-Professor John Hutton Balfour.

The Club agreed to erect a monument to the memory of our late member John Sadler. This has since been placed over his grave in Warriston Cemetery, and bears the following inscription:—

"Sacred to the memory of John Sadler, Curator, Royal Botanic Garden, Edinburgh. Born 3rd February 1837, died 9th December 1882.

"Erected, in affectionate remembrance, by his friends in the Scottish Alpine Botanical Club, 1884."

The members of the Club felt that this small tribute of respect was due to the memory of him who was one of the principal founders of the Club, and who contributed so much to its prestige and happiness.

The Club also elected three new members, namely, Rev. David Paul, M.A., Roxburgh; Arthur H. Evans, M.A., Cambridge; and Robert Lindsay, Curator Royal Botanic Garden, —all of whom were present at our Teesdale excursion. Our three new members are distinguished and enthusiastic botanists, and will prove a source of strength to the Club.

The River Tees, for a great part of its course, forms the southern boundary of the county of Durham, and for a still greater portion forms the northern boundary of Yorkshire. Middleton is situated on the Durham side of the river, about six miles above Barnard Castle, a place of great historic interest, and famous as the birthplace of John Baliol, king of Scotland.

Middleton-in-Teesdale is about 700 feet above the level of the sea.

The Club arrived at Middleton on the afternoon of Monday 28th July, and having two hours to spend before dinner, we drove in our waggonette to Winch Bridge, about 2 or 3 miles above Middleton. This is a curious old suspension bridge over the Tees. The banks of the river are here rocky and precipitous. The best plants grow on the Yorkshire side of the river. On the rocks immediately below the bridge we gathered several rare plants, including *Arabis hirsuta*, *Hypericum hirsutum*, *Rubus saxatilis*, *Potentilla fruticosa*, *Epilobium angustifolium*, *Galium boreale*, *Scabiosa Columbaria*, *Serratula tinctoria*, *Carduus heterophyllus*, *Hieracium crocatum* and *boreale*, *Campanula latifolia*, *Bartsia alpina*, *Primula farinosa*, *Polygonum viviparum*, *Gymnadenia conopsea*, *Tofieldia palustris*, *Carex pallescens*. Of grasses we gathered *Avena pratensis* (very fine), *Sesleria cœrulea*, *Melica nutans* and *uniflora*. Some of these plants were collected for the first time by several members of the Club. The specimens of *Gymnadenia conopsea* were exceedingly fine; one specimen measured 2 feet in length, with a compact spike 7 inches long.

The specimens of *Campanula latifolia* were also very fine, and most luxuriant. All the road sides and ditches near Middleton were quite overgrown with this handsome plant, and several were gathered pure white.

Another plant was very abundant in this district of Teesdale, viz., *Primula farinosa.* It is one of the commonest plants of the district. It may be mentioned also that *Poterium officinale* was very common in most of the fields in this part of Teesdale.

In the woods around Middleton was gathered *Stachys Betonica.*

The members of the Club who had not previously visited this interesting district were particularly struck with seeing so many *Alpine* plants growing so low down, as at Winch Bridge, only 856 feet above the sea-level, plants that are only met with in Scotland high upon the mountains, such as *Bartsia alpina,* which in Teesdale grows abundantly in all the meadows, whereas in Scotland it is only found sparingly on alpine ledges; so too with *Tofieldia palustris* and some others.

The next day, Tuesday 29th July, our excursion was to Widdybank Fell and Falcon Clints. After breakfast we drove in a waggonette about 8 miles, passing on our way the High Force, a beautiful waterfall, where the River Tees makes a leap of 69 feet. We did not pause to examine the rocks and woods around this waterfall, understanding that the grounds were strictly private. We took our carriage as far as Langdon Beck, a small stream which after its union with Harwood Beck runs into the Tees. Shortly after leaving our waggonette we came on a bank literally covered with *Peucedanum Ostruthium,* commonly called Masterwort—an umbelliferous plant formerly much cultivated for its medicinal properties. It was, however, near a farm-house, and had evidently been introduced, although quite naturalised. This plant is not indigenous to Britain; it is a native of mountain pastures in Central Europe.

Our course next lay along the Langdon Beck, and after crossing the Harwood Beck we entered on the marshy ground at the north-east of Widdybank Fell. Here and on our way to the summit we gathered the following plants:—*Scabiosa Columbaria, Bartsia alpina, Primula farinosa, Polygonum viviparum, Listera ovata* and *cordata, Tofieldia* *palustris*, *Gymnadenia conopsea*, *Habenaria viridis*, *Isolepis setacea*, *Eleocharis pauciflora*, *Blysmus compressus*, *Kobresia caricina*, *Carex limosa*, *pallescens*, and *capillaris*.

Widdybank Fell is only 1716 feet in height, and of it has been said, "there is probably no piece of ground in Britain that produces so many rare plants within a limited space as Widdybank Fell."

We were fortunate enough to gather most of the rare plants known to grow in this locality, although we missed a few which grow very sparingly, and were not in flower during our visit, such as *Arenaria uliginosa*. In fact, we were too late for most of the rare plants of Upper Teesdale. After ascending to the top of the hill, we descended by a small stream which leads into the "Weel," a peculiar tarn-like expansion of the Tees, fully five miles in length, where the river is deep and sluggish. In the Weel we gathered *Sparganium natans*. At the foot of the Weel the Tees forms a series of beautiful waterfalls, the highest of which is called the Caldron Snout. Here a suspension bridge crosses the river, from which a fine view of the waterfalls is obtained.

On the Durham side of the river, for two miles below the Caldron Snout, the rocks are high, precipitous, and somewhat difficult to explore. These rocks are called Falcon Clints. *Woodsia ilvensis* is said to have been found on these rocks, but is believed now to be extinct; certain it is we saw no trace of it. We found several good plants on these rocks, such as *Draba incana*, *Thalictrum alpinum*, *Arenaria verna*, *Saxifraga aizoides* and *hypnoides*, *Sedum Rhodiola* and *villosum*, *Epilobium angustifolium*, *Lonicera Periclymenum*, *Galium sylvestre* and *boreale*, *Carduus heterophyllus*, *Hieracium boreale*, *Juniperus communis*. Of ferns we found *Cryptogramme crispa*, *Asplenium Ruta-muraria*, *Trichomanes*, *viride* and *Adiantumnigrum*, *Polypodium Phegopteris* and *Dryopteris*, and a fine plant of *Nephrodium Filix-mas* var. *pumila*. On the way down we found a few plants of *Gentiana verna* in fruit.

On Wednesday, 30th July, our excursion was to Cronkley Fell, a mountain on the Yorkshire side of the Tees, and to the south of Widdybank Fell. It is 1739 feet high. The rocks on the summit are composed of that peculiar formation known as "sugar-loaf" limestone, which seems to be favourable for some rare plants. The day was fine, and we had a most enjoyable excursion. We drove up the same way as to Widdybank, and crossed the Tees by a bridge, and so got easily on the hill. Before crossing the Tees we gathered fine plants of *Gentiana verna** and *Primula farinosa*, both of which grew in considerable abundance, on a bank on the Durham side of Tees. On the Yorkshire side of the river we saw immense tracts of *Potentilla fruticosa.* It covered several acres.

On the summit of the mountain on the ("sugar-loaf") limestone, were collected the following plants, which appear to be only found on this formation :—*Helianthemum canum*, *Viola canina* var. *arenaria*, *Hippocrepis comosa*, and *Dryas octopetala.*

In addition were gathered in this excursion :—*Draba incana*, *Arenaria verna*, *Rubus Chamæmorus*, *Saxifraga aizoides* and *hypnoides*, *Peplis Portula*, *Vaccinium Vitis Idæa*, *Oxycoccus palustris*, *Gentiana Amarella*, *Littorella lacustris*, *Listera ovata*, *Juncus triglumis*, *Kobresia caricina*, *Carex capillaris*, *Cryptogramme crispa*, *Asplenium Trichomanes*, *viride* and *Ruta-muraria*, *Cystopteris fragilis*, *Aspidium aculeatum* var. *lobatum*, *Polypodium Dryopteris*, *Nephrodium Filix-mas* var. *abbreviatum* or *pumilum*, *Lycopodium clavatum*, *alpinum*, and *Selago*, and *Selaginella selaginoides.*

On Thursday, 31st July, our excursion was to Mickle Fell, one of the highest mountains in Yorkshire. It lies to the south-west of Cronkley Fell, and is 2591 feet in height. It is composed chiefly of limestone, but near the top there are numerous deep round holes very much like the mouths of old coal pits. To get to this mountain, we crossed the Tees at Middleton, and entered the valley of the Lune, and drove as far as Lune Head Lead Mines. These mines are not being worked at present.

On our way up the Lune valley, we passed on our right hand a hill with a very fine Druidical circle of stones on its top, but, strange to say, not marked on the Ordnance Survey map.

After leaving our carriage we had a long dreary walk

* One of the plants of *Gentiana verna*, gathered by Professor Dickson, proved to be a pure white variety.

through "moors and mosses mony o'," and having not a few burns to cross, in which some of our party came to grief. The day was showery and misty. We, however, reached the summit, but as the mist never cleared we had no view. Had the day been fine, we would have had a most extensive view from the top of Mickle Fell.

The hill was by no means productive, but several good plants were gathered. *Gentiana verna* was found in various places, but the plants were small, although in several places very abundant. One of the best plants found was *Myosotis alpestris.* It was first picked by Mr Boyd, and afterwards by the other members of the party. None of the specimens, however, were in flower; but there can be no doubt it is the true plant. It is recorded from Mickle Fell, in Floras. On our way up the mountain, we gathered in considerable abundance *Saxifraga hypnoides*, of a very cæspitose habit, forming pretty dense cushions. Amongst the other plants collected may be mentioned, *Saxifraga stellaris, Draba incana*, *Montia fontana*, a white variety of *Myosotis palustris*, *Epilobium alsinifolium*, *Littorella lacustris*, *Listera cordata ;* and of ferns, *Cryptogramme crispa*, *Asplenium viride*, *Trichomanes*, *Adiantum-nigrum*, *Polypodium Phegopteris*, *Dryopteris*, and *Botrychium Lunaria.* We also gathered *Lycopodium clavatum*, *alpinum* and *Selago;* also *Selaginella selaginoides.*

On Friday, 1st August, several of the party returned home; whilst six of our number left Middleton about six o'clock in the morning for Kirkby Lonsdale, *via* Tebay Junction.

At Tebay we had an hour to wait for the train, and spent the time botanising the side of the river, and found some good plants, including *Hypericum dubium* and *humifusum*, *Genista tinctoria*, *Hieracium crocatum* and *boreale*, *Stachys Betonica*, *Calamintha clinopodium*, *Gymnadenia conopsea*, and *Carex pallescens.*

We arrived early in the forenoon at Kirkby Lonsdale, a fine old English town, pleasantly situated on the right bank of the Lune. Here we were comfortably quartered at the Royal Hotel. After luncheon we drove in a waggonette to Farlton Knot, and walked back along the ridge to Hatton Roof Crag, where we met our conveyance. The day was fine, and we had a most successful excursion. Shortly after beginning our walk, we found *Malva moschata*, and on our way up the hill gathered abundance of *Polypodium Robertianum.*

Farlton Knot is a hill of a very peculiar formation of limestone, the stone lying in wavy beds, and forming very deep fissures, in which many good plants were found. Near the top was abundance of *Nephrodium rigidum;* its rigid form and characteristic green colour making it a conspicuous object even in the distance. We found also quantities of *Scolopendrium vulgare* growing in the deep fissures of the limestone rocks, some of the specimens being very fine, also *Asperula cynanchica* and *Carlina vulgaris.*

As we passed along the rocks we found the following rare plants:—*Arenaria verna, Geranium Robertianum* (white), *G. lucidum, Sedum anglicum, Sanicula europœa, Epipactis latifolia* var. *viridans* and var. *rubiginosa*, *Listera cordata, Paris quadrifolia, Convallaria majalis, Polygonatum officinale, Arum maculatum, Asplenium Ruta-muraria, Trichomanes*, and *viride, Aspidium aculcatum, Nephrodium Oreopteris*, and *Polypodium Dryopteris.*

We also collected in this excursion *Tamus communis, Plantago media*, and *Campanula latifolia.*

We reached our hotel in good time for dinner, all highly delighted with the success of our excursion, but regretting much that we had such a short time to explore this very rich botanical region.

On Saturday, 2nd August, three of the members returned to Edinburgh; but Mr Boyd, Mr Paul, and Mr Evans proceeded to the Lake District, to explore the botany of that most delightful region.

Mr Evans kindly furnished me with a list of the principal plants collected.

On some New Cases of Epiphytism among Algæ. By

John Rattray, M.A., B.Sc., F.R.S.E., Scottish Marine Station, Granton, Edinburgh.

(Read March 12, 1885.)

Although the instances of so-called *parasitism* among algæ are probably for the most part nothing more than simpler cases of *epiphytic* association between different members of the family in question, it is not unlikely that a more intimate parasitic connection exists between several forms. In the former case the minute filiform rhizoids of the epiphyte simply twine round any part of the thalli, or round the ramuli, of the host plants, and grasp these exclusively for the purpose of securing support, as they might lay hold of any other foreign body of corresponding size in suitable localities, but they in no sense derive nourishment more simply as a result of the act; whereas, in the latter case, the rhizoids come into the most intimate connection with the cells of the host plants, and extract from them some of the highly elaborated organic matter that is passing through their simple tissues. Thus in those algæ that are found on many different hosts, and that may accordingly be looked upon as exhibiting but few selective properties—such as *Ceramium rubrum* (Huds.) Ag., *C. diaphanum* (Lightf.), Roth., *C. Deslongchampsii*, Chauv., *Callithamnion Hookeri*, Ag., *C. polyspermum*, Ag., *Cladophora lætevirens*, Kütz., *Delesseria alata* (Huds.), Lamour, *D. sinuosa* (Good. et Woodw.) Lamour, *Ectocarpus siliculosus*, Kütz., *E. littoralis*, Lyngb., *Enteromorpha compressa*, Grev., *Plocamium coccineum*, (Huds.), Lyngb., *Porphyra lacinata* (Lightf.), Ag., *Ptilota plumosa* (L.), Ag., *Ulothrix flacca* (Dillw.), Thur., *Monostroma latissima* (Kütz.), Wittr., and others—it is not unfrequently possible, by careful manipulation under a dissecting microscope, to unravel the rhizoidal plexus, so as to exhibit its separate parts in an intact condition. In this manner the effects produced by the epiphytes upon the host plants as a whole, and upon their individual parts, become manifest. Among these may be noted the following:—

1. Slight local modifications of the external cell membranes immediately around the areas affected. These modifications assume the character of very delicate and in many instances hardly appreciable swellings.

2. Alterations in the appearance, and consequently in the physiological activity, of the endochromaceous granules that are located just beneath the areas that are grasped. These changes are sometimes manifested by delicate modifications in the hue of the granules; those, for example, of Chlorospermic hosts, being somewhat paler than in adjoining

unaffected places. These appearances become more evident when the host is densely covered by a rhizoidal plexus in some given area; and that they serve to modify not only the conditions of internal tension within the host cells, but also the strength and direction of the molecular diffusion currents existing between adjoining cells, thereby being the means of ultimately establishing altered conditions throughout the entire plant, is obvious.

3. Modifications of the host plants as a whole are also sometimes brought about in virtue of the weight of the epiphytes, especially in cases where the former are largely infested by the latter. Thus in general a somewhat greater rigidity, as well as a somewhat more stunted growth of the thalli than would normally be found, are induced. These results seem to be most easily explained by the increased strains to which the host plants are subjected, in virtue of the action of the wind or waves against the increased surface afforded by the epiphytes. A necessity for more efficient root-hold on the part of the host thus arises, in the first instance, in order that it may secure at once permanence of place and prolongation of life. The rhizoids accordingly become somewhat more strongly developed by an increased flow of food molecules to them, this in turn reacting on the total supply of such molecules that are available for the normal growth of the organism. Similar conditions obtain in connection with the other regions of the host, and a general diminution in the vegetative development ensues. The size of the thallus being thus changed, it is naturally to be expected that its capacity for fructification would also be diminished; and although little doubt can exist that this will ultimately be shown, the effects of epiphytism have not yet been traced so far. It is, moreover, of interest to note in this connection that the dynamical effects[1] of the epiphyte-bearing plants on the shales or other substrata to which they may be affixed are increased, inasmuch as the buoyant power is augmented; while contrariwise, the intensity of wave impact, and consequently the erosive power of the sea, is diminished, owing to the greater resistance offered by the associated

[1] See also "Note on Ectocarpus," *Trans. Roy. Soc. Edin.*, vol. xxxii. pt. 3 1884–85, and *Trans. Bot. Soc. Edin.*, vol. xiv. pt. 2.

organisms than by these organisms considered separately. This factor becomes an exceedingly significant one when the epiphytes, as not unfrequently happens, are relatively of large size, *e.g.*, *Fuci, Ascophylla, Laminariæ*, or the like.

Although it is not possible in most cases to determine any law underlying the association of seaweeds with respect to their relative sizes, it is worthy of remark that the great elasticity of some species is of importance in preventing such forms, when acting the part of hosts, from being detached from their places, when more rigid forms of corresponding size would be torn away. This is especially the case in the *Porphyras*, where the toughness of the fronds constitutes one of the most noteworthy characters.

Perhaps one of the most intimate cases of association between different weeds is to be found between the forms *Polysiphonia fastigiata* * (Roth.), Grev., and *Ascophyllum nodosum* (L.) Le Jol. That we have here to deal with a case of partial parasitism can hardly be questioned. The thallus of the host (*Ascophyllum*) is modified in its external appearance, where the *Polysiphonia* is attached, and is distinctly penetrated by the rhizoids of the latter, the cells of which thus come into close contact with the comparatively thin-walled subepidermal cells of the former. It is true, indeed, that it is not absolutely necessary for the life of this epiphyte that it should thus become fixed to any host, as it occurs, though comparatively rarely, growing on a rocky substratum, but, in such cases, its vegetative growth is less perfect—though it be otherwise exposed to similar external conditions, with respect to depth, and general environment—thereby showing that a direct advantage is gained by an epiphytic habit.

In addition to the extensive lists of epiphytes or parasites that have already been recorded by Mr George W. Traill † among the algæ of the basin of the Firth of Forth, the following cases have been observed by me during the past season in the same area:—

* According to Professors Magnus and Areschoug, this plant is absent from the Scandinavian coast of the Skager Rack, though it is abundant in corresponding latitudes on the coast of Scotland.

† *Proc. Roy. Dublin Soc.*, April 17, 1882; *Monograph of the Algæ of the Firth of Forth*, Edinburgh, 1885.

Epiphytes.	Host Plants.
Laminaria saccharina (*L.*) *Lamour.*	Lithothamnion fasciculatum, *Lamk.* (5 fms.).
Do.	Laminaria digitata (*L.*), *Lamour.* (8 fms.).
Do.	Ceramium rubrum (*Huds.*), *Ag.* (4 fms.).
Ectocarpus siliculosus, *Kütz.* (young).	Do.
Do.	Enteromorpha intestinalis (*L.*), *Link.*
Fucus vesiculosus, *L.*	Cladophora lætevirens, *Harv.*
Do.	Catenella opuntia (*Good. et Woodw.*), *Grev.*
Mesogloia vermicularis, *Ag.*	Polyides rotundus, *Grev.* (2 fms.).
Chordaria flagelliformis, *Ag.*	Fucus serratus, *L.*
Delesseria sinuosa (*Good. et Woodw.*), *Lamour.*	Lithothamnion fasciculatum, *Lamk.* (5 fms.).
Do.	Phyllophora membranifolia (*Good. et Woodw.*), *J. Ag.*
Delesseria alata (*Huds.*), *Grev.*	Fucus serratus, *L.*
Ceramium rubrum (*Huds.*), *Ag.*	Chylocladia clavellosa (*Turn.*), *Grev.*
Do.	Callithamnion polyspermum, *Ag.*
Do.	Phyllophora Brodiaei (*Turn.*), *Ag.*
Do.	Polyides rotundus, *Grev.*
Do.	Polysiphonia fibrillosa, *J. Ag.*
Ceramium diaphanum (*Lightf.*), *Roth.*	Dumontia filiformis (*Fl. Dan.*), *Grev.*
Chylocladia clavellosa (*Turn.*), *Grev.*	Polysiphonia fibrillosa, *J. Ag.*
Do.	Laminaria saccharina (*L.*), *Lamour.*
Callithamnion polyspermum, *Ag.*	Cladophora arcta (*Dillw.*), *Kütz.*
Do.	Ectocarpus siliculosus, *Kütz.*
Do.	Enteromorpha compressa, *Grev.*
Do.	Delesseria sinuosa (*Good. et Woodw.*), *Lamour.*
Do.	Conferva melagonium, *Web. et Mohr.*
Do.	Ulva linza, *L.*
Callithamnion Turneri, *Ag.*	Corallina officinalis, *L.*

Epiphytes.	Host Plants.
Nitophyllum punctatum (*Stackh.*), *Harv.*	Desmarestia aculeata (*L.*), *Lamour.* (drift from deep water; *several* cases of this association have been observed).
Ptilota elegans, *Bonnem.*	Fucus vesiculosus, *L.*
Polysiphonia fibrillosa, *J. Ag.*	Desmarestia aculeata (*L.*), *Lamour.* (10 fms.).
Rhodymenia palmata (*L.*), *Grev.*	Cladophora rupestris, *Kütz.*
Plocamium coccineum (*Huds.*), *Lyngb.*	Ptilota plumosa (*L.*), *Ag.* (6 fms.).
Porphyra laciniata (*Lightf.*), *Ag.*	Desmarestia aculeata (*L.*), *Lamour.* (drift from deep water).
Do.	Ceramium rubrum (*Huds.*), *Ag.*
Rhizoclonium riparium (*Roth.*), *Harv.*	Cladophora rupestris, *Kütz.*
Ulva linza, *L.*	Polysiphonia fibrillosa, *J. Ag.*
Do.	Do. nigrescens (*Dillw.*), *Grev.*
Do.	Cladophora rupestris, *Kütz.*
Enteromorpha compressa, *Grev.*	Polysiphonia fibrillosa, *J. Ag.*
Do.	Ceramium Deslongchampsii (*Huds.*), *Ag.*
Cladophora rupestris, *Kütz.*	Chondrus crispus (*L.*), *Stackh.*
Melobesia sp.?	Polyides rotundus, *Grev.*

It may be useful to supplement this list by annexing a number of cases of association of a similar kind which Professor Magnus* of Berlin has recently noted during a cruise on the east coast of Britain, across the North Sea, and along the opposite continental shores. These were as follows—

Lighthouse Bylk, W. ¾ N., 8½ fms., "Harte-sandige Grund," 21st July.

"Mit dem Schleppnetze kamen herauf sehr viel *Cystoclonium purpurascens, Ceramium rubrum, C. decurrens, C. diaphanum,* häufig auf andern algen, namentlich *Polysiphonia violacea* sitzend."

Between Sprogoe and Corsoer, 22–32 fms., stony ground, 22nd July.

Furcellaria fastigiata (Huds), Lamour., "auf welcher *Poly-*

* *Die botanischen Ergebuissen der Nordseefahrt,* vom. 21 Juli bis Sept. 9, 1872. Berlin, 1874.

siphonia nigrescens (Dillw.), Grev., *P. byssoides* (Good. et Woodw.), Grev. und *Delesseria alata* (Huds.), Lamour., sassen." Also *Ectocarpus littoralis*, Lyngb. on *Zostera marina*, L.

In Mandal Harbour, Norwegian Coast.

Ceramium decurrens, Harv., often on *Enteromorpha* (species not given).

Ectocarpus siliculosus, Kütz., often on *Fucus vesiculosus*, L., *Chordaria flagelliformis* (Fl. Dan.), Ag., *Cladophora uncialis*, Harv. and *Ceramium gracillimum*, Griff. et Harv.

Rhodymenia palmata (L.), Grev., *Delesseria sinuosa* (Good. et Woodw.), Lamour., *Lomentaria kaliformis*, Good. et Woodw., on *Laminaria Cloustoni*, Edm.

Callithamnion Daviesii, Lyngb.,* on *Cladophora rupestris*, Kütz., *Elachistea fucicola* (Velley), Fries, on *Fucus serratus*, L., and on *Ozothallia vulgaris*, Decne. et Thur. *Punctaria tenuissima*, Grev., on *Zostera marina*, L. (dead).

In Bay of Hvidingsoe, 6th July.

Leathesia tuberiformis, Gray, and *Mesogloia vermicularis*, Ag., on *Furcellaria fastigiata* (Huds.), Lamour; *Melobesia pustulata*, Lamour., and *Asperococcus bullosus*, on *Leathesia tuberiformis*, Gray; and *Mesogloia vermicularis*, Ag., *Sphacelaria cirrhosa* (Roth.), Ag., *Leathesia tuberiformis*, Gray, and *Corallina officinalis*, L., on *Halidrys siliquosa* (L.), Lyngb.; *Melobesia pustulata*, Lamour., on *Corallina officinalis*, L.; *Polysiphonia fastigiata* (Roth.), Grev., on *Ozothallia vulgaris*, Decne. et Thur.; *Myrionema orbiculare*, J. Ag., on *Zostera marina*, L., which also bears *Mesogloia zosteræ*, Harv.; *Hapalidium confervicolà* (Kütz.), Aresch.; *Ceramium diaphanum* (Lightf.), Roth., and *Chorda filum* (L.), Stackh., *Rhodymenia palmata* (L.), Grev.; *Ceramium rubrum* (Huds.), Ag., *Cystoclonium purpurascens* (Huds.), Kütz., and *Stilophora rhizodes* (Ehrenb.), J. Ag., on fronds of Laminariæ.

In channel at Hougesund, 5–20 fms. 27th July.

Rhodymenia palmata (L.), Grev.; *Ptilota plumosa* (L.), Ag., *Euthora cristata* (L.), J. Ag., *Cystoclonium purpurascens* (Huds.), Kütz., *Delesseria sinuosa* (Good. et Woodw.), Lamour., *Ceramium rubrum* (Huds.), Ag., *Asperococcus bullosus*, Lamour., on *Laminaria Cloustoni*, Edm., and *L. latifolia*, Ag.

In Haven of Bergen, 30–31st July.

Sphacelaria cirrhosa, Kütz., on *Ozothallia vulgaris*, Decne. et Thur.; *Elachistea fucicola* (Velley), Fries, *Cladophora rupestris*, Kütz., *Polysiphonia elongata* (Huds.), Harv., *P. urceolata* (Lightf.), Grev., and *Sphacelaria cirrhosa*, Kutz., on *Fucus vesiculosus*, L.; *Delesseria sinuosa* (Good. et Woodw.), Lamour, and *Polysiphonia*

* = *Chantransia Daviesii*, Thur.

elongata (Huds.), Harv., on Laminariæ; *Callithamnion plumula*, Harv., on *Delesseria sinuosa* (Good. et Woodw.), Lamour.

In Skerries at Solswig, Bergen, 10 fms., 1st Aug.

Polysiphonia parasitica, Grev., *Ptilota plumosa* (L.), Ag., and *Peyssonnelia Dubyi*, Crouan., on *Lithothamnion calcareum* (Ett. et Soll.), Aresch.; *Entermorpha* (sp. not given), on *Fucus serratus*, L.; *Leathesia tuberiformis*, Gray, and *Dictyota dichotoma* (Huds.), Lamour., on *Corallina officinalis*, L.; *Asperococcus bullosus*, Lamour., on *Phyllophora rubens* (Good. et Woodw.), Grev., and *Euthora cristata* (L.), J. Ag., on Laminarian stalks.

In another Bay, at depths beyond 1 fathom.

Zostera marina, L., on *Chorda filum* (L.), Stackh.; *Aspericoccus bullosus*, Lamour., *Desmarestia aculeata* (L.), Lamour., *Euthora cristata* (L.), J. Ag., and *Cystoclonium purpurascens* (Huds.), Kütz., on *Laminaria digitata* (L.), Lamour.; *Polysiphonia byssoides* (Good. et Woodw.), Grev., and *Callithamnion byssoideum*, Arn., on *Desmarestia aculeata* (L.), Lamour.; *Leathesia tuberiformis*, Gray, and *Dictyota dichotoma* (Huds.), Lamour., on *Corallina officinalis*, L., at a depth of 1 fathom.

At Korsfjord, near Glesvaer, 3rd Aug.

Leathesia tuberiformis, Gray, *Dictyota dichotoma* (Huds.), Lamour, and *Mesogloia virescens*, Carm., on *Corallina officinalis*, L.; *Asperococcus echinatus* (Mert.), Grev., *Cladophora arcta* (Dillw.), Kütz., *C. rupestris* (L.), Kütz., and *Sphacelaria cirrhosa*, Kütz., on *Fucus*, sp., at a depth of 1 fathom. *Halidrys siliquosa* (L.), Lyngb. (deeper), on *Lithothamnion polymorphum* (L.), Aresch., *Ptilota plumosa* (L.), Ag., *Euthora cristata* (L.), J. Ag., *Delesseria sinuosa* (Good. et Woodw.), Lamour., *Rhodymenia palmata* (L.), Grev. (young), *Bonnemaisonia asparagoides* (Woodw.), Ag. (more seldom), *Aglaophyllum punctatum* (Stackh.), Aresch. (more seldom), and *Cystoclonium purpurascens* (Huds.), Kütz., on Laminariæ from moderate depths. *Chrysymenia clavellosa*, Harv. (young), on *Euthora cristata* (L.), J. Ag.; *Melobesia pustulata*, Lamour., and *Peyssonnelia Dubyi*, Crouan., on Laminariæ.

At Peterhead, Scotland, 7th Aug.

Elachistea fucicola (Velley), Fries, on *Fucus vesiculosus*, L.; *Polysiphonia fastigiata* (Roth.), Grev., on *Ozothallia vulgaris*, Decne. et Thur.; *Iridœa edulis*, Bory, on *Laminaria digitata* (L.), Lamour.

At Fisherrow, Portobello, Edinburgh, 12th Aug.

Ceramium rubrum (Huds.), Ag., on *Corallina officinalis*, L.; *Enteromorpha compressa*, Grev., and *Ceramium rubrum* (Huds.), Ag., on *Fucus serratus*, L. ; *Elachistea fucicola* (Velley), Fries, on *Fucus vesiculosus*, L.

Off Yarmouth Roads, 12 fms.

Hapalidium confervicola (Kütz.), Aresch., on *Plocamium coccineum* (Huds.), Lyngb.

At Nieuve-Diep, 21st Aug.

Ceramium rubrum (Huds.), Ag., on *Chondrus crispus* (L.), Stackh. (broad). *Erythrotrichia ceramicola*, Aresch., on *Ceramium rubrum* (Huds.), Ag. ; *Elachistea fucicola* (Velley), Fries, on *Fucus serratus*, L. ; *F. platycarpus*, Thur., and *F. serratus*, L., *Melobesia membranacea* (Esper.), Lamour., on *Zostera marina*, L.

To the west of Heligoland.

Delesseria sanguinea, Lamour., *D. sinuosa* (Good. et Woodw.), Lamour, and *Chrysymenia clavellosa*, Harv., were recorded on the crustacean *Hyas araneus*, from a depth of 5 fathoms.

I have repeatedly observed *Delesseria sinuosa* (Good. et Woodw.), Lamour., and *D. alata* (Huds), Lamour., on *Hyas coarctatus*, from a depth of 10 fathoms and upwards in the Firth of Forth. The specimens of these algæ were small in all cases, the former being relatively the more minute, but they were sufficiently large to leave no doubt as to their identity. *Cystoclonium purpurascens* (Huds.), Kütz., also occurs in small specimens on the carapaces of living crustacea, and sometimes also on the lighter-coloured spiriform shells of some mollusca (*Turitella*, &c.).

At Heligoland, *Callithamnion Daviesii*, Lyngb., and *Ceramium rubrum* (Huds.), Ag., occurred on *Cladostephus spongiosus* (Lightf.), Ag., near the surface; while at Wilhelmshafen *Enteromorpha intestinalis* (L.), Link., was found on *Fuci* and *Callithamnion corymbosum*, Ag., on *Ceramium rubrum* (Huds.), Ag., which grew on lobster boxes.

At Sylt.

Erythrotrichia ceriamicola, Aresch., and *Lyngbya confervicola* (Dillw.), Aresch., were observed on *Polysiphonia nigrescens* (Dillw.), Grev., and *Ceramium rubrum* (Huds.), Ag.; while in the Little Belt, N.W. of Fanöö, in a depth of 10 to 16 fathoms (8th Sept.), *Ceramium rubrum* (Huds.), Ag., and *Elachistea fucicola* (Velley), Fries, occurred on *Fucus serratus*, L.

In Apenrader Bay, 8–14 fms., 9th Sept.

Lyngbya confervicola (Dillw.), Aresch., was found on *Furcellaria* *fastigiata* (Huds.), Lamour., *Polysiphonia nigrescens* (Dillw.), Grev., and *Callithamnion Daviesii*, Lyngb.; while *Fucus vesiculosus*, L., carried *Polysiphonia nigrescens* (Dillw.), Grev., *Polysiphonia violacea*, J. Ag., *Rivularia hemispherica*, Aresch., and *Ectocarpus siliculosus*, Kütz.

In his *Algoid Regions in the Eastern Part of the Skager Rack*, T. R. Kjellman * has noted the following instances of epiphytism in the Tilopteridan Formation (5 to 10 fathoms) of his Sublittoral Region, of which he regards *Phlœospora subarticulata*, Aresch., as the typical plant :—

Melobesia farinosa (?) Lamour., on *Zostera marina* (sparingly); *Polysiphonia byssoides* (Good. et Woodw.), Grev., on *Furcellaria fastigiata* (Huds.), Lamour. (sparingly); *Callithamnion plumula* (Ell.), Thur., on *Zostera marina* (all the year).

Again, in his Punctaria Formation (6 to 10 fathoms), of which *Punctaria tenuissima*, Grev., and *Chorda minuta*, Kjellm., are the types, *Callothrix confervicola* (Dillw.), Ag., on *Ceramium rubrum* (Huds.), Ag. (sparingly); while in the Lithoderma Formation, situated in the middle of the Littoral Region (10 to 15 fathoms), and of which *Lithoderma fatiscens*, Aresch., *L. polymorphum*, and *Phyllophora Brodiæi* (Turn.), J. Ag., are the typical plants, *Spermothamnion Turneri* (Mertens), Aresch., has been found on *Furcellaria fastigiata* (Huds.), Lamour.

In the case of various seaweeds, collected in more distant regions by Professor Moseley during the cruise of H.M.S. "Challenger," Professor Dickie † has noted a few similar cases of interesting associations. Thus *Ectocarpus germinatus*, H. f. et Harv., was collected plentifully on *Desmarestia* (localities—Cape Horn, Falkland Islands); *Conferva* and *Sphærozyga*, which were too imperfectly preserved for closer determination, on *Ballia callitricha*, Ag., and *Melobesia verucata* also on Ballia (localities—Atlantic, Mediterranean, Auckland, New Zealand, Tasmania).

Many other cases of interest have been observed by Harvey,‡ Hauck § and other algologists.

The instances which I have noted above were observed in connection with specimens procured between tide marks, except in a few cases which have already been notified; those, on the other hand, recorded by Magnus and Kjell-

* *Bihang Till K. Svenska Vet. Akad. Handlingar*, Bd. v. No. 6.
† *Journal Linn. Soc.*, vol. xv., *Bot.*, pp. 43–45.
‡ Harvey, *Phycologia Britannica*.
§ Hauck, *Meeresalgen Deutschlands und Oesterreichs*, Leipzig, 1885.

man, in addition to the fact that new localities are indicated, have a special interest, as having often been observed among plants procured from considerable depths. Here the conditions in the struggle for existence are so far modified that the association can hardly be regarded as *necessary*, in order that the epiphytes may secure a position for growth, but must be looked upon as more truly of an *accidental* character; as at the depths in question, many of the tidal species are absent, and the nature of the environments are not so strained by overcrowding. Beyond the tidal belt very few cases of chlorospermic epiphytes are found, the majority of the instances occurring between Rhodosperms and Melanosperms; and generally it may be noted, that as depth increases epiphytic associations go on diminishing, but probably do not entirely disappear till the bathymetrical limits of algoid vegetation have been reached.

Note on Strophanthus hispidus, *with Exhibition of Specimens obtained from Mr John Buchanan.* By Professor Thomas R. Fraser, M.D., F.R.SS. L. & E.

(Read May 14, 1885.)

My purpose to-night is not to give a description of the Strophanthus plant, but merely to do little more than exhibit specimens of a large supply of several parts of the plant, which have been kindly brought to me from Africa by Mr John Buchanan.

It is now a good many years ago since I made an examination of the plant and of some of its products. This examination was interrupted by several causes, and especially by the difficulty of obtaining a sufficient supply of material. Mr Buchanan's replenishment of my supply has therefore been very welcome.

In 1879 I published a paper in the *Proceedings of the Royal Society of Edinburgh*, and in 1872 in the *Journal of Anatomy and Physiology;* and gave in these papers a description of the localities in Africa in which the plant had been found, of the characters of its fruit, of the use made of it by the natives of the districts in which it occurs, and of the results I had obtained by an examination of the action and chemical composition of the seed.

The district in which it is found seems to be a wide one. It is not restricted to Kombé or to the Shiré valley, in Western Africa, where Mr Buchanan's supply was obtained; but it has been stated by travellers to occur also in the Gaboon country, in Guinea, and in Senegambia.

It is used by the natives as an arrow poison, and is known under the designations of the Kombé poison, and of the Inee, Onarge, or Onage poison. I have not discovered any evidence of its use in any part of Africa as a medicine.

The part used is the seed, which is ground into a paste, and smeared round the arrow above the barb. From this seed I have separated an active principle, which does not contain nitrogen, which is of the chemical nature of the bodies often termed neutral principles, and which I have named *Strophanthin*.

My previous examination of the seed has shown that it is extremely active; and that its action, like that of digitalis, is exerted chiefly on the muscles. Substances that act on muscle usually concentrate, as it were, their action upon the muscle of the heart. So powerfully is the heart muscle affected by Strophanthus, that when an almost inconceivably dilute solution of a pure extract, a solution for instance of one in ten millions, is passed through the heart of a frog, the contractions of the heart are in a few minutes greatly increased in strength, and made by-and-by to cease. This action constitutes one of the chief values of digitalis in heart disease, but Strophanthus is more powerful than digitalis in producing it.

Having determined this action, I next used Strophanthus in the treatment of heart disease, and the results have been so remarkably gratifying in their success, that Strophanthus will, I am convinced, become generally used as a remedy in heart disease, and as a diuretic medicine.

The specimens illustrative of the plant which I owe to Mr Buchanan's kindness are the following:—

1. Dried and pressed leaves of the plant, which, it will be observed, correspond with the leaves in the specimens of *Strophanthus hispidus* contained in the Society's Herbarium.

2. Portions of the stem and branches.
3. Portions of the root.
4. Several immature follicles (in spirit).
5. Dried mature follicles, from which the bark has not been scraped.
6. Dried mature follicles, with the bark scraped off. These constitute for me the most valuable of the acquisitions, as the contained seeds in the several hundreds of these follicles which I now possess, will allow me to complete the chemical and physiological examination which is not yet quite finished. Each follicle contains from 70 to 250 small seeds, which have beautiful comose appendages attached to them, giving to the seeds very much the appearance of arrows, completely furnished with heads, shafts, and feathers.
7. Some of the poisoned arrows themselves from the Shiré district.

The seeds arrived in very good condition, and a proof of this has been obtained by Mr Lindsay, curator of the Botanical Garden, who has succeeded in rearing young plants from them, which I trust may produce flowers, so that we may be able to establish if the plant is the *Strophanthus hispidus* described by Oliver in the *Icones Plantarum.*

Report on Temperatures and Open-Air Vegetation at the Royal Botanic Garden, Edinburgh, from July 1884 *to June* 1885. By Robert Lindsay, Curator of the Garden.

July 1884.—Since the last meeting of the Botanical Society (July 10) outdoor vegetation has, on the whole, made satisfactory progress. July was a very wet month, there being only seven days when no rain fell. Thunderstorms were frequent throughout. The lowest night temperature was 39° on the nights of the 20th and 26th, the highest 55° on the 10th and 16th. The lowest day temperature was 58° on the 24th, and the highest 77° on the 8th and 14th.

August was an exceedingly dry month; there were twenty-one days when no rain fell. West and south-west winds prevailed. The lowest reading of the thermometer occurred on the night of the 29th, when 40° was registered, and the highest 56° on the night of the 15th. The lowest day temperature was 59°, on the 27th, and the highest 79°, on the 6th. Bright sunshine was frequent. Herbaceous and alpine plants, and bedding and other tender plants flowered abundantly during the month.

September was also dry, there being nineteen days when no rain fell. Slight showers were frequent at the beginning and end of the month, which prevented grass on lawns from becoming browned. The lowest night temperature was 37° on the 3rd and 5th, the highest 58° on the night of the 20th. The lowest day temperature was 56° on the 14th, the highest 70° on the 9th. Westerly winds were prevalent. Owing to the dry weather, autumn tints appeared earlier than usual; American Maples had their leaves well coloured by the beginning of the month. Herbaceous plants, though slightly dwarfed, continued to flower freely, and ripened good seed very early. All outdoor work has had but little interruption throughout the month.

During *October* the dry character of the preceding months was continued. There were nineteen dry days. The wind was westerly during the whole month. The first frost this season occurred on the 11th, when 29°, or 3° of frost, was registered; and again on the 29th, when 28°, or 4° of frost, occurred. Other low readings were on the 10th, 35°; 27th, 33°; and 28th, 33°. The highest night temperature was on the 16th, 49°. The lowest day temperature was 45°, on the 10th; and the highest 69°, on the 4th. Deciduous trees and shrubs have parted with their foliage early; by the end of the month most kinds were stripped bare, while at the same date last year but few leaves had fallen. Autumn tints on various trees and shrubs were very fine, but of short duration. Maples, Oaks, Pyrus, Beech, and Virginian Creeper were among the finest. Forest and fruit trees generally have formed firm, well ripened wood, which will be of great advantage in the event of a hard winter coming on. Holly and

Cotoneaster are well covered with berries, now finely coloured. Other berry-bearing shrubs are but sparingly set. Rhododendrons, Azaleas, and other Ericaceous plants have not been so well set with flower-buds for some years back. The season is most favourable for transplanting and outdoor work generally. On the rock garden 315 species and varieties of dwarf-growing herbaceous and alpine plants came into bloom since our last meeting, making a total of 1112 for the season, as against 981 at the same date last year, being the largest number yet recorded as having flowered there in one season. Amongst those which flowered were the following, viz.:—

Orobanche rubra.	Erica ramulosa.
Gnaphalium Leontopodium.	Ranunculus rutæfolius.
Tropæolum speciosum.	Montbretia Pottsii.
Spiræa bullata.	„ crocosmæflora.
Silene Schaftii.	Senecio speciosus.
Libertia azurea.	Cyclamen hederæfolium.
Cyananthus lobatus.	Gladiolus Saundersii.
Sedum Ewersii.	Colchicum maximum.
Pterocephalus Parnassi.	Origanum Tournefortii.
Campanula Waldsteiniana.	Stokesia cyanea.
„ isophylla alba.	Gentiana Andrewsii.
Meconopsis Wallichii.	Crocus pulchellus.
Coreopsis tenuifolia.	Sternbergia lutea.
Calluna vulgaris plena.	Parochætus communis.
Mutisia decurrens.	Helleborus altifolius.

November.—During November the thermometer was at or below the freezing-point on thirteen occasions, indicating collectively 64° of frost, as against 37° for the corresponding month last year. The lowest readings were on the 14th, 25°; 15th, 27°; 23rd, 25°; 29th, 23°; 30th, 19. The highest morning readings were on the 1st, 56°; 5th, 48°; 7th, 55°; 9th, 49°; 11th, 48°. The highest day temperature was 60°, on the 1st, and the lowest 32°, on the 30th. Rain fell on sixteen days, chiefly during the first half of the month, which moistened the surface of the ground only; underneath the surface the ground is dry to an extent not hitherto observed in November. The usual storms during this month have been less frequent and severe; outdoor work has, therefore, been very little interrupted. Only two species of plants came into flower on the rock-garden, viz., *Kniphofia Quartiniana* and *Statice incana*, but there are a good many species still in bloom of those formerly recorded. Outdoor vegetation is in an almost dormant condition.

December.—Frost was registered on twenty mornings during the past month of December, indicating collectively 88°; during the same month of 1883, 22° only were registered. Although frost has thus been pretty constant throughout the month, yet it has not been very severe at any particular time, the lowest point reached being 12° of frost. On the 23rd more or less frost occurred every night from the 15th till the end of the month. A slight fall of snow took place on the evening of the 16th, which had not altogether disappeared by the end of the month, owing to the recurring frost at nights. The highest day temperature was 50°, which was registered on five occasions between the 6th and the 14th; the lowest was 29° on the 22nd of the month. The lowest night readings were on the 22nd, 22°; 23rd, 20°; 26th, 22°; 29th, 24°; 30th, 27°; and the highest morning readings were on the 3rd, 44°; 7th, 46°; 11th, 43°; 13th, 46°; 14th, 45°. The following six species of plants came into flower, on the rock garden, during the month, viz., *Crocus byzantinus*, *Helleborus niger angustifolius, H. orientalis, H. albicans major*, *H. purpurascens* var., *Hepatica triloba*, making a total of 1121 species, and well marked varieties as having flowered during the past year. At the meeting of the Society on January 10 last, I exhibited flowers of fifty-three species of plants which were gathered out-of-doors; to-day only twenty-six species could be found, none of which are typical spring flowers.

January 1885.—The weather of January was very favourable in regard to open-air vegetation. The temperature was uniformly cold throughout the month, but at no time excessively so. No extremes either of heat or cold having occurred, vegetation has suffered very little in consequence; comparatively tender plants are still uninjured in the open ground. Frost was registered on no less than eighteen occasions, amounting collectively to 72°, as compared with 20° for the corresponding month last year.

The lowest readings of the thermometer occurred on the 2nd, 26°; 20th, 26°; 22nd, 25°; 23rd, 18°; and 24th, 22°. The highest morning reading was 40°, which was repeated on six mornings. The lowest day temperature was 32°, which occurred on the 23rd of the month, and the highest 55°, on the 29th. West and south-west winds were frequent, and there were sixteen perfectly dry days.

The continuance of moderately cold dull weather during the month has had the effect of retarding the flowering of spring plants considerably. Of the forty selected plants whose dates of flowering are annually recorded, only two came into flower by the end of the month, viz., *Tussilago fragans*, on the 7th, and *Dondia Epipactis*, on the 20th; while at the same date last year no less than sixteen were in flower. *Rhododendron atrovirens*, which opened its first flowers on January 10 last year, is not yet out. Hazel was in flower on January 14 last year, and February 4 this; Snowdrop, January 19 last year, February 5 this; *Tussilago alba*, January 18 last year, February 10 this.

On the rock garden eight species and varieties came into flower during the month, viz., single and double Primroses, Cowslip, *Dondia Epipactis*, *Hepatica angulosa*, and three species of Helleborus. Last January eighteen were noted. Throughout the garden the most conspicuous plants in flower were the various species of Helleborus, *Jasminum nudiflorum*, *Erica herbacea alba*, *Garrya elliptica*, and *Andromeda floribunda*.

The following plants in pots were exhibited in full flower from cold frames in the garden:—*Cyclamen Coum vernum*, *Iris reticulata* Krelagei, *Muscari lingulatum*, *Narcissus Bulbocodium monophyllus*, *Saxifraga Burseriana*, and its variety *major*.

February.—During February the thermometer was at or below the freezing-point on sixteen occasions, indicating collectively 67° of frost, as against 24° for the corresponding month last year. The lowest readings were registered on the 15th, 25°; 18th, 24°; 19th, 24°; 20th, 23°; 21st, 19°. The highest morning readings were on the 8th, 44°; 12th, 48°; 22nd, 44°; 24th, 49°; 27th, 47°. The lowest day temperature was 35°, which occurred on the 16th and 17th, and the highest day temperature was 57°

on the 24th. A good deal of rain fell throughout the month, but hardly any snow. Vegetation is making slow progress. Ribes, Thorns, Lilacs, Roses, and other deciduous trees and shrubs, are late in developing leaf and flower-buds. They are from three weeks to a month later than last season; the buds, however, are remarkably strong and vigorous, and with more genial weather will make rapid progress. The Hazel, Alder, *Rhododendron atrovirens*, and *Daphne Mezereum* came into flower, and were well covered with bloom during the month. Early flowering hybrid Rhododendrons are well set with flower-buds, and, along with most other hardy plants which are used for forcing purposes, are being more readily induced to flower when put into heat than is usual, mainly owing to their having been so well ripened during the fine dry summer last year. Spring flowers are also late in coming into bloom, but they promise to be very fine ere long; those that have already flowered are strong and richly coloured. On the rock garden twenty-four species and varieties of hardy plants came into flower during the month, while at the same date last year forty-one were recorded as having flowered. At the end of February 1884, no less than ninety different species were counted in flower. At the end of the past month only thirty-eight could be found.

March.—During the past month the weather has been excessively cold and dry, vegetation generally has in consequence made very little progress, and is still about three weeks behind. The thermometer fell below freezing-point on nineteen nights; collectively, 82° of frost were registered for the month, as against 29° for the corresponding month last year. The lowest readings occurred on the 9th, 23°; 14th, 25°; 22nd, 25°; 23rd, 21°; 28th, 26°. The highest morning readings were—on the 8th, 40°; 11th, 40°; 17th, 45°; 26th, 45°; 29th, 44°. The lowest day temperature was 39°, which occurred on the 9th; and the highest, 55°, on the 28th. Flowers of *Rhododendron Nobleanum* were injured by frost on the 23rd. Deciduous trees and shrubs are late in developing their leaves; Thorns, Poplar, and Lilac, which usually have their leaves more or less expanded by the end of March, had not a single leaf fully developed at that date this year. Willows and Elms are flowering most abundantly, and on walls *Pyrus japonica*, *Ribes sanguineum* (single and double flowering), and *Forsythia viridissima* have not been so finely flowered for some years back. Magnolias, double-flowering Peach, and other plants on walls are well set with flower-buds. Spring flowering bulbs are vigorous, and flowering well, notwithstanding their lateness in opening; cold east winds are shortening their period of flowering considerably, which a few genial showers of rain would do much to prevent. The season has been most favourable for seed sowing, the ground being in splendid condition for that purpose. The extremely dry state of the ground causing a scarcity of worms is probably the reason why the various birds which abound in the Botanic Garden are so assiduously stripping the flowers of Crocuses and Primroses as soon as they expand in some portions of the garden. Formerly their depredations were mainly confined to newly-sown seeds, Holly berries, and the like; as there are abundance both of seeds and berries, their preference for a floral diet seems all the more remarkable.

On the rock garden a large number of plants is now in flower. Sixty-five species came into bloom during March, exclusive of those which opened in the previous month, many of which are still flowering. Among the most interesting which opened in March were the following:—

Chionodoxa Lucilliæ.	Narcissus pumilus.
„ sardensis.	Puschkinia scilloides.
Crocus nevadensis.	Primula marginata.
Corbularia nivalis.	„ ciliata purpurata.
Helleborus colchicus.	„ Wulfeniana.
Iris reticulata.	Rhododendron præcox.
Korolkowia Sewerzowi.	&c. &c.

Of the forty spring-flowering plants whose dates of flowering are annually recorded to the Society, seventeen came into flower during the month.

Register of Spring Flowering Plants, showing dates of flowering at the Royal Botanic Garden, Edinburgh, during the years 1884 *and* 1885 :—

	First Flowers opened.	
	1884.	1885.
1. Adonis vernalis,	March 26	April 8
2. Arabia albida,	Jan. 23	Feb. 28
3. Aubretia grandiflora,	Feb. 10	March 8
4. Bulbocodium vernum,	Jan. 26	Feb. 23
5. Corydalis solida,	March 13	April 3
6. Coryllus Avellana,	Jan. 14	Feb. 4
7. Crocus susianus,	,, 19	,, 18
8. vernus,	,, 28	,, 23
9. Daphne Mezereum,	,, 20	,, 11
10. Dondia Epipactis,	Dec. 20/83	Jan. 13
11. Draba aizoides,	Feb. 12	March 30
12. Eranthus hyemalis,	Jan. 21	Feb. 14
13. Erythronium Dens-canis,	March 12	March 22
14. Fritillaria imperialis,	,, 27	April 15
15. Galanthus nivalis,	Jan. 19	Feb. 6
16. plicatus,	,, 26	,, 8
17. Hyoscyamus scopolia,	March 20	April 1
18. Iris reticulata,	Feb. 28	March 6
19. Leucojum vernum,	Jan. 26	Feb. 12
20. Mandragora officinalis,	Feb. 9	March 17
21. Narcissus Pseudo-Narcissus,	March 18	April 8
22. pumilus,	Feb. 28	March 15
23. Nordmannia cordifolia,	,, 15	,, 1
24. Omphalodes verna,	,, 12	,, 31
25. Orobus vernus,	Feb. 9	March 15
26. Rhododendron atrovirens,	Jan. 10	Feb. 13
27. Nobleanum,	Feb. 2	March 5
28. Ribes sanguineum,	,, 20	,, 28
29. Scilla bifolia,	,, 14	,, 10
30. alba,	,, 21	,, 12
31. præcox,	Jan. 20	Feb. 25
32. sibirica,	,, 30	March 1
33. taurica,	Feb. 24	,, 14
34. Sisyrinchium grandiflorum,	,, 14	,, 9
35. ,, ,, album,	,, 12	,, 7
36. Symphytum caucasicum,	,, 15	April 12
37. Symplocarpus fœtidus,	,, 4	Feb. 20
38. Tussilago alba,	Jan. 18	,, 10
39. fragrans,	Dec. 26/83	Jan. 7
40. Tussilago nivea,	Feb. 14	April 2

During the month of April vegetation generally made good progress. The weather during the latter half of the month was mild and genial, frequent light showers of rain and bright sunshine alternated, and these conditions, combined with southerly winds, caused vegetation to make rapid progress. Many deciduous trees had their leaves well developed at the end of the month. Pear, Cherry, and Currant were in full flower and well laden; Apple blossom being also well advanced. Although a great deal of frost occurred, little or no damage was done, owing chiefly to the lateness of the season. The thermometer was below the freezing-point on ten occasions, indicating 27° of frost collectively, as against 37° for the corresponding month last year. The lowest readings were on the 2nd, 29°; 4th, 25°; 9th, 28°; 14th, 28°; 15th, 27°. The highest morning readings were on the 19th, 61°; 20th, 53°; 21st, 55°; 27th, 54°; 30th, 55°. The lowest day temperature was 42°, which occurred on the 8th, and the highest 68°, on the 19th.

The aggregate amount of frost registered this season up till the end of April is 466°, while for the same period last season 163° only were registered. The lowest point reached this season was 18° Fahr., or 14° of frost, which occurred on January 23. The following are the amounts of frost registered for each month, viz.:—October, 7°; November, 64°; December, 86°; January 70°; February, 67°; March, 82°; April, 27°.

The rock garden was very gay during the month; 182 species and varieties of alpine plants came into bloom, making a total of 280 since January 1, as compared with 225 for the same period last year. Amongst the most conspicuous plants which flowered were—

Adonis vernalis.
Androsace carnea.
  coronopifolia.
  Laggerii.
  foliosa.
Aubrietia Hendersoni.
Anemone fulgens.
  Robinsoniana.
  Pulsatilla.
Draba Maweana.
Dentaria enneaphylla.
Corbularia Graelsi.
Epigæa repens.
Gentiana verna.
Helonias bullata.
Iberis petræa.
Narcissus Bulbocodium minor.
  Emperor.
  Empress, &c.
  incomparabilis, Sir Watkin

Narcissus rupicola.
Lithospermum prostratum.
Petrocallis pyrenaica.
Primula ciliata purpurata.
    longiflora.
    Clusiana.
    cashmiriana.
    rosea.
    Sieboldi.
    viscosa.
Polygala Chamæbuxus.
Polygala Chamæbuxus purpurea.
Menziesia cœrulea.
    empetriformis.
Rhododendron ciliatum.
Soldanella montana.
Podophyllum Emodi.
Tulipa pulchella.
Ranunculus amplexicaulis.
Trifolium uniflorum.
Muscari Argæi.

May.—The month of May was unusually cold and ungenial; much rain and frost occurred during the first three weeks, which retarded vegetation considerably until the last week of the month, when good progress was made, a change of temperature having taken place. The season being a late one, no permanent damage has been done; the only plant seriously damaged was *Dielytra spectabilis*, which had its flowers destroyed. The thermometer was at or below the freezing-point on five occasions, indicating collectively 13° of frost (this is the greatest amount of frost registered in May since 1876, when 26° occurred). Last year no frost was registered in May. The lowest readings were—on the 6th, 29°; 7th, 31°; 8th, 29°; 12th, 26°; 14th, 32°. The highest morning readings were—on the 26th, 59°; 27th, 58°; 29th, 63°; 30th, 57°; 31st, 60°. The highest day temperature was 71°, on the 28th, and the lowest 45°, on the 3rd. The foliage of the ordinary forest trees is well developed; flower-buds are numerous, but late in expanding. By May 31 we generally have the Horse Chestnut, *Pavia flava*, Laburnum, Lilac, Hawthorn, and varieties of Sorbus in flower. This year we have only had double Cherry, Gean, Apple, and varieties of Maple in bloom, but they have flowered very well; Magnolias on walls are better set with flower-buds than they have been for several years back. Narcissus, Tulips, and hardy spring bulbous plants generally have flowered well; the earlier kinds are now forming seed freely. On the rock garden 139 species of hardy plants came into bloom, as against 228 for the same month last year. Only forty-two plants are of the same species as those recorded for May last year, the remainder having yet to bloom.

Among the finest which flowered were—

Andromeda fastigiata.
Androsace chamæjasme.
villosa.
Azalea procumbens.
Anemone narcissiflora.
alpina.
Anthemis aizoon.
Alyssum alpestre.
Cortusa Matthioli.
Coronilla minima.
Daphne Cneorum.
Dianthus gelidus.
Dodecatheon integrifolium.
Dracocephalum grandiflorum.
Erica australis rosea.
Enkianthus himalaicus.
Linaria alpina.
origanifolia.
Mertensia sibirica.
Myosotis antarctica.
Olearia Gunniana.
Pentstemon Menziesi.
Phlox amœna.
stolonifera.
Primula Sieboldi.
obconica.
sikkimensis.
Rhododendron lepidotum.
&c., &c.

June.—The month of June was mild and pleasant, though somewhat dry. On the whole it was favourable in advancing outdoor vegetation generally. The luxuriant foliage which hardy trees and shrubs developed during the month has been a matter of general observation. Most trees were late in coming into leaf, and thus escaped injury from late frosts. This, combined with the well-ripened condition of the wood produced last autumn, is sufficient to account for the fine display of foliage now seen. Amongst those which flowered well were various species and varieties of Cratægus, Æsculus, Pyrus, Sorbus, Sambucus, Rhododendron, Azalea, and Fraxinus. Variegated forms of Taxus, Biota, Retinospora, and other Conifers are remarkably well coloured, affording a pleasing contrast with the dark green foliage of the typical species. Late transplanted trees and shrubs have suffered severely from drought, and grass on lawns and verges began to turn brown by the end of the month. Herbaceous plants, as a rule, have done well, notwithstanding the drought which prevailed. The lowest night temperature was 35°, on the 9th of the month; other low readings occurred—on the 10th, 37°; 15th, 38°; 23rd, 39°; 26th, 37°. The lowest day temperature was 59°, on the 8th, and the highest, 77°, on the 12th. There were twenty rainless days, and slight showers only during the remaining ten days.

On the rock garden 350 species of herbaceous and alpine plants came into flower during the month, making a total of 818 for the season, as compared with 798 at corresponding date last year. The following were amongst the most conspicuous which flowered, viz.:—

Aciphylla squarrosa (♂ ♀).
Ajuga genevensis.
Androsace rotundifolia macrocalyx.
Allium cœruleum.
Anagallis tenella.
Arenaria montana.
Aster alpinus.
    albus.
Astragalus vaginatus.
Calochortus cœruleus.
Calceolaria Kellyana.
Celmisia spectabilis.
Chrysobactron Hookeri.
Clintonia Andrewsiana.
Coronilla iberica.
Craspedia Richea.
Dianthus alpinus.
    eximius (hybrid).
    Fischeri.
    neglectus.
    superbus.
Diphylleia cymosa.
Echium rubrum.
Erigeron aurantiacum.
    purpureum.
Erinus hispanicus albus.
Eriophorum alpinum.
Gaillardia maxima.
Gentiana lutea.
Geranium cinereum.
Gaultheria carnea.
Haplocarpha Leichtlini.
Hedysarum obscurum.
Houstonia cœrulea.
Hypoxis erecta.
Melissa grandiflora.
Mulgedium alpinum.
Lewisia rediviva.
Linum alpinum.
Libertia grandiflora.
Lychnis pyrenaica.
    viscaria splendens fl.-pl.
Ononis rotundifolia.
Onosma taurica.
Oxytropis Hallerii.
Pentstemon Lewisii.
Potentilla eriocarpa.
Pratia angulata.
Rosa pyrenaica.
Sedum oreganum.
Trifolium alpinum.
Vaccinium Mortinia.
Vella spinosa.
Veronica Haastii.
    carnosula.
    Chathamica.
    Hulkeana.
Vancouveria hexandra.
Verbascum olympicum.
Wahlenbergia saxicola.
    &c., &c.

Report on Temperature and Vegetation in the Garden of the Royal Institution of Glasgow, during 1884–1885. By R. Bullen, Curator.

December 1884.—Frost was registered on eighteen mornings during the month, the lowest reading being 21°, or 11° of frost, during the nights of the 21st and 22nd respectively. Total for the eighteen readings, 93°. The mean temperature was generally high during the day, the lowest readings being 32° on the 1st, 17th, and 23rd, and 30° on the 22nd and 28th. The highest readings were 48° on the 13th, and 50° on the 14th. Dull, showery, and often stormy weather prevailed during the first half of the month, accompanied by an occasional heavy downfall of rain and hail. Since the 19th the weather has been generally fine; vegetation is in a dormant state, and in striking contrast from the same month last year, when so many hardy plants were blooming prematurely.

January 1885.—Frost was registered on nineteen mornings during the month, the lowest reading being 20°, or 12° of frost, during the night of the 21st. Total of the nineteen readings, 95°. Although the total record of frost is nearly the same as last month, the low temperature at night was continuous from the 11th to the 25th, and being assisted by the cold dry weather which prevailed at the time made its effects felt to a much greater degree. The highest day temperature was 47° on the 5th, the lowest 31° on the 23rd, but on several other days the thermometer was at, or very little above, freezing-point. The frequent frosts have had the effect of keeping vegetation in check. The rainfall has been light, and weather all that could be desired for the season.

February.—The thermometer during February has been at or below the freezing-point fifteen times during the month, the lowest reading being 22° during the night of the 18th. Total frost, 73°. The highest day temperature was 53° on the 27th; the lowest 34°, on the 20th. Sharp frosty nights were continuous from the 13th to the 21st, both inclusive, after which mild weather prevailed until the night of the 28th, when 24°, or 8° of frost, were registered. The frosty nights were succeeded by fine days, but the snow which fell during the night of the 17th gave the country a wintry look. A severe gale of wind was experienced during the night of the 21st, but no serious damage resulted. Although showers were frequent during the early and latter part of the month, the rainfall was not heavy. Vegetation is still dormant, the only plants in bloom in the open ground being *Daphne Mezereum* and *D. m. album*, *Crocus vernus* and *biflorus*, and *Petasites vulgaris* and *lobata*.

March.—The thermometer has been at or below the freezing-point twenty-one times during the month; the remaining night readings also being low. The lowest was 22° during the night of the 22nd. The mean day temperature has also been low for the month, with cold and variable winds. The weather has been mostly dry, and favourable for working heavy soils; but the frequent frosts have prevented seed sowing to any great extent. Most trees and shrubs have a backward look. The leaf-buds of Lilacs are ready to burst, but the only shrub in actual leaf and bloom is the common *Ribes sanguineum.* Some forms of Salix and Ulmus are in bloom. Several herbaceous plants, which may frequently be seen in bloom here in February, such as *Pulmonaria officinalis* and *azurea*, *Helleborus viridis*, and some of the early Scillas, are not yet developed. Owing partly to the absence of severe frosts, and partly to the drier weather that has prevailed during the dormant season, the latter class of plants have suffered much less than is usual here.

April.—The thermometer has been at or below the freezing-point nine times, the lowest reading being 26° during the night of the 8th. No frost has been registered since the morning of the 18th. During the latter part of the month the temperature has been higher than usual, weather often sunless, and showers frequent, but generally light; this has had a marked effect on vegetation, the growth developed in a few days being wonderful. Like the corresponding month last year, the rainfall has been light, and favourable for seed sowing, which important operation had in many instances to be deferred owing to the frequent slight frosts.

May.—During the first half of the month 23° of frost were registered, the lowest readings being 27° during the nights of the 4th and 6th respectively. The day temperatures during the early part of the month was also correspondingly low, cold east and north-east winds prevailed, and with an occasional shower of hail and sleet, was anything but May-like. The weather during the latter half has also been variable, and generally cold, the highest day temperature recorded being 62° (in the shade), on the

28th. Owing to the untoward weather, vegetation has been considerably retarded; the leaves of some hardy trees, such as the Horse Chestnut and Bird Cherry, have a blighted look. Late-leafing trees, as well as hardy herbaceous plants, are slightly in advance of last year. Late-sown annuals have germinated freely. Deciduous trees and shrubs of all kinds are blooming freely, and there is every prospect of a good fruit season.

June.—The temperature has been low, 36 having been registered several times in the latter as well as in the early part of the month, and frequently the temperature did not exceed 40°. The lowest day reading was 58°, the highest 78°. The weather has been very dry; bright sunny days have been general; the few slight showers which have fallen have been of little benefit to vegetation, and most garden and farm crops are suffering. Spring-sown seed, particularly those of annuals, promised well, but being kept alive by artificial watering have made little progress; indeed, all half-hardy plants have a stunted look. Hardy trees and shrubs of all kinds have been prolific of bloom, but owing to the occasional cold nights and dry days the foliage is not so healthy as usual. Hardy herbaceous plants are mostly early in bloom.

Notes on the Vegetation and Vegetable Products of Blantyre and Zomba Districts of Africa. By John Buchanan, Associate.*

(Read May 14, 1885.)

From Quilimane up the Zambesi and Shiré to Katungas near to the Murchison Rapids.
Blantyre and Zomba.
Trees producing Fruit.
Flowering Plants.
Economic Plants.
Soil of the District.
Native Crops.

Quilimane and around it.—The town of Quilimane is built close to the River Kwakwa or Quilimane, on its left bank, and only a few feet above high water mark; so at full tide the banks of the ditches which traverse the streets, receive a fresh watering of mud, as their odoriferous contents are thus periodically dammed back. The great marsh

* See also *The Shiré Highlands (East Central Africa) as Colony and Mission.* By John Buchanan, planter at Zomba. Edinburgh and London: William Blackwood & Sons.

behind the town is not converted into an arid plain, even in the dry season, so the sanitary state of this entrepot for Eastern Africa is execrable. Though the cocoa-nut palm is predominant amongst the otherwise rank vegetation, other trees, such as the pine apple, orange, citron, guava also grow in the moist sandy soil. The fruit of the pine apple, which is not cultivated by the natives, is small, and its flavour poor. The mangoes of Quilimane are good, but not to be compared with those growing at Mazaro on the Zambesi, said to have been planted by Jesuit missionaries some centuries ago. The lines of trees * which grace the streets of Quilimane have a grateful effect during the heat of the day ; when in flower, a gorgeous mass of red, interspersed with legumes often a foot to a foot and a half long, gives a specially unique appearance to these East African boulevards. The limit of the sea-breeze appears to mark the habitat of successful growth of the cocoa-nut palm. In the area to which the reach of the tide extends, which is forty miles up the river, a patch of these palms is seen about twelve miles up from the town ; otherwise there are no such arboreal representatives on the river banks, though away from them in the plain calabash trees and those of the *Ficus Sycomorus* are common.

The Kwakwa River.—The banks of this river, on the sides of which Quilimane is built, and which is really one outlet of the Zambesi to the Indian Ocean, are fringed with small trees and bushes. At the head of it, a forest of Borassus palm trees grows, to which the natives resort for the fruit of the tree in times of famine. From the top of this tree, to which the natives ascend by driving spikes in the stem, a wine is got. When fermented it is very intoxicating. It is also used by Quilimane bakers as yeast. Of various species of aquatics which abound in this river, *Pistia Stratiotes* is the most plentiful. These weeds, when carried down by the current, so accumulate in bends of the river, as often seriously to impede navigation. Thus the River Shiré has been blocked for six weeks, chiefly by this large water-weed. Canoes had then to be hauled over the top of the dense beds of it ; whilst the African lake steamer ploughed through the masses by first throwing

* *Poinciana regia.*

her anchor into them, then reversing her engine, and pulling the entanglement away bit by bit. Besides *P. Stratiotes*, it may also consist of *Papyrus* and various grasses. A change of wind ultimately scatters these barriers.

The Zambesi.—Especially at Shupanga and Howri towards the coast, is the right bank of this river well wooded. At the former place the baobab, under which Mrs Livingstone lies, is a good representative of the most striking tree of these forests. It has a circumference of 66 feet at 4 feet from the ground. Indeed, the baobab, with its large trunk, thick limbs, great spread of branches, and flat top is the marked feature of the landscape. Here, too, the wood for the Government canoes is obtained. I have seen some splendid trees cut for this purpose, with a clear diameter of 3 and 4 feet. The plain on either side of the river is covered with bush, in which are a few large trees.

The Shiré River.—The plain is also found along both banks of this river so far as the Murchison Rapids. Belts of large species of Mimoseæ are found here and there upon it. The light green aspect of the clean trunk of one species is recognisable miles away. But, indeed, these thorn-trees of the natives, with their spines 4 inches long, half an inch thick at the base, and set in hairs, strike the stranger. Lines of these trees 50 yards wide run at right angles to the river or lake, at intervals of half a mile or more of the grassy plain ; indeed, at Lake Shirwa are often a foot in water. Baobabs are plentiful on Shirwa Island. This is interesting, as the lake, which is simply a huge marsh filled with water in the wet season, which is again evaporated during the African sunshine, is 1800 feet above the sea-level. The baobab never appears to reach a level higher than 2000 feet ; and the traveller round Lake Nyassa may thus take the baobab as an index of his altitude. The tamarind, which also takes the same limits of altitude, is plentiful on the higher reaches of the Shiré. Handsome trees of *Euphorbia candelabrum* are also seen on the river, as well as a tree of *Ficus Kotschyana* (native name *Mtundu*), at almost every village, around which the natives sit and hold palavers. The huts of the villages are closely packed, outside of them may be seen women pounding sorghum, men making enclosures by a grass fence, or basking on mats in the sun. A receptacle of black mud cut out in the solid interior of a small tree branch serves as a salt bin. The village has on one side a dense jungle, whose monotony of acacia thorns is here and there enlivened with Euphorbias having shady creepers intertwined. On theother side of the encampment stately baobabs raise their monster heads, as also do Njale trees, whose trunks rise straight from 30 to 40 feet. *Cleome gynandra* is cultivated in the open spaces between the huts ; while tobacco, raised under the eaves, is planted out on mounds ; and *Ipomœa* and *Convolvuli* meet you at every corner. A stockade, 10 or 12 feet high, encirles the village. It is made of *Pterocarpus* cuttings 10 or 12 feet long, and 4 to 8 inches in diameter. The passage through this stockade to the village will only admit one at a time, and can be closed by a board. It is ornamented on the outside by an arch of Euphorbias, around which creepers of a climbing species of *Bryophyllum* entwine. In the spaces outside the stockade may be seen many large fields of sorghum, patches of sweet potatoes, beans, and pumpkins, as well as rice on moist places ; and *Arachis hypogœa*, ground nuts, as well as *Voandzeia hittenanus*, ground beans, on sandy knolls.

Blantyre and Zomba.—At both these places, which attain an elevation of 3000 feet, the difference betwixt the highland and lowland vegetation of Eastern Africa is very marked. The district looks well wooded when viewed from a tree top or mountain side, though of forest there is none, except the jungle covering ravines which scarp the mountain sides. The *Napœa Kirkii*, n.n. *Msuku*, the most important tree of the district, grows freely to a fair size. A tree a foot in diameter and 16 feet long is not uncommon, though the usual length is from 10 to 12 feet. The *Msuku* is less liable to insect attacks than soft-wooded trees ; though hard and difficult to work, with an inclination to twist and split, it has, when planed and dressed, somewhat the appearance of mahogany. It is confined entirely to the highlands. I have never seen it growing lower than 2000 feet high, and it indicates a healthy district. The *Parinarium mobola*, n.n. *Mbembu*, has a clear straight stem of from 20 to 25 feet, invaluable for beams and joists, but it is now scarce round Blantyre. The *Khaya* *senegalensis*, n.n. *Mahawa*, supplies nearly all the wood for the canoes of the upper river. It has a straight bole, often 30 or 40 feet long; and the diameter is sometimes 4 feet at the base. Its companion *Erythrophlœum guineense*, n.n. *Mwayi*, reminds one of a gigantic British oak. Sparingly dispersed round water courses are *Parkia filicoidea*, *Eugenia cordata*, and other trees. Three species of *Brachystegia*, the native names of which are *Njombo*, *Msimbreti*, and *Nepaka*, are amongst the most common soft-wooded trees. From the first of these, *Brachystegia longifolia*, the bark-cloth is chiefly taken. The second can be recognised by the bluish tint of its young leaves miles away from the tree. When cut down these species seem to escape insect destruction for two months at least. On deep black soil Acacias flourish on the highlands; one species in particular, with its top cut level, as with shears, attracts the notice of every stranger. *Albizzia angolensis* is abundant, and yields the hardest wood of the district, which is dull black. As it is usually accompanied by a creeping species of *Loranthus*, its ripe legumes intertwined with the flowers of this parasite give it a beautiful appearance. Several species of *Pterocarpus* afford useful timber. From *Napini*, a species of *Terminalia*, a hard yellow wood is obtained, which is difficult to work. The natives manufacture their drums from *Erythrina tomentosa*, a soft-wooded tree. A 3-foot length from the trunk is hollowed out into a cylinder, the ends of which are covered with snake-skin, when the instrument is complete.

Trees producing Fruit.—The *Napæa Kirkii* yields msuku, a fruit much esteemed by the natives, who live for months often on little else. It has an astringent taste when kept in the mouth more than a few seconds. *Mtundua*, a species of *Garcinia*, yields a fair substitute for the mangosteen. The natives throughout the Shiré highlands esteem much a fruit of a slightly acid taste, like a well-grown damson, of a beautiful light red colour, called by them *Mpingi pingi*, and is obtained from *Ximenia americana*. A species of Anona produces an abundance of custard apples, though the fruit is often infested by ants and worms. Edible fruits are also got from *Eugenia cordata* and *Parinarium mobola*. An edible fruit with a pleasant acid taste, called *Ndana*, is derived from a species of *Flacourtia;* and another, *Matinaka*, is only found on the mountains at or above the 4000 feet level. *Ugulukututu*, derived from *Vangueria infausta*, might be profitably cultivated. While the shells of *Styslin* are used for utensils, such as drinking-cups or sugar-bowls, the fruit is eaten. The natives now bring in great quantities of *Rubus rigida* from the water-courses to the European settlements, to barter for beads or calico.

Flowering Plants.—The *Leguminosæ*, in special, afford many showy plants suited to European greenhouses. Such plants as *Tephrosia Vogeli*, *T. purpurea*, or *Clematis Kirkii*, would make an imposing appearance in any collection ; as also would several species of *Crotalaria* and *Solidago*, *Hibiscus* and *Abutilon*. *Dombeya Burgessiæ* is a handsome shrub ; while *Lobelia Milleri* enlivens the banks of streams, and *Buphane toxicaria* abounds at the close of the dry season and the beginning of the rains. Various species of *Convolvulus* and *Ipomœa* display their flowers in the bushes and trees. A very fine *Crinum*, as well as a few *Amaryllideæ*, are found; but the *Liliaceæ* are not worth growing. There are twenty to thirty species of ground orchids, some with sweet odours, but I have not come across an epiphyte worthy of home cultivation. On the contrary, some species of *Thunbergia* merit attention by the home cultivator ; but I have hitherto failed to obtain seeds of these. *Datura alba* is grown near the native villages, as the leaves of it are used to render the native beer intoxicating. *Helichrysum* and *Alyssum* grow abundantly at the top of Mount Zomba, where also a fine *Polygala*, with flowers distinct in colour from the surrounding vegetation, has a fine effect. Here, too, are found handsome tree-ferns. *Adiantum*, *Asplenium*, and *Pteris* are the common ferns of the district. The grasses will afford a rich field to the botanical collector. A *Selaginella* is found in damp shady places by streams and on the mountain sides.

Economic Plants.—The district abounds in such plants, though meanwhile the present high freights coastwise prevent the exportation of its products. Rubber can be got, though not in quantity. As *Indigofera tinctoria* grows wild throughout the district, indigo planting may become a staple industry. The *Sansevicra longiflora*, perhaps the most valuable of the fibre-producing plants, grows plentifully on mountain sides and on dry stony places. Its leaves are often 5 feet long, with a diameter of 2½ to 3 inches. The fibre is roughly made by beating the bark on stones in streams, and from it ropes are made. The import of Manilla hemp is thereby lessened. Plantains do not flourish in Blantyre, though they flourish at the north end of Lake Nyassa. The *Bwasi*, a species of *Polygala* mentioned by Livingstone as yielding fibre worth £40 per ton, is getting scarce. I have not seen fibre-producing aloes. The bark of *Garcinia* yields a red dye used by the natives for their cloth, who at the same time use ashes as a dye. Samples of gum from Acacias were reported, when sent home, as inferior. A red astringent gum, similar but inferior to kino, is obtained from a *Pterocarpus*, n.n. *Mlonebwa ;* but this appears valueless as an export. Hemp, though grown round every village, is cultivated not for its fibre, but as a smoking material. I need not refer to the pharmacopœia of the native doctors, which includes many herbs.

Soil of the District.—At both Blantyre and Zomba the country is not a level flat, but a vast undulating plain. In it you have every variety of soil, except stiff white clay. On the hills, where the slope is great, the soil is thin, most of it having been carried down into the valleys ; this is specially the case along the sides of streams, where again black loam may be found from a foot to sixteen feet thick, with a subsoil. In the Blantyre district of red clay, which makes good bricks, the soil is well suited for cereal growing, but the farmer in Blantyre must manure from the beginning. No forests add their yearly quota of decaying leaves to enrich the soil ; and though this is made up somewhat by the natives burning the bush, we can here expect no constant successive crops, as at the wheat farms of the American prairies. I do not hesitate to pronounce the climate good and healthy, although there is danger from fever at Blantyre. On the river Shiré the average temperature throughout the year is about 50°. The highest I have known is 95° in the shade, and the lowest 90°. This low temperature did immense damage to bananas, sugar-cane, and coffee, while in many places every leaf came off the Msuku and other trees in low places. The rainfall generally ranges from 30 to 50 inches. The lowest fall I have seen was 30 inches, and the highest 62. An inch and 1½ inch is the common rainfall in the twenty-four hours, but I once saw 6 inches in the same period. It seldom rains long at a time during an ordinary shower, and the sun rapidly dries the ground.

Native Crops.—Maize is the most important crop of the highlands; sorghum takes its place on the upper river, and millet lower down; while rice, which is also freely cultivated, has a ready market at Quilimane. Sweet potatoes and beans are also largely grown. In the highlands the bean shrub, *Cajanus indicus*, is met with everywhere. Some smaller grains are more sparsely cultivated, as well as cucumbers, pumpkins, and water melons. Castor oil plants, though not in the native gardens, may be seen round every village. Tobacco is grown for home use. The roots of the Cassava, which is extensively grown, are seldom used till they are two years old. Ground nut and sesamum, too bulky freights to send from the highlands, are freely cultivated for sale on the river.

We have introduced to Blantyre the cultivation of coffee, oranges, lemons, pomegranates, figs, granadillas, which all do well. The European vegetables grown in the mission gardens all thrive, with the exception of cauliflower. With a Government which could guarantee security to capitalists investing money, the district is worth colonial enterprise, promising, from the cultivation of such products as have been enumerated, a brilliant future.

Note on Asplenium germanicum. By John Lowe, M.D., King's Lynn.

(Read December 11, 1884.)

Having always entertained a strong doubt of the supposed hybridity of *Asplenium germanicum*, I have for many years, during occasional visits to Switzerland, kept a close look-out for any forms which might serve to throw additional light on this debated subject, and, having always observed it associated with *A. septentrionale* and never with *A. Ruta-muraria*, it seemed to me highly improbable that it could be anything more than a mere variety of the former, an opinion which I am pleased to find is also held by our President, Mr Boyd, who has kindly informed me of the facts which he recently brought under your notice touching

Asplenium germanicum.

this question. If my memory serves me, however, it was on one or two occasions found in company with both *A. Ruta-muraria* and *A. septentrionale* by the late Professor Balfour.

In 1877 I found some specimens on the Maloja Pass, above Chiavenna, similar in form to that recently exhibited by Mr Boyd to the Botanical Society, having distinct fronds of *A. germanicum* growing from the same root with *A. septentrionale*, but there were unfortunately no intermediate forms proving their common origin, and I was unable to bring the roots home in a sufficiently good state to enable me to keep them alive.

In 1882 I was more fortunate in finding, near the same locality, several other specimens bearing on the same root every intermediate form betwixt *A. germanicum* and *A. septentrionale.* A few which are here figured (p. 243) will, I venture to think, help to decide the question. The roots which were brought home are still flourishing, and have put up a goodly crop of fronds, which are all typical forms of *A. germanicum.* This fact is especially interesting when viewed side by side with the instance noted by Mr Boyd, who informs me that his specimen, varying betwixt the two forms, finally developed into *A. septentrionale.*

In the figures which I have given it will be observed that only the intermediate forms are figured, but there were on the same root other fronds, having the distinctive characters of each species. I need scarcely add that extreme care was taken to satisfy myself that there was only a single root, all the fronds being observed to issue from the same point.

Preliminary Note on the Evolution of Oxygen by Sea-Weeds. By John Rattray, M.A., B.Sc., F.R.S.E., Scottish Marine Station, Granton, Edinburgh.

(Read May 14, 1885.)

Soon after commencing my work on the Algæ of the basin of the Firth of Forth in the summer of last year, I observed that living specimens of different species when kept in vessels of water in the floating laboratory, and exposed to the influence of sunlight, emitted a very variable number of bubbles of gas, though placed as far as possible under similar external conditions. Not being able to discover any data *bearing on the proportion of oxygen to the entire quantity of gaseous matter accumulating under such circumstances*, I determined to make a series of experiments, with the view of finding out whether any variations could be shown to occur in this connection among the different species, and also consequently for the purpose of arriving at some approximate data on the efficiency of the several species in aiding the waves and other movements of the sea in oxygenating the ocean waters.

The method of work adopted was as follows:—A small number of cylindrical glass jars of moderate dimensions was procured, these selected measuring about 4½ inches in diameter and 9½ inches in height. Their lower extremities were left permanently open, while the upper end of each, which was gradually attenuated to form a neck, was closed by an india-rubber perforated stopper, through which a collecting tube, graduated to cubic centimeters, was passed. The diameter of the neck of each jar measured 1½ inches, and the height of the collecting tube, though not always constant, averaged about 7 inches, its diameter being half an inch. The large size of the jars was found to be essential, in order that weeds of considerable magnitude might be selected for experiment and kept in their normal conditions.

In all cases the specimens chosen were left attached to the substratum upon which they grew, so that their rhizoids as well as their more expanded thalli were invariably intact. Where the attachment was, as sometimes happened (*e.g.*, in the case of *Fucus canaliculatus*), upon rocks, the part of the rock upon which any given plant was fixed was removed at a distance of a few inches round the specimen by means of a chisel, and no specimens were used in which the sandstone was fractured in the immediate vicinity of the point of attachment of the plant. The exclusion of other Algæ except members of the species in question was in most instances attained by selecting from what might be called *exclusive* areas; that is, from places upon which one species grew to the exclusion of all others of the same or of different genera; but in a few cases in which it was found impossible to secure such conditions, and in which rounded stones of small size, but bearing a good growth of a given species were made use of, these stones were carefully examined by a lens and rejected when a mixture of organisms occurred.

The specimen once selected, was now washed carefully in sea-water, so as to remove all loose muddy or sandy materials; it was then completely submerged, and allowed to remain at rest for some time, in order to get rid of all bubbles of air that might be entangled among the more minute ramuli before being finally placed inside the jar. This last process was effected in the usual manner. The jar was filled very slowly with sea-water, so as to prevent small bubbles of air from being included, and so accumulating at the top of the collecting tube when the jar was reversed. The specimen was now slipped under and inside this, without being allowed to reach the surface of the water, and a second cylindrical vessel with a flat bottom, and having a diameter a few inches greater than that of the jar, its height being equal to about one-third of the latter, was slowly filled with sea-water, and passed under the vessel which now contained the plant or plants. The whole apparatus was then raised out of the water, and exposed to the direct action of the rays of the sun.

The time of this exposure was not always the same, because in many cases, in which small specimens had to be dealt with, a longer period had to be allowed, in order that a sufficient amount of gas might be collected to enable further observations to be made; but in all instances the periods of exposure have been carefully recorded, and the conditions of the weather during those periods given.

The changes of the temperature of the water in the apparatus now introduced a disturbing element of great importance, inasmuch as with its variations the amount of oxygen, and of the other accumulated gaseous substances, absorbed by it would also vary. To counteract as far as possible these changes, or, in other words, to maintain the uniformity of the temperature of the water in the vessels, a current was established. This was readily effected by pumping water at frequent intervals from the sea into a tank at a higher level, from which it was again drained off into the apparatus by means of a small india-rubber tube provided with a small glass nozzle or a wooden clip, to prevent the passage of a current of too great strength. By this means the temperature of the water in the apparatus was found to vary within very small limits; but I have been unable to maintain an absolute constancy, partly because of the variability in the intensity of the heat of the sun, which induced a more or less rapid increase or diminution of the temperature in the upper part of the apparatus, which the convection currents could not perfectly antagonise, and partly because the experiments had to be continued during the night, when the apparatus could not be attended to.

The significance of this factor I endeavoured to determine by erecting a second apparatus prepared like the first, but without any plants, and exposed in every way to similar external conditions. A similar current of sea-water was passed through the apparatus from the tank, and in it the gaseous molecules given off by the water itself in virtue of changes of temperature accumulated. In this manner the part played by the water as such was determined, and in any case, where even a very small accumulation of gases took place the experiment was repeated. When a hardly appreciable quantity of gas had accumulated in the second apparatus, the influence of the changes of temperature on the water was regarded as insufficient to modify the reading in the apparatus in which the experimental plant or plants were exposed, and this reading was accordingly accepted.

It need hardly be noted that, in admitting a current of sea-water into the vessels through the india-rubber tubing, great care was taken so to regulate the conditions that bubbles of air were not passed in along with the water, nor were swift surface eddies set up, as these might have caused an abnormal amount of air to pass into the circulating water.

After a sufficient amount of gas had accumulated in the collecting tube, the entire apparatus was removed and immersed in a tubful of sea-water which had been prepared for some time so as to settle and acquire a temperature equal to that of the water in the apparatus. The depth of water in the tub was such that the lower end of the collecting tube of the experimental apparatus could be removed from the jar without coming above its surface. The accumulated gas was now decanted into a clean eudiometer which was carefully transferred, its open end being closed by the thumb, to a chemical stand, and on this it was clamped with its lower extremity under the surface of the mercury in the mercurial trough. A reading of the amount of gas present was now taken, the temperature of the room and the height of the barometer at the time being at the same time recorded. Potash and pyrogallic acid were then added in turn, and after allowing adequate time for absorption of the oxygen to take place a second reading of the remaining volume was made, the temperature and pressure being noted as previously. In all cases this direct method was employed in analysing the gases.

In reading the volumes of these gases, the level of the centre or summit the downwardly convex meniscus has been taken, and the observations were always made in the outer room of the floating laboratory, at a distance from all artificial heat, and in a place secluded from the action of sunlight. The mercury in the trough, after becoming unsuitable for work, owing to the presence of pyrogallate and water, was cleaned by being passed through filter paper.

It is important to note that the presence of micro-organisms of a vegetable or animal nature in the sea water inside the apparatus exercises another disturbing influence on the gaseous products; but, as already stated, this factor has not been found to cause an accumulation of gas in the empty apparatus, and its influence, though real, is not included in the annexed calculations.

The corrections of the volumes of the gases for temperature and pressure have been calculated from the following formula:—

$$V' = \frac{V \times (B - b - T)}{760 \times (1 + 0{\cdot}003665\, t)},$$

where V'=corrected volume, V=observed volume, B= height of barometer at time of reading, b=difference between height of mercury in trough and in eudiometer, t=temperature in degrees centigrade, T=tension of aqueous vapour in mm. of mercury at temperature t. With regard to the value of b in the above equation, it is to be noted that the watery substance in the eudiometer have been reduced to mm. of mercury by regarding $\frac{1}{13}$ of the volume of these substances as giving their mercurial equivalent. This factor is of importance, as the height of the column of mercury in the eudiometer has to be deducted from the reading of the barometer in making the calculations.

A. *Enteromorpha compressa* (L.) Grev.

In this case the results of seven experiments are given, different plants being employed on each occasion. Good specimens were procured in the immediate vicinity of this station, all being in full vigour of growth. The first experiment gave the following statistics:—

Time of Exposure.	Vol. of Gas collected.	Temp. of Room.	Height of Barom.	Height of Water in Eudio.	Vol. after Potash.	Vol. after Pyro. Acid.	Temp. of Room.	Height of Barom.	Height of Hg in Eudio.	Height of Watery Substances in Eudio.
hrs.	c.c.	Cent.	mm.	in mm. of Hg.	c.c.	c.c.	Cent.	mm.	mm.	in mm. of Hg.
$22\frac{1}{2}$	12·6	16°·2	755	4·8	12·6	6	16°·4	756	31·5	6·8

Correcting according to the formula,

$$V^1 = \frac{12{\cdot}6 \times (755 - \frac{1}{13} \text{ of } 4{\cdot}8 - 13{\cdot}710)}{760 \times (1 + 0{\cdot}003665 \times 16{\cdot}2)}.$$
$$= \log A - \log B.$$
$$= x - y.$$
$$= z.$$

Hence the number whose log. is z is the number required. In this instance it is found to be 11·5 approx.

The variations in the percentages of oxygen shown by the following table are indeed considerable, but perhaps cannot be looked upon as abnormal. The maximum, 61·2, was obtained in the second experiment, the minimun in the third, namely, 51·7. On comparing the condition of the plants in these two cases, a very remarkable difference was recorded. Both were in an exceedingly perfect condition of health, and had not been injured in any part by impact of foreign bodies, but on examining the former under the microscope, the spores were found to be just moving out of the cells. That a plant at the acme of its vigour was thus observed is of interest, as proving that in such a condition its efficacy as an oxygenator is very great—higher indeed than in any previous, and, of necessity, than in any subsequent period of its existence. In the second instance referred to, the stage for emission of spores had not yet arrived, nor did this occur during the week following, while

Similarly, by substituting the required figures, the volume remaining, after removal of the oxygen by the pyrogallic acid, will be found to be 5·2 c.c. Hence $11·5-5·2=6·3$ = amount of oxygen that was present, *thus representing* 54·8 *p.c. of the whole volume collected.*

The following table gives the results of the remaining experiments that were made on this species. The figures having reference to the experiment just discussed have been inserted to make the table complete.

No. of Expt.	Time of Exposure.	Vol. of Gas collected.	Temp. of Room.	Height of Barom.	Height of Water in Eudio.	Vol. of Gas collected after correction.	Vol. of Gas after Potash.	Vol. of Gas after Pyro. Acid.	Temp. of Room.	Height of Barom.	Height of Hg in Eudio.	Height of Watery Substances in Eudio.	Vol. of Gas after correction.	Per cent. of Oxygen collected.	Remarks.
	Hrs.	c.c.	Cent.	mm.	mm.	c.c.	c.c.	c.c.	Cent.	mm.	mm.	mm.	c.c.		
I.	22⅓	12·6	16°·2	775	4·8	11·5	12·6	6	16°·4	756	31·5	6·8	5·2	54·8	Sky in part overcast, subsequently bright sunshine and a little cloud.
II.	25¾	16·4	15°·9	759	2	15·2	16·4	7	13°·9	759	65	4	5·9	61·2	Sky mostly clear with bright sunshine, a gentle breeze.
III.	22⅓	15·9	16°·6	755	2·7	14·5	15·9	8·1	16°·1	757	38	4·9	7	51·7	Sky sometimes overcast, intermittent sunshine.
IV.	25¾	15	15°·9	759	3	13·8	15·9	6·8	13°·3	760	60	5	5·8	58	Sky cloudy, bright sunshine at times, and generally calm.
V.	25¾	15·8	13°·3	760	2	14·8	15·8	7·2	17°·2	762	60	4	6·1	58·8	Sunshine intermittent, cloud and a little rain.
VI.	22	14·8	17°·6	770	2·9	13·7	11·8	7·3	17°·2	770	38	4·7	6·1	53·3	Sultry, with cloud and intermittent sunshine
VII.	22	15·3	17°·4	770	2·9	15·3	14·2	7·8	16°·9	770	41	4·9	6·7	52·8	Sultry, with cloud and intermittent sunshine.

By adding the above percentages and dividing by 7, the number of experiments, average percentage of 57·2 is obtained for the oxygen factor.

It is noteworthy that in the above experiments, as in all the succeeding ones, the addition of potash, which would readily have absorbed any carbonic acid gas present, produced no appreciable change in the volumes of the collected gases, *it accordingly follows, and this is a very significant deduction, that among the gases no trace of carbonic acid existed.* As bearing on this inference, however, it must be stated that the analyses have never been made during the earlier part of the day.

B. Ulva latissima, Kütz. Monostroma latissimum (Kütz). Wittr.

Excellent specimens of this plant were procured on small round stones on the gently sloping somewhat shingly beach leading down into the estuary from the entrance to Granton Quarry. In the first series about a dozen of experiments were performed, and from these the following eight have been selected as representative.

SERIES 1.

No. of Expt.	Time of Exposure.	Vol. of Gas collected.	Temp. of Room.	Height of Barom.	Height of Water in Eudio.	Vol. of Gas collected after correction.	Vol. of Gas after Potash.	Vols. of Gas after Pyro. Acid.	Temp. of Room.	Height of Barom.	Height of Hg in Eudio.	Height of Watery Substances in Eudio.	Vol. of Gas after correction.	Per cent. of Oxygen collected.	Remarks.
	Hrs.	c.c.	Cent.	mm.	mm.	c.c.	c.c.	c.c.	Cent.	mm.	mm.	mm.	c.c.		
I.	4	15·4	16°·2	772	2·4	14·4	15·4	7·8	14°·1	778	44	4·4	7	51·4	Sunshine generally, sultry, but cooler towards the close.
II.	46	14·7	16°	778	2·5	13·9	14·7	8	12°·8	778	28	3·9	7·4	46·8	Sky sometimes overcast and cloudy, sultry and bright sunshine.
III.	22	10·8	11°·7	775	5	10·3	10·8	5·3	13°·2	775	19	7·4	4·9	52·5	Misty, sunshine less than in above cases, but clear later on.
IV.	24	8·2	13°·3	775	6·9	7·8	8·2	4·1	13°·1	775	3	9·5	3·8	50·7	Misty, sunshine less than in above cases, but clear later on.
V.	26	10·6	13°	775	5·4	10·1	10·6	5·1	12°·8	775	25	7·8	4·6	54·5	Sunshine general, a little fog.
VI.	26	10·2	12°·3	774	5·6	9·7	10·2	4·9	12°·5	774	7	8·9	4·6	52·6	Intermittent sunshine, cloudy, on the whole mild.
VII.	27	9	12°·5	774	6·8	8·5	9	4·3	12°·4	774	6	9·5	4	57·9	Mild, sunshine, cloud.
VIII.	$27\frac{1}{2}$	7·5	12°·4	774	7·4	7·1	7·5	4·2	15°·9	774	6	10·5	3·9	45·1	Mild, sunshine, cloud.

Average percentage of oxygen = 59·8.

SERIES 2.

No. of Expt.	Time of Exposure.	Vol. of Gas collected.	Temp. of Room.	Height of Barom.	Height of Water in Eudio.	Vol. of Gas collected after correction.	Vol. of Gas after Potash.	Vols. of Gas after Pyro. Acid.	Temp. of Room.	Height of Barom.	Height of Hg in Eudio.	Height of Watery Substances in Eudio.	Vol. of Gas after correction.	Per cent. of Oxygen collected.	Remarks.
IX.	50	2·6	7°·3	978	10·9	2·5	2·6	1·6	7°·8	778	0	13·9	1·5	40	Dry, a little frost at night, snatches of sunshine during day.
X.	50	1·4	8°·3	778	11·9	1·3	1·4	0·8	8° 4	778	0	14·8	0·78	40	Sunshine on whole general, a little frost at night.
XI.	50	1·5	8°·6	778	11·8	1·4	1·5	0·9	8°·8	778	0	14·2	0·86	38·6	Sunshine on whole general, a little frost at night.

Average percentage of oxygen = 35·9.

the plant was kept under daily observation. The clear green and fresh colour of all the cells, however, at once disproved all possibility of the presence of pathological conditions, nor is it unlikely that this number approximately represents the average normal percentage for an ordinary specimen of this alga.

In the case of the fourth and fifth experiments the specimens were also approaching the stage for extravasation of the spores, inasmuch these were shed on the fifth day after the experiments ceased; while in the case of the first plant, the results of which are recorded above, a similar emission of motile spores only occurred after eight days. *The general inference, therefore, that the maximum of oxygen evolution is reached at the time of sporulation seems to be clearly warrantable in this species,* and the deduction has been corroborated by some of the experiments recorded on p. 251.

The experiments in connection with this species, which is very abundantly represented in most localities of the estuary of the Forth, have been divided into two series, differing widely in the percentages of oxygen which they present. The first series was conducted during the month of September, and under very favourable conditions on the whole with regard to mildness and amount of sunshine. The latter, on the other hand, was undertaken in November, when the amount of sunshine was but small, and the night no longer mild. A comparison of the two series, therefore, shows that in the warmer autumn months there is a very pronounced excess of oxygen given out, as compared with what takes place at the approach of or during winter. It must also be noted, that although care was taken to procure sound specimens for all the experiments, greater difficulty was encountered in this respect in the latter series, and in one instance especially (Exp. XI.) the plant selected was somewhat injured along one of its margins. Owing to this difficulty, the second group of experiments were limited to five, but from a slight admission of air into the eudiometer tube during the process of analyses in two cases, the results so far obtained had to be abandoned.

Among the plants chosen for the first group of experiments, emission of spores was observed in none, yet all were

C. PORPHYRA LACINIATA (Lightf.), Ag.

Specimens procured from same locality and with same kind of attachment as in the case of *Monostroma latissima*. The time of exposure varied as in other instances with the size of the plant.

No. of Expt.	Time of Exposure.	Vol. of Gas collected.	Temp. of Room.	Height of Barom.	Height of Water in Eudio.	Vol. of Gas collected after correction.	Vol. of Gas after Potash.	Vol. of Gas after Pyro. Acid.	Temp. of Room.	Height of Barom.	Height of Hg in Eudio.	Height of Watery Substances in Eudio.	Vol. of Gas after correction.	Per cent. of Oxygen collected.	Remarks.
	Hrs.	c.c.	Cent.	mm.	mm.	c.c.	c.c.	c.c.	Cent.	mm.	mm.	mm.	c.c.		
I.	47	20·2	15°·2	770	0	19·1	22·2	7·7	14°·3	767	42	55	6·8	64·4	Sunshine, a little fog and cloudy.
II.	47	20	15°·1	770	0	18·9	20	7·5	14°·4	767	43	58	6·6	65·1	Sunshine, a little fog and cloudy.
III.	62½	12·8	15°·8	765	45	11·9	12·8	5·2	15°·5	765	34	85	4·6	61·4	Sunshine general, mild and cloudy sometimes.
IV.	62½	17·5	15°·7	765	18	16·3	17·5	7·8	15°·7	765	55	40	6·7	58·9	Sunshine general. mild and cloudy sometimes.
V.	63	15	16°·1	765	2·1	13·9	15	6·6	16°·6	764	45	4·7	5·7	59	Nimbus cloud, no wind, sunshine.
VI.	63	16·3	16°·6	764	1·4	15·1	16·3	7·3	16°·7	764	52	3·9	6·2	58·9	Nimbus cloud, no wind, sunshine.
VII.	52	18·4	15°·5	756	0·7	17	18·4	8	14°·7	756	39	4·2	6·9	59·4	Intermittent sunshine, mild, gentle breeze.
VIII.	48	15·8	15°·4	756	2·4	14·5	15·8	7·1	15°·8	756	40	4·1	6·3	56·9	Intermittent sunshine, mild, gentle breeze.
IX.	48	9·1	15°·5	756	7·1	8·6	9·4	4·5	15°·8	756	10	9	4·0	53·5	Nimbus cloud at times, otherwise fine, sunshine general.
X.	24	14·4	14°	765	3·2	13·5	14·4	6·4	14°·1	765	37	5·2	5·6	58·6	Slight showers, generally mild and fine.
XI.	14	14·5	13°·5	760	2·5	13·5	14·5	6·8	13°·6	760	45	4·7	5·9	56·3	Moderate wind, sunshine and cloud alternating.

Average percentage of oxygen = 59·3.

D. Conferva tortuosa, J. Ag. Chaetomorpha tortuosa, Kütz.

Excellent specimens of this were procured from Inchkeith, where it occurred in large masses in some of the tidal pools.

No. of Expt.	Time of Exposure.	Vol. of Gas collected.	Temp. of Room.	Height of Barom.	Height of Water in Eudio.	Vol. of Gas collected after correction.	Vol. of Gas after Potash.	Vol. of Gas after Pyro. Acid.	Temp. of Room.	Height of Barom.	Height of Hg in Eudio.	Height of Watery Substances in Eudio.	Vol. of Gas after correction.	Per cent. of Oxygen collected.	Remarks.
	Hrs.	c.c.	Cent.	mm.	mm.	c.c.	c.c.	c.c.	Cent.	mm.	mm.	mm.	c.c.		
I.	144	10 73	17°·3	783	5·7	9·4 68·6	10	4·3 31·4	17°·1	783	20	8·3	3·9 28·5	58 5	Wind moderate, a little rain, sunshine general, sky sometimes overcast.
II.	144	83 12·6 25·2	16°·4	783	3·7	78 11·9 23·9	12·6	35·7 5·3 10·6	16°·3	783	32	6 6	32·4 4·8 9·6	57·8	Intermittent sunshine, fine to cloudy, gentle breeze.
III.	144	37·8 16·4 65·2	16°·6	783	1·7	35·8 15·6 62·0	16·4	15·9 6·2 24·6	15°·8	783	59	4·1	14·4 5·4 21·4	65·5?	Calm, sunshine general, sometimes a little cloud.
IV.	163	81·6 16·2 73·3	10°·3	767	1·1	77·6 15·5 70·1	16·2	30·8 6·4 28·9	14°·9	768	72	3·2	26·8 5·4 24·4	65·2	Mild, cloudy, but generally clear and sunny.
V.	266	89·5 14·4 81·5	15°·1	768	2·7	85·6 13·6 76·9	14·5	35·3 6·6 37·3	15°·5	768	38	5·1	29·8 5·8 32·8	57·4	Slight wind, hazy and overcast, sunshine and clear.
VI.	64	95·9 19·4	11°·7	770	0·5	90·5 18·5	19·4	43·9 9·1	12°·2	770	60	2·2	38·6 7·9	57·3	Intermittent, but general sunshine or cloud, calm.
VII.	64	13·3	12°·3	770	3·6	12·6	13 3	8·9	12°·5	770	38	5·6	5·3	58	Intermittent, but general sunshine or cloud, calm.

Average percentage of oxygen = 59·9.

in a highly vigorous condition of vitality. It does not seem easy to account adequately for the somewhat low percentage shown in Experiments II. and VIII., but under ordinary normal circumstances probably the general average stated, viz., 50·8 per cent., may not be far from the truth.

The high percentages of oxygen obtained in the above experiments is very noteworthy, and demonstrate clearly that the presence of the pinkish red colouring matter present in the cells, and masking the green colour of the chlorophyll, does not diminish their physiological activity in this respect. As in the previous cases, all the specimens experimented with were subsequently examined microscopically, some being kept alive in vessels of water for several days. Spores were observed to be emitted only in three instances, viz., in the first, second, and sixth; the others did not show this even after being kept alive for upwards of two weeks. The general inference already stated is accordingly substantiated in this case also, the occurrence of a maximum period of vitality contemporaneous with a maximun of physiological function being recognisable. That this has a greater influence than the amount of sunshine occurring during the period of exposure is also indicated by comparing the percentages in Experiments I. and IX., since, on the whole, more favourable conditions in this respect existed in the latter case than in the former, yet the percentage of oxygen in the one is much greater than in the other.

Two points deserve notice in connection with this table—(1) in nine of the specimens examined were spores observed, notwithstanding the high percentage shown in the third and fourth experiments; and (2) the calculation of the percentage has been divided into parts on account of the large amount of gas collected. Thus in (Exp. I.) 83 c.c. in all were obtained, of which 10 c.c. were taken for determining the oxygen, its amount in the remaining 73 c.c. being calculated by proportion. Thus, by considering that 10 c.c. became 9·4 c.c. after correction, 73 c.c. under similar conditions would become 68·6 c.c.; and again, by observing that 9·4 c.c. was reduced to 4·3 c.c., after pyrogallic acid was introduced, it follows that 68·6 c.c. would be reduced to 31·4 c.c. Thus, in the whole 83 c.c. (the original volume), is represented by 35·7 c.c. after the pyrogallic test. Hence it

E. Fucus canaliculatus, Linn.

Specimens of good growth to attached chips of Sandstone, and obtained in the estuarine face of the neck of land separating the old Granton Quarry from the Forth.

No. of Expt.	Time of Exposure.	Vol. of Gas collected.	Temp. of Room.	Height of Barom.	Height of Water in Eudio.	Vol. of Gas collected after correction.	Vol. of Gas after Potash.	Vol. of Gas after Pyro. Acid.	Temp. of Room.	Height of Barom.	Height of Hg in Eudio.	Height of Watery Substances in Eudio.	Vol. of Gas after correction.	Per cent. of Oxygen collected.	Remarks.
	Hrs.	c.c.	Cent.	mm.	mm.	c.c.	c.c.	c.c.	Cent.	mm.	mm.	mm.	c.c.		
I.	124	2·2	9°·7	756	11·2	2·0	2·2	1·2	9°·4	756	0	14·1	1·1	45	Sky overcast, sunshine moderate, settled, a little frost at night.
II.	124	1·9	9°·4	756	11·6	1·7	1·9	1·1	9°·8	756	0	14·7	1·0	41·2	Sky overcast, sunshine moderate, settled, a little frost at night.
III.	124	1·4	10°·3	756	11·9	1·3	1·4	0·8	10°·7	756	0	15·1	0·7	46·2	Sky overcast, sunshine moderate, settled, a little frost at night.
IV.	124	2·3	5°	756	11·3	2·2	2·3	1·4	5°·1	756	0	14·1	1·3	40·9	Sky overcast, sunshine moderate, settled, a little frost at night.
V.	124	1·2	5°·2	756	12·1	1·1	1·2	0·8	5°·5	756	0	14·6	0·7	36·4	Sky overcast, sunshine moderate, settled, a little frost at night.

Average percentage of oxygen = 41·9.

F. Chondrus crispus (L.), Stackh.

Specimens from tidal pools opposite Royston House, near Granton.

1.	336	1·4	2°·1	773	11·7	1·3	1·4	1	7°	731	0	14·7	0·9	30·8	Cold, showery and sunny, a little frost at night.

is clear that 58·5 per cent. of oxygen was originally present.

A similar method has been adopted in the case of the first five experiments on this table, the last two being calculated in the ordinary manner already described.

Seeing that no spores were observed in connection with the plants employed, the high percentages of oxygen are somewhat striking.

Good tufts of the closely allied *Chætomorpa melagonium* were also procured from the same locality, but the difficulties connected with their manipulation precluded an extensive series of experiments from being made. So far as my observations went, an average percentage of about 54 was obtained.

The experiments made on *Fucus canaliculatus,* Linn., had unfortunately to be conducted somewhat late in the season, during the earlier part of November. They cannot accordingly be taken as indicative of the average summer or early autumn conditions of the plant, yet they demonstrate that the oxygen-emitting power is not eclipsed by the advent of a little frost during night, or by the presence of conditions which cannot be looked upon as so favourable as in the earlier parts of the year. That the part played by the various perennial algæ in the oxygenation of ocean water, even during winter, is a very important one, cannot longer be doubted, nor is it unlikely that it may yet be shown that in the cases of those which emit their spores in the cold season their maximun power as oxygenators may be attained at the same time.

The single experiment recorded in the case of *Chondrus cripus* (L.), Stackh., was also made in the early part of November, but a little later than those recorded for *Fucus canaliculatus.* That this is sufficient to account for the low percentage, as in the former cases, can hardly be doubted; but unfortunately I have as yet been unable to collect data bearing on the summer evolution of oxygen in this common but interesting species.

In conclusion, it must be pointed out that the figures given in the preceding lists cannot be regarded as of *absolute* but only of *relative* importance. That more exact methods of analysis would probably give results varying from the above, is not unlikely; but since all the experiments have, so far as practicable, been carried out in the same manner, a comparison of the figures may prove of some interest. Thus by combining the averages in the case of *Enteromorpha, Ulva, Porphyra,* and *Conferva,* obtained above, a general average of 56·5 per cent. of oxygen is found—a figure which may accordingly be taken as fairly representing the summer and early autumn evolutions of these plants. By similarly combining the averages got for the second series of experiments with Ulva, and those with Fucus and Chondrus, a general average of 37·3 per cent. is obtained, which, as in the previous cases, may be taken as representative of the evolutions at the more inert stages of growth during the colder seasons of the year. A much more extensive series of observations must be made before an adequate conception of the oxygenating power of these comparatively lowly organised forms of life can be obtained, but that their capacities in this respect merit careful study is at once apparent from the foregoing tables. In the calculations no account has been taken of the volume of the seaweeds experimented with, the only problem being the determination of the amount of oxygen present in the entire volume of gases collected, it being clear that that this proportion will remain the same for the same species under the same circumstances, whether the volume of the algæ be large or small.

On the Development of Bifoliar Spurs into ordinary Buds in Pinus sylvestris. By Professor ALEXANDER DICKSON, M.D., LL.D.

(Read February 12, 1885.)

Many Coniferæ exhibit remarkable specialisation as regards branch development. In some, such as *Larix* and *Cedrus,* there is a marked tendency to a contracted development, or shortening of many of the shoots which appear as "spurs," with numerous leaves crowded together to form a fascicle. Here it is only certain of the shoots which are developed in this way, and of these it may happen that a spur of one season may next season become produced at its extremity in the ordinary elongated form with scattered foliage leaves. A further step in specialisation occurs in *Pinus*, where, in the adult condition, the leaves on the elongated shoots are reduced to chaffy scales, from whose axils buds are produced, which, after developing from 2–5 foliage-leaves, abort at the growing point. In this genus we have then the remarkable condition of the foliage leaves, in the adult plant, being developed exclusively in 2–5-membered fascicles on shortened and abortive branches, and as these are perfectly comparable to the spurs in the Larch and Cedar, they may likewise be described as spurs developing 2–5-membered leaf-fascicles. In *Pinus sylvestris*, and a number of other species, there are only two foliage-leaves in the fascicle, and hence it seems convenient to designate such spurs as bifoliar. These "spurs" in *Pinus* fall off bodily after a certain period—from two to five years, according to the species—and, in this, as pointed out by Dr James Stark,* we have an approximation to the condition in many Cupressineæ, where the individual leaves are not shed, but where there is from year to year a shedding of leafy twigs, a phenomenon to which the term *cladoptosis* has been applied. The highest specialisation in branch-development occurring in the order is to be noted in the genera *Sciadopitys* and *Phyllocladus*, where, in the adult state, there are no foliage-leaves at all, the leaves being all reduced to the form of scales, and where the "leaf-function" is performed by green cladodes which are slender and needle-like in *Sciadopitys*, and in the form of flat expansion in *Phyllocladus*. It is to be noted that in *Pinus*, with its development of foliage-leaves exclusively on abortive spurs in the adult condition, the ordinary or unspecialised condition is exhibited in the seedling plant, where we have a development of foliage-leaves scattered on an elongated shoot—a condition which persists throughout life in such genera as *Abies* and *Picea*; and, similarly, we have in the seedling *Sciadopitys* a few genuine foliage-leaves immediately succeeding the cotyledons, although in later life we have the very highly specialised condition above described, where the foliage-leaves entirely disappear.

* "On the Shedding of Branches and Leaves of Coniferæ," by Dr James Stark (with note by Professor Alex. Dickson), *Trans. Roy. Soc. Edin.*, vol. xxvii. pp. 651–59, plate xliv.

The specimen I now exhibit is one which I found in the neighbourhood of Biggar this winter. It is a small branch of *Pinus sylvestris*, the extremity of which has been destroyed—probably broken off. In consequence of this accident a large number of the "bifoliar spurs"—about twenty within a space of 3 inches below the injury—have been stimulated to further development, resulting in the production of a well-marked scaly bud placed between the bases of the two foliage-leaves of the original fascicle. It is further to be noted that the development of these buds is stronger the nearer their position to the seat of injury. In the more feebly stimulated spurs of this kind there is simply a closed scaly bud springing from between the bases of the two leaves of the fascicle; but in the stronger ones, near the seat of injury, the condition is somewhat different. In these the extremity of the spur produced beyond the bases of the two leaves of the fascicle does not immediately produce a closed bud, but before doing so develops a variable number of short but well marked foliage-leaves, and, in the very strongest ones, these foliage-leaves have secondary bifoliar spurs developed in their axils.

Such a specimen is interesting in two ways—1st, as a well-marked case of the development, in consequence of the removal of the extremity of the branch, of lateral buds, which would otherwise have remained more or less dormant—a phenomenon sufficiently familiar to the cultivator in his operations of pruning or "cutting back;" 2nd, as exhibiting, in the stronger buds above-mentioned, a reversion to the early or unspecialised condition in the development of foliage-leaves on the prolonged axis of the stimulated spur.

Abnormal development of this kind in *Pinus* is probably not very uncommon. Many years ago I observed very much the same condition in a branch of Scotch Fir, where the end of the shoot had been destroyed; and Dr Masters, in his *Vegetable Teratology*, gives a figure where he represents the "ordinary arrangement of the leaves in fascicles of three" in *Pinus Pinea*, as contrasted with an "unusual arrangement of leaves of the same plant in spires."* From his figure I should imagine that the abnormality represented was a spur stimulated to further growth, as in my specimen, from which

* *Vegetable Teratology*, p. 86, fig. 41.

the leaves of the original fascicle had fallen off; and it is further to be noted that the spirally-arranged foliage-leaves are of the same character—comparatively short—as in my case.

*Haberlandt's Views on the Physiological Functions of Plant Tissues.** By G. F. Scott Elliot, B.A.

(Read July 9, 1885.)

Each cell in the living plant is, in his view, specially devoted to some primary function, though it may also have one or more minor functions. Thus it is on the principle of division of labour that the morphological differentiation of the plant is based (Schleiden and Nägeli). And the principal object of the paper is to explain the anatomical characters of the tissues by their physiological functions.

He accordingly adopts a classification of the tissues founded on their functions, as follows:—

I. *Skin System*, including epidermis and periderm.

II. *Mechanical.*—Bast (*i.e.*, hard bast), libriform cells, collenchyma and sclerenchyma.

III. *Nutritive Tissues*, divided into—

(1) Absorption tissues (epithelium of roots and root-hairs).

(2) Assimilation system (chlorophyll or palisade parenchyma).

(3) Conduction system (conduction parenchyma and bundles, the parenchymatous sheaths, laticiferous vessels).

(4) Reservation tissues (those tissues which in buds and seeds are devoted to storing material).

(5) Aeration system (intercellular spaces, stomata, and lenticels).

The embryological tissues adopted are—

Protodermis, which corresponds to dermatogen.

Cambium, by which he seems to mean the original meristem cells of the future bundle (Procambium).

Ground parenchyma, *i.e.*, what remains after these two have been deducted.

* Haberlandt, G., *Physiologische Pflanzen Anatomie*, Leipzig, 1884.

The original cambium bundle is distinguished from the peripheral embryonal layer, and the ground parenchyma by its prosenchymatoid cells, with a narrow lumen. It is formed among the primary meristem cells by longitudinal division planes, and the horizontal cross walls of the prismatic cells thus formed become afterwards oblique.

Growth.—Sachs holds that the direction of the new division planes, in the case of a single initial cell, is wholly determined by the form and growth of the embryonal tissue considered as a whole.

Haberlandt goes with much detail into this question, and shows that the initial cell has probably an individual determining influence on the formation of new division planes, especially where these are transverse.

I. *Skin System.*—One of the chief dangers of plant life lies in excessive transpiration of water, which results in death by desiccation, and it is the chief function of the skin system to protect the plant against this transpiration.

Probably it also protects the plant against the effects of excessive illumination in the day time, and radiation of heat by night. Also, in the case of winter buds, abrupt changes of temperature are thus guarded against. It is possible to verify the latter by direct experiment, as has been already done.

(*a*) *Epidermis.*—Treating the epidermis in this sense, it will be seen that the epithelium of the roots and guard cells of the stomata are not included in the skin system.

In the outer wall of the epidermis there is, besides the inner cellulose lamella, a cuticular layer, and there is also the cuticle extending over the whole outer surface (this cuticular layer and the cuticle containing a substance cutin). Now, in water plants there is never any great thickening of these last two layers (sometimes it is nearly absent); while in all land plants it is present, and in plants from dry climates (where the danger of desiccation is great), it is often very pronounced. Hence probably this cutin is the chief protection against desiccation. Many direct experiments have been undertaken to show this; for example, apples from which the epidermis has been removed transpire 55 times as much per hour per square cm., as those in a normal state. The epidermis cells, seen from above, have very often a wavy irregular outline. This may perhaps be due to their affording in this way a longer surface of attachment. One also sees abundant chlorophyll in the guard cells of the stomata, but in the other epidermal cells of the upper leaf-surface it is sparingly present.

Now, the palisade parenchyma lies directly under the epidermis, hence much chlorophyll in the cells above would interfere with the illumination of the palisade parenchyma. Perhaps the convexity upwards of the epidermis cells may also enable them to act as lenses collecting the light on to the underlying palisade parenchyma. The thick coating of hairs on many desert and steppe plants may also prevent transpiration. (It is interesting to compare the leaf of *Populus alba*, which is freely movable in the wind, and has a thick covering of hairs on the under surface, with that of *P. nigra*, which is fixed, and has no hairs.)

(*b*) *Periderm*, or the Phellogen and its products.

Cork.—The chief characteristic of the cork cells lies in the suberin layer, which is not penetrated by the pore canals. This suberin is extremely impermeable for water, gases, and heat. It is also very flexible and elastic. One of its functions is to heal wounds, and the bitter tannin and other principles found in it may help in protecting the plant against insects.

Phellogen.—This consists of thin-walled meristem cells full of protoplasm, which divide tangentially, the outer layer usually becoming cork, while the inner remains as phellogen. Sometimes it also forms chlorophyll parenchyma or *phelloderm*. At first the phellogen is immediately beneath the epidermis. Later, however, it is deeper in position, and the superficial parts thus cut off from it get dried up and form the periderm. This periderm can only be of use as a protecting layer, and the old and functionally useless rind parenchyma subserves the same purpose. It is sometimes thrown off by specially developed separation layers derived from the cork tissue, but without suberin.

(*c*) *Development of the Skin System.*—Epidermis is usually derived from dermatogen, but in the perforated leaves of Arum and Philodendron a perfectly developed epidermis is derived from the ground parenchyma round the holes. The phellogen never appears directly at the growing point.

II. *Mechanical System.*—Algæ require a certain amount of mechanical strength, and this is imparted by the swollen condition of their cells, just as an india-rubber tube filled with water at a high pressure has a considerable rigidity. In higher plants a special tissue (stereom) is found, consisting of bast (*i.e.*, hard bast), the libriform cells (bast-like cells of the wood), the collenchyma, and sclerenchyma.

As regards the different elements in this system—

(1) The *bast* and *libriform cells* show pores arranged in a left-handed spiral, from which we infer that the fibrillæ are also arranged in a left-handed spiral, so that the cells may be considered as a number of small hollow cables dovetailing into one another through their fusiform shape.

(2) The *collenchyma* cells contain living protoplasm, and the thickening is laid down in the corners of the cells. They are therefore specially adapted to growing tissues. It is interesting to note that in the development of typical hard bast, a collenchymatous thickening is laid down in the corners of the cells which is afterwards reabsorbed.

(3) *Sclerenchyma cells,* that is to say parenchymatous mechanical elements, such as the stone cells of many fruits. Their function in many cases is quite uncertain. The direct researches of Schwendener and others, as to the mechanical properties of hard bast, show an enormous capability of bearing weight. In *Pincenectia recurvata* this is equal to that of the best German steel.

One chief object to be attained is a certain rigidity against the bending force of the wind. And just as in a bent piece of iron, the convex side is exposed to tension and the concave to pressure, while there is a central unstrained part; so in the plant one finds the bast elements arranged in bundles towards the periphery, these bundles being united across the centre by weaker parenchyma.

In cylindrical organs (*e.g.*, *Lamium album*) one finds simply two cross girders, or a set of peripheral girders (*Scirpus cœspitosus* and especially *Juncus glaucus*). These peripheral bundles may fuse into a hollow cylinder with the conducting elements embedded in it. In ordinary leaves (*e.g.*, Iris), there is a simple longitudinal girder seen in transverse section. In overhanging leaves (*e.g.*, Typha), the concave part of the girder is cylindrical, and the convex flat and ribbon-like. So far as regards rigidity, there is generally a tendency of the bast to the periphery.

But there is another tendency of the wind besides bending, viz., dragging or tearing a tree out by its roots. And if the bast is at the periphery, any slight irregularity might lead to the breaking of a single string. Hence there is also a development of the bast in the centre. This is especially seen in roots and rhizomes, and also in the tendrils and stems of climbing plants. This arrangement is also the best for supporting the longitudinal pressure from above, due to the weight of the tree.

In *Pandanus odoratissimus* and *Zea Mays* a circle of adventitious roots grow out round the base, which act both as buttresses and anchoring fibres.

A cross section of these roots near the ground shows a strong central development of bast, and an external sub-epidermal hollow cylinder. Perhaps it may be interesting to note, that in the Forth Bridge the girders starting the arches, and which have exactly the same object to fulfil, have the same arrangement of a central mass within a hollow cylinder.

A leaf blade is also exposed to shearing stresses, but these are resisted by the anastomoses of the veins. Sometimes a system of connected veins runs right round the edge, especially in serrate leaves, and a transverse semicircular development of bast round the edge, for the same purpose, is found in many plants.

The mechanical system usually develops from the cambium. If there are separate individual cambium bundles, one bundle may form, as in *Juncus glaucus*, both the hard bast of the exterior and interior part of the mechanical system, as well as the central vaso-parenchymatous portion between the two. So also in Umbelliferæ, both the oil canals and the mechanical bast ribs arise from a common cambium string.

In the case of the scattering of Geranium seeds, and also in the leaves of certain steppe grasses, movements are produced by the bast cells. In the latter case, the outer bast of the leaf consists of two layers. In very dry weather the innermost of these layers contracts, causing the leaves to roll up, and they uncurl when it becomes moister. There are teeth in the upper surface, which press against each other and so protect the more tender tissues.

III. *The Nutritive Tissues*—

(*a*) *Absorption System.*—A special absorption system may be absent, *e.g.*, Algæ. In aquatic plants, and plants with a low transpiring power, *e.g.*, Conifers and Psilotum, a root epithelium is found, but no root hairs. These root hairs have a special function in absorption. It appears most probable, that the nutritive material required for vegetation exists in the form of insoluble salts lying in water in the particles of earth. Now, when a root hair meets one of these particles of earth, it spreads itself out over it, or even curls round it. The membrane of the root hair would be thus in connection with the little drop of water, and the carbonic acid partly due to respiration from the root hair would dissolve the salts. There are many special absorption tissues, *e.g.*, spongy aerial roots of certain tropical orchids. Also, the cells of many mosses, *e.g.*, Sphagnaceæ, mycelia of fungi, and similar mycelia in many parasites (*Thesium pratense*), and saprophytes. A very similar structure is found in the young plant while nourished from the parent.

(*b*) *Assimilation System* consists of those cells whose primary function it is to produce organic matter from carbonic acid and water. The chlorophyll grains are usually of very small size in the higher plants, probably to afford a larger surface compared with their size. They are usually arranged round the sides of the cell, perhaps to allow as much light as possible to pass to the cells below. The palisade cells are usually parallel to the direction of incident light, being elongated in that direction, and this explains why in vertical leaves they are sometimes found pointing obliquely upwards. They may be formed on the lower surface when this is illuminated. A great chemical advantage is gained if the already manufactured products are conducted away as quickly as possible, and this principle seems to have a great influence on the arrangement of the assimilation system.

Three types may be distinguished—

First, Assimilation and conducting tissues in one, as in Mosses.

Secondly, A single conducting system. This includes most Monocotyledons, Pines, and other Conifers.

Thirdly, The ordinary dicotyledonous system, in which the spongy parenchyma connects the assimilating cells with the parenchymatous sheaths round the bundles which conduct the assimilation products away. (This is beautifully seen in *Ficus elastica*).

(c) *Conduction System Proper.*—There are three chief streams always flowing through the plant. The water with salts in solution flowing from the roots utilised as cell sap; and two distinct streams from the leaves directed to all parts, one of them conveying the carbohydrates and asparagin, whilst the other takes the various albuminoids.

He considers that the water from the roots is carried by the vessels and tracheids of the wood, and for this there is the following evidence. Höhnel showed experimentally that there is no communication between the vessels and the intercellular spaces, stomata, or lenticels; Böhm and Höhnel, and especially Volkner, state that the vessels always contain water at night only, and during the day air at a low pressure. Elfving, by means of eosin solution, showed the taking up of fluids by the tracheids; and he also injected melted cocoa butter into the branches of several plants, and found that after cooling it was impossible to inject water by pressure. He points out also the uninterrupted continuity of these vessels from the roots to the leaves, and their much smaller development in aquatic plants. The various thickenings would on this theory be a means of strengthening the tubes, without interfering with the percolation of water out of them. The dotted ducts he considers as mechanical valves which prevent the backflow of the water into the vessels when too much has been drawn from them by the active transpiration during the day.

On the other hand, the carbohydrates and amides are, according to him, conveyed by the parenchymatous sheaths of the smaller vascular bundles to the parenchyma of the nerves, and thence by the woody and medullary parenchyma through the plant.

The albuminoid substances, again, are conducted through the sieve tubes and cambiform cells. These latter contain a parietal layer of finely granular protoplasmic matter, a band of protoplasmic matter, and in the centre a clear fluid with an alkaloid reaction. The strong development of soft bast in an axis of inflorescence or flower stem, accompanied with a vegetative branch of the same thickness in the same plant, may also be noted, and some direct experiments have also been attempted.

The contents of laticiferous vessels are not fully known; but, on the one hand, they contain ferments dissolving albumen as well as albuminoids, also sugars and gums, alkaloids, &c., and, on the other hand, products which may be regarded as effete. From their intimate connection with the conducting tissues and from the way in which they appear to replace the spongy parenchyma and parenchymatous sheaths, he infers that they act chiefly as conducting organs for plastic building materals. Schullerus points out also that the richness of the laticiferous vessels in these substances (plastic building material) is greatest during the active development of the embryo and germination of the seed, and is least in the period of quiescence. Their contents are also thin and watery in etiolated plants. At the same time, however, they do contain useless and effete products.

As regards the different types of vascular bundles, he regards the concentric as the primary, while the radial arrangement of the root is a modification to connect the absorbing root epithelium directly with the vessels, and the arrangement of the leaf bundle similarly connects them with the assimilating tissues.

(*d*) *Reservation Tissues* (Store System).—If a section be made of the endosperm of a seed, a series of curved lines can be seen radiating from the embryo to the surface. The elongated reserve cells of the endosperm lie along these curves, and thus they may act as mechanical supports, while at the same time they afford a constant supply of material to the embryo.

(*e*) *Aeration System*.—The intercellular space increases the surface in the plant which is exposed to air. They are thus specially adapted to transpiration of water vapour, &c., and accordingly show great modifications according to climate and habitat.

For example, the two layers of palisade cells (the cells being rounded) form two systems of intercellular spaces at the corners. In *Hakea suaveolens* these are not in free communication at all points. The intercellular spaces in each of the two layers only communicate with each other at certain points, so that the water vapour has to follow a zigzag and devious course to leave the plant. The stomata show a similar adaptation. In water plants and those not exposed to much transpiration, they are level with or above the surface; while in tropical plants (and on the upper surface only of the leaves of temperate plants), there is a sort of chamber lying below the wind influence, above the stomatic opening, and full of water vapour.

Growth in Thickness of the Stem.—He shows that there is a perfect transition in function between the various elements of the xylem. Thus there are libriform cells, or as he calls them false tracheids, which have dotted canals, and conduct water in addition to their primary mechanical function; thick-walled vessels, which are partly mechanical as well as in his view water canals; also woody parenchyma cells, which are partly mechanical, though their chief function is to convey the carbohydrates; and again vascular fibrous cells (Ersatzfaserzellen), each of which is really a group of woody parenchyma cells, which has not developed septa.

Notes of a Visit to North America, as Delegate to the British Association Meeting at Montreal, and to the American Association at Philadelphia, 1884. By W. Caldwell Crawford.

(Read March 12, 1885.)

(*Abstract.*)

Last summer the Council of this Society appointed the author to be their delegate at these meetings, and his chief object in presenting these notes is to thank the Society for doing him that honour.

I arrived in Canada in the middle of August, landing at Rimouski, on the St Lawrence; and travelling along the railway to Rivière du Loup, I got my first impressions of American vegetation. The sides of the railway track were bright with *Impatiens fulva*, a species not belonging to Europe, although it has established itself here in a few places. I then crossed the St Lawrence, and sailed up that beautiful half river, half fiord—the Saguenay—for a hundred miles or more. Here I made my first acquaintance with Canadian forest scenery. The hills slope right down to the water's edge, and are covered with trees. Here and there is a little village, with a population entirely French. The trees were almost all pines of comparatively small size. It is melancholy to notice here, and all over America the immense tracts of forest which have been destroyed by fire. Frequently one sees the old timber strewing the ground, and almost entirely rotten—the fire having taken place perhaps fifty years ago; above these there is another generation of prostrate trees, comparatively fresh—the fire having occurred ten or twelve years ago; and then there may be a still younger generation, which will in all probability meet the same fate as its predecessors. I mention this destruction of forests, not because of its economic bearings, but because it is in this way that the ground is cleared for a new flora to make its appearance. As the steamer stopped frequently for an hour or so, I had time to go on shore, and I picked up many American plants, amongst them *Osmunda interrupta* and *Onoclea sensibilis.*

Having arrived at Quebec, I walked some miles into the country, and met a number of European plants: the chicory, with its abundant bright blue flowers, reminded me of Germany, also the ox-eye daisy and common Linaria of home. Naturally the sight of familiar plants suggested the question, How did they come there, and displace the native plants? A distinguished naturalist who was with us maintained that these European plants had become stronger in their struggle with cultivation, and were better fitted to survive than others which had grown for ages in countries where the struggle for existence was less severe. As population spreads, the natural vegetation is forced to occupy poorer and poorer ground. But this by no means solves the problem; the clearing of the ground of forests is probably a more important factor. As Asa Gray said later, "it is opportunity, rather than specially acquired vigour, which gives the old world weeds an advantage" over indigenous plants.

At Toronto a friend took me to see the "bush," the bush as it was in prehistoric times uncorrupted by civilisation, and there I saw the important rôle which the Compositæ play in the North American flora. This "bush" was a tract of boggy ground covered with Arbor-vitæ, called cedars in America, from 30 to 60 feet high, hemlock spruces, white birches, and the like. Underneath, the shade was not dense, and we were quite buried in masses of sun-flowers, Gaillardias, and other composites.

After the British Association meeting at Montreal, I went to Philadelphia, and there I had a rare botanical treat. In company with Professor Asa Gray and a number of distinguished American botanists, I visited the Pine Barrens of New Jersey. The flora of this State includes many southern plants brought thither by the Gulf Stream. We collected some forty even at that late season of the year, amongst them the extremely interesting fern *Schizæa pusilla*, a cleistogamous grass—Amphicarpon, an Eriocaulon which wanders as far as the Hebrides, *Drosera filiformis*, Mimosas, and Desmodiums; and my delight was great on finding Sarracenias in great abundance.

Later I visited the prairies in the north-west of Canada and Yellowstone, but the flowers by that time had disappeared. Subsequently I went to California, and paid a visit to the magnificent redwood trees on the coast; and Yosemite, where the flora was most interesting.

Two or three days were spent amongst the vineyards and orangeries of Los Angelos. I never tasted finer outdoor grapes than here; they were muscats. The best for wine making are the ordinary kinds which produce good wine in France.

My visit to the St Gabriel Winery Company I must mention, because it was thoroughly American and representative. It has been only a few years in existence, and it has become the "boss" vinery of the world. All its arrangements were admirable. Fifteen hundred acres were covered with vines. Every acre yields on an average 4 tons, and as grapes were being sold at from $18 to $22 per ton, the gross profit per acre may be put down at from £13 to £15. Chinamen do the work of *vignerons* at a dollar a day. The ground is first ploughed about 18 inches deep, by two ploughings, and the little cuttings are stuck into the soil; there are generally only about 3 per cent. of deaths. Those planted in the previous April looked very vigorous. The contrast between the continental mode of crushing grapes and the American is striking. On the Continent the winepress used from time immemorial is the method adopted, in America they employ a centrifugal machine, which crushes 200 tons a day in the most perfect and cleanly manner. In this single vineyard they have about 6000 tons in a season to crush; hence the necessity for these machines.

On our journey home we passed through Arizona and New Mexico. We crossed a partial desert amongst yuccas for a long way; as it became more arid, we passed thousands of Cacti, frequently 20 feet high, and now and again much more. They looked very strange. Americans are always devising means of developing the natural resources of their great country, and a notion was mentioned to me to turn these enormous Cacti to some useful dollar-producing purpose. Nothing else will grow there in Arizona, so it is proposed to graft vines on these great succulent masses.

The author then summed up the chief differences between the North American and European floras, and the probable causes that have led to these differences. He cannot do better in this abstract than refer to Professor Asa Gray's admirable address "On the Characteristics of the North American Flora," published in the B. A. Report of the Montreal meeting, and in *Nature*, December 1884, as one of the most brilliant contributions to the geographical distribution of plants.*

Obituary Notice of the late T. C. Archer, F.R.S.E., Director of the Museum of Science and Art, Edinburgh. By A. Galletly, Curator.

(Read April 9, 1885.)

Thomas Croxen Archer was born in Northamptonshire in the year 1817, and was educated in London as a surgeon, but does not appear to have practised for more than a few years. He received an appointment in the Import Department of the Customs, at Liverpool, in 1841, and remained in the service for nineteen years. Having a natural taste for botany, he took a special interest in the vegetable products which were brought to that port from all parts of

* See also "Die Florenreiche der Erde," by Dr Oscar Drude, and Petermann's "Mitteilungen," *Ergänzunsheft*, No. 74, 1884.

the world. He formed an extensive collection of Liverpool imports for the Great Exhibition of 1851, and it was this which first brought him into public notice. While other public-spirited men at Liverpool were at a loss to know what to send to the Exhibition, Mr Archer had the shrewdness to see that nothing would show the greatness of the town better than a correctly-named series of specimens of the raw products—mineral, vegetable, and animal—which, at one season or another, were floating in the famous docks on the side of the Mersey.

In 1853 Mr Archer wrote a small volume on *Economic Botany* for the well-known series of popular works on Natural History, published by Reeve & Co., London. It is illustrated with coloured plates by Fitch. This book contains, in small compass, much useful information on the botanical sources of imported fruits, nuts, and oil-seeds; starches and gums; textile fibres; dyeing and tanning materials; building and furniture woods; and some medicinal products. About this time, Mr Archer had a good deal of correspondence with Sir William Hooker, who was then forming the fine Museum of Economic Botany at Kew. A few years later a collection of the same kind, though smaller in scale, was got together by Mr Archer, at an astonishingly small expense, in connection with the Royal Institution, Liverpool. He also took a particular interest in the Botanic Garden of that town, his liking for exotic being stronger than for British botany. He was fond, however, of making botanical excursions to country districts in Lancashire, Cheshire, and North Wales. He was appointed Professor of Botany in Queen's College, Liverpool, in July 1857; but this College does not appear to have been continued as an educational institution for more than a few years afterwards.

Professor Archer was appointed Director of the Edinburgh Museum of Science and Art in May 1860. He brought with him from Liverpool his private collection, which consisted of fully two hundred specimens, chiefly of vegetable products used in the arts. These mainly consisted of the same substances which he had obtained for the collection of imports for the Great Exhibition, most of those of vegetable origin being described in his book.

Mr Archer was elected a resident member of our Society in 1861, and as President in 1862. In March 1863 Mr Archer read before this Society an account of the economical uses of the Carnauba palm (*Copernicia cerifera*), which grows wild in some of the provinces fringing the coast on the east side of Brazil. As this communication was not printed, and as perhaps nowhere else is there to be found a tree which can be employed for so many useful purposes, it may be of some interest to state briefly here what these are. Its roots produce a medicine similar in its nature to sarsaparilla; its stem affords strong and light fibres, and also serves for joints, rafters, and fences; from the core a substitute for cork is got, and the stem also yields a kind of flour, as well as a white liquid similar to the milk of the cocoa-nut; in addition to these, musical instruments and water pipes are made from the stem; the young leaves yield a nutritious vegetable, these also furnish a kind of sago together with a saccharine substance, and from them wine and vinegar are made; the pulp of the fruit has an agreeable taste, and the roasted nut is to some extent used as coffee; another use of the fruit is to feed cattle; mats, hats, baskets, and brooms are made of the straw, which also yields common salt and alkali; and finally, a wax, extensively used in the northern provinces of Brazil for the manufacture of candles, is got from the leaves.

Mr Archer made a short communication to the Society in April 1863, on Guarana, a hardened paste, prepared from the seeds of the *Paullinia sorbilis* (Sapindaceæ), used all over Brazil to make a refreshing beverage and as a medicine for various diseases. This is one of the few substances containing theine.

At the meeting held on the 24th March 1864, he read a few brief notices of some of the vegetable products shown in the London International Exhibition of 1862. Among other objects, he noticed a kind of gutta-percha from Guiana, called "Balata," and obtained from *Sapota Mullieri;* also curious applications of willow wood from Austria, in the shape of coats and other articles of clothing made of plaited and dyed strips of the wood—the coats being sold for a few shillings each. At the third subsequent meeting (June 1864) he gave some account of the manner in which the betel-nut, obtained from the *Areca catechu*, is prepared and used in the East.

In June 1865 he made three communications—one on some galls new to commerce, another on Cape Saffron, and a third on cubebs from South Africa.

On April 12, 1866, he read a short paper on some insects hurtful to forest trees.

Mr Archer made his last communications to this Society on the 12th May 1870. These were Botanical Notes—(1) of a journey through Spain and Portugal, (2) on the Garden of Montserrat, Portugal, and (3) on the Rock of Gibraltar. The sights which most attracted his attention were the forests of evergreen oak, which he at first mistook for olive trees, enlivened, wherever peasants' houses were situated, with herds of black swine feeding on fallen acorns; the brushwood of various species of Cistus, and the bush-like *Euphorbia rupicola* on the plains of La Mancha; the hill forests of Estremadura, with their luxuriant chestnuts and oaks; the large flocks of merino sheep wandering over plains where not a blade of grass was to be seen; and generally, the grand orange and lemon trees, the pomegranate orchards, the olive plantations, and the dwarf palms of Southern Spain. Especially attractive to him was the Botanic Garden of Madrid, with its sunproof plants protecting those of a more tender nature from the scorching heat rays, its blue blossomed hedges of *Plumbago capensis*, its walls covered with the rose-coloured flowers of *Bougainvillea spectabilis*, and its splendid bushes of the beautiful Barbadoes pride (*Poinciana pulcherrima*).

The separate account of Mr Cooke's garden at Montserrat, near Lisbon, shows that it contains, or at least contained, a greater variety of rare plants than any other garden in Europe except Kew; but whereas in the English garden all the treasures are closely packed under glass roofs, at Montserrat they have no covering but the azure sky. In the third communication, he gave a list of plants which he noticed on the Rock of Gibraltar.

Mr Archer formed in 1862 or 1863 a Microscopical Society in Edinburgh, but it was not long kept up. It held, however, a good number of well-attended meetings, at which many interesting microscopic objects were shown.

Among the members were Professor Balfour, Dr Greville, Professor Allman, Mr Dallas, Mr Jenner, Mr Neill Fraser, Mr M'Nab, and Mr Sadler.

Along with Mr Peterson, of the office of Crown Domains, St Petersburg, Professor Archer wrote an elaborate official report on the vegetable substances used in manufactures shown in the International Exhibition of 1862. In this report detailed lists are given of the exhibited woods from several countries, which appear to have been collected and named with skill and care. The Spanish list contains the comparatively large number of 312 indigenous and acclimatised woods. Mr Archer refers to the work of examining the numerous specimens of gums, resins, gutta-percha, and caoutchouc shown, as being particularly laborious. He acted as an Associate Commissioner at the Paris Universal Exhibition of 1867 for the class dealing with Forest Products; and was again at work at the Vienna Universal Exhibition of 1873, and wrote several reports for the British Commission in connection with it.

Professor Archer was British Commissioner, conjointly with Colonel Sandford, at the Philadelphia Exhibition of 1876, and while there, notwithstanding heavy official duties, had some opportunities of studying the botany of the United States. He was much gratified when at Philadelphia with the opportunity, which, as one of the high officials of the Exhibition, he enjoyed, of tasting the native-grown tropical fruits of the Southern States, of the West Indies, and even to some extent those of South America.

Of late years he spent most of his leisure time in his garden, and took great delight in examining any specially fine or interesting plants in conservatories belonging to his friends, as well as in looking over the beds of alpine flowers in their grounds. His death took place on 19th February 1885.

In private life Mr Archer was much esteemed by his associates. He had attractive powers of conversation, had travelled much, and was altogether a very entertaining companion. In his official work he was very active and energetic, and did everything he could to extend the usefulness of the Museum; but at the same time he was considerate and kind to his subordinates, and solicitous at all times for their welfare.

Notes on the Grasses of the Southern Punjab. By W. Coldstream, B.A., H.M. Bengal Civil Service.

(Read 9th July 1885.)

(*Abstract.*)

The tract of country described in the paper is that which, till the occurrence of recent administrative changes, constituted the Hissar division. It stretches from near Delhi westward to the Sutlej River to the confines of Multan and Bahwalpur; there are large sandy areas in this tract, which, however, is in parts watered by the Western Jumna Canal, and the stream of the Gaggar. The soil is prolific in the rainy season, which is the time of growth of the principal harvest. The country is on the whole very dry, hot, and sandy. Rainfall varies from 12½ to 20 inches. Some of the principal trees are *Acacia arabica* (native name, Keekur), *A. leucophlœa* (native name, Ronj), *Tecoma undulata* (native name, Rohira), which has large showy orange-coloured blossoms, and grows wild even in the barren and sandy tracts; *Prosopis spicigera* (Jhand), *Capparis aphylla* (Karil), *Salvadora oleoides* (Jāl), and on the banks of streams and canals the valuable *Dalbergia sissu* (Sheesham wood), a congener of the Bombay blackwood. The principal crops are *Sorghum vulgare* (Jowar), and *Penicillaria spicata* (Baijra). These form the staple food of the people. But wheat, gram (*Cicer arietinum*), and on the fertile spots sugar-cane, are also grown in considerable quantities. The unripe sorghum plant is said to be occasionally poisonous to cattle in seasons of drought. The crops sometimes grow on sandhills and wonderfully unpromising-looking soil. The farmer often dreads too heavy a rainfall, because it is apt to wash his crop out of the soft and sloping ground of the sandhill. The wild grasses are numerous, and, as this is a pastoral region, their nutritious qualities as fodder render them a peculiarly valuable natural product. For months in the year the cattle are largely dependent on the produce of the uncultivated grass lands. The breed of cattle is famous. The region is very liable to scarcity and fodder famines, owing to partial or entire failure of the rains. The mitigation of distress at such times, by attention to fodder supply, is one of the practical questions which are engaging the attention of the Agricultural Department of the Government of India. That this is an eminently practical question is proved by the fact that, in the cold season of 1877–78, about 480,000 head of stock, including bullocks, cows, buffaloes, camels, sheep, and goats, are estimated to have died. The questions of stacking, ensilage, arboriculture, and the supply of arboreal fodder, have yet to be studied. Stacks of sorghum and millet keep well; but the natives do not stack grass, though the officers of the Hissar cattle farm do; and it is found that the hay keeps well for five or six years, or even longer. Nor do the natives sow grass; all the grass fodder which is consumed is what grows wild in the uncultivated areas. Much might be done to keep the cattle alive in times of scarcity by stacking fodder in large quantities. The recent remark of Sir Alfred Lyall, Lieut.-Governor of the North-West Provinces, holds good for this region, that "a large number of cattle die every year because their owners take no trouble to keep them alive."

Some of the most interesting grasses of the region are the following, the native names being given in parenthesis:—

Cynodon Dactylon (Dūb).—Makes into good turf for lawns, and is much eaten by horses. The grass is stubbed up from the roots, and given to horses.

Andropogon pertusus (Palwa).—Especially relished by buffaloes.

Sporobolus tenacissimus (Kheo).—Particularly good for horses.

Heteropogon contortus (Sarwāla).

Panicum colonum (Sanwak).—Its grain is collected and sold in the bazaars for making bread.

Panicum helopus (Kuri).

Elionurus hirsutus (Sín, or Sewan).

Eleusine flagelliflora (Ghantil).

Eleusine ægyptiaca (Bhobra).—One of the most nutritious grasses; seeds eaten in seasons of scarcity.

Pennisetum cenchroides and *Cenchrus montanus* (both called Anjan and Dáhman).—These grasses are considered the most nutritious of all.

Andropogon laniger (Bûr, or Khawi).—A nutritious and fragrant grass; imparts an aroma to the milk of cattle eating it.

Sorghum halepense (Barú).—The wild sorghum or jowar. When eaten in a season of drought before its grain is developed, this is said to be sometimes fatal to cattle; but at other times it is a nutritious grass grain, much eaten by the poorer classes in Bikaner.

Andropogon muricatus (Panni).—The principal thatching grass of the Punjab. Its root forms the scented khas-khas used for lattices or damp screens.

Elionurus hirsutus (Sin or Shin).—Seed collected and eaten by the people of Rajputana. It is the grass (along with a few others) whose grazing qualities give the grazing grounds of Bikaner their high character. Called Cusa in Hindu mythology.

Elionurus hirsutus (Bhurat).—A grass very common in the Bikaner territory and elsewhere; seeds eaten mixed with baijra flour.

The first eight are said to stack well. If thoroughly protected from rain, stacked grass will last in the climate of Hissar for a long period—some species for ten, twelve, and even twenty years; it seems, in fact, when properly dried and protected, to be nearly imperishable.

MISCELLANEOUS CONTRIBUTIONS AND EXHIBITIONS.

SESSION 1884–85.

November 13, 1884.

On the motion of Mr S. Grieve, a committee was appointed to inquire into the best means of conducting a Botanical Camp, and also as to the advisability of the Botanical Society either hiring or acquiring camp materials for the use of its members. Mr Grieve was appointed convener.

Exhibition and accompanying note by A. P. Aitken, M.A., D.Sc., on *Astragalus mollissimus*. This plant, communicated by a friend from Northern Texas, U.S., is called by the Mexicans "Loco," *i.e.*, "crazy." It is often greedily eaten by horses and cattle, the effect produced being similar to that resulting from excessive opium eating by man. The horse, "becoming dazed, stupid, and crazy," gets thin and dies. An instance was given where, on one ranche, 100 out of 160 horses were lost through its effects.

Exhibition of a cluster of flowers of *Lapageria alba*, by Dr Paterson, Bridge of Allan.

Mr Lindsay exhibited a large quantity of seeds of Japanese trees and shrubs, presented through Dr Cleghorn to the Royal Botanic Garden, by the kindness of the Japanese Commissioners, to the International Forestry Exhibition.

Mr John Campbell of Ledaig sent flowers in bloom, gathered in his garden on the day previous to the meeting.

December 11.

After the election of Office-Bearers, the Society resolved to award Mr A. Taylor, F.C.S., who had retired from the office of Assistant Secretary, a cordial vote of thanks for his valuable honorary services during the past five years, and also a honorarium of twenty guineas.

Mr J. Rattray, M.A., B.Sc., exhibited and described specimens of "Abnormal Capitula of *Chrysanthemum leucanthemum*," from Misses Whyte and Kidd, Dundee. In all the specimens exhibited, the capitula had assumed the form of a cycloid inserted at right angles to the more or less flattened peduncle, the long corollas of the ligulate florets thus growing parallel to, instead of out from, the extremity of the peduncle. In one an incomplete secondary capitulum had originated from its side.

January 8, 1885.

A note was communicated from Miss Owen, Gorey, Ireland, "On the Occurrence of *Pythium de Baryanum* on the Roots of Dahlias." The fungus at first appeared as brown patches, which gradually spread into the substance of the tuber. When microscopically examined, it was identified by Mr Worthington Smith as the above form. It was noticed that the cells invaded by the fungus hyphæ were filled with bodies exactly resembling sphere crystals of inulin, while those in the normal condition had liquid contents.

Saprolegnia.—Dr Macfarlane exhibited and described specimens of a Saprolegnia from the body of a blackbird found floating in a water-cistern. The fungoid growth on the submerged part of the body was wholly zoogonidial, while the portion immediately above water was oogonidial. From several experiments subsequently made, he considered that the presence of the two generations under the above conditions was frequent. He drew attention also to the excellent results obtained by preserving such fungi in chrom-acetic acid, the microscopic appearances remaining as in the fresh state.

Nepenthes, &c.—Dr Macfarlane exhibited pitchers of Nepenthes and *Heliamphora nutans*, received from Messrs Burbidge and Veitch. The Nepenthes included *N. villosa, Edwardsiana, Harryana, Rajah, sanguinea, Northiana, cincta, Lowii*, and *bicalcarata*. He mentioned that in *N. Lowii* the digestive glands at the bottom of the pitcher were so large and densely arranged as to resemble a piece of shagreen. In *Heliamphora nutans* he pointed out a very striking resemblance in the young state to pitchers of *Sarracenia rubra*, this being departed from more and more as the pitchers became older.

March 12.

A report was submitted by Mr S. Grieve, as convener of the Camp Committee, in which it was proposed that the Society should institute a Botanical Camp this year. The report was approved.

Mr E. M. Holmes, F.L.S., sent for exhibition specimens of two rare British Mosses, identified by him as *Pottia cæspitosa* and *Thuidium abietinum.*

Specimens of white and parti-coloured ling (*Calluna vulgaris*) were exhibited from Mr Wolfe Murray of Cringletie, and Mr Watson, Snaip.

Dr Macfarlane exhibited and remarked upon the inflorescence and pitchers of various species of Nepenthes received from Messrs Courtauld and Veitch.

April 9.

The following motion, which had been intimated by Dr Craig at a previous meeting, was unanimously agreed to by the Fellows:— "That in the rules relating to the election of Office-Bearers, the word November be substituted for December."

Mr A. Taylor read "A note on *Sanseviera longifolia*," plants of which had been raised from seeds sent to the Edinburgh Botanic Garden by Mr John Buchanan of Blantyre, East Africa.

"Exhibition of Photographs of Botanical interest taken during the voyage of H.M.'s exploring Ship 'Challenger,'" by Hugh Cleghorn, M.D., LL.D.

Mr Mark King exhibited a double-spathed variety of *Richardia æthiopica*.

May 14.

Mr Lindsay read a note from Mr M. Dunn, Dalkeith Palace Gardens, on temperature and progress of vegetation in that locality, at the same time exhibiting a fine specimen of the Morell (*Morchella esculenta*) from that gentleman.

Dr Foulis exhibited a new lantern arrangement for demonstrating botanical microscopic objects.

A white variety of *Gentiana verna* was exhibited by Professor Dickson, found by him in Teesdale, while with the Scottish Alpine Botanical Club.

June 11.

Mr A. Taylor read a note on the Prairie grasses of Manitoba, and exhibited specimens of these presented to the Herbarium by Mr L. Bonny, Winnipeg. The names of these, as determined by Dr W. Watson, are—*Calamagrostis canadensis, Aira cæspitosa, Triticum caninum, Elymus striatus, Glyceria poa.*

Dr Buchanan White sent the following note :—

"I wish to exhibit, on behalf of Mr James Brebner, of Dundee, Fellow of the Society, the accompanying specimens of a plant which he gathered in the neighbourhood of Loch Tummel, Perthshire, in July last, and which I have recently identified as *Schœnus ferrugineus*, C., a species which has not hitherto been recorded as British. *S. ferrugineus* can be readily distinguished from the allied *S. nigricans* by being smaller in all its parts, by the shorter and more erect lower bract, fewer spikelets (usually two, but often only one), and glumes smooth or almost smooth on the back. From its European distribution it was not unlikely to occur in Britain, and will probably occur elsewhere in Scotland if looked for."

Professor Babington sent a note correcting an error in the last Part of the *Transactions*, where Mr Evans is stated to have exhibited "*Viola stagnina*, new to Britain" (p. 165, line 14). Professor Babington states—"It was given by me as a British plant in the *Manual*, 3rd ed., p. 36, 1851. I gathered it in Bottisham Fen in 1829, but we then confounded it with *V. lactea* (Sm.), our present *V. canina β lancifolia.* Henslow published it under the name of *V. lactea*, in his *Catalogue of British Plants*, 2nd ed., 1835, as a native of Cambridgeshire."

Mr Dunn, Dalkeith Palace Gardens, exhibited a branch of

Eucalyptus globulus with flower-buds, from a plant in the open air at Dalkeith Gardens.

Mr Lindsay drew attention to a flower of *Phyllocactus anguliger*, which was sent to the meeting from the gardens at Trinity Grove, and to a plant of *Iris iberica*, from Mr Munro, Abercorn Nursery, Piershill; and to various interesting plants in flower from the Botanic Garden, among which were the following:—

Androsace foliosa.
Allium karataviense.
Arisæma triphylla.
Dianthus glacialis.
  hybrid from neglectus.
Delphinium brunonianum.
Polygonum affine var. Brunonia.
Primula prolifera.
Primula floribunda.
  capitata.
Platystemma violoides.
Silene quadridentata.
Myosotis alpestris.
Saxifraga odontophylla.
  cæsia.
  squarrosa.
Linaria origanifolia, &c.

Mr P. Neill Fraser exhibited from his garden at Murrayfield—A large variety of blooms of hybrid creeping Phloxes and flowering bulbs of *Bellevalia* (*Muscari*) *romana*, figured in Curtis' *Botanical Magazine*, vol. xx. pl. 939, but apparently rare in cultivation in this country now.

"On the Germination of Ruscus, Myrsiphyllum, and Asparagus." Professor Dickson exhibited seedling plants of Ruscus, Myrsiphyllum, and Asparagus, chiefly in illustration of the postscript to his paper on *R. androgynus*, published in the last Part of the Society's *Transactions*. Since that date the seedlings of *R. racemosus* had each produced (as was anticipated) a well-developed foliage-leaf of somewhat similar character to those produced in *R. androgynus*. In neither *R. aculeatus*, nor Myrsiphyllum, nor Asparagus, was there any trace of foliage-leaves.

Professor Dickson also exhibited seedling plants of the remarkable South African plant, *Bowiea volubilis*, where in the adult condition the leaves are all reduced to small scales, and the leaf function is performed by the green tendril-like branches. In the seedling condition, however, there are developed true foliage-leaves, elongated, linear, channelled on the upper surface, and semi-cylindrical on the lower. For detection of this case Professor Dickson said botanists were indebted to Mr George Oliver, one of the foremen in the Royal Botanic Garden.

July 9.

Mr S. Grieve intimated that the use of Invermerran Farm House, at the head of Glen Lyon, had been kindly granted by Mr Bullough, the proprietor, with consent of Mr Lindsay the tenant, for the use of the Botanical Camp in the end of July and August.

Professor Dickson exhibited and described a monstrous Foxglove, from Mr W. B. Simpson, Dundee.

OFFICE-BEARERS.

At the General Meeting held on Thursday, 11th December 1884, the following Office-Bearers for 1884–85 were elected:—

PRESIDENT.

Professor Dickson, M.D., F.R.S.E.

VICE-PRESIDENTS.

Robert Gray, F.R.S.E.
William Craig, M.D., C.M., F.R.C.S.E., F.R.S.E.
William B. Boyd of Faldonside.
Thomas Alexander Goldie Balfour, M.D., F.R.C.P.E., F.R.S.E.

COUNCILLORS.

Charles Jenner, F.R.S.E.
Alexander Buchan, A.M., F.R.S.E.
Hugh Cleghorn, M.D., F.R.S.E.
Rev. John Macmurtrie, M.A.
Robert Lindsay.
Patrick Geddes, F.R.S.E.
Symington Grieve.
Andrew Taylor, F.C.S.
William Sanderson.
Rev. J. M. Robertson, M.A.

Honorary Secretary—Professor Douglas Maclagan, M.D., F.R.S.E.
Honorary Curator—The Professor of Botany.
Foreign Secretary—Andrew P. Aitken, M.A., Sc.D.
Honorary Treasurer—Patrick Neill Fraser.
Assistant-Secretary—John M. Macfarlane, D.Sc.

LOCAL SECRETARIES.

Aberdeen—Stephen A. Wilson of North Kinmundy.
Berwick—Philip W. Maclagan, M.D.
Birmingham—George A. Panton, F.L.S., 95 Colmore Row.
Calcutta—John Anderson, M.D., F.L.S.
,, George King, M.D., Botanic Garden.
Cambridge—Charles C. Babington, M.A., F.R.S., Professor of Botany.
,, Arthur Evans, M.A.
Dublin—W. R. M'Nab, M.D., F.L.S., Professor of Botany, Roy. Col. Science.
Dumfries—James Gilchrist, M.D.
Exeter—Thomas Shapter, M.D.
Fife—J. T. Boswell, LL.D., F.L.S., of Balmuto, Kirkcaldy.
Greenock—Donald M'Raild, M.D.
Kilbarchan—Rev. G. Alison.
London—William Carruthers, F.R.S., F.L.S., British Museum.
London, Brixton—John Archibald, M.B., C.M., F.R.C.S.E.
Manchester—Benjamin Carrington, M.D., Eccles.
Melbourne, Australia—Baron Ferdinand von Mueller, M.D.

Nairn—WILLIAM ALEX. STABLES.
Norfolk—JOHN LOWE, M.D., King's Lynn.
Nova Scotia—GEORGE LAWSON, LL.D., Dalhousie.
Ottawa, Ontario—W. R. RIDDELL, B.Sc., B.A., Prov. Normal School.
Oxford—Professor BAYLEY BALFOUR.
Perth—F. B. WHITE, M.D., F.L.S.
Saharunpore, India—J. F. DUTHIE, B.A., F.L.S., Botanic Garden.
Shrewsbury—Rev. W. A. LEIGHTON, B.A., F.L.S.
Silloth—JOHN LEITCH, M.B., C.M.
Wellington, New Zealand—JAMES HECTOR, M.D., F.R.SS. L. & E.
Wolverhampton—JOHN FRASER, M.A., M.D.
Zanzibar—Sir JOHN KIRK, M.D., F.L.S.

Fellows elected, Session 1884–85.

1884.

Nov. 13. G. A. HOLT, Strangeways, Manchester, *Non-Res. Fellow.*
JOHN ALEXANDER, Anuradhapura, Ceylon, *Non-Res. Fellow.*

Dec. 11. JOHN ALLAN, Rosefield, Portobello, *Res. Fellow.*
C. WATSON, The Clouds, Duns, *Res. Fellow.*

1885.

May 14. G. BURN MURDOCH, M.B. C.M., Edinburgh, *Res. Fellow.*
A. D. WEBSTER, Penrhyn, *Non-Res. Fellow.*

July 9. J. FOULIS, M.D., F.R.C.P.E., Edinburgh, *Res. Fellow.*
D'ARCY W. THOMPSON, B.A., Dundee, *Res. Fellow.*
PETER MACEWAN, Edinburgh, *Res. Fellow.*

ADDITIONS

TO THE

LIBRARY, HERBARIUM, AND MUSEUM,

AT THE

ROYAL BOTANIC GARDEN, EDINBURGH,

FROM 1ST OCTOBER 1884 TO 1ST OCTOBER 1885.

LIBRARY.

BOOKS.

AGARDH, J. G. Till Algernes Systematik. VII. Florideæ.—*From the Author.*

BALFOUR, J. H. Plants of the Bible. New edit. 1885.—*From Miss Balfour.*

BECKER, GEO. F. Geology of the Comstock Lode and the Wahoe District.—*From the U.S. Survey Director.*

BOISSIER, ED. Flora Orientalis. 5 vols.—*From the Author.*

CURTIS, JOSEPH S. Silver-Lead Deposits of Eureka, Nevada.—*From the U.S. Survey Director.*

DON, GEORGE. The Gardeners' Dictionary. 4 vols.—*From Thomas Walker, Esq., Carluke.*

FONTAINE, WILLIAM M. Contributions to the Knowledge of the Older Mesozoic Flora of Virginia.—*From the U.S. Survey Director.*

HENNEDY, ROGER. The Clydesdale Flora.—*From A. Somerville, Esq., B.Sc., F.L.S.*

HOFFMANN, Dr H. Resultate der wichtigsten pflanzen-phänologischen Beobachtungen in Europa.—*From the Author.*

HOFFMANN and IHNE. Beiträge zur Phänologie.—*From the Authors.*

HOOKER, Sir J. D. Flora of British India. Vol. IV. Part 3.—*From the India Office.*

IRVING, ROLAND D. The Copper-Bearing Rocks of Lake Superior.—*From the U.S. Survey Director.*

KINGSTON, QUEEN'S COLLEGE. Calendar of the College. 1885.—*From the Trustees.*

LORD, ELIOT. Comstock Mining and Miners.—*From the U.S. Survey Director.*

Millardet, Prof. A. Histoire des Principales Variétés et Espèces de Vignes d'origine américane qui resistent au Phylloxera.—*From the Author.*

Mueller, Baron Ferd. von. Eucalyptographia, 10th decade, and systematic census.—*From the Author.*

Schübeler, Dr F. C. Vœxtlivet i Norge med Sœrligt hensyn til Plantegeographien.—*From the Author.*

Walcot, Charles D. Palæontology of Eureka District.—*From the U.S. Survey Director.*

PAMPHLETS, REPRINTS FROM SCIENTIFIC PUBLICATIONS, &c.

Blytt, A. Clastoderma de Baryanum.

——— Om vexellagring og dens mulige betydning for tidsregningen i geologien og lœren om arternes forandringer.

——— Bidrag til Kundshaben om Norges Soparter.—*From the Author.*

Bornet, Ed. Algues de Madagascar recoltées, par Ch. Thiebaut.

——— Note sur le genre *Aulosira.*—*From the Author.*

Clos, M. D. Contributions a la Morphologie du Calice.—*From the Author.*

Cohn, Dr Ferd. Heinreich Robert Göppert als Naturforscher.

——— Bericht über die Thätigkeit der botanischen Section der Schlesischen Gesellschaft im Jahre 1884.—*From the Author.*

Fawcett, J. Seventh Annual Report of the Dulwich College Science Society.—*From the Society.*

Foslie, M. Om nogle nye arctiske havalger.

——— Bidrag til Kundskab om de til gruppen Digitatœ horende Laminarier.—*From the Author.*

Gay, Fr. Note sur les Conjuguées du Midi de la France.—*From the Author.*

Hoffmann, Prof. H. Phänologische Studien.

——— Phänologische Beobachtungen.—*From the Author.*

Lawson, G., Ph.D. Revision of the Canadian *Ranunculaceæ.*—*From the Author.*

M'Rae, J. G. Report of the Bombay Forest Department for 1883–84.—*From the India Office.*

Mueller, Baron Ferd. Systematic Census of Australian Plants. 1st Annual Supplement.—*From the Author.*

Putnam, Charles E. Elephant Pipes in the Museum of the Academy of Natural Sciences, Davenport, Iowa.—*From the Author.*

Ribbentrop, B. Review of Forest Administration in British India, 1883–84.—*From the India Office.*

Rodrigues, J. Barbosa. *Esterhazya superba.* Especie nova da Familia das Scrophulariaceas.—*From the Author.*

Schomburgk, R., Ph.D. Report on Botanic Garden and Government Plantations, Adelaide, South Australia, for 1884.—*From the Author.*

SELWYN, A. R. C., LL.D., and G. M. DAWSON, D.Sc. Descriptive Sketch of the Physical Geography and Geology of Canada.—*From the Authors.*

WILKINSON, W. H. Notes on the Flora of North America.—*From the Author.*

WILLE, N. Bidrag til Kundskaben om Norges Ferskvandsalger.

——— Om en ny endophytisk Alge.—*From the Author.*

WALKER and GAMBLE. Report of Madras Forest Department for 1883–84.—*From the India Office.*

TRANSACTIONS, &c., OF LEARNED SOCIETIES, AND KINDRED INSTITUTIONS.

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BELFAST.—Natural and Philosophical Society.
Proceedings for Session 1884–85.—*From the Society.*

BERLIN.—Botanischer Verein fur die Provinz Brandenburg.
Verhandlungen. Nos. XXV., XXVI.—*From the Society.*

BERNE.—Société Helvétique des Sciences Naturelles.
Mittheilungen. Heft. 1 and 2, 1884.—*From the Society.*

BERWICK.—Berwickshire Naturalists' Club.
Proceedings, Vol. X. No. 3.—*From the Club.*

BONN.—Naturhistorischer Vereine der Preussischen, Rheinlande, und Westfalens. First Part. 1885.
Autoren- und Sachregister.—*From the Society.*

BOSTON.—Massachussetts Horticultural Society.
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Memoirs. Vol. III. Nos. 8–11.—*From the Society.*

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Abhandl. Bd. IX. Heft. 2.—*From the Society.*

BRISBANE.—Royal Society of Queensland.
Proceedings. Vol. I. Parts 2, 3, 4.—*From the Society.*

BRUSSELS.—L'Académie Royale des Sciences de Belgique.
Bulletins de l'Académie. Ser. III. Tomes VI., VII., VIII.
Annuaires. 1884, 1885.—*From the Academy.*

BRUSSELS.—Société Royale de Botanique de Belgique.
Bulletin XXIII., XXIV. Fasc. 1.—*From the Society.*

CHERBOURG.—Société Nationale des Sciences de Cherbourg.
Memoirs. Tome XXIV.
Catalogue de la Bibliothéque. 1883.—*From the Society.*

CINCINNATI.—Society of Natural History.
Vol. VII. No. 4; Vol. VIII. Nos. 1, 2, 3.

COPENHAGEN.—Botaniske Forening i Kobenhavn.
Botaniske Tidsskrift (Journal de Botanique). Series III. Vol. XIV. Liv. 3 and 4.—*From the Society.*

DUBLIN.—Royal Society.
Transactions. Vol. III. Parts 4 and 6.
Proceedings. Vol. IV. Parts 5 and 6.

EDINBURGH.—Botanical Society.
Transactions and Proceedings. Vol. XV. Part 2. XVI. Part 1.—*From the Society.*

——— Geological Society.
Transactions. Vol. IV. Part 3; Vol. V. Part 1.—*From the Society*

Royal Physical Society.
Proceedings. Sessions 1883-84, 1884-85.—*From the Society.*

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Transactions. Vol. XI. Part 2.—*From the Society.*

ERLANGEN.—Physikalisch Medicinischen Societät zu Erlangen. Heft. 16. 1882-83.—*From the Society.*

GLASGOW.—Natural History Society.
Proceedings. Vol. I. New Ser., Parts 1 and 3.—*From the Society.*

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HAARLEM.—Bevordering van Nijverheid.
Tijdschrift. Deel. IX.—*From the Society.*
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HALLE.—Kais. Leop. Carol. Deutsche Akad. der Naturforscher.
Nova Acta. Band XLVII. No. 4.—*From the Society.*
Leopoldina, Part 20.

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Vol. III. Parts 3-6.—*From the Society.*

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Schriften. 1884, Part 1; 1885, Part 2.—*From the Society.*

LIÈGE.—La Belgique Horticole, Annale de Botanique et d'Horticulture. Par Dr Edouard Morren, 1883, 1884.—*From the Editor.*

LIVERPOOL.—Literary and Philosophical Society of Liverpool.
Proceedings. Vol. XXXVIII.—*From the Society.*

LONDON.—India Office—Forest Department.
Report of Government Botanical Gardens at Saharunpur and Mussoorie for 1885.—*From the India Office.*

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Journal. Nos. 136-139.
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List of Linnean Society, 1884-1885.—*From the Society.*

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Calendar, 1885, 1886.—*From the Society.*

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Manchester.—The Botanical Record Club.
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Literary and Philosophical Society.
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Transactions. Vol. VIII. Part 1.—*From the Club.*

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Comptes rendus. Tom. XXXI. 6, 7; Tom. XXXII. 1–6.
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Proceedings. Vol. I. Part 5. 1884–85.

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Proceedings. Parts 1–3, 1885.—*From the Academy.*

Plymouth.—Plymouth Institution and Devon and Cornwall Natural History Society.
Transactions. Vol. IX. Part 1.—*From the Society.*

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Journal and Proceedings. Vols. XVII. and XVIII.—*From the Society.*

San Francisco.—California Academy of Sciences.
Bulletin. Nos. 1, 2, and 3.

Toronto.—Canadian Institute. The Canadian Journal of Science, Literature, and History. Vol. III. Nos. 1, 2.—*From the Society.*

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Report of Board of Regents, 1883.—*From the Institute.*

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Transactions and Proceedings. Vol. XVII.—*From the Institute.*

Nineteenth Annual Report of Colonial Museum and Laboratory.—*From Director.*

PERIODICALS.

Grevillea. Edited by Dr M. C. Cooke. Nos. 68, 69.—*Purchased.*

The Journal of Botany. Nos. 268–273.—*Purchased.*

The Journal of Forestry.—*From the Proprietors.*

Nature. Nos. 790–830.—*From the Editor.*

The Scottish Naturalist. Edited by Dr F. B. White. No. 7.—*From Perthshire Society of Natural Science.*

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HOLMES, E. M., F.L.S. Three specimens of rare British Mosses.

KEW HERBARIUM. Algæ of the Robert Brown Australian Collection.

SOMERVILLE, A., B.Sc., F.L.S. Three rare British Plants from new localities.

Mr WOLFE MURRAY and Mr WATSON. Parti-coloured and white specimens of the common Ling (*Calluna vulgaris*).

M'NAB, JAMES, Philadelphia. Specimen of American species of Dodder (*Cuscuta*).

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TRANSACTIONS AND PROCEEDINGS

OF THE

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TRANSACTIONS

OF THE

BOTANICAL SOCIETY.

SESSION L.

10th December 1885.—Professor DICKSON, President, in the Chair.

The PRESIDENT briefly reviewed the work of the past year, and congratulated the Society on the state of its finances, notwithstanding the expenditure incurred in connection with Dr Spruce's valuable Monograph on South American Hepaticæ, the publication of which is a just source of satisfaction.

During the summer of 1885 the Camp Committee, by the kind permission of John Bullough, Esq., of Meggernie Castle, explored the upper part of Glenlyon, where they made important collections, which would ere long be laid before the Society. The best thanks of the Fellows were due to Mr Symington Grieve for the energetic way in which he had organised our "new departure" in this direction.

The Council entered on negotiations as to the purchase of the botanical library of the late Mr Anderson-Henry, but withdrew therefrom, a private purchaser having offered to the trustees a larger sum for the library than it was considered proper to ask the Government to advance.

As regarded the ordinary business of the Society, various important communications had been submitted.

The Rev. David Landsborough gave the result of his experiments on the cultivation of Australian and New Zealand plants on the east coast of Arran; and a second communication would be made by him that evening.

The Society had had three valuable papers from Mr John Rattray—1st, "On the Geographical Distribution of Algæ in the Firth of Forth," in which he dealt with the relation of the distribution of different types to different bathymetrical conditions, varying illumination, &c.; 2nd, "On some New Cases of Epiphytism among Algæ;" and 3rd, "Preliminary Note on the Evolution of Oxygen by Sea-Weeds."

A short, though important, note was communicated by Professor T. R. Fraser on *Strophanthus hispidus*, a plant which promises in his hands to yield a most valuable remedy in cardiac affections. And, in this connection, reference was made to the pleasure experienced by the Fellows on receiving a communication, in person, from Mr John Buchanan of Blantyre, Central Africa, to whom the Society, the Botanic Garden, and Professor Fraser himself have been indebted for much valuable material.

A communication was made by Mr William Coldstream on the important subject of the Fodder-Grasses of India.

Mr Scott-Elliot furnished a careful resumé of Haberlandt's views on the physiological functions of plant tissues. Such resumés were of great importance, and it was well to remind the younger members that the presentation of such communications is one of the original objects of the Society, as laid down in its constitution.

During the past year the Society had had to deplore the loss of some well-known and highly-esteemed Fellows, viz., the Earl of Selkirk, Mr W. W. Evans, Mr Alexander Croall, Mr James F. Robinson, Mr James Welsh, Edmond Bossier and Dr W. B. Carpenter. Of these obituary notices would ere long appear; but it was impossible to refrain from special reference to the great loss which had been sustained by the Society and the whole scientific world in the very unexpected death of Dr W. B. Carpenter, whose accomplishments in almost all the departments of natural science may be said to have been unrivalled.

The President then made some special observations on certain points in the morphology of *Frullania* and other leafy Jungermannieæ. [These observations appear as a separate paper in the *Transactions.*]

Obituary Notice of William Benjamin Carpenter, C.B., M.D., LL.D., F.R.S. By ANDREW TAYLOR.

WILLIAM BENJAMIN CARPENTER died from the result of an accident, at the age of 72, on November 10, 1885. At the meeting of the British Association in Aberdeen during the previous autumn, some of our older members were struck by the untiring energy he displayed, which, indeed, was almost equal to that manifested during our Society's first year of life, in 1836, when he was a conspicuous contributor of papers.

W. B. Carpenter, fourth child and eldest son of Dr Lant Carpenter, an eminent Unitarian minister, was born at Exeter in 1813. On removing to Bristol, the father added to his pastoral duties the instruction of twelve youths together with his own family, and the world has had practical results of this training. Mary Carpenter, the champion of destitute and criminal children, was the eldest of the family, and soon became the special friend and mentor of the future physiologist. Dr James Martineau, who was a pupil with William Carpenter, when both had ideas of being civil engineers, gratefully speaks of the influence on their budding boyhood of the sedate little girl who looked at you so steadily, and always spoke like a book. The instruction given covered successive courses of geology, natural philosophy, and chemistry, with illustrative specimens, diagrams, and experiments. Mrs Carpenter's instructions in geography, given with very admirable detail, made Martineau, previously only a classicist, write—"I never can forget the shame I felt on discovering at Bristol the depths of my ignorance of the natural world and of modern times." At least two other names, besides those just given, have become noted from this home school; I only mention Dr Philip Pearsall Carpenter, B.A., Ph.D., who died at Montreal in 1877. William B. Carpenter began his career of educationalist at twelve, for, like others of the family, he taught while he learned. He thus early began to form that clear literary style so characteristic of his scientific treatises; and he never throughout life laid aside the vocation of an enthusiastic educator. Though pre-eminently a specialist, he never lost his zest for polite literature and art, along with the pressing public questions of the day. Mary Carpenter could still recuperate her energies, fagged with reformatory worries, in the serene fields of natural science; and so William kept an even-balanced mind by alternating university business details with excursions into microscopy or the like. But above all there stood manifest in his life turmoil a puritanic devotion to duty, as well as reverence for the written Word of God. The intellectual society of Bristol had a powerful influence in the development of the young scientist. Meeting such celebrities as Conybeare, De la Beche, and Prichard, who often visited his father's house on matters pertaining to the then young Literary and Philosophical Society of the city, or Sedgwick, Buckland, and Philips, during a British Association meeting in its precincts, the spark of enthusiasm was kindled not to be put out. Besides, Frederick Denison Maurice, as well as James Martineau, were there also to represent mental philosophy. In the latter period of his Bristol novitiate, Carpenter became apprentice to Mr Estlin, a medical practitioner in the city, who shortly after sent him as companion to a patient on a West Indian voyage. On returning to Britain, Carpenter joined the medical classes of University College, London, at the age of twenty, in 1833. On passing the examinations of the Royal College of Surgeons and the Apothecaries Society in 1835, he transferred his medical studies to Edinburgh in the following year. About this time he began to give popular scientfiic lectures; but, according to Dr Shapter, who heard him in 1835 at Exeter, the future Gilchrist lecturer had not yet come to his great power of attracting popular audiences. The time of Carpenter's arrival in Edinburgh marked something like an epoch in the fortunes of its medical school; for the old practitioners, so well commemorated in the autobiography of Sir Robert Christison, were being replaced by a newer race of teachers, of which, indeed, the subject of this notice was amongst the last representatives. In this, our jubilee year, let us recall 1836, when John Percy, our greatest English metallurgist, and W. B. Carpenter, but lately *facile princeps* of our physiologists, were prominent at our early meetings, held within the then new University buildings, besides being active workers at committees or herbarium. If morphology now presses so greatly to the front, pushing back the classificatory studies of our founders, and almost making our symbolism of Linnæus and Jussieu somewhat antique, be it remembered that the germs of Carpenter's *Principles of General and Comparative Physiology*—the first published British manual of the new science of biology—may be found in our modest First and Second Annual Reports.

At the third meeting of the Society, held on 12th May 1836, Mr Carpenter read a communication on the connection between electricity and vegetable life, arguing that, though dominated by the principle of vitality, electricity may have produced organic chemical compounds; and propounding hypothetical views on the food of plants. This was followed at the July meeting by a dissertation on the structural analogies betwixt the principal groups of the animal and vegetable kingdoms, and the application to plants of the laws of development which have been established in the structure of animals. At the opening meeting of our second session, Mr Carpenter enforced the necessity of the Society making a collection of vegetable monstrosities as a study essential to the philosophic botanist, and referred at the same time to Unger's researches on the parasitic fungi. In his report on the progress of botany for the year, Professor Graham devotes a large portion of his space to Mr Carpenter's paper in the July number of the *Edinburgh New Philosophical Journal*, dwelling with much approbation on its conclusions—1st, that a special function arises only out of one more general, and this by a gradual change; 2nd, that in all cases where the different functions are strongly specialised, the general structure retains more or less the primitive community of function which originally characterised it; and the only postulates which Dr Graham could not grant were on collateral subjects, which Mr Carpenter had not personally studied. In April 1837, Mr Carpenter made remarks on the forms of the organs of respiration in different classes of plants and at different periods of their growth. And in the session of 1838, at two meetings, papers were sent from Bristol, tracing the organs of reproduction from the lowest cryptogam to the most specialised flowering plant, and showing an essential unity specialised as to details throughout the vegetable kingdom.

The last of these communications was illustrated by many beautiful drawings, executed by Mary Carpenter, who was also at this time a frequent donor to the University Herbarium. Indeed, the sister through life found her pencil a favourite amusement, and she impressed on the writer how greatly she found refreshment in her often arduous and depressing philanthropic life work from her fossils or herbarium. Dried ferns, beautifully gummed down on paper, or plant imprints on shales from the Coal Measures, were amongst her educational apparatus successfully used to awaken the dawning intellects of city arabs. Thus, indirectly, the influence of our Society may have touched the great juvenile reformatory cause.

Carpenter had Edward Forbes as a college companion. Both were leading members of the Royal Physical, as well as our own Society, and they also carried on as their life works the investigation of marine life begun in Edinburgh. Carpenter's graduation thesis, in 1839, on "The Physiological Inferences to be deduced from the Structure of the Nervous System of the Invertebrate Animals," attracted the attention of Johannes Müller, who inserted a translation of it in his *Archiv* for 1840.

In the year 1839 Carpenter became an M.D. of Edinburgh, and published the *Principles of General and Comparative Physiology*, intended as an introduction to the study of human physiology, and as a guide to the philosophical pursuit of natural history. Dr Graham, in his Report on the Progress of Botany, delivered 14th March 1839, gave a discriminating eulogium of the work, and pronounced it the most important botanical event of the year, after the publication of the views of Schleiden. Dr Carpenter remained for five years in Bristol, commencing medical practice, and marrying in 1840. He communicated, in July 1841, "An Outline of a Philosophical History of the Reproductive Function in Plants and Animals," which was afterwards published in the *London and Edinburgh Monthly Journal of Medical Science*, vol. i. p. 653. After this, busy professional authorship claimed for a time his whole energies, and his strictly scientific investigations afterwards referred to the study of the minute shells of the Mollusca, as well as of the Protozoic Foraminifera—all of which culminated in those deep-sea researches with which his name was to become famous. But in other ways Carpenter cemented his connection with this Society. On more than one occasion he rendered effective assistance to the late Professor Balfour in Arran, where he visited every summer, and with whom he kept up a life-long intimacy. A visit to the Botanic Gardens was regularly made during his runs to Edinburgh, and personal intercourse with old college companions helped to keep burning his scientific enthusiasm.

Carpenter's London literary and scientific career began in 1843. Its results were chiefly manifest in successive editions and amplifications of his works on human and comparative physiology. His *Mental Physiology*, published in 1874, had perhaps the greatest popularity amongst general students. *The Microscope and its Revelations* reached a sixth edition in 1881. His papers on the "Foraminifera," in the *Philosophical Transactions*, as well as a richly illustrated monograph, published by the Ray Society in 1862, are perhaps the most severely scientific of his writings.

Dr Carpenter became Fullerian Professor of Physiology in the Royal Institution during his first year of London life. He was elected a Fellow of the Royal Society in 1844, receiving in 1861 the council's gold medal for contributions to physiological science. He subsequently became Professor of Medical Jurisprudence in University College, Lecturer on General Anatomy and Physiology at the London Hospital School of Medicine, and Examiner in Physiology and Comparative Anatomy in the University of London. From 1851 to 1859 Dr Carpenter was Principal of University Hall, the residential institution attached to University College. In 1856 he was appointed Registrar of the University, which enabled him to resign such onerous positions, and to give more time to original investigations. He now commenced, during holidays at Arran and elsewhere, those researches on the structure and development of the beautiful little feather-star, the publication of which led to his association with Wyville Thomson, and to the subsequent deep-sea explorations, first of the "Lightning" and then of the "Challenger." In 1879 he retired from the registrarship on a well-earned pension, being at the same time elected a member of the Senate of the University of London, and subsequently nominated a C.B. In 1871 the honorary degree of LL.D. was conferred on him by the University of Edinburgh. In 1872 he was president of the British Association for the Advancement of Science, then met at Brighton. In 1873 he was elected a corresponding member of the Institute of France. In 1883 the Lyell medal of the Geological Society was awarded him.

Dr Shapter of Exeter not unfrequently saw Dr Carpenter in after life, though the last time was at Edinburgh, when he received the LL.D., and he writes:—"It is notable that both he and his father met their ends by accidents." In the summer of 1839 Dr Lant Carpenter had to cease his multitudinous labours, and, accompanied by a medical friend, to make a long continental health tour. On the day before Good Friday of the next year, news reached Bristol that while travelling one night from Leghorn to Marseilles, he had been sitting solitary on the steamer's deck, and was suddenly missed; he must have fallen overboard. Some forty-five years after the death the then newly-made Edinburgh graduate was summoned as quickly. When taking a hot-air bath, the curtains of his bed accidentally got on fire on the Monday evening. He died at 3 A.M. of the following morning.

On September 25, 1885, another of the great present-day writers on geographic and systematic botany, EDMOND BOISSIER, passed from us at Valeyels, his country seat, near Orbe, Switzerland. Born at Geneva in 1810, he early came under the influence of those enthusiastic naturalists who pursued their studies in the glorious surroundings which environ this centre of intellectual activity. When a boy, he made a special collection of alpine plants growing around his paternal home, disciplining himself in mountain wanderings for a future life work of botanical exploration. On one occasion he extended a journey, originally planned only to the Great St Bernard, so far as Turin, returning with a franc in his purse. The elder De Candolle was guide, philosopher, and friend to the young botanist; and, at least, two handsome publications will permanently record his life work.

The *Voyage botanique dans le midi de l'Espagne pendant l'annee* 1837, 2 vols. 4to; and the *Flora Orientalis*, 5 vols. 8vo, 1867–1881, are both the records of travel undertaken in the countries embraced in them, as well as of subsequent systematic work in the herbarium and library; while, again, the Monograph of the species of Euphorbia, which originally appeared in De Candolle's *Prodromus*, but was afterwards published separately with a series of illustrations, is equally valued.

Boissier made himself a reputation as an horticulturist, specially in the department of alpine plants; while, again, the *Abies Pinsapo*, now a well known denizen of our pinetums, was discovered by him in his Spanish travels on the mountains of Granada, where it formed forests, at an elevation of 4000 to 5000 feet, in places where snow lies from four to five months in the year.

E. Boissier was a corresponding member of our Society.

Dunbar James Douglas, sixth and last Earl of Selkirk, died on April 4, 1885, after a short illness, at St Mary's Isle, Kirkcudbright, having nearly completed his seventy-sixth year. The Earl was elected a non-resident member of our Society so far back as 1838. His mind was specially of a scientific bent; and though his geological inquiries, notably "On Sea-Water Level Marks on the Coast of Sweden," read to the London Geological Society in 1867, may bulk most prominently in public notice, still his relation to us, specially in connection with his early colonising work in the now celebrated Canadian Far West, demands the present record.

The late Alexander Croall was elected an Associate on the same day in which the Earl of Selkirk was admitted a member of our Society. The conjunction is at least unique, and proves in the exhibition of two distinguished after careers that science is the true leveller. We admitted one who pointed out our aims both in foreign courts, in the House of Lords, and at the Royal Society; and at the same time another, who, *per ardua*, the joiner's bench, the clay-biggin' schoolhouse, and night herborisings snatched after the day's teaching drudgery, had his claims as a botanist recognised by Royalty, and his name ranked in the honourable muster-roll of Dr Smiles' "men who have risen." Mr Croall was one of several otherwise obscure observers brought to the front by the late John Hutton Balfour. He thus contributed much information regarding rare Scottish plants. Thus, so early as 1840, Dr Balfour exhibited specimens of *Convolvulus soldanella*, found by Mr Croall near Montrose, being the first time that it had been noticed as a native of that part of the east coast of Scotland. Mr Croall's career as common school teacher about Montrose extended from 1839 to 1863. It was during this period he began his botanical career, inspired thereto mainly by a paper on "Plants," read by a journeyman gardener before the Montrose Scientific Institute, of which he and another of our members—alas! now to be designated the late Dr Gilchrist—soon became the main stoops. During this, his novitiate, period, Croall used to start at twelve o'clock for the Forfarshire hills on a night such as Friday preceding a school holiday, so as to begin botanising at daylight, and he afterwards walked distances of 30 or 40 miles, in order to get home the same evening. In prolonged excursions, made during the autumn holidays, to Clova, Deeside, and the like places, he commonly slept on the heather, carrying provisions in his pocket. He became a correspondent of Balfour, Dickie, Hooker, and Darwin. About the year 1855 he prepared an herbarium of the plants of Braemar for Her Majesty the Queen; and in 1860, *British Sea-Weeds: Nature Printed*, was published by Bradbury & Evans, of which he was chief author. Mr Croall also became an authority on the zoology of the district, especially on conchology and entomology.

In 1863 he became keeper of the museum and herbarium attached to the City of Derby Library, which he also supervised; and in 1873 he was appointed curator of the Smith Institute, Stirling. In both cities he spread a taste for practical natural history pursuits. Indeed, he was till his death the moving spirit of the Stirling Natural History and Archæological Society, besides carrying on an extensive correspondence with other than district scientists. Mr Croall made a special study of the fungi and lichens, and was an expert in mosses, as is evidenced by the frequency with which his name is mentioned in Dr Braithwaite's *British Moss Flora*, now in course of publication.

Mr Croall collected a valuable herbarium; the specimens illustrating the district in which he latterly resided he bequeathed to the Stirling Natural History and Archæological Society, of which he was long president. He also left a garden of wild flowers, gathered in various parts, some of them not to be found elsewhere in Scotland.

Alexander Croall died at Stirling on the 19th May 1885, after a long illness, having also, like the Earl of Selkirk, attained seventy-six years.

Besides the sets of the plants of Braemar, both flowering and cryptogamic, prepared at the request of the Queen and Prince Albert, a considerable number of other sets were prepared, mostly for public herbaria; and, in all, the specimens are well selected and carefully prepared.

The *British Sea-Weeds: Nature Printed*, undertaken in conjunction with Mr Johnstone, was in four large 8vo vols.

The late William Wilson Evans was for many years an acting office-bearer of the Botanical Society at a time when the distribution of specimens was a prominent part of its operations, and his name thus became wide spread. He was till lately an occasional attendant at our meetings. Mr Evans was born at Dysart, Fifeshire, on 1st January 1820. He early developed as a boy a love for plants and flowers, and received the training of a practical gardener. His first distinction came when in the gardens at Mortonhall, in 1840, in the shape of the Caledonian Horticultural Society's medal for a *hortus siccus* of native plants. In 1841 Mr Evans, gardener, Caledonian Horticultural Society Gardens, was elected an associate of our Society; and in 1842, he contributed "Notes on Preserving the Colour of Plants intended for the Herbarium" (see *Trans.*, vol. i.); and in 1846 there were given "Observations on some Rare Plants picked in the Neighbourhood of Edinburgh," by Dr Balfour and Mr Evans. In 1842 Evans entered upon his duties as clerk at the Old Experimental Gardens, now forming the eastern half of the Botanic Garden, in which the herbarium and rock garden are situated; and in 1843 he was elected assistant-secretary and curator to this Society. The manuscript attendance-book, kept in our archives, shows how Mr Evans was assisted in the work of distributing plants in the herbarium during 1844–45 by Charles Babington and others.

Mr Evans became curator of the Caledonian Horticultural Society Gardens in 1848, on the late James Macnab vacating the post for the position in which he died. In 1857 the ground occupied by the Experimental Garden was taken over by Government, to be added to the Botanic Garden; and Evans rented the farm of Tynefield, in East Lothian. He subsequently became estate manager to the late Sir George Clerk, Bart., of Penicuik, in 1864; and from 1872 held the same position on the estate of Macbie Hill, Peeblesshire. He latterly returned to Edinburgh, occupying much of his time in arranging his herbarium, which comprised a wide range of species of British plants, both phanerogams and cryptogams. He died there on 5th May 1885, after a brief illness of ten days, the result of a paralytic shock. Mr Evans discovered several species new to the Edinburgh district, which have been duly recorded in Balfour and Sadler's *Flora Edinensis.*

Mr James Welsh, of the firm of Dicksons & Co., nurserymen, Edinburgh, died on the 18th June 1885, in the fifty-second year of his age. Mr Welsh forms almost the last of a string of noted horticultural veterans on our roll of Fellows, who well represented their special side of our science. He was proposed by the late William Gorrie in 1872. If he did not contribute to our *Transactions*, he wrote elsewhere somewhat extensively on arboricultural subjects, such as the larch disease, and the growth of tree stems even in a prostrate condition. But, beyond all, he used his commercial position in promoting botanical science in a very marked manner. He introduced many new exotic species into our parks and gardens. *Acer Hookeriana* from the Himalayas, *Prunus Pissardii* and *Populus Bolleana* from Tashkend, have become popular mostly through his influence. He also introduced new species of primulas and phlox hybrids. Mr Welsh made long herborisings as a boy; and in business years found opportunity to carry his botanical box with him in his journeyings; in one instance, at least, doing good service to arboriculture, for he thus brought forward the golden leaved weeping ash, then new to Scotland. Mr Welsh joined the firm of Dicksons & Co. in 1862, on the death of Mr Scott, and had been, till his retirement to his native hills, in hopes of recovering health, an active citizen of Edinburgh.

Mr James F. Robinson of Frodsham, Cheshire, one of our Associates, died in November 1884. He was a distinguished topographical botanist, as well as a correspondent of Edward Forbes and H. C. Watson. He contributed more than one paper to our *Transactions*, on the peculiar flora of the Cheshire meres, besides enriching the University Herbarium with interesting specimens.

On Calamagrostis strigosa (*Hartman*) *as a British Plant, and two Carex Forms new to Scotland*, &c. By A. Bennett, F.L.S., Croydon.

(Read 14th January 1886.)

In 1883, when reading Dr Smiles' *Life of Robert Dick of Thurso*, it occurred to me that the *Calamagrostis* Dick recorded from Loch Duran as "*C. lapponica*, the Lapland reed," could hardly be that species; and I wrote to Mr James Grant of Wick, calling his attention to the record, and urging him to visit the locality. His reply was disappointing; he wrote—"The loch is now drained, and I fear the plant is now lost." Afterwards he looked at Dick's specimens at Thurso, and supposed them to be *C. stricta*. Doubtless, Dick applied the name *lapponica* in the sense Sir W. J. Hooker had done in giving that name to the Irish variety of *C. stricta* (the var. *Hookeri* of Syme's *English*

Botany), and not to the true *lapponica* of Wahlenberg's *Flora Lapponica*.

It was not, however, until last July that Mr Grant could make a thorough search of the ground formerly occupied by the loch and its borders; he was successful in finding it, and sent me a supply of fresh specimens and roots.

On carefully examining these, I found it could not be referred to *C. stricta* of Nuttal; and on comparing his specimens with Anderssen's *Gramineæ Scandinaveæ*, and Hartman's *Handbook of the Scandinavian Flora*, it seemed to me to be either *C. strigosa*, Hartm., or *C. borealis*, Læstadius. As I had no specimens of either, I asked my friend, Mr N. E. Brown of the Kew Herbarium, to compare the specimens with *strigosa* and *borealis* in Fries' Herbarium Normale. His reply was:—"The grass is *Calamagrostis strigosa*, Hartm.; for though the ligule is less acute than in the typical specimens, still I do not see what else it can be." Since then the name has been confirmed by Dr Almquist, who writes:—"The specimens are very near the Norwegian form."

This is a very interesting addition to the flora of Caithness, coming so soon after the finding of *Carex salina*, and showing the affinity of the flora of the extreme north of Scotland with that of Scandinavia, which I venture to predict will be further shown by future discoveries.

I give some references to the species, with a few remarks.

Calamagrostis strigosa, Hartm. in *Handbok i Skan. Flora*, ed. i. (see Nyman), ed. ii. 1879; Fries' *Summa Veg. Scand.*, p. 240–1; Fries' *Herbarium Normale*, fas. 8, No. 86; Anderssen's *Gramineæ Scand.*, p. 97, fig. 99; Nyman, *Conspectus Floræ Europææ*, p. 799; *Arundo strigosa*, Wahlenberg, *Fl. Lapponica*, t. ii. p. 29; Blytt, *Norsk Flora*, p. 136; et *Norges Flora*, p. 86.

In Europe it was confined to Scandinavia, where it occurs at Alten, in Finmark, about 70° N. lat.; Karesando, in Tornea Lapland, at 66½° N. lat.; Trondhjem, in North Norway, at 63° 20′ N. lat.; and Caithness, Scotland, at 58° 35′.

If we include *C. aleutica* of Bongard, and *C. nutkaensis* of

Trinius under *strigosa*, as was done by General Munro in Sir J. D. Hooker's paper on Arctic Plants in the *Linnean Transactions*, p. 307, it will extend its distribution to N. E. Asia and W. and N. E. America (Arctic). In this paper Hooker also gives it as a Greenland plant. Dr Lange (*Conspectus Floræ Grœnlandicæ*) doubts its occurrence, and no specimens from there exist at Copenhagen. There is some reason to think that it may be found there, as the Swedish expedition of 1883 gathered *C. lapponica*, Wg., at Sofieham, in North Greenland.

Anderssen, under *C. lapponica*, Wg., has a note—"In Scotia adest forma nostræ plantæ valde similis." Where could he have obtained this information? I cannot trace it. Surely it could not have been the Forfar plant always referred to *C. stricta*, Nutt.

C. strigosa differs from *C. stricta* (*Deyeuxia stricta* of Hooker's *Student's Manual*, 3rd ed.) by its larger and more acute glumes, armature of the pedicels, length of hairs of the florets, more acute ligules, in minor characters and habit.

Calamagrostis is a genus in which the species are specially difficult of determination, and they seem considerably more so in the north than in the south of Europe; sub-species and hybrids occurring there that make it very difficult to fix the limits of the forms. In an early state *Calamagrostes* are liable to be passed over for other grasses, and it will be well that all lochs that possess a sloping shore with accompanying marsh, and rivers, whose banks are low, with ditches alongside, should be examined for other species of the genus in Scotland. I shall be only too pleased to render any help.

While on the subject of a grass, I should like to suggest that *Sclerochloa Borreri*, Bab., ought to be found on the Scottish coast. Unless we consider *S. conferta*, Fries, to be a northern sub-species of this, it is found in Iceland, Greenland, and Scandinavia, so there is really no reason why it should not be found. Has it been confounded with forms of *distans* or *maritima?*

Carex aquatilis, Wg., var. *cuspidata*, Læstadius. Among my friend Mr Hanbury's gatherings in Caithness last July, I found a few specimens of this form of *aquatilis*, where it was growing with *C. aquatilis*, var. *Watsoni*, Syme, and *C.*

salina, *β Kattegatensis*, Almq. (Fr.). It is a rare form, having been found by Læstadius in Tornea, Lapland, and by Lundberg in Wester Bothnia, in North Sweden.

Carex rigida, Good, var. *inferalpina*, Læstadius. Mr Hanbury gathered this in the Little Culrannoch, in Forfarshire, last year. It is the form of *rigida* that comes nearest to *aquatilis*, and, I suspect, is the plant mentioned by Syme in third edition of *English Botany*, as found by him on the Little Craigendahl, in Braemar. It is widely spread in Lapland, and occurs also in Norway and Greenland.

It may be satisfactory to state that Dr Almquist has since confirmed my determinations of the above plants.

Carex elongata, L. Found by Mr M'Andrew at Kenmore Holms in Kirkcudbright, its most northern recorded station being Cumberland hitherto.

Equisetum litorale, Kühlew. ap Rup., 1845; *E. inundatum*, Lasch; *E. Kochianum*, Böchel; *E. uliginosum*, Heng.; *E. arvense-limosum*, Lasch. (See Nyman.)

Mr W. H. Beeby has found on Bisley Common, in Surrey, an *Equisetum*, which he thought might be *E. ramosum*, but Dr Lange of Copenhagen determines it as above.

Nyman, in his *Conspectus*, gives its distribution as North Germany, Denmark, Upland in Sweden, Ingria (Russia), Silesia, Bohemia, Bavaria, Austria, Hungary, France (Arles), and Switzerland (Lake Necomii).

It seems to be a rare plant in most of these countries. In Surrey it occurs among white sand, overlaying deep peat, occurring here and there on the peat itself, but rarely.

Ascherson, *Flora Brandenburg* (Prussia), considers this an hybrid, *E. arvense* × *limosum*, and gives a variety of it, *β gracile*, Milde.

Garcke, *Fl. v. Nord und Mittel-Deutchsland*, also gives it the same name.

Hartman, *Handbok i Skan. Flora*, 2nd ed., numbers it as a species.

I am glad to be able to send a specimen for the Herbarium.

A Forest Tour in Provence and the Cevennes. By Major F. Bailey, R.E. (With Map.)

(Read May 13, 1886.)

On the 22nd April 1885, a party, consisting of MM. Puton and Boppe, the director and deputy-director of the Forest School, Mr Elliott, of the Punjab Forest Department, nine English students, Mr Takasima, a Japanese gentleman studying at the school, and the writer of these pages, left Nancy for Marseilles. After we had passed Dijon, and before darkness set in, the line led us along the foot of the Côte d'Or hills, which are famous for the wine they produce; and when morning dawned we found ourselves near the mouths of the Rhone, crossing the desolate Plaine de la Cran, which consists entirely of pebbles and gravel, and is probably of glacial origin. It is quite uncultivated, and is likely to remain so until the works now in progress for leading the turbid water of the Durance to deposit their silt upon it are somewhat more advanced, and until a fringe of forest can be raised on the northern side, as a protection against the terrible *mistral* wind which blows from that direction. The sudden change of $5\frac{1}{2}°$ of latitude we had passed through, made itself evident by the advanced condition of the vegetation. At Nancy the leaf-buds were only bursting, whereas at Marseilles the trees on the numerous boulevards and in the beautiful public gardens were in full foliage. Here we observed a number of palms in flower, and a small species of bamboo, not unlike the Himalayan *ringal* (*Arundinaria falcata*); while near our hotel was a fine row of Australian gum trees (*Eucalyptus globulus*), 6 feet in girth, and said to be seventeen years old. It is not possible to leave Marseilles without remarking on the magnificent mules which one sees everywhere in the streets, some of them being probably 17 hands high. These animals, laden with a most unnecessary amount of cumbrous harness, are put into the waggon-shafts, preceded by a string of three or four horses and ponies of gradually diminishing size, and the team is finished off with a very small pony, or sometimes a donkey! We also saw a number of active, wiry little Algerian ponies running in light carts, and reminding us of a good class of northern Indian country-breds.

The Forest of La Sainte Baume.

The railway from Marseilles to Aubagne passes through a very pretty bit of country. On the high ground the Aleppo pine (*P. halepensis*) grows in fair abundance, the white limestone rock appearing through its dark foliage. At the foot of the hills, in the fertile valley through which the line follows the stream, numerous chateaux and villas were seen, some of them standing in beautifully kept grounds, containing trees and shrubs of many kinds, most of which were in spring leaf, the horse-chestnut and black-thorn being in flower, whilst fresh green meadows, studded with white narcissus and other flowers, flanked the railway. On leaving Aubagne we travelled on a branch line to Auriol, near which place the country became more wild, and the number of vine terraces increased; but it was sad to note the desolation wrought in recent years by the *Phylloxera*, the terraces, which in prosperous days were built at an enormous cost, now showing only the stump of a vine here and there, other crops being raised upon them. It is said that it will be necessary to wait three years before replanting the ground, and grafting an American species of vine; this will not involve a very heavy outlay, but in the meantime the loss of the grape crop is most severely felt. On arriving at Auriol we were received by a forest guard, who had brought two carriages to convey us to the village of St Zacharias, where we were met by MM. Delaporte and Rogé, the local inspector and sub-inspector; and accompanied by them we started on a walk of eight miles to the Hospice of St Baume, where we were to pass the night. The Provençal region, in which we now were, differs widely from that which we had left at Nancy. During half the year rain very rarely falls, and the country then becomes excessively hot—"as hot as India," as a friend of the writer, who passes the winters at Hyères, and has been in Hindustan, once said to him. The nature of the forest vegetation is completely changed by this distribution of the rainfall, the number of species being much smaller than it is in more favoured localities. Here is found the Aleppo pine, which characterises the hot districts bordering the Mediterranean, the broad-leaved kinds being chiefly those with persistent leaves, such as the wild olive and the evergreen oak (*Q. Ilex*). The trees do not attain such large dimensions as those in the north, but they are of sufficient girth to yield useful timber, and they grow wherever they can find a little soil in which to establish themselves. The shrubs are for the most part evergreen, and bushy in form, one of the principal kinds being the dwarf oak (*Q. coccifera*), which, growing to a height of about 3 feet, fairly covers the ground in places; it is associated with several species of juniper and other shrubs. The herbaceous plants are chiefly those which characterise limestone soil in hot regions, most of them having rigid leaves and highly scented flowers; such, for example, as the lavender, the rosemary, and thyme. An undergrowth thus constituted protects the soil, which, however, is not of a nature very liable to erosion, whilst it acts to some extent in arresting the progress of forest fires, which cannot spread rapidly through it. In the part of the hills we were passing through, the limestone rock was visible everywhere, there being hardly any soil upon it—none at all, indeed, in many places; but in spite of this, and of the ill-usage the forest, which is private property, is subjected to, there is a light crop of pine and oak growing spontaneously; the latter being treated as a simple coppice, cut for fuel every five years. Sheep are admitted, but not in large numbers, and it is probable that the harm they do is small, in comparison with that caused by over-cutting, there being little doubt that, if this were restricted, a fine forest could be raised in spite of the limited grazing that is practised. There were a great many caterpillars on the pines, which seemed to suffer a good deal in consequence. As we rose higher up the valley, the hills became more bare of trees, and their appearance, furrowed by dry water-courses, marked by numerous small landslips, and scored over by a network of sheep-tracks, forcibly reminded those of us who had been in the Punjab, of some parts of that province. As we mounted still higher the slopes became even more barren, and it was easy to imagine how soon a multitude of goats, such as would be found in a similar locality in India, would cause the complete disappearance of the last vestiges of forest growth. After walking for some time through this uninviting tract, we gained a plateau, bounded towards the sea by high rocks, on the soil washed down from which some fields have been established; and at the further end of this plateau is situated the hospice where we were to pass the night.

The hospice of La Sainte Baume (Holy Grotto) is maintained by the Dominican Monks for the accommodation and feeding of the pilgrims who visit the shrine annually during the summer months, to the number of thirty or forty thousand. The sacred grotto is high up in the rocks above, and is said to have been the refuge of Mary Magdalene after the Crucifixion. Notwithstanding that the day was Friday, we were provided with an excellent breakfast, after which we proceeded to inspect the forest, which formed for us, of course, the great attraction of the place. It covers an area of 340 acres, at the foot of the rocks, immediately below the grotto, and has been preserved by the monks as sacred from very early times. Except to satisfy their very limited requirements, it remained untouched until the Revolution of 1790, when it was appropriated by the State. Some trees were then cut, but very few, on account of the absence of export roads, and to this day it is almost a virgin forest, only dead or dying trees being taken out. On entering it, one is immediately struck by its extraordinary character. Here, in the hot, dry region of Provence, we could imagine ourselves suddenly transported back to Nancy. There are huge beech trees, with oak (*Q. sessiliflora*), maple, lime, hornbeam, and other kinds that are not found anywhere else in this part of the country, certainly not within a distance of nearly seventy miles as the crow flies. There are many yew trees, some of huge size and apparently of great age, and also a large number of hollies. The ground, which is, generally speaking, covered with a deep layer of vegetable mould, was, where the forest was at all open, carpeted with flowers, many of them kinds found at Nancy, the sweet-scented violet and narcissus being very plentiful. *Daphne oleoides*, so common in parts of the Himalaya, was also very abundant, and the whole tract was alive with nightingales and thrushes. The mean altitude is about 2500 feet above sea-level, and the annual rainfall is 36 inches, spread over six months of the year. The presence of the forest here is accounted for by the theory that the currents of air from the sea on the one side, and from the Alps on the other, meet on the rocky ridge which runs parallel to the coast-line, and discharge their moisture on it; but it seems at least probable that their influence is aided by springs, which rise at the foot of the cliffs in sufficient quantity to keep the soil always moist. However this may be, there the forest lies, surrounded on all sides by barren desolation, and in it are some of as fine trees as one could wish to see. A remarkable fact in connection with them is that their wood is extraordinarily heavy, generally speaking, one-third more so than that of the same species grown at Nancy; this being probably due to the increased light and heat which they receive as compared with those which are found in more northerly latitudes, as well as to the moisture pervading the air and soil. Some of the hornbeam is so heavy that it will not float in water. There are signs of ancient cultivation within the forest—yew trees, apparently centuries old, now standing on the old terraces.

As we neared the foot of the cliff, the trees became stunted, and finally they ceased altogether; but we followed a path leading to the summit, where we obtained a view over the dried-up desolate country surrounding us on every side, and we were then able fully to realise the remarkable position that this little oasis occupies. On our way down we paid a visit to the holy grotto, which contains a beautiful spring of water, as well as many altars and statues, and while we were there the friar, who lives at its entrance, returned; he is a botanist, and had his wallet full of specimens he had collected on his way up the hill. After some conversation with him, we descended through the forest by another road to the hospice, where the amiable and cheerful monk who has charge of it met us, and after dinner we sought our rooms, and slept soundly on our straw mattresses.

Next morning we shouldered our knapsacks and started to walk across the hills to Aubagne, in order to take the train to Toulon. The first thing that struck us, was that the moment the limits of the State forest were passed, we had left behind us all trace of the remarkable vegetation we had observed the day before. This may no doubt be partly accounted for by protection being less rigid in the private forest we were entering; but it seemed also probable that the natural conditions had changed, the soil being no longer moistened by springs issuing from under the cliffs. We were now in a forest of Scots pine, subjected to uncontrolled though moderate selection fellings, which, notwithstanding the entrance of sheep, permit the maintenance of a fair crop of trees of small size, the larger ones being capable of yielding useful planks. The population is scanty, fires being unknown, and there are very few goats, which it is said do not thrive here. There was a fair undergrowth of young pine mixed with juniper, and wherever the cover was light the ground was carpeted with green herbs. Further on some oaks appeared, one fine old tree 20 feet in girth remaining to testify that they were indeed "giants in the earth" in former days. This forest stretches up to the foot of the high perpendicular limestone cliffs, above which there is a communal forest, managed on the selection method, and said to contain somewhat better trees than those we saw, but unfortunately we were unable to visit it. Before crossing a ridge we came upon an abandoned mine, with a coal seam 8 inches thick, which it does not pay to work. The descent was a very abrupt one, through a simple coppice of evergreen oak, cut at the age of twenty years; but the ground was very rocky, and the crop thin. Lower down we saw isolated Aleppo pines standing among the oak coppice, and there was a good deal of the dwarf oak, the evergreen leaves of which exercise an important influence in opposing the spread of forest fires. The wild, rocky aspect of the hills, and the general appearance of the vegetation, reminded some of us very much of parts of India; but as we approached the stream at the bottom of the valley all this changed, and we were able to note the great difference produced in the growth of the trees by the moister soil. Here were pines of large size, mixed with elm, poplar, chestnut, and plane (*Acer platanoides*); while the laburnum and Judas tree (*Cercis*) were in full bloom, and the grass green and bright, the contrast to the scene we had left being very agreeable. Presently the valley opened out, and further on we passed a saw-mill worked by water power, in which planks for packing cases were being cut up, and the road then led through a number of orchards and meadows. On reaching Aubagne we took the train to Toulon, the railway passing along the coast, and affording some fine views of the sea. Here again the vines are nearly all destroyed, and cereals are grown on the terraces which were constructed for them; but we saw great numbers of olive trees and many fields of "everlastings," which are exported for making funeral wreaths. We were met at the station and conducted to our hotel by M. Madon, the forest officer in charge of the Maures, to whose kindness and courtesy we subsequently owed so much.

On the following morning we were to have inspected the celebrated Mont Faron, but heavy rain fell all day, a most unusual circumstance at this time of year, and it was impossible to get out; while, as our arrangements for carriages had all been, of necessity, made in advance, we could not find another day for the expedition, and had reluctantly to give it up.

Forest of Montrieux.

After a night somewhat disturbed by the roaring of lions in a menagerie hard by, we made an early start in a large omnibus to visit the Forest of Montrieux, which is situated in the hills, at a distance of about twenty miles north of Toulon. After passing Mont Faron, which rises close behind the town, an excellent road led us over a plateau between olive gardens and ruined vineyards, and thence down into the valley of the Capot stream, which the previous day's storm had raised to flood level. When nearing our destination we turned down a narrow lane, dashed across a torrent, and then walked through a forest of oaks and pines to the convent of Montrieux-le-Jeune, where we had breakfast. M. Madon then gave us some information about the culture of the olive in this region. The trees are grown up to an altitude of about 1300 feet, the produce being very variable according to soil and situation. There are two varieties,—the larger of which yields, in favourable localities, a good crop every three years, or from £8 to £10 an acre; the smaller kind yields a good crop every two years, but the net returns are much the same. The trees, which are always grafted, are usually planted in clusters of two or three together, the group being pruned in various ways, frequently with a hollow centre, so as to favour the production of fruit on the inside as well as the outside surface of the "vase" thus formed. Shoots appearing on the bole of the tree or springing from its base are kept carefully pruned back, the leaves and twigs thus removed being buried below it, so as to avoid taking more than necessary from the soil. The crop is gathered from November to January, the fruit being picked up from the ground, and also plucked; it is then taken to a mill, turned by water-power or by horses, and crushed, with its kernel, in order to extract the oil, the most expensive kind being that which comes from the unripe olives. The trees have lately suffered much from attacks by an insect, the larva of which is developed in the fruit.

M. Madon's little lecture finished, we started to walk through the forest, sending our omnibus to await us at Belgentier. The forest, which is State property, has an area of 2700 acres. Like that of St Baume, it was protected as ecclesiastical property up to the time of the Revolution, and it used to yield a considerable proportion of the oak timber required for the navy; but over-cutting and insufficient protection have now reduced it to a very poor condition, and trees capable of yielding wood of this class are nowhere to be seen. It is difficult, indeed, to realise that they ever existed; but it is said that they were all taken out during the Revolution and the first Empire, and that the forest has never been allowed to recover. The lower portion, where we entered, is now stocked with *Quercus Ilex* and *sessiliflora*; the former cut at a young age for tanning bark, and the latter, worked as a simple coppice, being cut at the age of twenty-two years for conversion into charcoal. Bark and charcoal can be profitably exported, the gross annual revenue from these sources being about 3s. 3d. per acre; but there are very few roads now existing in this locality, and it would not pay to export firewood; so that the small wood, which cannot be utilised for charcoal, is left upon the ground, where it rots in a couple of years or so. The heads of the Department are anxious to raise a high forest of pines in place of the present crop, but the local officers are opposed to this project, as they are afraid of fires. The charcoal is burnt during the winter, so as to avoid danger from this cause.

Regarding this part of the country, generally, it may be said that the rock is limestone, the principal trees being the Aleppo pine and the evergreen oak; the ground is steep and difficult, so that the forests do not yield much. There is no doubt that timber of large size grew in former days on these hills; but at the end of last century the country fell into disorder, M. Madon's grandfather, who then occupied a high official position, having to go about under the protection of a pair of ferocious hounds, and having to treat with brigand chiefs for safe conduct through it. At that time the people were not under any sort of control, and the entire district became denuded of trees, from which condition it seems almost impossible that it can ever recover; for the ground is owned principally by communes and private proprietors, who cannot afford to refrain from cutting in order to allow the forests time to grow up. They have to pay taxes, and must get revenue; while the stock being very small, it must be worked over at short intervals, and no accumulation of capital is possible. Say, for instance, that the forests yield a gross revenue of 3s. 6d. an acre, the cost of working, with maintenance and taxes, comes to something like 2s. 6d., and not much saving can be effected out of the balance. But it would be a very great advantage if the State would set an example, by showing the people what the soil is capable of producing under proper treatment; and a portion, at least, of every State forest in this region should, for this, if for no other object, be brought as soon as possible into a good condition. In most mountainous districts the fairly level ground is cultivated; but forests grow well on slopes up to 35°, the working out of the timber being both difficult and costly when the fall is much greater than this. Such steep ground had better be kept under simple protection, letting the forest grow up as much as it will, removing none but dead or dying trees, and spending time and money on those parts of the area only which are likely to pay well. At Montrieux, for instance, there are said to be 1100 acres of rocky ground, which, if left alone, would grow a light crop of trees, affording protection to those on better soil, and at the same time giving seed; here all efforts should be concentrated on the remainder of the forest, so as to bring it into the best possible condition, as an example to be followed by degrees by the neighbouring proprietors. The moral to be learnt from a study of these hills is that all existing forests should be most jealously guarded against the destruction, which must sooner or later overtake them, if they are not rigorously and efficiently protected against over-cutting, fires, and grazing. When once they have been ruined, those which are not State property can hardly ever be resuscitated, and even if success be attained it is at an enormous cost. While we were pondering on these questions, the rain, which had been threatening for some time, burst upon us with the violence of a tropical shower, and we had to find our way to Belgentier in a drenched condition, down a path which was converted for the moment into a little torrent, through which we had to wade. On arrival we found that, to make matters worse, our carriage had not arrived, and we had to wait an hour for it to take us back to Toulon.

The Maures.

From Toulon we took train to Cuers, in order to visit the Maures, a low range of hills rising to a height of 2500 feet, near the sea-coast between Toulon and Fréjus. This range, which has precisely the same geological formation as the Vosges, is extremely like them in appearance ; the rock is principally granite, gneiss, or mica-schist, and there are numerous springs throughout it. The chain is continued beyond Fréjus by the hills of the Esterel, which extend eastwards to Antibes, and differ from the Maures in that the rock is chiefly porphyry, the numerous clefts and cracks in which permit the water to drain off with rapidity, and hence the soil is dry, poor, and shallow. The abrupt cliffs which mark this part of the range form a noticeable contrast to the rounded, grass-grown summits of the Maures.

This region is protected from the cold north winds by the Alps, but receives the warm Mediterranean breezes; and hence the climate is very mild, permitting the culture of the olive and orange, as well as of the vine and cereals. Wherever water is found in sufficient quantity, pasture is practised very extensively; but this is not possible everywhere, and large areas are maintained under forest. The vegetation differs very much from that of the north of France. Here we find among the larger trees the Aleppo pine and cluster pine (*P. pinaster*), with the stone pine (*Pinus pinea*) growing occasionally near the sea; and among broad-leaved kinds we have the cork oak (*Q. suber*), which is not found elsewhere in France except in the Eastern Pyrenees, the Spanish chestnut, which is grown for the sake of its fruit, the pubescent variety of *Quercus sessiliflora*, and more rarely the ash and maple (*Acer campestris*). Among shrubs there are the wild olive, the dwarf oak, the juniper, the arborescent heather (*Erica arborea*), the arbutus, oleander, broom, and others; while among smaller plants may be mentioned the common heather (*Erica scoparia*), myrtle, lavender, cactus, and cistus. *Chamærops humilis* and the date palm flourish in this locality, and distinguish it botanically from the rest of France. It is the region of conifers and of the cork oak, the produce from the latter being exceedingly valuable, and increasing in price every year.

An omnibus met us at Cuers, and carried us some miles on the road towards Collobrières, where we were to pass the night. We stopped for a few minutes at Pierrefeu to look at the country. The village, which is built on granite rocks forced up by volcanic action, overlooks an extremely fertile cultivated plain, across which we saw, towards the north, limestone mountains of the same formation as those we were on the previous day, the plateaux and steep scarps of which reminded us of the Jura; while towards the east and south the rounded tops of the Vosges-like Maures were visible. The numerous spurs constructed to keep the stream within its bed showed us that we were no longer on the limestone. Here, in the Maures, the slopes rarely exceed 30°, and the construction of export roads and work of all kinds is consequently comparatively easy. After driving a little further we left the road, and mounted the hill-side through a forest of pines, partly Aleppo and partly cluster, with some evergreen oak in places, and a dense growth of the arborescent heather. The forest is communal property, and its area is about 7500 acres. The cluster pine cannot here be grown profitably for resin, as the soil is too dry to produce it in sufficient quantity ; the pines are, therefore, felled under the selection method, at a minimum girth of 3 feet 8 inches, and are cut up into planks, the price per ree in the forest being 4s. The evergreen oak is worked for bark as a simple coppice. A little further on we came upon some cork oak, and the number of that species increased as we advanced. This tree constitutes the principal wealth of the country, the crop being a very profitable one, as owners of cork forest are able to count on a revenue of 25s., and yet, in rare cases, as much as £19 an acre. Such forests, of course, cannot be bought under a very high figure. About this part of the Maures the State does not possess much of the forest, about 37,000 acres being owned by private proprietors, and about 7000 acres by village communities. Communes possessing forests of this kind have large revenues, and as a rule they have constructed fine roads and bridges out of them ; but it is remarkable that, their credit being good, they are nearly always heavily in debt, Pierrefeu being said to have an annual income of £2000 a-year, while its debt amounts to about £15,000. We were told that ten or a dozen of the inhabitants of Collobrières possess fortunes amounting to £40,000, one of them having £200,000, all made by cork and Spanish chestnut, of which large quantities are grown higher up the valley. These men are content to wear blue blouses, and to live in the same style as their poorer neighbours.

M. Madon described to us the method of treating the cork oak. The removal of the cork is effected as follows: —An annular incision is made near the base of the tree, and another at a height of about 4½ feet above it, these being joined by a third incision carried vertically down from the upper to the lower one. Great care and long practice are necessary to enable the workmen to perform this operation without cutting into the matrix. The cork is then raised with the blade of the axe and the wedge-shaped end of the handle, and if it does not come off well it is struck with the back of the axe-head to loosen it; but this again must be carefully done to avoid injuring the matrix, on which a new growth of cork is to form. The layer of cork first taken off is of no value; nothing can be made of it. The second and subsequent growths, which are comparatively smooth, and form the cork of commerce, are removed when they have attained a thickness of nine-tenths of an inch—that is to say, after intervals of from six to ten years. May and June, when the trees are in full sap, are the months usually chosen for this operation. After the lower ring of cork has been removed, a second one is taken off higher up, and so on up the trunk of the tree and its lower branches. In the case of trees of small girth, the addition of an inch to the radius involves a greater proportional increase in the circumference than it does in the case of large ones; and the cork growing to that thickness on small trees is liable to crack and split into vertical furrows, which, when they are irregular, greatly diminish the value of the cork. On this account it is usual to make two vertical incisions on opposite sides of the young tree, which gape wide with its increasing growth, but which avoid the formation of the objectionable, irregularly-shaped, natural furrows that would otherwise have been formed. The rule is to take off only one ring at a time, and to allow the tree an interval of two or three years' rest before attacking it again; but this wholesome restriction is not always observed, and it is not uncommon to see trees which have been stripped, at one time, of their covering of cork throughout the greater part of their stem and large branches, this leading frequently to the deterioration or even the death of the tree so ill-treated. Trees that have been barked in the manner above described, present a peculiar appearance, the cork of different ages having various colours, from the red of the youngest to the grey, rough, moss-covered natural growth on the upper part of the tree. Experts can tell the age of the cork by its colour and general appearance. The outer surface of the second and subsequent growths of cork, though smooth and clean by comparison with that of the natural layer, is hard and gritty, and has to be scraped off. This causes a loss in thickness; and a system has been devised by M. Capgrand-Motte, under which the growing cork is protected by a covering—a sort of jacket, in fact. This method was highly thought of at first, but it is now believed to be the cause of a fungus growth which has appeared on a large proportion of the trees so treated, and it has been abandoned.

The trees are nearly all coppice-shoots. Stems of less than 16 inches in circumference are not worked. It is said that a seedling tree will not here attain this size in less than forty years, whereas a coppice-shoot will do so in fifteen years. The collection of cork from the forest we visited has now been going on for about sixty years, and it is believed that the trees can be worked up to a great age. The yield per tree depends of course on its size; but it has been calculated that a square foot of matrix yields on an average $1\frac{1}{5}$ lb. of cork every eight or nine years. The price is very variable, rising sometimes to 50s. per 100 lbs., but more ordinarily the rate is 25s., the cost of collection being 3s. 6d.

The financial difficulties in which most of the communes are involved, lead to the result that, notwithstanding the intervention of the Forest Department, their forests are not, generally speaking, kept in such good order as those of private proprietors. It is a common practice with them to farm out the collection of cork on twelve-years' leases; but this, generally, or at any rate frequently, leads to the contractors taking off all the cork of marketable thickness in the last two seasons, and handing back the trees in a condition in which they cannot yield much more for several years. The system should be discontinued.

The cork oak is a tree of light cover. Here it grows mixed with the cluster pine; but there can be no doubt that the proportion of pine, which tree is of very small value as compared with the oak, is far too large, and that the cover is in many places too heavy, so much so that the development of the oaks is seriously impeded, while in places they have been completely killed, many of the pines being also dead, and left standing at the risk of their breeding insects. That the cork oak does not entirely disappear under this treatment, is due to the fortunate circumstance that it can support a fairly heavy shade without actually dying outright; and that under it the trees continue to live in a stunted and unhealthy condition, giving a certain amount of seed; so that, except in the densest parts, there are nearly always some suppressed oaks of various sizes, even where the heather is very thick. We passed a piece of private forest in which precisely the contrary conditions prevail, the whole of the pines having been cut out, and a pure oak forest remaining. This has resulted in a very rapid growth of the young oak, and possibly it may turn out to be the correct method of treatment; but the opinion of the forest officers present seemed to be that it should not be generally adopted, for the present at any rate, both on account of the objections which exist to the maintenance of pure forests on general grounds, and also because, however well the oaks might grow, if left to themselves, without the shelter of the pines, it is by no means certain that they would prosper equally well when deprived of the shields of cork, with which nature has furnished them, doubtless to enable them to resist the fierce heat of the southern sun. It seems likely that under these conditions it is necessary to afford them some shelter, and that complete exposure, by the entire removal of the pines, will not have a good result. The proper plan seems to be to leave just enough pines to afford the needful shelter, and no more; certainly the cover of these trees should not be allowed to suppress the oaks.

One of the great difficulties to be encountered in this region is the forest fires, which sometimes cause incalculable damage. On limestone rock much of the undergrowth is of a nature which tends somewhat to impede the rapid progress of the flames. But here everything is as inflammable as possible, the ground below the shrubs being covered with pine needles and cones, which are full of resin. There is, in many parts of the forest, a dense undergrowth of shrubs, chiefly the arborescent heather, which, rising to a height of 12 to 14 feet, becomes, in the hot season, as dry as tinder, and when fire enters burns with terrific heat, killing off all the pines and such of the oaks as are too old to coppice. The ground then usually becomes covered with an extraordinarily dense crop of pine seedlings, sown from cones on the burnt trees, or from those on the ground which have been opened by the fire without the seed being injured; and these grow up more rapidly than the heather, forming with it an almost impenetrable thicket, in which the oaks, if not freed by clearing round them, become suffocated. It would be impossible to raise a finer crop of pines than that which follows the fire, but unfortunately it is the oak which is wanted, and not the pine. The ready reproduction of the latter species is, however, advantageous, for the associate required for oak is always growing,—there is nothing to be done to raise it; while as it does not coppice, it is always easy to get rid of. But should a second fire pass over the ground before the new crop of pines has seeded, the effect would be very serious, for then replanting must be resorted to.

There are several methods of dealing with the fires. The first and most effectual system is to grub up all the heather and other shrubs by the roots, so as to leave nothing on the ground that can burn. But this is an expensive process, costing from £3 to £5 an acre; and it has to be repeated, though at a reduced cost, every few years. It is rarely attempted, except by private proprietors, and it could not possibly pay in the case of a crop less remunerative than the cork oak. This process is manifestly open to the grave objection, that the soil, deprived of its protective covering, is deteriorated by exposure to the sun, and washed away by the heavy rains; but the cultivation which it receives during the process of extracting the roots may compensate this disadvantage to some extent. The usual method of guarding against fires is to completely clear broad lines—from 50 to 130 feet wide—of everything but cork oak; the roots of shrubs and coppicing trees being dug out, and all inflammable refuse being thrown into the forest on either side. The fire-lines are traced on the same principle as they are in India, viz., in all cases, round the outside of the forest, and through it when necessary; they follow the crests of ridges and spurs as far as possible. Fire-guards are employed to watch the forest during the four hottest months of the year, there being four of them for the forest of 7500 acres. These men spend their spare time in making and keeping in order the numerous paths that intersect the forest in all directions; and in case a fire breaks out, they give the alarm to the inhabitants of the neighbouring villages, who are compelled by law to assist in its suppression. This is accomplished principally by means of counter fires, in the management of which the people are very skilful. Proprietors in this region, who have not entirely cleared their forests of inflammable shrubs, are bound by law to maintain cleared fire-lines round them.

There is another method of dealing with fires, which is believed to be peculiar to the Maures and the Esterel. Under this system, locally known as that of *petits feux*, or small fires, the forests are burnt "to save their lives"; or, in other words, in order to secure them against risk of total destruction by the entry of an accidental or incendiary fire, over which it might be impossible to gain control, they are treated to burning in homœopathic doses under the fostering care of their owners and guardians. This practice, which in the lecture-hall at Nancy is characterised as "detestable from all points of view," is carried out by dividing each compartment of the forest into vertical strips, the first of which adjoins a cleared vertical fire-line; each strip is then burnt in succession from the top downwards, the workmen remaining with the fire in order to control its downward march, and to keep it from spreading inwards. The young pines are burnt up with the heather and other shrubs; but from what has been said before, it will be seen that this is not a matter of importance. Every endeavour is, however, made to save the young cork oaks, by keeping the fire from them, and the larger ones can, generally speaking, be protected. The small ones are burnt, but they coppice well; and by the time it is necessary to burn the forest again, they have attained a size which admits of their being specially cared for when the flames pass round them. The operation must be repeated every six or seven years, or more frequently if necessary, to prevent the undergrowth of shrubs from becoming so dense and tall, that the entry of an accidental fire would be attended with disastrous consequences. Of course there is a certain amount of risk of the fire escaping beyond control, but this does not often happen. Masses of young seedlings could not be treated in this manner; fire-lines must be made round them.

The advantage of this system, as compared with the clearance of the ground by digging out the roots of the shrubs, is its cheapness; it costs only some 3s. or 3s. 6d., instead of from £3 to £5 an acre. But its disadvantages are obvious, for it injures the stems of the older trees, and burns up the covering of decaying leaves, which, especially in this hot climate, is so much required to protect the soil, and prevent its impoverishment. The only thing that can be said in its favour, in addition to its cheapness, is that the "small fire" is under control, and the extent of the damage it causes can be estimated and taken account of; while by means of it the forest is saved from risk of total destruction, through an accidental or incendiary fire entering it after a great mass of combustible materials has accumulated on the ground. But the existence of this practice cannot be in any way used as an argument in favour of permitting the annual jungle fires to pass through the Indian forests. An essential feature of the Provence system is that there is an interval of six or seven years between two burnings, and that in this interval young trees can grow up and establish themselves; while the fire being kept always under control, the workmen can succeed in protecting from injury by it at least the greater part of the larger plants of valuable species. Annual fires do not fulfil the first of these conditions; while, except perhaps in the deodar forests, where the Provence system could hardly be applied, because the young trees unavoidably burnt will not coppice, there is usually so much coarse grass, and the fire is so intensely hot, that the kind of control above described could rarely if ever be exercised, and all young growth would almost to a certainty be burnt down.

A fourth system of protecting the forests from fire is a modification of that last described. Under it the shrubs are cut down, and either laid on the ground before the fire is lighted, or taken out and burnt separately. This system is sometimes practised when the shrubs, being very tall, would cause the flames to mount high up the stems of the older trees. It has some advantages over the ordinary method of *petits feux*, but costs about four times as much. Where precautions of the nature above indicated are not taken, or when they prove ineffectual, serious disasters occasionally ensue, areas of 25,000 acres of forest being sometimes consumed by a single conflagration. A portion of the forest we passed through was burnt in 1862, and totally destroyed.

After having spent several hours in studying the many interesting questions to which our attention had been directed in this forest, we drove to Collobrières, where we were to pass the night. While waiting for dinner, we went out to visit a cork factory in the village. The sheets of cork are boiled in order to make them soft and pliable, and they are then piled up under heavy weights to flatten them out. After this they are cut into strips, and these are again divided into a number of short lengths, so as to form little cubes, each of which is destined to be turned by a lathe into a bottle cork, the diameter of which depends on the thickness of the sheet of cork. It is surprising to see how easily the wet cork cuts, but of course the knives are kept very sharp.

Before leaving Collobrières next morning we visited a factory in which the roots of arborescent heather (*Erica arborea*) are prepared for conversion into tobacco pipes, an industry which follows the practice of grubbing up the heather roots in the cork oak forests. This shrub has an underground stem, which, when the part above ground is burnt down, lives and gives vigorous coppice shoots, these being in their turn burnt down, and after a number of years the stem attains very large dimensions, much in the same manner as is the case with the sal (*Shorea robusta*) in Northern India. The underground stems or stumps when dug out are, as a rule, converted into charcoal; but a small proportion of them, ordinarily some 4 or 5 per cent., which have sufficiently compact fibre, are selected for pipe-making, and are carried down on the backs of mules to the factory, where they are sawn up into pieces having more or less the shape of a pipe, these being exported to Paris and other places, where they are carved and finished. The wood is liable to split if it is allowed to dry rapidly; and to avoid this the stumps are thrown into water as soon as possible after their extraction from the ground, and the sawn pieces are exported wet. The result is what is known in England as "briar" wood pipe, this name being evidently a corruption of the French word *bruyère* or heather. The stumps of the arbutus (*A. Unedo*) are also used for the same purpose; but they are not so valuable as the heather.

On leaving Collobrierès we drove for some miles up the cart road, passing many tracts well stocked with Spanish chestnuts, which are grown, partly for the sake of their wood, and partly for their fruit; in the latter case they are always grafted. The forest guard said, that far away on the hill, there was a tree of this species measuring 45 feet in circumference, but we had no opportunity of testing the accuracy of this statement. After breakfasting at the roadside, we shouldered our knapsacks, and mounted to the top of the ridge, where we saw further examples of the extraordinary vigour with which the cluster pine grows on parts of the forest that have been recently burnt, and can maintain itself above the heather coppice. It seems quite possible that the best way to obtain a crop of deodar or pine in some of the Himalayan forests, where there is a dense matting of needles on the ground, may be to burn them off, taking due precautions to control the fire, and prevent its injuring the stems of the older trees.

After walking for some distance, we ascended the peak of Notre Dame des Anges, from which we obtained a magnificent view over the greater part of the department of Var; St Baume, Hyerès, Fréjus, and the hills about Toulon being seen in the distance. Below us was a small State forest protected by fire-lines, on which the cork oak only was allowed to grow. Notre Dame des Anges, and another peak of exactly similar height (2556 feet), are the two highest points of the Maures. After enjoying the view for a short time, and examining the ruined church, we commenced the descent to the railway station of Gonfaron. On the way down we passed through a magnificent forest of Spanish chestnut, which has hitherto been worked on the method known as *furetage*, or selection of coppice-shoots, with a view to its yielding vine-props. We observed one remarkable group of eleven stems, each about $3\frac{1}{2}$ feet in girth, growing on a large circumference. At first we supposed that the chestnut must coppice at a great age, but a closer inspection showed us that the space within the circle of stems was occupied by the stools of several generations of coppice-shoots, the diameter of the ring being increased at each felling. The failure of the vine during the last few years has greatly reduced the demand for props, and the owners are now, in consequence, beginning to graft for fruit. The method employed is that known in France as the "whistle-graft," which we were shown how to make. It is made on coppice-shoots of two years, or even of one year old, a small quantity of fruit being obtained the third year afterwards; but the crop very rapidly increases, and is a very profitable one.

After descending for a short distance further, we came upon a small sledge drawn by a horse, and used to drag vine props down to the cart-road. It consisted of two rough side pieces shod with iron, and joined by cross-bars; two upright stakes at each side sufficing, with the aid of cords, to secure the load. We were fairly astonished at the performances achieved with this simple apparatus. The road or path was steep, and zigzagged, and had such an uneven surface that we should have thought it impossible to get the sledge down without upsetting it. But the horse, who seemed to know his business thoroughly, started off at a brisk pace, cleverly negotiating the sharp turns; while the driver, who walked behind, holding a cord which was attached to the sledge, put on the drag, pulling sideways when necessary, in order to counterbalance the numerous inequalities in the surface of the road, and the sledge went swinging down the track, on what seemed to us its dangerous course, but we saw it landed on the cart-road without accident. It would have been easy to make a good road; but apparently the present one serves its purpose sufficiently well, though the sledge must sometimes be tilted over at an angle of 40°. Such a machine as this might easily be used in India, being dragged by a mule or by men.

On reaching Gonfaron we took the train for Fréjus, the railway passing through a fertile plain, where we first saw the stone pine (*P. pinea*), with its remarkable, brush-like, densely shading crown. Here we were met by MM. Tassy and Muterse, the inspector and assistant-inspector in charge of the Esterel, the latter of whom hospitably entertained some of the party at dinner. Fréjus is remarkable, among other things, for its nightingales, a number of whom sang throughout the evening close to the house; but their melody would have been more enjoyable if it had not been for a company of bull frogs, who added their deep discordant base to the chorus.

The Esterel.

On the last day of April we made an early start to visit the State forests of the Esterel. We drove past the old Roman ruins for which Fréjus is celebrated; and crossing the plain, where we saw the Aleppo, cluster, and stone pines all growing together, ascended for some distance by the excellent forest carriage road. We then called a halt, while M. Muterse explained his method of protection against fire. This consists in a system of fire-lines for the younger, and of *petits feux* for the older parts of the forests. There are fire-lines on the crests of all main ridges and spurs, and along both sides of all roads, intermediate lines being cut where they are considered necessary. The forest guards' houses, which are built on points favourable for observation, are connected by telephone with the central house where the *garde général* lives; so that, on a fire breaking out, the alarm can at once be communicated to every part of the forest, and the whole of the guards and work people can be assembled at any point in a very short time. Sheds with brooms and tools, required to aid in extinguishing fires, are established at intervals throughout the forest, so that no delay may occur through having to fetch them from a central point. If a fire occurs, it can generally be got under control in this manner; but if, unfortunately, it has spread much before the men get to it, there is nothing to be done but to light counter fires, which is a very difficult operation if they are required to burn up wind. The arrangements made by M. Muterse are admirable in every way, and might well serve as a model of how such things should be done in India. Until we came to the Maures and Esterel, we had no idea that forest fires were such a serious question in any part of France, or that such complete arrangements existed for their suppression. The system of *petits feux* is the same as that previously explained; but it may be here added that the law provides that the Prefect shall fix a period in each year during which the lighting or carrying of fire within or near the forests is prohibited; here the period is that from June to September inclusive. The "small fires" must not be lighted during those months, and there must be fire-lines of a fixed minimum breadth, cleared of all pines and brushwood, round every forest so treated. In case of the fire spreading from one property to another during the progress of these operations, or otherwise, the owner of the forest into which the fire has spread can, in case of proved carelessness or non-compliance with the regulations, claim damages against the proprietor of that in which it originated; and on this account the burning is conducted with great care, the ground being watched for fully thirty hours afterwards, in order to make sure that pieces of smouldering wood do not cause the fire to break out again.

The forest is stocked with cork oak mixed with cluster pine, the latter being, as was noticed in the Maures, in too large a proportion; and the efforts of the local forest officers are now directed to the establishment of a mixture such as will tend to promote the greatest possible yield of cork, which is, or at any rate will be, the paying crop. There is self-sown cluster pine everywhere, the seed, which has a large wing, being blown to long distances; and after the ground has been burnt over, a dense crop of pine seedlings comes up, with oak coppice mixed among it in a greater or less proportion. The pines are then cut back, so as to allow the young oaks to grow; and forests of the latter species, mixed with a due proportion of pine, are now being raised in this manner; but in some parts of the area there are no oaks, the ground being entirely occupied by pine poles. We were told that the intention is to plant oaks in such places a few years before clean felling the pines; after which a crop of self-sown seedling pines will be obtained, and the required mixture of species will be thus constituted. Sixty acres of oak were planted last year. At present there is no fixed yield either of cork or of pine wood. As regards the quantity of cork to be removed, it is said that the most important consideration is to avoid over-working the trees, as this diminishes their power of production; but there are no hard-and-fast rules as to the proportion of cork that can be taken from a tree. M. Capgrand-Motte's method of protective envelopes has been tried, but resulted in 95 per cent. of failures, a fungus growth having attacked the matrix. The pines are felled at a minimum girth of 3½ feet; they are barked, cut into 7 feet lengths, and carted out for export by rail to Marseilles to be used for packing cases. It would not pay to allow the trees to grow larger, because the timber they yield would never be suitable for building; and, while sufficiently large planks of sapwood and heartwood together can be obtained from them at that girth, the growth of the tree is thereafter relatively much slower than before.

The all-round gross revenue of this forest at present does not exceed 2s. 6d. per acre; but it will, no doubt, be very much larger a few years hence, when the cork oaks, which are now generally speaking young, have had time to grow up. The roads and buildings are extremely well laid out and constructed, each guard's house having a well-kept piece of garden attached to it. Near the *garde général's* house, where we breakfasted, we saw some Australian *Eucalypti* growing, and also our old Indian friend the loquat (*Photinia japonica*). From the ridge near the house we had a magnificent view towards the north-west; but we were unfortunately prevented by heavy rain from attempting to ascend the neighbouring high peak, which we should have very much liked to do. After breakfast, and a conversation by means of the telephone with some of the guards in distant parts of the forest, we drove by another road to St Raphael, where we saw many gum trees in flower, and also a clump of bamboos, not unlike the small species (*Arundinaria falcata*) which grows on the Siwalik Hills to the south of Dehra Dun. We passed the night at Nice; and after a day spent in well-earned repose, which included a visit to the bank in order to replenish the purse, and to the conservator to pay our respects, we took train to Nismes, a journey of some fourteen hours by rail, where we spent Sunday morning, reaching Alais, at the foot of the Cevennes, during the evening.

The Cevennes.

The forest of Grande Comble, near La Lavade, was next day visited. It is 5000 acres in extent, and is maintained in order to supply props for a neighbouring coal mine. It was formed in 1840 and subsequent years, by grubbing up the shrubs, chiefly heather, burning them as they lay, and sowing cluster pine seed broadcast on their ashes. When the trees had reached the age of thirty years, the crop was clean-felled; and the ground then became covered with self-sown seedlings, but seed was scattered where it was thought that their number was insufficient. The trees are now, therefore, about fifteen years old, and they are cut when they have attained a girth of from 15 inches to 3 feet, which is the size of which mine-props are required to be. Formerly the lower branches of the pines used to be pruned off in order to reduce the amount of combustible material near the ground; but this practice has been abandoned, as it was found to interfere with the development of the trees; and there is not much risk of fire, against which other precautions are taken. A plaster model of the forest was exhibited, and the coal mine was also inspected, after which the party travelled by train to Genolhac, higher up the valley. This was the first railway made in France, and it is still the only line of traffic, for there are no cart roads. It was constructed for the export of produce from the iron, coal, and sulphur mines, of which there are here a considerable number. We were told that mine-props are brought by train from the Landes, and sold at Alais at the extraordinary low price of 3½d. per running metre. It is difficult to understand how it can pay to bring them so far for sale at such a price. The railway to Genolhac winds through the Cevennes mountains, and rises very rapidly, the scene reminding us of parts of the Himalaya, and the stream-bed filled with silt telling its own tale of the denudation of the hills through which it runs. There are terraced fields, with chestnut and other fruit trees growing on the steep ground between them, which is supported in places by small, rough, dry-stone retaining walls; but, except in one or two places near Genolhac, there are no forests to be seen.

The 5th of May was the last day of our tour. We rose early, and accompanied by M. Dhombres, the conservator, and MM. Fabre and L'Abbé, the inspector and sub-inspector, commenced the ascent of Mont Lozère, to visit the afforestation works going on there. Four ponies were brought for the elders of the party. They were about fourteen hands high, framed like little cart-horses, and were models of what a hill pony ought to be. One felt that one's weight was a mere trifle to them, and they were as sure-footed as mules.

Regarding the climate of these mountains generally, it may be said that there is little or no rain from February to September, the heat and drought during the height of summer being very great, and the temperature rising to 104° Fahrenheit. Then, in September, there are hurricanes of wind, followed by deluges of rain, the average annual fall being 80 inches. These storms are said to be caused by the meeting of moisture-charged air currents from the ocean and the Mediterranean; they burst with great violence, occasionally as much as 18 inches of rain falling within a single period of twenty-four hours.* Such a flood as this washes down the hillsides, and the streams rise with incredible rapidity, causing great loss of life and property. If it be added that large droves of sheep are annually brought up from the hot southern plain to graze in these hills, it will not be hard to understand that overcutting of the forests, which once clothed the mountain slopes, has led to their almost complete disappearance; and it is on this account that the works we were about to visit have been undertaken. That the forests remained as long

* It is said that in 1866, 18 inches of rain fell at Bleymard in twenty-four hours, the total fall during three successive days being 24 inches.

as they did, is probably due to the fortunate circumstance that the people about this region do not keep goats. With this latter exception, the conditions resemble very closely those met with in many parts of India, and the visit was a particularly instructive one to us on that account.

It is said that the works have already had an influence in reducing the amount of silt carried down by the rivers, and in improving the water supply in the hills. Before 1860, when they were commenced, there were very few trees left, the soil being shallow and almost entirely deprived of vegetable mould. The cluster pine was at first sown broadcast up to an altitude of 1800 feet, which is the limit of its growth as a good-sized tree in this locality. The seedlings grew well for a time, but they met with a severe check in consequence of a series of cold winters, and lately a mixture has been introduced by planting Spanish chestnuts.

The path from Genolhac to the summit of Mont Lozère is 8 miles long and 7 feet wide, having an uniform gradient of 7 in a hundred. It cost £200 a mile. After following this path for some distance, we crossed a torrent, which a few years ago threatened to do much damage. It is not sufficient in a case of this sort merely to sow seeds on the ground ; for success is impossible unless the slipping and falling away of the soil is first arrested. In 1875 dry-stone walls were therefore built across the bed, the loose soil near the head of the ravine being retained in its place by smaller walls, and by fascines picketed down, with young trees planted behind them. Acacia and alder were also planted behind the larger works, and they have succeeded admirably ; but unfortunately a portion of the head of the torrent is situated in private property, and on this account it has not yet been taken in hand. A slope was pointed out to us on the opposite side of the valley, where the loose surface had been fixed by planting broom in lines.

On rising to a height of 2300 feet, we found ourselves above the limit of the cluster pine, which here had a very stunted appearance. The ground had been sown with *Pinus montana*, mixed with a few Scotch pines, *Laricio* *des Cevennes* and Austrian pine, which would be properly located on limestone not on granite, and with oak (*Q. sessiliflora*), the acorns of the latter being deep-sown, in order to protect them from frost and rats. We had been passing through a private estate; and as we entered the Government forest we were struck with its much better condition, due to the needful thinnings having been made among the pines, which do not thrive when grown in dense masses; they had been too long neglected in the private forest, and the young trees had suffered much from this cause. Here the seed from which the wings had been broken off was sown broadcast during the winter; and having been protected from extreme cold by the snow, it came up in the spring. We saw a small nursery of Austrian pines, which are to be used lower down, and some plantations of Scotch pine, larch, and birch. The plants are not put out in lines, but are inserted wherever sufficient soil can be found for them; in some places oak had been sown in patches and pine broadcast. At an altitude of about 4000 feet, we entered a natural beech forest, which, before protection was commenced, had been ruined by pasture and over-cutting; when we were there, however, it was throwing up some good coppice-shoots, and will some day again be valuable. Higher up, on an exposed but gentle slope, we came upon a plantation of beech and silver fir (both species of heavy cover) made in open ground without any shelter. This is an experiment only, and its success is not certain; but the sowings have been managed in a very ingenious manner, and it seems quite possible that, in the moist atmosphere at this altitude, they will be successful. Holes 2 feet by 1 foot, and 2 feet deep, were dug, and then half-filled with loose earth, a shelter being made on the south-west side by building up the turf with some stones in the form of a little roughly made wall. The seeds were sown in this corner of the hole, and the young plants grow up under shelter of its sides, and of the little wall at the surface, until they are five years old. All this time the tops are appearing outside the holes, and are somewhat exposed to the sun; but as the roots are far down, in, comparatively speaking, moist soil, and as the stems are also protected by the sides of the hole, the seedlings do not suffer much from the want of overhead shade. But this locality is subject to a most bitterly cold north wind, which blows with terrific force over the open ground ; and, in order to protect the tops of the young plants from its influence, the stone and turf walls are, at this stage, shifted round to the north sides of the holes. The young trees thus treated are now making good progress. This system might advantageously be tried for sowing deodar on exposed slopes in the Himalaya. The soil on Mont Lozère is so friable and loose that, even close to the crest of the hill, where the slope is very gentle, there are signs of the formation of ravines, and it has been necessary to erect some stone walls in order to arrest their progress.

We breakfasted in the forest house at an altitude of 4500 feet, where the snow was still lying on the ground in patches. The house is built in the form of a round tower, with very thick walls, in order to resist the force of the wind; from its windows we obtained a magnificent view across the valley of the Rhone to the Alps near Grenoble, the snow-capped Mont Ventoux standing out in the foreground.

After breakfast we visited a beech nursery. The seedlings are protected from the sun by straw screens during the first year, but are completely exposed during the second and third years; they are pricked out a year afterwards, and planted at the age of five years. We then ascended to the summit, where planting work was going on, at an altitude of 5000 feet, in the peaty soil just below it. There is no doubt whatever that in former years this mountain was covered with large silver firs; their stumps are still found buried in the peat, and there are large beams of the wood in some of the houses. The disappearance of this tree is to be accounted for by over-felling, which led gradually to the establishment of a pure beech forest, while uncontrolled grazing completed the extermination of the fir. It is now desired to reintroduce a mixture of the two species. When we were there the beech were being put out, the plants being carried up in baskets from the nursery near the house; the fir will be introduced subsequently. The holes are dug by a gang of men working with a very handy implement, something like a mattock, one blade of which is a pick and the other a turf-cutter. The men are followed by women, who put in the seedlings, which are very deeply planted, the earth covering a considerable portion of the stem, in order to protect it from exposure; little walls of turf and stones, similar to those previously described, being made to protect the plants from the wind. A previous attempt to plant *Pinus montana* on this ground failed entirely. On our way back to Genolhac we saw a place where the broom was being cut down in horizontal bands, in order to admit of the ground being planted up. We also observed another locality, at an altitude of 2000 feet, where the cluster pine, aged from fifteen to twenty years, was either dead or dying from want of protection against wind, and *P. Laricio* was being planted to replace it. On the opposite side of the valley, however, it was growing well at the same level, under the protection of a spur; cedar being mixed with the pine in the proportion of one to three. The cluster pine must have shelter from cold winds, or it does not flourish at all. On nearing Genolhac, a factory was pointed out to us in which a silk-dye is extracted from the wood of the Spanish chestnut.

Next day we commenced our return journey, the line of railway passing through the volcanic region of the department of Ardeche, and entering the valley of the Rhone at Teil, whence we passed northwards by way of Lyons and Dijon to Nancy.

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cross-fertilisation by insect agency seldom takes place.

MAP TO ACCOMPANY ACCOUNT OF MAJOR BAILEY'S TOUR IN PROVENCE.

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On the Fertilisation of Epipactis latifolia. By A. D. Webster, Llandegai, Penrhyn.

(Read 12th November 1885.)

Having during the past few years, but particularly the summer of 1885, devoted considerable attention to the above interesting subject, I have thought the following observations not unworthy of record, as contributing to a subject which, as yet, has received little investigation. In the woodlands of this county (Carnarvonshire), where the plant grows in unusual quantity, exceptional opportunities have been afforded me of studying it under various conditions as to soil, altitude, and situation.

All, or nearly all my observations tend to show (1) that *Epipactis latifolia* is very imperfectly fertilised; (2), that, although visited by insects, cross-fertilisation seldom takes place; and (3) that self-fertilisation by the pollen falling spontaneously on the stigma is not uncommon.

1. That the plant is very imperfectly fertilised is evident from the small quantity of seed produced. On examining nearly one hundred plants when the seeds were ripe in October, I was surprised at the small number of capsules produced. (The ovules of unfertilised flowers drop from the plant at an early date, thus affording an unerring guide as to the difference between barren and well-filled capsules.)

I examined nineteen plants growing in consecutive order in one wood, and out of a possible 492 capsules only 38 produced seed. Thinking that perhaps the density of foliage or maritime situation might account for this unusually small production of seed, I examined the plant in quantity in two other warm, shady woodlands, but with almost similar results. Sixteen plants, growing within a short distance of each other, produced only 32 capsules from 516 flowers; while in another wood similarly situated 26 were produced out of a total of 215. This small production of seed, in an unusually fine season like that of 1885, clearly proves that *Epipactis latifolia* is very imperfectly fertilised, and, as will be seen hereafter, that cross-fertilisation by insect agency seldom takes place.

The conclusions naturally arrived at are, that this orchid is more frequently self than cross-fertilised, but when the small production of seed is taken into account, very imperfectly by either method.

2. That, although visited by insects, cross-fertilisation seldom takes place, is proved by the following observations:—Amongst insects of sufficient size to remove the pollinia that I have seen visiting the flowers of this *Epipactis*, I may mention the red-tailed humble bee and our common wasp, the latter, however, but very rarely. On the other hand, the red-tailed humble bee visits the flowers of this plant frequently, but, owing to its peculiar method of sipping the nectar without entering the flower, never removes the pollinia. On August 21, 1885, being in a wood where beds of this plant were in full flower, I saw the above bee enter several flowers on two different plants growing side by side, without in any case removing the pollinia. On the 24th of the same month, and in the same wood, I saw a red-tailed humble bee visit successively no less than sixteen flowers on a spike of this *Epipactis* without removing any of the pollinia. In this case the spike of flowers was so dense that the bee crawled from one to the other in a spiral fashion from bottom to top without once bringing its head or proboscis in contact with the viscid disc at the base of the pollinia. After sucking the nectar from the last flower, it flew off for a few yards, but immediately returned and revisited three of the same flowers, but this time in a half discontented fashion, as if striving to improve on work that had been already well done. Again, on the 26th of the same month, I saw several visit the flowers of this plant (one visited most of the flowers on seven plants in succession) without removing the pollen, although, being near, I noticed them visit numerous flowers that contained the pollen masses. The bees hung on the distal portion of the labellum and inserted their long proboscis without the head coming in contact with the viscid disc. The evening was lovely, and I spent an hour watching the plants, but during that time, although wasps were flying about in number, not one visited a flower. (This certainly was the opposite of what I expected, as several

naturalists are under the belief that this *Epipactis* is constantly fertilised by this insect, one indeed going so far as to say that if wasps were becoming extinct in any locality, so, in all probability, would *Epipactis latifolia.*) On other occasions, however, I did see the common wasp visit several flowers, but the visits were short, and, if I may use the expression, heartless, as if it could derive little therefrom. Owing to their long narrow shape and short proboscis, wasps remove the pollen masses with ease, for I have caught them immediately after coming out of the flower with the pollinia attached to their head; but as these visits are few and far between, fertilisation by this way is of rare occurrence. In numerous instances, also, the pollen masses will be found glued to the upper sepal of the flower, which is done as follows:—The wasp on entering, particularly a newly-opened flower, gets the pollinia attached to its head when sucking the nectar; but immediately on entering another flower, the upper sepal is so situated that the sharp stiff edge comes in contact with the viscid substance, which, with the pollinia, is left attached to it. This, I have never seen take place, but repeated experiments bear out the statement. It is also readily illustrated with a pencil. In various other parts of the plants it is not uncommon to find the pollen masses attached as if the discs were not sufficiently viscid to retain their hold on the insect's head, and on more than one occasion I have found them unbroken, on their stigmatic surface. Small insects also visit the flowers in numbers, as I have watched them creeping about within the labellum and other parts; but in numerous instances many of those which come in contact with the viscid stigma are unable to free themselves, and so perish. The largest insect that I have seen killed in this way was $\frac{3}{16}$ of an inch in length. When the plants begin to wither, or immediately after fertilisation takes place, the distal portion of the labellum curves upwards, and effectually closes the entrance to the basal portion or nectary, but for what end I am unable to say.

3. That self-fertilisation by the pollen falling spontaneously on the stigma is not uncommon. I have frequently observed that the pollen masses in a few days,

or perhaps a week after the flowers open, become swollen, or the particles of pollen disunited so as to protrude slightly beyond the sharp upper edge of the stigma. At the same time, or later on, the pollen becomes remarkably friable, and before the plant withers, either spontaneously or by the action of the wind, falls on the stigma and other parts of the flower. The peculiar position of the pollen masses—hanging directly above the stigmatic surface—ensures this the more readily. That the pollen masses become detached and fall apart is beyond dispute, as I have on many occasions found the grains scattered over the leaves, flower, and stem of the plant, as well as, in one or two instances, noticed the pollen masses still within their cells, but with the corners broken off and lying on the stigmatic surface. This breaking up of the pollen masses may be spontaneous, but it is materially assisted by both wind and rain.

On examining numbers of the plant, I have found it a general rule that the entire pollinia, or a large part of them, have not been removed from such flowers as bear well-filled capsules. Now this of itself seems to me to indicate self-fertilisation by particles of the pollen falling on the stigma, for it is quite evident that if wasps (the only insect, so far as is known, that in this country does fertilise the plant) visited and impregnated the flower, they could hardly have avoided removing the pollinia. To make sure, I examined several withered flowers with swollen ovaries on different plants, and was surprised to find that in most cases remnants of the then musty pollen could be distinctly detected within the shrivelled anther.

After reading the above remarks, one is naturally led to ask:—Why, if *Epipactis latifolia* is so imperfectly fertilised, is the plant so abundant?

This I can only answer as follows:—(1) Nature, as if to make up for the small production of seed, has endowed this plant, unlike the generality of our native orchids, with special facilities for the perpetuation of its race. The original roots do not, as in most other orchids, die off annually, but serve for collecting nutriment for the succeeding plant, the eye or bud of which is formed close to the old or last year's stem. At times the plant produces several of these eyes in one season; indeed, during the present summer, I counted sixteen and twenty-six flowering stems on two plants, and it is not at all uncommon for three or four stems to be found attached to the same plant. (2) Each capsule (judging by the number in the almost equally sized *Cephalanthera grandiflora*) will contain about 6000 seeds, so that even if one only were produced on each plant, it would be more than sufficient to keep up the stock.

In conclusion, one cannot but wonder how remarkable it is that the nectar of *Epipactis latifolia* should be so highly attractive to the red-tailed humble bee, that cannot fertilise the flower; while to the wasp, that can remove the pollen masses with ease, and thereby insure cross-fertilisation, it offers but little attraction, as is clearly shown by the almost total absence of its visits. I have mentioned above, that, under certain conditions, the roots of this plant produce eyes or buds, but, strange as it may appear, this is not the case in all, for I have examined numbers without any such means of reproduction. In many instances also, indeed it is the general rule in this district, that the plant in question is destitute of a rostellum, the viscid matter at the base of the pollinia being free or uncovered, thus imitating in structure the degraded and self-fertilised *Cephalanthera grandiflora.*

Now, can it be that *Epipactis latifolia*, from not being sufficiently attractive to insects, or from the want of proper insects in this country to fertilise it, is gradually becoming modified, and propagation by increase of the root slowly but surely taking the place of seed, or at least materially assisting to prevent the extinction of the plant, as would in all probability result from the present imperfect fertilisation and subsequent small production of seed? This is rendered all the more probable by the curious fact that, in most if not all of our native orchids that are either partially or wholly self-fertilised, nature, as if to make up for the small production of seed, has endowed them with special facilities for perpetuation,—namely, by increase of the root.

Take the example of *Neottia nidus-avis*, which is very imperfectly cross-fertilised, but in which nearly all the rootlets produce young plants; also that of *Epipactis latifolia*, which, under certain circumstances, behaves in a similar manner. Again, *Ophrys apifera*, which is perhaps the most noted example of constant self-fertilisation in British Orchideæ, is well known to appear and disappear somewhat mysteriously from certain localities, by the young tubers increasing beneath ground until of a flowering size; *Cephalanthera grandiflora*, which is fertilised in the bud state by the emitting of tubes from the pollen grains, also increases by the root, but of this rare species I am able to give little original information.

Report on the Excursion of the Scottish Alpine Botanical Club to Killin and Loch Awe in 1885. By William Craig, M.D., F.R.C.S.Ed., F.R.S.E.

(Read 11th March 1886.)

The annual excursion of the Scottish Alpine Botanical Club in 1885 was to Killin and Loch Awe. The following members were present during the whole or part of the time:—Professor Dickson, President; Mr W. B. Boyd, Vice-President; Rev. George Alison, Chaplain; Dr Aitken, Minstrel; Dr Craig, Secretary and Treasurer; Rev. David Paul, Dr Stuart, Mr Archibald Gibson, Mr G. H. Potts, Mr A. H. Evans, and Mr Robert Lindsay. There were also present as visitors at Loch Awe, Mr James B. Gibson, Glasgow, and Rev. W. W. Peyton, Broughty Ferry. The latter is an experienced alpine climber and an excellent geologist.

The Club arrived at Killin on Thursday, 30th July 1885, and took up their quarters as usual at Cameron's Bridge of Lochay Hotel, the favourite resort of botanists, and specially of the Scottish Alpine Botanica Club. The formation of the Club took place in this hote in 1870.

Friday, 31st July.—After an early breakfast, the members of the Club drove to Lawers Inn, where we left our conveyance, and immediately commenced the ascent of Ben Lawers, the *eighth* highest mountain in Scotland, but undoubtedly the richest in botanical treasures.

The morning being misty, and the grass wet with dew, we made the ascent as far as Lochan a'Chait by the "old peat road." On a steep bank on the west side of Lawers Burn we gathered beautiful specimens of Digitalis of a cream colour, and some pure white—probably the very bank on which Mr M'Nab, in an excursion with the late Professor Graham in 1839, "found a beautiful cream-coloured variety of *Digitalis purpurea*, a little way above Lawers Inn, by the side of a stream," and recorded the same in the first volume of the *Transactions* of the Society.

By the time we reached Lochan a'Chait the mist had cleared away, and the day had become exceedingly hot, with a burning sun over our heads. This rendered alpine climbing somewhat uncomfortable, and we were glad occasionally to get under the shade of the rocks, and on our way to the summit we found the large patches of snow most refreshing and cooling. Upwards of twenty patches of snow were observed on this side of the hill, some of these many feet deep, and covering several acres.

The whole party reached the summit in the course of the afternoon, and were rewarded with a magnificent view.

We found most of the good plants known to grow on Ben Lawers, including *Cerastium alpinum*, L.; *C. latifolium*, Sm.; *Sagina Linnæi*, Presl.; *Potentilla salisburgensis*, Hænke; *Saxifraga nivalis*, L.; *S. cernua*, L., one specimen of which was in flower; *Erigeron alpinum*, L., in fine flower; *Trientalis europæa*, L.; *Myosotis alpestris*, Schmidt (many of the ravines were exquisitely beautiful with this, the prettiest of all our forget-me-nots); *Juncus triglumis*, L.; *J. biglumis*, L.; *J. castaneus*, L.; *Carex pulla*, Good.; *Cystopteris montana*, Link.; and *Aspidium lonchitis*, Sw. A plant of the last, with very broad pinnæ, was also gathered.

Another excellent find was *Cystopteris montana*, in fine condition, and in considerable abundance. It was on Ben Lawers that this beautiful fern was first discovered in Britain in 1836. It has occasionally been gathered since on Ben Lawers, but the station was known only to few, if at all, and certainly it was not known to any member of the Alpine Club. This was one of two plants whose locality on Ben Lawers the late Mr Sadler was never able to find, though he had often searched for it. I have no means of knowing whether this was the original station or not.

Next day, Saturday, 1st August, our excursion was to the head of Glen Lochay. After a drive of 8 or 10 miles up the glen, we divided, one part examined various corries on the mountains dividing the Lochay from the Dochart, and found several good alpine plants, including *Dryas octopetala*, L.; *Saxifraga nivalis*, L.; *Saussurea alpina*, DC.; *Arctostaphylos Uva-ursi*, Spreng.; *Bartsia alpina*, L.; *Salix reticulata*, L.; *Listera cordata*, Br.; *Juncus biglumis*, L.; *Carex pauciflora*, Lightf.; *C. atrata*, L.; and *C. capillaris*, L. The other members explored the rocks on the Lyon side of the Lochay, and found many good alpine plants, including *Cystopteris montana*, Link., in fine condition, and *Juncus castaneus*, L., very fine. No trace of *Woodsia hyperborea* was seen by either party, although on a previous occasion it was observed by both parties in considerable quantity. The day was very warm and sunny.

On Monday, 3rd August, Mr Paul and Mr Evans went again to Ben Lawers, specially to search for *Arenaria hirta*, Wormsk., and *Sagina nivalis*, Fries, both of which plants they succeeded in gathering. The day, however, on Ben Lawers was stormy, and our two friends encountered several showers of rain and hail. They rejoined the other members of the Club in the evening at Loch Awe.

The other members of the Club removed to Loch Awe, where we were most comfortably entertained in that most charming hotel known as the Loch Awe Hotel.

After luncheon we visited the ruins of Kilchurn Castle and the banks of the Orchy. The day was fine, and the water of the loch was very low. Amongst the plants gathered may be mentioned—*Nymphæa alba*, L., specimens of which we found on ground quite dry, owing to the long period of dry weather experienced last summer;

Chrysanthemum parthenium, Pers., abundant on the ruins of Kilchurn Castle; *Meum athamanticum*, Jacq., abundant on the banks of the Orchy; *Jasione montana*, L., and *Carex vesicaria*, L.

On Tuesday, 4th August, the Club visited Beinn Laoigh, a mountain on the confines of Argyllshire and Perthshire. It is 3708 feet high, and is the twenty-fifth highest in Britain. This hill is rich in alpine plants, many of which were gathered on this excursion. I shall only mention a few—*Pyrola rotundifolia*, L.; *Bartsia alpina*, L.; *Juncus castaneus*, L.; *Carex vaginata*, Tausch; *Carex saxatilis*, L.; *Hymenophyllum unilaterale*, Willd.; *Cystopteris montana*, Link, in great abundance; and *Aspidium lonchitis*, Lev. The chief find of the day was a crested variety of *Aspidium lonchitis*. Three such plants were found all growing near each other. In all the three plants every frond was crested, and even the old withered fronds of previous years had also been crested. In these circumstances, we have reason to hope that the variety will be permanent. So far as I am aware, these are the only plants of the holly fern that have been found crested. One of the plants is at Faldonside, and the others at the Royal Botanic Garden.

On the way back to Loch Awe, some of the party gathered, in the old churchyard at Dalmally, *Inula Helenium*, L.

On Wednesday, 5th August, our excursion was to Ben Cruachan, a mountain 3689 feet high. On a previous occasion the Club explored the large corry on the east side of the mountain, from which flows the Allt Mhoille. To-day we accordingly resolved to explore a smaller corry on the west of the great corry, from which Allt Coire Ghlais flows. The day was very hot, and we had a stiff pull, after we left our hotel, till we got over the steep shoulder of Ben Cruachan, called Monadh Driseag, about 2000 feet high. After we got into the corry, we found it most unproductive. The best plants collected were—*Sedum Rhodiola*, DC., with variegated leaves; *Saussurea alpina*, DC.; *Hieracium alpinum*, L.; var. *holosericeum*, Buckh., this variety is not common, and was the best find of the day; *Vaccinium uliginosum*, L.; and *Hymenophyllum unilaterale*, Willd.

On Thursday, 6th August, several of our number left for home, whilst those that remained resolved to have an easy day, sailing and botanising the sides of the loch. One party, headed by the President, went with the steamer as far as Portinisherrich, and securing a small boat at the inn, visited Eilean nam Meann, a small island on which are the ruins of a fine old castle. The ruins are grand, and well worth a visit, but we had not much time to examine the botany of the island. We saw abundance of *Chrysanthemum parthenium*, Pers.; and on the walls of the ruins very fine specimens of *Asplenium trichomanes*, L. The castle is considered to have been an early stronghold of the Campbells of Argyll. On a bank at the side of the loch, just opposite the inn, we saw a quantity of a large *Malva* in a semi-wild condition. This party returned with the steamer in the afternoon.

Another party, headed by the Vice-President, botanised the woods on the shores of Loch Awe, from the hotel towards the Pass of Brander. Amongst the plants collected may be mentioned—*Hypericum Androsœmum*, L.; *Malaxis paludosa*, Sw.; several varieties of *Lomaria spicant*, Desv.; and several good plants of *Nephrodium Oreopteris*, Desv., in which each pinna ended in a point or horn. Mr Boyd found six or eight plants with all the pinnæ in this abnormal condition. This variety is called by some botanists *Nephrodium Oreopteris*, var. *truncata*.

One of the plants found on Ben Cruachan was apparently a seedling of *Ajuga reptans*, with variegated leaves. This plant is growing in the Royal Botanic Garden, and the species will be correctly determined when the plant flowers.

On Friday, 7th August, the members of the Club left Loch Awe for their several destinations, and this virtually ended a pleasant excursion, and one which was not without interest to botanists.

On the Growth and Fertilisation of Cypripedium Calceolus.

By A. D. Webster, Llandegai, Penrhyn.

(Read 8th July 1886.)

The following notes have been made at various times as opportunities offered over a period of several years, but principally during the present season, as exceptional opportunities were afforded me of studying the plant in a semi-wild state. Nearly two dozen flowers were produced by established, out-door specimens of this Cypripedium and its near American ally *C. parviflorum* (some botanists consider the latter a continental variety of *C. Calceolus;* and as regards structure, mode of growth, and time of flowering, the two are nearly identical). Two strong, healthy plants that had been established for several years were marked off for investigation as regards time of appearing, rate of growth, period of flowering, and method of fertilisation ; and the following diary, kept from the time the buds appeared above the ground until the flowers had withered away, may be useful in following out the life history of this singularly interesting plant. The bud, remarkably plump and healthy looking, appeared above ground on 19th April 1886.

On 26th April it was $2\frac{1}{2}$ inches high, the weather during that time being very favourable for growth, with warm, sunny showers. On 3rd May the height was $4\frac{3}{4}$ inches, and the leaves were beginning to open out from the stem. On 10th May it was 8 inches high, and thus showed a growth of $3\frac{1}{4}$ inches in six days.

At this stage the lower leaves were almost perfectly developed and the flower bud visible. On 17th May the height was 9 inches, the leaves being fully developed, and the flower bud plainly visible. On 24th May the full height $12\frac{1}{2}$ inches was attained, at which period the flower was fully developed and half open. This was the greatest rate of growth during any week, although only one-quarter inch more than during the six days from 3rd May to 10th May. During the five weeks from 19th April, when the bud first appeared, until 24th May, when the plant and flower was fully developed, the weather was satisfactory for growth.

The flower remained open for twenty days, or until 12th June, when it collapsed.

Fertilisation.—As regards fertilisation, I may state at the outset that no native orchid on which I have experimented is more difficult to understand, or has more completely baffled my observations than this. That Darwin's description of the wonderful manner in which the pollen of this orchid is removed by insects is true, I am, however, well able to corroborate, for on several occasions I have seen insects visit the flower by the large opening in the labellum, and after repeated failure to get out by the same way, owing to the inflected edges, at last force themselves out by one of the two orifices close to the anthers, and in doing so their backs were smeared with the glutinous pollen.

This part of the work, the removing of the pollen, is neatly enough performed, but how the pollen is to be brought in contact with the stigma has puzzled me greatly. It is quite evident that unless the same insect visits another, or revisits the same flower, fertilisation cannot take place, and from all my observations that such is likely to occur is very improbable, although by no means impossible, for the following reasons:—

1. The difficulty of escape experienced by an insect that visits the flower.

2. Only those insects which experience the greatest difficulty can remove the pollen.

1. When an insect of sufficient size to remove the pollen enters the labellum of the flower by the large opening at the top, I have invariably noticed that its first aim is to escape again, for a search after nectar seems out of the question. In all cases that have come under my own notice, the insect first tries, for several times in succession, to escape by the way it entered, but the edges of the labellum are incurved, and the numerous fine hairs within the flower are pointed downwards from the edges on each side, so that escape by scaling the sides is well-nigh impossible. I have seen on different occasions several insects, after much labour, ascend the edges of the labellum, but when they came to the incurved edges, which may be considered the special barrier, back they fell into the bottom of the labellum. I have seen this repeated several times by the

same insect, until, tired and disgusted, the attempts to escape by this way were given up. Next, the insect, allured, no doubt, by the light emitted through three colourless, almost transparent lines at the upper end of the labellum, crawls towards these, but by this way also finds escape out of the question. These light lines, however, have conducted the insect to near the upper end of the labellum, and within a short distance of the two small orifices, situated one on either side of the anthers. A rush is now made for exit by this way, and as the hairs here point in the opposite direction to those on the flat sides of the labellum, the insect crawls easily up to the small orifice, and after two or three attempts forces its way out. In so doing it becomes smeared with the pollen, with which it inevitably comes in contact, the anthers being placed directly above the small orifices and under the stigma.

The pollen is so sticky and the orifices so small that insects (small bees excepted) which come in contact with the former are frequently unable to free themselves, and so perish. Again, I have frequently found insects, that were of too large a size to escape by these orifices, dead within the labellum.

Now, from these observations, it is hardly to be expected that an insect, after once experiencing the difficulty of escape from the labellum, would turn round and revisit the same flower or that on another plant; indeed, in all the instances that have come under my own notice, the insect's escape from this temporary prison was quickly followed by desertion of the locality in which the plants grew.

That cross fertilisation is thus effected to any great extent I cannot think; and although Darwin and others have seen insects visit the flowers of this Cypripedium, and escape with pollen attached to their back, it is not on record, and I believe no one has yet seen the same insect visit another flower or revisit the same one. The temptations for insects to visit the flower are, likewise, small indeed, for I have frequently watched for hours, during bright sunny weather, when insect life was abundant, their visits to the various alpine plants growing in close contiguity, but rarely did one approach the score of

Cypripedium flowers in full bloom. Occasionally I have seen insects alight on the labellum, but the temptations to enter the flower must have been few, to judge from their speedy departure.

2. Only such insects as experience the greatest amount of difficulty in escaping from the flower can remove the pollen.

When small insects, even up to the size of our common brown ant, enter the flower, and creep out again by either of the orifices near the anthers, their backs will not come in contact with the pollen, as the distance between this and the portion of the labellum on which they tread is too great, being in most specimens that I have measured one-eighth of an inch.*

Small bees, such as the sand wasp and others, are of the size to remove the pollen, but then the difficulty they experience in escaping is great. I have placed several of these within the labellum of the flower, and saw them force their way out besmeared with the pollen, but usually a good deal of time and great effort is expended in thus effecting an escape, and, to my mind, impresses the insect with the idea not to venture into such a trap again.

From all my observations then, I incline to think that but little temptation to visit the flower is offered to insects, and that from difficulty of exit, insects which have once entered this prison chamber, are not likely to do so a second time. But it may be asked, If the fertilisation of *Cypripedium Calceolus* is so imperfectly performed, how is the plant so abundant on the Continent? To this I would reply, that, like *Epipactis latifolia* (about which I had the honour a year ago of contributing a paper to the Society), Nature, as if to make up for imperfect fertilisation, has endowed this plant with a peculiarly safe method of reproduction, viz., by increase of the root; for, when favourably situated, established plants of this Cypripedium increase rapidly, single crowns soon spreading over a wide area.

* A specimen, with the glutinous pollen attached, was sent for identification to Professor Westwood, who named it *Syrphus syzittapipiens*, Linn.

Carex helvola, *Blytt*, *in Scotland.* By Arthur Bennett, F.L.S.

(Read 13th May 1886.)

While examining specimens of *Carex curta* var. *alpicola*, to try and clear up the question whether we possess the true *C. vitilis*, Fries, in Britain, I was much struck with the habit of a specimen so named from Lochnagar, which was sent me some years ago by Mr F. M. Webb, who was then curator of the Edinburgh Herbarium. On dissecting this specimen, and comparing it with my continental Carices, it seemed to match the above named species of Blytt. To make sure, I split the specimen, and sent Dr A. Blytt of Christiania half the example, and his answer was very satisfactory:—"The specimen of Carex you sent me belongs, no doubt, to *Carex helvola.* This specimen is rather scanty, and you ought to look for better ones at the locality where it was found by Professor Balfour. *Carex helvola* is rather common in the Norwegian highlands, and ought to grow also in the Scotch, the flora of which is so very like ours. It has not been found with ripe seeds with us, and is perhaps a hybrid."

The specimen was undoubtedly scanty, but unavoidably so. The label of the specimen runs thus:—

"1433 *b* *Carex curta β alpicola*, Wahl.
C. vitilis, Fries (Bab. Man).
Loch-na-Gar.
Coll. 11 Aug. 1846.
Prof. J. H. Balfour. F. M. W."

Mr N. E. Brown, of the Kew Herbarium, writes me that there are two specimens from "Ben-muic-Dhui," which may be *helvola*, but he has not yet dissected them.

There is also a small specimen on a sheet of *Carex lagopina* in the Edinburgh Herbarium, gathered by Dr Boswell (Syme), which is probably *helvola*, but it is gathered without roots, and is young.

I give a few references and its principal continental distribution. It is also given for the "Rocky Mountains" with a query, in Mr Bailey's list of North American Carices; but it is not contained in a very complete set of Canadian Carices I owe to the kindness of Professor Macoun:—

Carex helvola, Blytt, in Fries' *Nya Botaniska Notiser*, 1849, p. 58.
Andersson, *Scand. Cyperaceæ*, p. 61.
Blytt, *Norges Flora*, p. 188–9, and Supp., p. 1254.
Hartman, *Handbok i Skan Flora*, ed. 11 (1879), pp. 471–2.
Nyman, *Conspectus Floræ Europææ*, p. 778.
Flora Danica, Supp., t. xxxii.
Herb. Normale, f. xiii. n. 85.
Carex tetrastachya, Transt. ap. Saut in Flora, 34 (1850).
Norway. North and Middle Sweden. Finland. Silesia. Tyrol.

In habit the plant is not unlike *C. microstachya*, Ehr., connecting in some degree the aspect of *C. lagopina*, *C. alpicola*, and *C. heleonastes.*

The growth of the rhizome is very characteristic, and if gathered with good roots, that alone is a good distinguishing character.

It must be remembered that Professor Balfour gathered this three years before Blytt described the species, and that of British plants *alpicola* was the nearest in aspect.

I trust that any botanist that visits Lochnagar this coming summer will search carefully for the plant; which should be looked for about the corrie of Loch-an-ean, in the neighbourhood of which *C. lagopina* grows. I would suggest also that likely localities are Ben-muic-Dhui, Ben Avon, Braemar, Ben-a-Buid, and perhaps Cairngorm.

On a Method of Transmitting Living Plants Abroad. By R. Lindsay, Curator, Royal Botanic Garden.

(Read 13th May 1886.)

The method usually adopted in transmitting living plants, particularly where very long journeys have to be undergone, is to pack the plants in Wardian cases, *i.e.*, cases fitted with glass sashes, which, when closed, are nearly air-tight. This is no doubt the best mode of conveying plants safely, provided they are properly attended to on the journey. To do so it is almost necessary for some one who understands the requirements of plant life, to take charge of the case, as, when sent without any special attention being paid to them, the results are frequently unsatisfactory. The dangers attending such structures appear to be want of ventilation and shading. The plants soon become drawn up and weakly in the steamy atmosphere of a close-fitting case, and often arrive at their destination in a dying or dead condition.

One of the most successful importations of plants that I recollect having seen was contained in a small wooden box sent to the Garden from Australia by Baron von Mueller, in 1866. The plants had been over three months on the journey, but were found to be in perfect health on their arrival at the Garden. This result we attributed chiefly to the simple manner in which the case was constructed. It consisted of a rough square wooden box, filled with soil, into which the plants (which had previously been grown in pots) were placed; two narrow strips of wood were nailed on to the sides of the box in an upright position, to which a cross-piece was attached, constituting a handle. The whole was then covered with strong cotton cloth, no glass being used. In vol. viii., p. 482, *Transactions of the Botanical Society*, a description is given of this case by the late Mr M'Nab. In July last our associate, Mr Buchanan, desiring to take some economic plants out with him to Central Africa, an opportunity was afforded of making an experiment. This was rendered all the more necessary, as on previous occasions similar plants sent to Central Africa from the garden, packed in Wardian cases, although taken every care of on the way out, were found to be mostly dead on their arrival. On this occasion, a case similar to that now exhibited was prepared. It is 18 inches long, 12 inches wide, 16 inches deep, has a ridge roof with a handle fastened on the top for carrying. The main difference from an ordinary Wardian case is in the substitution of cotton blinds for glass sashes. The blinds are nailed to the top of the ridge and tied down with cords to the sides of the case. The advantage of this method is the admission of sufficient light and air to maintain the plants in a healthy condition; the fine threads of the cloth act as a shade from strong sunshine, and do not admit so much air as to cause the interior to become quickly dried up. The plants sent on this trial consisted of india-rubbers, several tea plants, cinchonas, and ipecacuanha. They were all turned out of the pots in which they had been growing previously, the balls of soil slightly reduced, and then wrapped up tightly amongst sphagnum moss. The plants were then packed in the case firmly, in an upright position, using sphagnum for filling in the interstices. Thin strips of wood were placed across the balls, the ends of which were nailed to a flange inside the case for that purpose, thus preventing the plants from moving, even if the case was turned on end. After being well watered and allowed to settle for a day, the blinds were tied down and the case sent to London to Mr Buchanan He was eighty-two days on the journey, and in a letter to Mr Taylor he reports that all the plants arrived in a perfectly healthy condition, except the cinchonas, and that he had not given up all hope even of them. I may mention that the cinchonas referred to were not very vigorous plants to begin with; they were the best we had at the time, but were merely young seedlings. It would be well to have this method still further tested, either by having a few plants sent to a distance alone, or at all events in charge of some one less skilful in the management of plants than Mr Buchanan. For all but very tender plants (where special provision would be required), I think more favourable results would be attained by the use of a case such as that described, provided it were placed free from danger of sea water getting through the canvas, than if the usual Wardian case were used.

On the Adaptation of Albuca corymbosa, *Baker, and* Albuca juncifolia, *Baker, to Insect Fertilisation.* By John Wilson, University of St Andrews. (Plate XII.)

(Read 8th July 1886.)

Last year Mr Alexander Wilson, the writer's brother, brought a number of bulbs of a liliaceous plant from their habitat near Port Elizabeth, Cape Colony, and during the present summer they were flowered under glass at St Andrews. One was sent to Mr Baker, Kew, who described it as a new species, under the name of *Albuca* (*Eualbuca*) *corymbosa*.*

It may be well to give here a few statistics of growth made by nine plants:—

Average number of leaves on each bulb, 8.
Greatest number of leaves on a single bulb, 14.
Longest leaf, 21½ inches.
Breadth of leaf at base, often ½ an inch.
Average height of whole inflorescence, 13 inches.
Greatest height of single inflorescence, 18 inches.
Average number of flowers in each corymb, 9.
Greatest number of flowers in one corymb, 12.
Length of pedicels, ½–3 inches.
Greatest number of flower-stems borne by one bulb, 3.
Greatest number of flowers borne by one bulb, $10 + 10 + 4 = 24$.

The ground colour of the flowers is pale yellow, deepening into rich golden yellow at the apices of the perianth segments. On the outer side of each segment there is a broad central band of bright green. On the inner surface there is a similarly situated, but not so well defined band. In the fully opened flower the three outer perianth segments spread widely apart. They are then longer than the inner segments, and enclose them when the flower shuts at night and on dull days. At the apex of each of the outer segments there is a pad of tissue, thickest on the inner face (Plate XII. fig. 2, *p.*). A small area of the apex is occupied by minute papillæ. The inner segments remain erect and connivent (Plate XII. fig. 2, *is.*), forming a flask-shaped investment to the essential organs. In some cases, the space between two adjacent segments may be visible throughout their entire length (Plate XII. fig. 2), but, oftener, the margins are so close together that only a

* *Gardeners' Chronicle*, vol. xxvi. July 1886.

slit is left at the mid point. The margins bounding the slit or space are delicate and recurved. The inner segments seen from without are truncated, and have a slight terminal mesial indentation; viewed from within, each of the swollen, cucullate apices is seen to be prolonged downward into a hook-like process, along the outside of which is an area bearing golden papillæ (Plate XII. fig. 3, *is.*). The hooks fit neatly into depressions in the stigmatic surface, but do not adhere thereto. The three outer stamens (Plate XII. figs. 2, 3, *ost.*) are erect, immovable, shorter than the inner stamens. They are more or less aborted; some having pollen, others not. They stand opposite the slits existing between the inner segments, and where the slits are wide the upper portion of the stamens may protrude. The inner stamens are invariably functional. They follow, in part, the curvature of the inner segments, in the hollow of which they lie (Plate XII. figs. 3, 4, *ist.*). The upper part of the filament is broad and strap-like, widening out, and narrowing again a little distance beneath the anther. The basal portion of the filament is very broad, and immediately above this a twisting and puckering takes place, giving rise to a kind of spring (Plate XII. fig. 4, *spr.*), possessing considerable elasticity, and tending to cause the part of the filament above it to move outward. Thus, when an inner segment is pushed backward, the stamen opposite follows it until the limit of elasticity is reached, at about an angle of 45° with the axis of the flower. If not pushed too far, the inner segment reassumes its former position when the pressure is removed. The inner stamens can be pushed backwards as a whole, a hinge-like movement taking place with great readiness at their insertion. This must be done if it is desired to expose the septal glands which lie at the base of the ovary (Plate XII. fig. 5, *gl.*). These glands are hidden by the broadened basal parts of the filaments. The style is prismatic and massive. The stigma is covered with yellow papillæ, resembling those on the perianth segments, but longer. There may or may not be a triradiate or columnar, papillose, axial boss rising above the common stigmatic surface (PlateXII. figs. 5, 6, *pr.*), and passing outward between the deflexed portions of the inner perianth segments. At an early period of development, the inner stamens are held by the cucullate apices of the inner segments, so that, if these be forced backwards, they carry the stamens with them. Afterwards the anthers (which dehisce introrsely) become free, owing to the more rapid growth of the inner perianth segments; but as they still lie against the inner faces of the segments, they are never in contact with the stigma. The flowers are faintly and sweetly scented.

Before the writer's experiments were commenced, he noticed a hive-bee attempt to reach the nectary of an Albuca flower. It first tried to penetrate to it by the openings between the inner segments, and failed. Speedily it discovered the right route. By pushing its head into the cavity formed by the apices of the inner segments, one of these yielded, and the bee entered readily, and was almost completely hidden. It is to be noted that, when a segment is pushed back, the stamen in front of it follows, and allows an insect to pass underneath the anther; the bee therefore emerged, thickly dusted with pollen about the head and back. On reaching another flower, it went at once to the right entrance. Unfortunately, the two flowers visited by the bee were not marked. The hive-bee seems to be about the size of insect fitted to fertilise this Albuca. The pollen carried on the insect's head will come into direct contact with the stigma of the next flower visited, especially if the latter is provided with the central prominence. The pollen on the insect's back will be deposited on the papillose area of the inner segments, which, on returning to their natural position, may convey it to the stigma. It must, however, be pointed out that, by the latter method, the carried pollen may be mixed with the pollen left by the insect in its retreat from the flower which is being visited.

With the view of demonstrating the adaptation of the flowers to cross-fertilisation, many experiments were made, the results of which are given in the table on next page.

It will be observed that the averages are unfair as regards exact comparison, inasmuch as the number of flowers used in the different series vary. The most unlooked-for case is in Series I., viz., the appearance of a fine capsule of perfect seed as the result of self-fertilisation with presumably inferior pollen. In face of the fact that the other two flowers treated in the same manner were not fertilised, and that no corresponding success is found in Series II., III., or IV., it seems extremely probable that an accidental cross had been effected with prepotent pollen from a distinct plant. On

Results of Experiments with Albuca corymbosa, *Baker.*

	No. of flowers fecundated.	No. of flowers unfertilised.	No. of flowers fertilised.	No. of seeds in the capsules.	Average No. of seeds in the capsules.	No. of seeds which germinated.	Average No. of seeds which did not germinate.
I. Pollen from semi-aborted (outer) stamens of the same flower, . . .	3	2	1	98	98	96	2
II. Pollen from semi-aborted (outer) stamens of flower of distinct plant, .	5	3	2	35, 87	61	32, 84	3
III. Pollen from fully developed (inner) stamens of the same flower, . . .	9	7	2	35, 73	54	34, 58	8
IV. Pollen from fully developed (inner) stamens of different flower on the same plant,	2	2	...	...	...	...	...
V. Pollen from fully developed (inner) stamens of flower of distinct plant, . .	12	2	10	103, 96, 91, 84, 72, 75, —, —, 112, 110	93 (nearly)	99, 91, 85, 79, 70, 74, —, —, 107, 109	3·6

the other hand, it must be remembered that exceptional cases occur. In Series II. the number of unfertilised is also larger than that of fertilised flowers. The seeds in both capsules are good, only three in each failing to germinate. In Series III. the number of unfertilised flowers, as compared with the fertilised, is very large, being 7 to 2, and from the larger capsule fifteen out of seventy-three seeds do not germinate. This series bears most significantly on the question of the cleistogamy of the flowers. Series IV. might have been expected to give other results. It is in Series V., as contrasted with Series III., that the crucial test lies. Of 12 flowers, fecundated with pollen from the functional stamens of distinct plants, only 2 are unfertilised, whereas where self-fecundation is resorted to, 7 out of 9 are unfertilised. Again, comparing the fruit in the two series, that of the former is of more uniform and greater excellence. The two capsules wanting in that series were good. One was sent to Mr Lindsay, curator of the Royal Botanic Garden, Edinburgh, and the other to Kew. Before being sent, 51 seeds were taken from the latter, and of them 49 germinated. The high vitality of the seeds in Series V. is obvious, the average number of ungerminated seeds in each of the eight pots being only 3·6.

The conclusions to be drawn from the experiments are briefly as follow:—(1) that the pollen borne by the half-aborted anthers *may* sometimes be potent, either to fertilise the same flower (?) or the flowers of a distinct plant; (2) that the pollen of the truly functional stamen of one flower may often be impotent as regards its operations on another flower of the same plant; (3) that self-impregnated flowers are almost invariably sterile; (4) that cross-fecundation almost always results in fertility.

A severe blow is dealt at the theory of the cleistogamy of this Albuca, by the fact that out of 97 flowers the 63 unimpregnated artificially were not fertilised. If self-fertilisation were the natural mode, surely out of this large number a few would have borne fruit.

After the completion of the experiments with *Albuca corymbosa*, a single plant of *Albuca juncifolia*, Baker,* came into flower. The latter differs conspicuously from the former in having cernuous flowers. The central (axial) projection of the stigma was invariably present. The tip of it projects so far out as to form a knob in the bottom of

* *Bot. Mag.*, t. 6395; *Gardeners' Chronicle*, 1876, p. 534.

the depression, which is bounded by the exterior faces of the deflexed apices of the inner perianth segments. As in the other species, the knob, and the portions of the segments in juxtaposition with it, are clothed with papillæ. In *A. corymbosa* the incurved apices referred to are triangular, tapering, and hook-like; in *A. juncifolia* they form a semicircular pad of relatively great thickness in the middle, and thin and flexible at the junction with the main body of the segment. The outer stamens are quite antherless. The flowers are more odorous than those of *A. corymbosa*, and the nectary occupies a much smaller area, being perhaps confined to the narrow space between the base of the filament and the ovary. The filaments are the same in both species. The structural characteristics of *A. juncifolia* indicate that it is more highly specialised than *A. corymbosa;* and the following details of the experiments tend to substantiate the belief that it is also as highly, if not more highly, adapted to cross-fertilisation. The nine flowers forming the panicle were thus dealt with:—

1st flower removed (eventually).
2nd ,, impregnated with pollen from the 1st.
3rd ,, impregnated with pollen from the 4th.
4th ,, unimpregnated.
5th ,, impregnated with own pollen.
6th ,, impregnated with pollen from the 5th on the protruding tip of the stigma.
7th ,, impregnated with own pollen after the flower had been four days open.
8th ,, impregnated with own pollen.
9th ,, removed.

In no instance did fertilisation take place.

EXPLANATION OF PLATE XII.

Albuca corymbosa.

Fig. 1. *Albuca corymbosa* in flower (reduced).
Fig. 2. A single flower, having an outer perianth segment bent downward (nat. size). *os*, outer perianth segment; *is*, inner perianth segment; *ost*, outer stamen; *p*, apical pad.
Fig. 3. A single flower, having an inner perianth segment bent downward (nat. size). References as in fig. 2.
Fig. 4. An inner segment, with inner stamen *in situ*. *pa*, papillose area; *spr*, spring.
Fig. 5. Pistil. *pr*, stigmatic prominence; *gl*, septal gland.
Fig. 6. Stigma. *pr*, stigmatic prominence.
Fig. 7. Transverse sections of a leaf. *a*, at the base; *b* and *c*, near the apex.

On certain Properties of Rosewood and some other Hard Woods. By A. Galletly, Museum of Science and Art, Edinburgh.

(Read 11th February 1886.)

Brazilian rosewood appears to have been used in Europe for making furniture for more than 200 years. For that purpose it long stood next to mahogany in importance, but though still much used, other woods have now an almost equal hold on public favour. From an official return it would seem that the quantity annually exported from Brazil had increased from 560 tons in 1839 to 4700 tons in 1874, the value of the latter being about £70,000. In a book published in 1876 by the Government of Brazil, for the purpose of giving reliable information respecting the resources of the country, it is stated that rosewood exists in great abundance in the forests of Pernambuco, Alagoas, Bahia, Espirito Santo, Rio de Janeiro, and Minas Geraes. This official account of the plentiful supply of rosewood does not, however, agree with the reports about it which sometimes appear in English trade journals. But it is probable that one species of tree furnishes the rosewood usually sent from Brazil to England, while the statement in the volume above-mentioned may refer to woods more or less resembling each other from several species. However this may be, it is very strange that the species of tree which yields the Brazilian rosewood of commerce is not known to European botanists. It is doubtful, indeed, if even the genus has been correctly ascertained. We are equally ignorant respecting a rosewood imported from Honduras. Perhaps there is not another vegetable product, of the same importance commercially, the source of which has remained so long unknown to botanists. Many years ago Dr Lindley considered the tree to be a species of *Mimosa*, and subsequently believed it to belong to the genus *Triptolomea*. At one time it had been called, apparently on some authority, *Mimosa jacarandá*. It has been commonly stated in English works on economic botany that the commercial name for rosewood in Brazil is "jacarandá;" but this name appears to be applied in that country to the wood of several distinctly different trees. Some of the more important woods of Brazil are enumerated in the official book already referred to, and among these are noted the black, the purple, the violet, the white, and the thorny jacarandás, all of which have different specific names and three of them belong to the genus *Machœrium*. In this genus is also placed what in the same list is called the rose jacarandá, though curiously enough its specific name is not given.

It seems that the leaves of the Brazilian rosewood tree, or of one of the trees so-called, are in the Kew Herbarium, and judging by them and the appearance of the wood, Mr Bentham assigned this tree to the genus *Dalbergia*. The species, however, is still unknown at Kew.

The appearance of Brazilian rosewood is familiar to every one from its frequent use in furniture. It is called rosewood because, when fresh, it has a faint smell of roses, but apparently it soon loses this distinctive odour. Many experienced cabinetmakers assert that this wood changes in colour before it is many years old, its rich reddish or purplish brown colour becoming an iron grey. There appears, however, to be some doubt about the accuracy of this observation, owing probably to the fact that it is customary to stain the wood when made up into furniture, and therefore it may only be the stain that is fugitive. As will presently be seen, rosewood is remarkable for the large quantity of resinous colouring matter in its composition. It is sent to this country in half-round flitches, because "heartshake," or hollowness at the centre, generally extends far up the trees. This necessitates the cutting of the logs down the middle longitudinally, hence the notion among cabinetmakers that all rosewood trees have a rotten side.

Thinking it would be interesting to ascertain to some extent what chemical properties are peculiar to Brazilian rosewood, what to some East Indian woods from known species of *Dalbergia*, and what to a few other well-known woods, I have, with the assistance of one or two chemists, got an examination made of a small number of specimens of these.

The chemical examination of the woods referred to in what follows was made by treating them with the ordinary solvents used for this purpose.

First, as to the rosewoods. The specimen to be treated was reduced to fine sawdust, and allowed to digest in twice its bulk of shale naphtha at a temperature of about 150° F. (65·50 C.). The naphtha, after twenty-four hours, was drawn off, and the sawdust thrown on a filter and washed with more hot naphtha till nothing further would dissolve. The naphtha solution had a pale colour, and on evaporation left a yellowish resin.

After leaving the sawdust for a time in a warm place to get entirely rid of the naphtha, it was next treated in a similar manner with ether, until everything which it would dissolve was extracted. The evaporation of the ether gave a second resin of generally a very dark colour.

By a similar process a third extract was made with methylated spirit (alcohol), the solution being very dark coloured and on evaporation giving a resinous body of an extremely dark, almost black colour.

The relative proportions of these extracts varied in the different rosewoods examined, as will be seen from the following table:—

Kind of Wood.	Treated with	Quantity of Extract.	
Rio de Janeiro Rosewood, *Dalbergia* sp.? Specific gravity, ·932, .	Naphtha,	1·527	per cent.
	Ether,	2·746	,,
	Alcohol,	15·704	,,
Bahia Rosewood, *Dalbergia* sp.? Specific gravity, ·953, . .	Naphtha,	1·432	,,
	Ether,	5·771	,,
	Alcohol,	13·178	,,
Honduras* Rosewood, Specific gravity, ·670, ...	Naphtha,	1·390	,,
	Ether,	0·524	,,
	Alcohol,	8·549	,,
East Indian Rosewood, *Dalbergia latifolia.* Specific gravity, ·825, ...	Naphtha,	1·555	,,
	Ether,	3·981	,,
	Alcohol,	11·234	,,
Sissoo (East Indian wood), *Dalbergia Sissoo.* Specific gravity, ·910, ...	Naphtha,	3·800	,,
	Ether,	3·760	,,
	Alcohol,	10·000	,,

The naphtha extracts have the ready solubility in

* The specific gravity of the specimen of Honduras rosewood operated upon appears to be exceptionally low.

naphthas and spirit of wine, characteristic of the ordinary pine resins. Like the latter, they also creep up the sides of the evaporating basin into globules, and when heated on a spatula give the characteristic pine resin odour. Some at least of these naphtha extracts become much deepened in colour by standing for days in an open porcelain basin occasionally wetted with methylated spirit.

Compared with alcohol, ether takes out a small proportion of resinous matter, but both extracts are highly coloured. The probability is that the natural process of oxidation converts the one into the other, and that if the ether extracts were exposed for a sufficient time to the action of the atmosphere it would have the same properties as the alcoholic extract. Resinous colouring matters generally are liable to oxidation, causing slight alterations in their properties.

The alcoholic extract, which is of the same character in all the rosewoods, is the most important, the relative proportion of it being high compared with the naphtha and ether extracts. When the last traces of the spirit are evaporated it is a dark, brittle substance, which easily scales off the evaporating basin. This substance has been tested with the solvents usually employed for dissolving resins, colouring matters as well as fatty and waxy bodies, and its behaviour in this respect is quite peculiar. It is—

1. Insoluble in benzole.
2. Insoluble in bisulphide of carbon.
3. Insoluble in spirit of turpentine.
4. Insoluble in warm olive oil.
5. Slightly soluble in hot acetic acid.
6. Soluble in chloroform.
7. Very soluble in acetone.

[The ether extract has the same characters.]

The properties of this rosewood extract, as shown by its different solubilities, distinguish it, so far as is known, from that of other woods, although mahogany extract in some points resemble it. It is rare to find any substance, belonging to the class of bodies just mentioned, so entirely insoluble in some of these solvents and so readily soluble in others. Substances of a resinous character generally, whether colouring matters or not, are compounds of carbon, hydrogen, and oxygen—nitrogen being absent. Rosewood extract was also found, after testing, not to contain nitrogen. A striking peculiarity of this extract is its strong tinctorial power, 1 part in 100,000 parts of alcohol showing a distinct colour in an ordinary test tube. It does not appear to have the qualities of a weak organic acid. It may also be mentioned that this spirit extract gives to paper a colour very much like that produced by nitrate of silver.

The Sissoo wood differs chiefly in its naphtha extract. The proportion of this is much larger than in any of the other rosewoods examined, and it appears to have some peculiarities requiring further examination. One of these, however, is worthy of particular notice. If, before it is more than a couple of days old, it is dissolved in alcohol, it communicates a deep and splendid purple colour to that liquid. It appears, however, to lose this property very soon, probably by oxidation.

Two examples of mahogany operated upon gave the following results:—

Kind of Wood.	Treated with	Quantity of Extract.
Spanish or Cuba Mahogany, *Swietenia Mahogani.* Specific gravity, ·840, ...	Naphtha,	1·338 per cent.
	Ether,	2·843 ,,
	Alcohol,	12·292 ,,
Honduras or Bay Mahogany. *Swietenia Mahogani.* Specific gravity, ·420, ...	Naphtha,	0·864 ,,
	Ether,	0·292 ,,
	Alcohol,	3·145 ,,

A comparison of the tables shows that Spanish mahogany, which was treated in the same manner as the rosewoods, gave nearly the same percentages of the various extracts. But the naphtha extract of mahogany has not the pine resin odour when heated on a spatula, and its ether and alcohol extracts have only a light pinkish colour in the solid state, and have hardly any tinctorial power in solution. The spirit extract has one property remarkably different from any noticed in the alcoholic extract of rosewood. When dry, it is brittle and very friable on being rubbed between the fingers; but when heated up with turpentine to a temperature nearly at its boiling point, it suddenly swells to many times its volume, becoming transparent and of a fine claret colour. This extract behaves in a somewhat similar manner with olive oil. Of all the extracts examined, which include those of greenheart and teak as well as the rosewoods, this is the only one which has shown this peculiarity.

The alcoholic extract of mahogany is—

1. Insoluble in benzole.
2. Insoluble in bisulphide of carbon.
3. Insoluble in turpentine, but when heated it suddenly swells to many times its original volume.
4. Insoluble in warm olive oil, but swells.
5. Soluble in hot acetic acid.
6. Insoluble in chloroform.
7. Readily soluble in acetone.

[The ether extract of mahogany has nearly the same characters.]

It will be noticed that the sample of "Spanish" mahogany used had twice the density of the Honduras specimen, and that the extracts from the latter are much smaller in amount than those obtained from the former. Honduras mahogany is generally a much lighter wood than that imported from Cuba.

The wood of greenheart, *Nectandra Rodiœi*, specific gravity ·991, treated in the same way as the above, gave—

With naphtha,	1·99 per cent.
With ether,	0·18 ,,
With alcohol,	3·20 ,,

These extracts have the following solubilities:—

Naphtha Extract.

1. Soluble in bisulphide of carbon.
2. Soluble in ether and alcohol.
3. Insoluble in acetic acid.
4. Soluble in acetone, but not readily.

This is more a vegetable fat than a resin. It has not the characteristic resinous odour even when fused, and its alcoholic solution gives a precipitate with acetate of lead, corresponding with fatty bodies generally. It does not dry up, on the water bath, to a brittle substance, but remains greasy—thus differing completely from the pine resin character of the rosewoods.

Alcoholic Extract.

1. Slightly soluble in benzole.
2. Slightly soluble in bisulphide of carbon.
3. Insoluble in turpentine.
4. Soluble in hot acetic acid.
5. Readily soluble in acetone.

Ether Extract.

1. Readily soluble in bisulphide of carbon.
2. Soluble in benzole.
3. Insoluble in acetic acid.
4. Insoluble in acetone.

None of the solutions possess the strong tinctorial power of the rosewood extracts.

A specimen of teak, *Tectona grandis*, specific gravity ·660, also treated in the same way, gave—

With naphtha,	3·56 per cent.
With ether,	0·42 ,,
With alcohol,	3·54 ,,

And the solubilities of these are:—

Naphtha Extract.

1. Soluble in benzole, but not readily.
2. Almost insoluble in alcohol.
3. Almost insoluble in ether.
4. Soluble in turpentine.

Ether Extract (soft and almost greasy).

1. Soluble in benzole.
2. Soluble in bisulphide of carbon.
3. Soluble in turpentine.
4. Slightly soluble in hot olive oil.
5. Insoluble in hot acetic acid.
6. Soluble in chloroform.
7. Soluble in acetone, but much less so than is the case with ether extracts of the rosewoods or mahogany.

Alcoholic Extract.

1. Insoluble in benzole.
2. Insoluble in bisulphide of carbon.
3. Insoluble in turpentine.
4. Insoluble in hot olive oil.
5. Slightly soluble in hot acetic acid.
6. Slightly soluble in chloroform.
7. Readily soluble in acetone.

It is necessary to state that the specimen of teak operated upon had a specific gravity considerably less than what is usual with this wood.

The naphtha extract of teak, which is proportionally large, is a waxy substance, of a green colour, and very sticky, even when long heated on the bath. It does not become brittle when cold. At the temperature of boiling water, or at least when very close upon it, it is a highly viscid body, proving the absence of any fatty oils in the wood. These oils, being all freely soluble in warm naphtha, would have given this extract a greasy character in place of its strong sticky nature. The absence of any kind of a fatty oil in this wood is confirmed by the insolubility of the extract in ether or alcohol.

The solubilities of the ether and alcoholic extracts of teak are remarkably different from those of the rosewoods and of the mahogany, which have been given. A comparison of the tables will show that they are almost reversed.

I am indebted to the following chemists for conducting most of the above experiments:—Mr William Baxter, formerly of the Bathgate Chemical Works; Mr David Brown, of the firm of Messrs J. F. Macfarlan & Co., Edinburgh; and Mr John Galletly, Addiewell Chemical Works, West Calder.

The Inflorescence, Floral Structure, and Fertilisation of Scrophularia aquatica *and* S. nodosa. By T. Wemyss Fulton, M.B., C.M. (Plate XIII.)

(Read 14th January 1886.)

The plants of the genus *Scrophularia* present many points of interest in regard to their floral arrangements and mode of fertilisation. In order fully to appreciate how the one is related to the other, it is necessary to consider in some detail both the whole inflorescence and the flower. The inflorescence, which is of the indefinite kind, consists of a tall raceme, sometimes over 7 feet high, bearing lateral branches placed practically in alternating opposite pairs, each of which forms a dichotomous or dichasial cyme, but it may, from partial suppression of the later ramifications, ultimately assume a helicoid type. Although the racemes of both species have the same general character, they exhibit some points of difference. In *S. aquatica* the cymes are comparatively short, and nearly horizontal; they tend to be separated vertically by wide intervals, but have their flowers brought approximately to the same horizontal plane by a peculiar twisting of the secondary and succeeding branches through a quarter of a circle—the members of each pair in an opposite direction. The cymes of *S. nodosa* are longer, directed obliquely upwards, less separated, and their ramifications are not appreciably twisted. It is important to note that each cyme behaves, as it were, like a distinct inflorescence, continuing to produce flowers of successive generations, while the raceme is adding to the number of cymes at the top. Consequently, while there is a centripetal evolution of the flowers of any given generation, yet flowers are always to be found scattered up and down the stem, those of the first generation above being contemporary with those of increasingly later generations below. A single raceme may produce several hundreds of flowers in the course of a season, but comparatively few exist at the same time, and the plants grow close together in clumps, so that many racemes are brought into close proximity. The importance of these facts will be seen when we come to the mode of cross fertilisation.

The flowers* are small, inconspicuous, and of an unusual shape. The gamopetalous globose corolla is about the size of a pea, and nearly horizontal in position. Its comparatively wide circular mouth is bounded by four lips—an inferior, minute transverse and decurved; two lateral, vertical prominent and slightly everted; and a bifid superior, much the most ample and conspicuous, which projects horizontally as a roof above the matured reproductive organs (Plate XIII. figs. 1–4). From the throat the scale-like petaloid portion of the staminode projects downwards and forwards, and may aid in protecting the pollen from rain without increasing the conspicuousness of the flower, or, as Trelease has suggested, in diminishing the aperture of the corolla.† In colour the corolla is deep brownish purple or purplish brown, most marked on the upper part, and remarkably constant in tint. The nectary appears to consist of the upper part of a pentagonal ring encircling the base of the pistil. The lateral angles of the thickened superior part (fig. 1, *n*) project into the base of two sulci, situated between the adherent filament of the staminode (*s*), which forms a mesial ridge, and the

* The description always refers to *S. aquatica*, unless when otherwise stated.

† Muller suggests that this structure is of no importance and beyond the influence of natural selection, but according to Darwin rudimentary or aborted organs are very liable to vary, and the following description of the variations observed in about 1000 flowers examined by me will show that the staminode is at all events not more variable than other parts of the flower :—(1) The staminode varied only twice, both cases being on the same plant, and both showing partial reversion to the polleniferous condition. (2) Coherence of two corollas in two calyces, with one ovary and pistil and eight stamens. (3) An ordinary corolla, with two free styles and two partially coherent ovaries, and four stamens. (4) The union of the two inner stamens in their entire length, with the shortened style lying in a mesial groove on their upper surface, and the stigma amidst the dehiscing pollen. (5) The external stamens completely absent. (6) One of the inner stamens entirely petalised, and adhering to the lower lip which was contorted. (7) One of the inner stamens partially petaloid, and adherent to the lower lip ; a speck of pollen covered by a petaloid hood, and a minute hollow petaloid spur distinctly yellowish at the tip. Besides these, I found an unopened flower, twice the normal size, containing seven minute saltatory looping mites, which had eaten the upper part of the circumovarial disc (nectary) and part of the anthers. The sexual organs had the position as in the bud ; the pistil small and stunted ; the stamens, especially their filaments, enormously swollen. The pistil frequently varies in length, sometimes just reaching the lower lip. The colour, except in the monstrosity above-mentioned, I found constant.

geniculate bases of the filaments of the external stamens (*ft*). In these sulci the nectar collects as two droplets (*n'*), one on each side of this ridge; and in protected flowers these droplets ultimately coalesce to form an adherent film, which creeps along the roof of the corolla. By this means the anthers are secured from being wetted, and the nectar is rendered easily visible from the outside.

A striking feature in the sexual evolution of the flowers of *Scrophularia* is the proterogynous dichogamy which they exhibit, the stigma reaching maturity and moving into the position for cross fertilisation before the stamens begin to rise from the floor of the corolla.

In the young unopened bud the terminal portion of the style is bent back superiorly, and points towards the nectary, but by a progressive unbending the stigma is brought to the mouth of the corolla; and when the flower opens the style is still bent up, and the stigma occupies a position in the centre of the aperture of entrance, but behind its plane (fig. 1, *p*). It is in this situation, or at some point between it and the horizontal position subsequently attained, that cross-fertilisation normally occurs. If fertilisation is effected, the style descends and becomes curved in the opposite direction, so as closely to clasp the lower lip (fig. 3); but if fertilisation is prevented, the style remains projecting horizontally from the mouth of the corolla (fig. 2) until long after all the stamens are forward, for the purpose, apparently, of ensuring self-fertilisation if cross-fertilisation fails.

Darwin, in speaking of the movements of the sexual organs,* says:—"In *Scrophularia aquatica* the pistil is bent downwards from the mouth of the corolla, but it thus strikes the pollen-dusted breasts of the wasps which habitually visit those ill-scented flowers." That this decurvation of the style, however, is a consequence of fertilisation, as Muller pointed out, and not a movement made to aid it, may be seen by watching protected flowers, or by this simple experiment. On one raceme I selected two equally developed young flowers with their styles bent up, and put pollen on one and not on the other. In about four hours the style of the one which was fertilised was completely decurved, while in the other it remained horizontal.

* *Forms of Flowers*, p. 147.

During the pistillate stage the stamens lie bent back on the floor of the corolla, below the level of the lower lip, and therefore out of the path to the nectary; but as soon as this stage is completed, they begin to unbend and come forward. They do so singly and in succession, but there is a decided pause between the movement of the first and second pairs (fig. 4). The two inferior stamens, which lie next the pistil, move forward first, the one which is nearest the flower of the previous generation usually, but not always, taking the lead (figs. 2, 3). The external stamens follow in a similar way (fig. 5), and come to lie above the horizontally projecting internal pair. Owing to a somewhat spiral twist in the filaments, especially of the external stamens, the first part of the movement brings the anther into the middle line. It then traverses an arc in the same plane as and almost coincident with that which the stigma took previously, and finally, from the straightening of the filament, it is protruded considerably beyond the margin of the lower lip. Dehiscence, which takes place superiorly by a gradually increasing transverse slit, begins shortly after the anther rises; and the latter is maintained in an obliquely erect position so long as it contains pollen, but when the pollen is shed it falls into line with the horizontal filament. In protected flowers the anthers retain their pollen for a considerable time after all the stamens are forward, as projecting, slightly coherent masses which block up the lower half of the corolla aperture, and cross-fertilisation could readily occur even at this stage; but in those exposed to the visits of insects it is rare to find a single anther fully forward that has not been robbed of its pollen. The pollen is powdery, and readily adheres to even a polished surface.

Since each flower passes through a similar cycle, the relative number of the flowers in the different stages will indicate the relative duration of those stages.

The following table shows the several stages of 810 flowers examined at different periods of the year and day, and in various states of the weather:—

Pistillate = 213 [26·2].*			Staminate = 597 [73·7].			
Stigma curved up.	Stigma straight out.	Stigma curved down.	One stamen forward.	Two stamens forward.	Three stamens forward.	Four stamens forward.
71 (33·3)	77 (36·1)	65 (30·5)	77 (12·8)	199 (33·3)	61 (10·2)	260 (43·5)

Scrophularia is the commonest of the very few entomophilous plants which are habitually cross-fertilised by the agency of wasps, but the exact mode by which it is accomplished has been misunderstood. Professor Stephen Wilson, in a paper read before the British Association in 1878, "On the Association of an Inconspicuous Corolla with Proterogynous Dichogamy," states that indefinite inflorescences which have proterogynously dichogamic flowers have the younger pistillate flowers above the older flowers in the male stage, and selecting *S. nodosa* as an example, he describes how wasps alight on the top flower, pass in a somewhat irregular manner to the lower ones, and leave the plant "from the lowest flowers." He says that this is the mode by which cross-fertilisation of different individuals is effected; and Müller adopts his opinion. But in *Scrophularia* there is no limitation of the flowers in either of the two sexual stages to a particular portion of the raceme; they are irregularly intermixed, and both may be found on the same cyme. There are, of course, successive crops of flowers centripetally developed, but the different generations are not distinctly separated, but overlap, as it were; and thus there is no parity with a proterandrous indefinite inflorescence, such as *Digitalis*, where the development of the dichogamy has a simple positional relation to the whole inflorescence. The wasps, then, if they kept to one raceme and pursued a descending mode of visitation, would fertilise the great majority of its flowers with pollen from flowers higher up, and this would be very detrimental to the continuance of the species.

I have watched wasps visiting the flowers of *S. nodosa* and of *S. aquatica* on numerous occasions, but they never adopted a regular descending method of working, nor indeed

* The figures within brackets give the percentage proportions.

any method. On the contrary, although very industrious, they display a total lack of the systematic habits of the bee, and flicker about from one raceme to another in the most arbitrary manner. They visit very few flowers on one inflorescence before passing to another, and then not always to the nearest. Nor do they necessarily visit the female flowers first, but alight indifferently on any one, in whatever stage, and at any part of the raceme; they may pass for a distance up or down, or, what is more common, around the inflorescence, and they frequently return to the same raceme, and even to the same cyme, and after an interval to the same flower. They appear to be entirely guided as to which flowers they should alight on by the presence or absence of nectar, which is visible from the outside. Now it is obvious that this irregular mode of visitation corresponds with the irregular disposition of the flowers in the two sexual stages. It is probable that the interpollination which must frequently occur is rendered ineffectual by the prepotency of foreign pollen, and since the flowers are most assiduously and repeatedly visited,* cross-fertilisation can scarcely ever fail. The wasp, clinging back-downwards, thrusts in its head above the reproductive organs, which are touched by the under-surface of its head, prothorax, and the basal segments of the anterior legs.

Bees also occasionally visit the flowers of both species. I have observed four kinds of humble-bees at each, and rarely the hive-bee at *S. nodosa*. They were all sucking, and the smaller bees scraped pollen on to their under surface. It is interesting to note that while the bees on the whole maintain their ascending h abt, they do not usually systematically visit all the flowers in a raceme before leaving it; if a flower-bearing cyme of an adjacent raceme is interposed, they generally pass to that. On two occasions I observed a fly eating pollen; but these flowers are remarkably free from the visits of Diptera, and of the smaller insects which habitually haunt most open flowers.

* I examined a large number of newly-opened flowers with a lens, and rarely failed to detect abundance of pollen, not only on the stigma but scattered about the lower lip.

Now it might be supposed that the peculiar features presented by the inflorescence and flowers of these plants were wholly due to the selective influence of wasps, but a careful study of the habit and action of bees on *S. aquatica* points to the conclusion that modification has gone on in two different directions, viz., first and chiefly, in adaptation to wasps in order to ensure the maximum amount of cross-fertilisation; secondly, for the purpose of rendering the plants unattractive to bees.

In regard to the former case, it may be briefly said that the plants show adaptation to wasps in the general structure, disposition, and relation of the flowers; in the close proximity of different racemes, so that many of the flowers of one are intermingled with those of others, the wasps being thus lured from one raceme to another; and in the duration of the period of flowering, which begins when wasps become abundant, and terminates almost to a day with the disappearance of these insects. In November the last wasps of the year may be found, chilled and torpid, clinging to the leaves or flowers, which simultaneously have the movements of their reproductive organs arrested: that degree of cold inimical to the one destroys the other.

There are several minor advantages to the plant from having wasps instead of bees as the agents of fertilisation: they work later in the day, later in the year, and in windy weather when no bees are on the wing; their carnivorous habits secure immunity from the visits of merely pilfering insects, and, above all, because there are exceedingly few, and in some districts no other floral competitors for their visits.

In regard to the second point, that bees are really injurious is highly probable from the following considerations:—1. They often ingeniously thrust their proboscis into scarcely opened flowers, and steal the nectar before the stigma is mature. 2. Even when the developed stigma is in a position to be fertilised, their slender proboscis can reach the nectar by the side of the upcurved style without the stigma being touched. 3. Many, but not all, of the humble-bees can always reach the nectar without necessarily touching the reproductive organs. 4. From their tendency to retain the ascending habit, much more inter-fertilisation than cross-fertilisation would be produced, thus diminishing fertility and weakening the progeny. The plants will therefore gain by being protected from bees; and this conclusion furnishes a clue to the explanation of many of the peculiarities of the floral arrangements.

The characters which render them comparatively unattractive to bees appear to be the absence of a conspicuous corolla, of agreeable odour, the peculiar shape of the corolla, and, still more, the comparative paucity and wide separation of the flowers. The inconspicuousness of the corolla depends partly on its small size, and partly on its dull colour. The size is adapted for the head of the wasp, and this explanation might suffice, but for the fact that it is too small to secure the nectar and pollen from rain. After a shower a considerable number of the flowers have their pollen and nectar spoilt, even when such apparently unprotected flowers as those of *Teucrium Scorodonia* are unwetted; and after a few hours of wind and rain the majority are full of water, and though wasps very soon begin to frequent the racemes they find very few worth alighting on. Kerner, Müller, and others have shown the admirable and often elaborate provisions provided in most flowers to protect these substances from rain, and their variety and commonness prove their importance. But in *Scrophularia* it seems to be less injurious to occasionally lose nectar and pollen, and to suffer a temporary suspension of cross-fertilisation, than to protect them at the risk of encouraging the visits of bees ; for, in order also to secure that the nectar remain visible to the comparatively stupid wasp, and accessible to its truncated mouth-organs, such protection would imply amplification of the corolla, and this would entail the disadvantage of increased conspicuousness. Again, the most striking feature of the mouth of the corolla is the absence of any labellum, or foothold and platform for operations, so common in flowers adapted for bees. It looks like one of the latter reversed, and I have observed bees to slip from the corolla, especially when collecting pollen. The remarkable colour also points to the same conclusion. It resembles that of other wasp-fertilised flowers, and although not uncommon in those fertilised by flies, it is one of the least attractive to bees, and is, besides, in itself very inconspicuous. I was especially impressed by this when using gauze nets to envelop portions of the raceme for experimental purposes. I first used dark green, but found that brown coloured ones were much less noticeable. When the flowers become blanched to a light green tint, as they ultimately do when cut racemes are kept standing in water in a shady room, they are more conspicuous at a distance than are the brownish-purple ones. It seems probable, therefore, that the colour is really protective. In reference to this point it is a noteworthy fact that the ripening ovary develops a dark purplish hue; and since it is clasped by the persistent and relatively large calyx (whose tension previously squeezes off the loosened corolla) it simulates to some degree the perfect flower. The buds, too, so different in this respect from those of the majority of plants, are as deeply coloured as the opened flowers. The object of these apparently unimportant features may therefore be to shield the flowers by simulating them, and the result is apparent in the close scrutiny made by the insects up and down the racemes. On one occasion I observed a wasp carefully searching a brown seeding dock that grew on the edge of a clump of *S. aquatica*, apparently mistaking it for the inflorescence of the latter, and I have frequently seen them on the point of alighting on buds and maturing ovaries.

But probably more important is the wide dispersion of the flowers. Aggregation is one of the most potent of the subsidiary attractions for bees, as enabling them to obtain the maximum of honey or pollen in the minimum of time. For instance, the individual flowers of *Reseda luteola* are small, colourless, inconspicuous, and odourless; yet there are few inflorescences more thronged with bees. The complete concealment of the honey in a valvular chamber to which the bee alone has the key, doubtless has something to do with this partiality; but the very close aggregation of the flowers furnishes a strong inducement, as there are more flowers on one inch of its raceme than on the whole inflorescence of *S. aquatica.*

These floral features, when considered in relation to the injurious action of bees, are, I think, strong arguments for concluding that they are modifications produced by the action of general laws, in order to protect the flowers from the bees' visits. Darwin* tells us that the freely-exposed nectar of *Epipactis latifolia*, which is habitually visited by wasps, is never sucked by bees, which apparently dislike it. Whether bees would prove injurious to this plant, which is apparently protected from them by a change in the character of the secretion, or be less effective in performing cross-fertilisation, I do not know; but it may occasionally happen, that by reversion, or by retrograde variation, a plant will escape from the keen competition for the visits of bees, by limiting itself to the attraction of a less engaged species; and in that case it would be advantageous to keep the nectar for it alone. Darwin says that the continuance of this Orchid is dependent on the existence of wasps, and the same may probably be said of the Figwort.

The effect of the habit or mode of working of the insect has thus a marked influence on the inflorescence, as may be seen by comparing that of the Figwort with that of almost any of the *Labiatæ* fertilised by bees. Both are constructed on the same type, but in the latter the dichasial cymes are modified by vertical and horizontal aggregation, by partial suppression, and by more rapid development of the flowers, so as to bring the dichogamy into relation with the development of the inflorescence as a whole. Many of the *Scrophulariaceæ* probably attain the same end by suppression of all the flowers of the cymes except those of the first generation, retaining their lengthened raceme—such, for example, as in *Digitalis.*

Before concluding, I may say a word about the marked proterogynous dichogamy of *Scrophularia.* Dichogamy, or the separation of the sexes in hermaphrodite flowers by successive development of the reproductive organs, when it exists in anemophilous, or wind-fertilised, flowers, is almost invariably proterogynous. In entomophilous dichogamic flowers, on the other hand, the great majority are proterandrous, especially, and most markedly, in crowded or

* *Cross and Self-Fertilisation of Plants*, pp. 375, 423.

aggregated inflorescences. But there is a large minority where the inflorescence bears only one or very few flowers, or where they are dispersed and scattered, in which the dichogamy is proterogynous. Examples may be found among the *Ranunculaceæ, Geraniaceæ, Rosaceæ*, &c., which do not depend on bees for cross-fertilisation.

The proterandry of indefinite inflorescences is thus closely associated with the ascending habits of bees, and since this mode of floral visitation can be shown to be more rapid and natural than a descending mode, it is obvious the proterandry has been in such cases produced by the particular mode of visitation, and not *vice versa*. But, on the other hand, most flowers fertilised by flies, which display no system or method in floral visitation are proterogynous. These facts seem to point to this, viz., that, as a rule, the primitive proterogynous condition of anemophilous flowers has been retained in the transition to insect-fertilisation, unless where it was detrimental, as it would be in inflorescences fertilised by bees. It is not detrimental in *Scrophularia;* but it has no advantage over proterandry, which would be equally effective, and therefore it seems probable that *Scrophularia* presents us with the most primitive type of inflorescence in the order to which it belongs.

EXPLANATION OF PLATE XIII.

Figs. 1–5. Front view of expanded flowers of *Scrophularia nodosa.*

Fig. 1. Newly opened flower, with style (*p*) still bent up and stigma in the centre of the aperture of entrance; *n*, lateral angles of nectariferous collar; *n'*, nectar collected in the lateral sulci; *s*, staminode; *ft*, filaments of external stamens. First or pistillate stage.

Fig. 2. Unfertilised flower with style projecting horizontally from the mouth of the corolla. The two inferior stamens have appeared.

Fig. 3. Fertilised flower with style curved downwards so as closely to clasp the lower lip. The two inferior stamens have now come forward. First staminate stage.

Fig. 4. Fertilised flower, with the two inferior stamens fully exposed, and the external or second pair beginning to appear. Intermediate between first and second staminate stages.

Fig. 5. External stamens fully exposed and lying above the horizontally projecting internal pair. Second staminate stage.

Report of Half-Hardy Plants Growing on the East Coast of Arran. By the Rev. D. Landsborough, Kilmarnock.

(Read 12th November 1885.)

In my report this year I refer mainly to gum trees, tree ferns, tree lilies, and wattles.*

Eucalyptus.

No tree so fully realises the beautiful saying of Scripture, "The leaves of the tree were for the healing of the nations," as the gum trees of Australia. They heal the land by drying the poisonous marsh. They heal the air by emitting quantities of ozone to purify it, removing injurious organic matter. They heal man by preventing the spread of disease, by arresting the violence of fever, by allaying the irritation of cough, and by giving sleep to the sleepless. I am glad to be able to report that many Eucalypti grow in Arran. They are as follows:—

1. The Blue Gum (*Eucalyptus globulus*).—This is the best known and the most extensively planted of all the species. It germinates freely, grows rapidly, and attains a great height—as high as 330 feet. When young, the leaves are soft, covered with a fine bloom, and diffuse abundantly a camphoraceous odour. They also abound in that oil which has been found so beneficial as a medicine. Like most of the genus, its appearance in the earlier years of growth is very different from its more advanced state. Then the leaves acquire a scimitar shape, become leathery, diffuse less perfume, and the tree is altogether less attractive. In this country it has the disadvantage of being delicate—no tree in Scotland, growing in the open air, having survived the severe winter of 1880–81, except the one at Craigyard, Lamlash. Sown in 1874, it is now 36 feet in height, and is 1 foot 10½ inches in girth. Another plant grows at Strabane, Brodick. The species is named from the form of the leaves when the plant is young. It has not yet bloomed in Arran, nor have any of the other species.

* Unless otherwise mentioned, the girths are taken 5 feet from the ground.

2. The Twiggy or Manna Gum (*E. viminalis*).—This may be called the weeping blue gum, for while it differs from the blue gum in the leaves being small and roundish, and in the branches being very slender, the leaves much resemble the blue gum in perfume, bloom, and in hue, though this is somewhat more of a plum colour. This species is hardy; a large tree grows at Whittinghame, East Lothian, and a young specimen has been planted this year at Lamlash. It is named *viminalis*, from its slender branches, and "manna gum," from manna being obtained from it.

3. The Almond-leaved Gum (*E. amygdalina*).—This is said to be one of the tallest trees in the world, growing, in some instances, to the height of more than 450 feet. A tree of this species has grown at Cromla, Corrie, for about fourteen years. It is somewhat slow in growth, being only about 25 feet in height and 13 inches in girth. This is more hardy than the blue gum, but not so hardy as some other species. It is named from the leaves resembling those of the almond tree. This and the blue gum are the species from which the oil of commerce is principally obtained.

4. The White Gum (*E. pauciflora*, syn. *coriacea*).—In 1879 I received seeds of this species from Mr Bailey, Government Botanist, Queensland; it had been gathered on the Blue Mountains, New South Wales, and was sown at once. The following year it was planted at Craigyard, Lamlash. It is already 18½ feet in height, and 7½ inches in girth, and probably will one day be the tallest tree of any kind in Scotland. It is so hardy that not a leaf was browned in the severe winter of 1880–81. The leaves are large, approaching the size of those of the blue gum, and are covered with a whitish bloom. It received its name from the whiteness of the trunk after the annual shedding of the bark. It is a native of Tasmania, and the white trunks give a peculiar character to the forests of that great island.

5. The Alpine Gum (*E. alpina*).—This tree is an interesting and important addition to the forestry of Arran, as it is quite different in habit from any of the gums formerly introduced. The leaf is large, thick, and

remarkably broad, one giving a measurement of 9 inches by 4½. It is specially illustrative of that feature in the trees of Australia which enables them to expose themselves edgeways, instead of horizontally, to the sun, for the development of one side of the leaf is almost twice that of the other, and thus the superior weight of the one side causes it to hang down, and to make the opposite side stand erect. The habit of the tree corresponds to the shape of the leaf, being remarkably broad. This tree illustrates the fact that some alpine plants grow well in the vicinity of the sea. A native of the alpine regions of Australia, it grows at Corrie Hotel, Arran, in full luxuriance within 35 yards of the sea. It was planted last year, and is now 3½ feet in height.

6. The Cider Tree or Mountain White Gum (*E. Gunnii*).—The leaves of this species are small, of a light green colour, and are highly odoriferous. It is very hardy, and grows in the open air at Kew. A plant 6 feet in height grows at Craigyard, Lamlash; a smaller one at the Free Church Manse, Whiting Bay. It receives the name cider tree from the liquid that flows from it when the bark is pierced.

7. The Urn-bearing Gum (*E. urnigera*).—The leaves of this species are of medium size and of a dark green colour. It grows at Strabane, Brodick, and is very hardy. It receives its name from the shape of the fruit.

8. The Coccus-bearing Gum (*E. coccifera*).—This differs from most of the genus in the leaves being leathery, even when the plant is very young. They are small, of a dark bluish colour, and covered with whitish bloom. This species is very hardy. A specimen grows at Powderham Castle, Kenton, Devonshire, more than 60 feet in height and more than a foot in diameter. A tree of what I consider this species, though the authorities at Kew have pronounced it to be *E. amygdalina*, grows at Castle Kennedy, Wigtownshire. It grows at several places in Arran.

In addition to the above Eucalypti already in Arran, through the kindness of friends allowing me to plant them in their gardens, I may mention that I have specimens of the Fig-leaved Gum (*E. ficifolia*), from Broken Inlet, Western Australia, the leaves of which, as its name denotes, resemble those of a *Ficus*. It is remarkable for flowering when comparatively young, and from the flowers being of a crimson colour; I have also a plant, of the crimson-flowered Iron-Bark (*E. leucoxylon* var. *coccinea*), whose flowers are magenta-crimson in colour. The leaves are small and narrow, and the branches slender, so that it resembles a Babylonian willow. The wood is said to excel that of all other trees in hardness. I have also the red Iron-Bark (*E. siderophloia*), the bark of which as its name tells, is almost iron-like in hardness. The leaves resemble those of the Turkey oak, the veins are red, on account of which it is named the red iron-bark.

This summer I have further, through William Stewart, Esq., been favoured by receiving from Baron von Müeller, Government Botanist, Victoria, seeds of *E. coccifera*—these have germinated; also of *E. pauciflora*, the white gum already mentioned as growing well in Arran. I have received a similar favour from Mr Bailey, Government Botanist, Queensland, who has sent the seeds of "a rare and most valuable lemon-scented iron-bark" (*E. staigeriana*) from the Palmer River, Queensland. This has germinated under the kind care of my friend, Mr Gray, gardener, Newfield.

I may add that plants of several of the hardy gums, as *E. pauciflora*, *E. Gunnii*, *E. urnigera*, and *E. coccifera*, are now growing at various places on the west coast of Scotland—at Knockdolian and Auchearne near Ballantrae; at the Manse, Roseneath, and at Ballinakill, Cantyre.

Dicksonia.

At one time I imagined that tree ferns were remarkably slow in growth, and that no one could hope to raise them from spores, and see them worthy of the name "tree ferns." All such ideas have been dissipated by my experience in growing them in the open air in Arran, as the following notes show:—

The great Bush Tree Fern (*Dicksonia antarctica*).—This plant was probably sown in 1865, as it was very small when I planted it at Cromla, Corrie, in 1867. It took about eight years to acquire its full girth of stem. The stem then began to ascend at the rate of about 3 inches yearly, while during this period the plant formed heads of fresh fronds both in spring and autumn. About the year 1880 the fronds began to bear spores, and since then it has grown annually about 2 inches, and it has also sent out yearly only one crown, developed in spring, and consisting of eighteen or more fronds, each of them about 6 feet in length and 2 feet in breadth. The stem is now 2 feet 2 inches high, and 2 feet 3½ inches in girth; it is a magnificent plant.

Dicksonia squarrosa.—This plant was brought from Canterbury, New Zealand, and was given me by Mr Gray, Newfield. It is in perfect health. The fronds are 3 feet 3½ inches in length, and 14 inches in breadth.

Cordyline.

The plants of this genus receive in Australia the name of "the Victoria palm," or "the cabbage palm." At Cromla, Corrie, where three species grow, they are worthy of the name "palm," as the largest, a plant of *Cordyline indivisa*, sown by me in 1873, and planted in 1875, is now, including leaves, 13 feet in height, and has a stem 1 foot 3 inches in girth. It may be expected soon to bloom.

Acacia.

The most graceful and beautiful of all evergreen shrubs are the pinnatifid species of this genus. That they are so considered in Australia, from which most of them come, appears from the name there given them "feather-leaf." I am happy to report most favourably of them in Arran. The Black Feather-leaf (*Acacia decurrens*), one of the most beautiful, and also the most delicate in foliage, is now growing at Craigyard, Lamlash. It is, like the other species, a standard, 7 feet 10 inches in height, and is growing in great luxuriance. It grows also at the Lamlash Cemetery. Another variety, named the Feather-veined Feather-leaf (*Acacia penninervis*), of a blue-green shade, which does not close its pinnules at night, and in dull weather, as does the other, also grows at Craigyard, Lamlash. A third Feather-leaf (*A. longifolia*) grows at

Strabane, Brodick. The Broad-leaf Acacia (*A. pycnantha*) grows at Craigyard.

Miscellaneous Plants.—The broad-leaved Chinese Fir (*Cunninghamia sinensis*), the New Zealand Bramble (*Rubus australis*), *Pittosporum undulatum*, whose flower is so fragrant, and the oak or Beef Wood (*Casuarina equisetifolia*), all grow in the Castle Garden, Brodick. Camellias, Myrtles, and *Desfontainea spinosa* (7 feet 8 inches high), all bloom freely at Cromla, Corrie. *Agalina tomentosa* has just been planted at Craigyard, Lamlash. I have also plants of the Bottle Tree of Australia (*Brachychiton diversifolium*), the Grass Tree of Australia (*Xanthorrhœa arborea*) of *Libertia grandiflora*, and of a *Dasylirion* from Mexico, which I hope ere long to transfer to Arran.

The Marine Algæ of Joppa, in the County of Mid-Lothian.

By George Wm. Traill.

(Read 8th April 1886.)

I have prepared the following paper, in the hope that it may be useful to those of our members who are commencing the study of marine algæ; and also that others may be induced to turn their attention to this branch of botany when they learn how many rare and beautiful species await them at a locality so easy of access as the rocks of Joppa.

Before giving the list in detail, it may be interesting to refer to several species which, on account of their rarity and luxuriance, may be viewed as specialties of this locality.

Of these, *Sphacelaria plumigera* holds a prominent place. This occurs in muddy pools near low water, almost immediately below the salt works. The species is perennial, and unilocular sporangia are found in winter. Agardh, in writing to me, states that he never saw any specimens so perfect as those I sent him from Joppa.

Owing to the rigidity and dryness of the plant,—features which it possesses in common with the other members of the genus,—it does not readily adhere to paper; but this difficulty may be overcome by sprinkling skimmed milk over the specimens before pressing them.

Diatoms are often found attached to this alga in such profusion as entirely to hide the host plant. Of these, *Rhabdonema arcuatum*, *Synedra affinis* and *Grammatophora marina* are amongst the most frequent.

Bryopsis plumosa.—This occurs in considerable abundance in pools a little below half tide. It is a summer annual, and is in best condition in July and August. Many of the plants are of great luxuriance and size, and compare favourably with those from the southern shores of England. The best way to mount specimens is to lay them out on paper under sea-water in the usual way, and then fix them on a board, allowing them to dry thoroughly without pressure. Their beautiful glossy green is by this means retained.

Callithamnion strictum, Ag.—This rare species I found for the first time in 1880 on rocks uncovered at the lowest spring tides only. On my sending specimens to Bornet of Paris they were identified by him, in the absence of fruit, as *Callithamnion strictum*, which is new to the British flora.

Callithamnion corymbosum, Ag.—This species I found for the first time in June 1882, when it was in good fructification. It occurs on muddy rocks uncovered at very low tides only, and there is a fresh water stream at the place. The plants are of as fine a colour as any I have seen from the south coast or from Ireland.

Tilopteris Mertensii.—This handsome species occurs on muddy stones and rocks at low water. It is always submerged. I have usually found the finest sporangia in June. The Joppa specimens, though smaller than those from southern localities, are generally perfect, and of good colour.

ABBREVIATIONS.—h. w., high-water; l. w., low-water; ½ t., half-tide.

	Usual duration of Species.	Best time for Fruit.	Habitat, &c.
Ahnfeldtia plicata, *Ag.*	Perennial	Winter	Pools near l. w.
Bangia fusco-purpurea, *Lyngb.*	Mar.–Sept.	May & June	Rocks near h. w., usually in the shade.
Bryopsis plumosa, *Lx.*	May–Oct.	July	Pools below ½ t., fine and abundant. The diatom *Rhabdonema arcuatum* is often abundant on old plants.
Callithamnion arbuscula, *Lyngb.*	All the year	May–Aug.	Rocks in the shade below ½ t., usually uncovered for several hours daily.
corymbosum, *Ag.*	June–Sept.	July–Aug.	Muddy rocks at l. w. (G. W. T.).
floridulum, *Ag.*	All the year	Aut. & Win.	Sandy rocks at about ½ t.
Hookeri, *Ag.*	Mar.–Oct.	June & July	On small algæ at l. w.
plumula, *Lyngb.*	May–Oct.	July	Cast ashore, rare.
polyspermum, *Ag.*	Mar.–Oct.	June & July	Rocks in the shade, common.
roseum, *Lyngb.*	Mar.–Oct.	June & July	Muddy rocks, rare.
Rothii, *Lyngb.*	Perennial	Winter	Rocks near h. w.
strictum, *Ag.*	All the year		Muddy rocks, l. w. New to Britain (G. W. T.).
Calothrix confervicola, *Ag.*	Sum. & Aut.		On small algæ near h. w.
Catenella Opuntia, *Grev.*	Perennial	Tetraspores in July	Rocks in the shade, near h. w., rare.
Ceramium acanthonotum, *Carm.*	All the year	Win. & Spr.	Rocks at about ½ t.
Deslongchampsii, *Chauv.*	All the year	July & Aug.	Common in pools. *Grammatophora marina* often occurs on this species.
diaphanum, *Roth.*	Mar.–Sept.	July & Aug.	Not uncommon in pools.
fastigiatum, *Harv.*	Annual	Aut. & Win. *Harv.*	"Joppa" (Greville), very rare.
flabelligerum, *J. Ag.*	Annual	Aut. & Win. *Harv.*	Pools near h. w., rare (G. W. T.).
rubrum, *Ag.*	All the year	June–Aug.	Common in pools.
var. proliferum	All the year	June–Aug.	Accompanying *Sph. olivacea* at l. w. (G. W. T.).
var. fasciculatum	All the year	June–Aug.	At l. w., rare (G. W. T.).
Chaetomorpha tortuosa, *Ag.*	May–Oct.	June & July	Pools at about ½ t. The diatoms *Licmophora paradoxa*, *L. dalmatica*, *Synedra affinis*, and *Achnanthes longipes*, are not uncommon as epiphytes.
Linum, *Ag.*	May–Oct.	Summer	Pools at about ½ t. New to Firth of Forth, 1885 (G.W.T.).
Melagonium, *Ag.*	Perennial	Summer	Pools near l. w.

	Usual duration of Species.	Best time for Fruit.	Habitat, &c.
Chondrus crispus, *Lx.*	Perennial	Spr. & Sum.	Common in pools and on rocks between tide marks.
Chorda filum, *Lx.*	Apr.–Dec.	July & Aug.	Cast ashore.
lomentaria, *Grev.*	Mar.–Nov.	Trichospor-angia in July & Aug.	Common in pools.
Chordaria flagelliformis, *Ag.*	Apr.–Nov.	Capsules in August.	(Typical.) Common in pools.
v. Y. minor of *Ag.*	Apr.–Nov.		Common in pools.
Chylocladia clavellosa, *Harv.*	Apr.–Oct.	July & Aug.	At l. w., very rare (G. W. T.).
Cladophora arcta, *v.* centralis, *Kutz.*	Mar.–July	Summer.	In pools, very rare (G. W. T.).
arctiuscula, *Crouan.*	All the year	Spring.	Exposed rocks near h. w. (G. W. T.). New to the Firth of Forth.
Cladophora rupestris, *Kutz.*	All the year	Summer	In pools and damp places.
lætevirens, *Kutz.*	Mar.–Dec.	Summer	Common in pools. Diatoms often epiphytic.
Cladostephus spongiosus, *Ag.*	Perennial	Winter	Common near l. w.
plumosus, *Holmes*	Perennial	Winter	At l. w. New to Firth of Forth (G. W. T.).
Cordylecladia erecta, *Ag.*	Perennial	Tetraspores in Summer	At l. w., rare. New to Firth of Forth (G. W. T.).
Corallina officinalis, *L.*	Perennial	Win. & Spr.	Common in pools.
Corynospora pedicellata, *J. Ag.*	Annual	November?	In pools, very rare (Rev. D. Landsborough).
Delesseria alata, *Lx.*	All the year	Mar., Apr., & May	Under ledges in pools, near l. w., rather rare.
sinuosa, *Lx.*	Biennial	Winter	In dark pools, not uncommon, but small.
Dermocarpa prasina, *Bornet*			Epiphytic on *Pol. fastigiata*, &c. New to the Firth of Forth (G. W. T.).
Desmarestia aculeata, *Lx.*	Perennial	Sporangia in Summer	Cast ashore.
ligulata, *Lx.*	Annual	Sporangia in Summer	Cast ashore (Miss M. Traill), very rare.

	Usual duration of Species.	Best time for Fruit.	Habitat, &c.
Dictyosiphon foeniculaceus, *Grev.*	Apr.–Aug.	July & Aug.	Pools at ½ t. (This is the subspecies *hispidus* of Areschoug.
hippuroides, *Aresch.*	May–Sept.	August	Parasitical on *Chordaria flagelliformis*, rare. New to Firth of Forth, 1880 (G. W. T.).
Dumontia filiformis, *Grev.*	Mar.–Oct.; and sometimes longer	Summer	Common in pools. *Licmophora paradoxa* and other diatoms are common on old plants.
var. crispata.	Mar.–Oct.; and sometimes longer	Summer	Common, chiefly in streams.
Ectocarpus littoralis, *Lyngb.*	At all seasons	Summer	On algæ in pools, also on exposed muddy rocks.
siliculosus, *Lyngb.*	May–Sept.	June & July	On algæ in pools.
granulosus, *Ag.*	Apr.–Oct.	May–Sept.	Pools near l. w., very fine. On rocks and *Laminariæ.*
tomentosus, *Lyngb.*	Apr.–Sept.	Summer	On *Fuci* near l. w.
crinitus ? *Carm.*	Apr.–Oct.	August (E. Batters)	Muddy rocks in the shade, near h. w.
fasciculatus, *Harv.*	Sum. & Aut.	June–Sept.	Pools below ½ t., rare.
sphærophorus, *Carm.*	Apr.–Sept.	May–Aug.	On *Callithamnion polyspermum*, &c. (T.)
secundus ? *Kutz.*	May–Sept.		On algæ in pools, rare.
Elachistea fucicola, *Fr.*	June–Sept.	July & Aug.	On *Fucus vesiculosus*, rare.
Enteromorpha compressa, *Grev.*	All the year	Summer	Common in pools.
erecta, *Hook.*	Apr.–Sept.	Summer	Common in pools.
intestinalis, *Link.*	Apr.–Sept.	Summer	Common, chiefly in streams.
Fucus canaliculatus, *L.*	Perennial	June–Sept.	Common.
nodosus, *L.*	Perennial	Dec.–Sept.	Common.
serratus, *L.*	Perennial	Winter	Common.
vesiculosus, *L.*	Perennial	Sum. & Win.	Common.
platycarpus, *Thuret.*	Perennial	August.	Common.
Gelidium corneum, *v.* clavatum, *Lx.*	Perennial	Autumn	Rocks at ½ t. (G. W. T.).
Gigartina mamillosa, *J. Ag.*	Perennial	Winter	Common near l. w. on rocks.
Griffithsia setacea, *Ag.*	Perennial	Apr., May, & June	Pools near l. w., rare.
corallina, *Ag.*	Annual	Summer	Cast ashore, rare.
Halidrys siliquosa, *Lyngb.*	Perennial	Win. & Spr.	Cast ashore, rare.
Hildenbrandtia rubra, *Menegh.*	All the year	Autumn	On pebbles in shallow pools.
Hydrolapathum sanguineum, *Stackh.*	Biennial	Nov. Mar.	Rarely growing at l. w.; often cast ashore.

	Usual duration of Species.	Best time for Fruit.	Habitat, &c.
Himanthalia lorea, *Lyngb.*	All the year	August	Cast ashore, rare.
Laminaria flexicaulis, *Le Jolis.*	Perennial	Winter	Common on rocks at l. w.
Cloustonii, *Le Jolis.*	Perennial	Winter	Cast ashore.
saccharina, *Lx.*	Perennial	Sum. & Aut.	Pools near l. w.
Phyllitis, *Lx.*	Annual, Spr. & Sum.		Uncertain.
Laurencia pinnatifida, *Lx.*	All the year	Tetraspores, Win. & Spr.; Ceramidia in July	Rocks near l. w., rather rare, and small.
hybrida, *Lenorm.*	All the year	Tetraspores, Win. & Spr.; Ceramidia in July	On rocks and in pools, at about ½ t.
Leathesia tuberiformis, *Gray.*	May–Oct.		Rarely, and of small size.
Melobesia polymorpha, *L.*	Perennial	Autumn	Common on rocks.
pustulata, *Lx.*	Perennial	Autumn	On *Gigartina mamillosa*, &c., rare.
Lenormandi, *Aresch.*			On stones and shells (Prof. Henderson).
Monostroma Grevillei, *Ag.*	Mar.–June		Shallow pools near h. w., rare.
Myrionema strangulans, *Grev.*	Sum. & Aut.	July & Aug.	On *Enteromorpha compressa* (G. W. T.).
Odonthalia dentata, *Lyngb.*	Perennial	Jan. & Feb.	Rarely growing at l. w.; often cast ashore.
Petrocelis cruenta, *J. Ag.*	Perennial	Winter	Rocks near l. w.
Phlœospora brachiata, *Bornet.*	Annual	June, July, & Aug.	On *Rhodymenia palmata*, *Porphyra vulgaris*, &c., in pools below ½ t.
tortilis, *Aresch.*	Mar.–Sept.	July & Aug.	In a pool at ½ t., rare (G. W. T.).
Phyllitis cæspitosa, *Kutz.*	Mar.–Nov.	Trichosporangia in Spr. & Sum.	Common in shallow pools between tide marks.
v. debilis, *Kutz.*	Mar.–Nov.	Trichosporangia in Spr. & Sum.	Accompanying the above, often in fine specimens.
ascia, *Kutz.*	Mar.–Nov.	Trichosporangia in Spr. & Sum.	Pools between tide marks.

	Usual duration of Species.	Best time for Fruit.	Habitat, &c.
Phyllophora membranifolia, *J. Ag.*	Perennial	Winter	Pools near l. w.
rubens, *Grev.*	Perennial	Winter	Cast ashore, rare.
Brodiæi, *J. Ag.*	Perennial	Winter	Pools near l. w.
Traillii, *Holmes* MSS.	All the year	Winter	Rocks at low tides; new species (G. W. T., 1880).
Plocamium coccineum, *Lyngb.*	Perennial	Summer	Cast ashore; sometimes fine.
Polysiphonia atro-rubescens, *Grev.*	All the year	Sum. & Aut.	Pools near l. w.; sometimes fine.
nigrescens, *Grev.*	Mar.–Oct.; sometimes perennial	June–Sept.	Common in pools.
v. affinis.	Mar.–Oct.; sometimes perennial	June–Sept.	Not uncommon in pools.
elongata, *Grev.*	Perennial	July–Aug.	Rarely growing on shells and stones at l. w.
fastigiata, *Grev.*	Perennial	June–Sept.	On *Fucus nodosus*, common.
urceolata, *Grev.*	Mar.–Oct.	July–Aug.	On rocks at about ½ t., and in pools.
formosa? *Suhr.*	May–Sept.	August	In pools, not uncommon but small.
Polysiphonia divaricata (*Ag.*), *Kutz.*			On piles or stakes, accompanying *Cer. acanthonotum*, also on rocks near h. w., accompanying *Cladophora arctiuscula.* Identified by Magnus for the German North Sea Expedition, 1872. New to Britain.
Polyides rotundus, *Harv.*	Perennial	Winter	Pools near l. w.
Porphyra laciniata, *Ag.*	All the year	September	On exposed rocks and on algæ between ½ t. and h. w.
amethystea, *Kutz.*	Apr.–Oct.	September	On exposed rocks at and below ½ t. Certified by Agardh (G. W. T.).
leucosticta, *Thuret.*	May–Oct.	September	Epiphytic on algæ from ½ t. to l. w. New to Firth of Forth (G. W. T.).
vulgaris, *Ag.*	May–Sept.	Aug. & Sept.	On rocks and algæ in pools between tide marks.
linearis, *Grev.*	Aut. & Win.		On rocks and boulders at about the h. w. mark of neap tides.
Prasiola stipitata, *Suhr.*	All the year	Winter	Boulders and rocks near h. w. (G. W. T.). New to the Firth of Forth.
Ptilota elegans, *Bonnem.*	Perennial	Spr. & Sum.	Boulders at l. w., very rare (G. W. T.).
plumosa, *Ag.*	Perennial	June, July, & Aug.	Cast ashore; rare.

	Usual duration of Species.	Best time for Fruit.	Habitat, &c.
Punctaria plantaginea, *Grev.*	Mar.–July	May & June	Pools above ½ t., rather rare.
Rhizoclonium riparium, *Kutz.*	All the year		On rocks and *Fuci* near h. w.
Rhodomela subfusca, *Ag.*	Perennial	Capsules, Jan.–Apr.; Tetraspores, July	Common in pools.
Ralfsia verrucosa, *Harv.*	Perennial	July & Aug.	Rocks near h. w.
Rhodymenia palmata, *Grev.*	Biennial	Granules, Jan. & Feb. Tubercles, June, July, & Aug.; Tetraspores, August	Pools between tide marks.
Sphacelaria plumigera, *Holmes*	Perennial	Unilocular sporangia, Dec., Jan., & Feb.	Muddy pools near l. w.; fine and abundant.
radicans, *Harv.*	All the year	February	Sand-covered rocks near l. w.
var. velutina, *Traill.*	All the year	Aut. & Win.	In velvety patches on rocks near h. w., accompanying *Call. Rothii* (G. W. T.).
Tilopteris Mertensii, *Kutzing*	Mar.–July	May & June	Muddy pools near l. w. (G. W. T.).
Ulothrix flacca, *Thuret*	Nov.–Aug.	Apr., May, & June	On rocks and algæ near h. w.
isogona, *Thuret*	Nov.–Aug.	Apr., May, & June	Accompanying the above.
Ulva latissima, *L.*	All the year	Summer	Common in pools.
Linza, *L.*	May–Sept.	Summer	Pools at ½ t.; fine and abundant.
Vaucheria (species ?), *De Candolle.*	Annual	Autumn	Muddy rocks in the shade near h. w. (E. Batters).

Report on Temperatures and Open-Air Vegetation at the Royal Botanic Garden, Edinburgh, from July 1885 *to June* 1886. By Robert Lindsay, Curator of the Garden.

July 1885.—All outdoor vegetation suffered severely from the excessive drought which prevailed during the month of July. Many trees and shrubs had their growth arrested. Herbaceous plants were dwarfed, but continued to flower freely. Grass lawns were very brown, and required little or no cutting. Aphides were very abundant. Beech, Elm, and Lime trees were specially infested by them, much injury being done to their foliage in consequence. There were twenty dry days, and only slight showers of rain during the remainder. The lowest night temperature was 41° on the 1st of the month, and the highest 75° on the 25th. The highest day temperature was 84° on the 23rd, and the lowest 56° on the 26th. On the Rock Garden 239 species and varieties of plants came into flower during July, amongst which were the following:—

Astragalus purpureus.
Anemone rivularis.
Asteriscus maritimus.
Anomatheca cruenta.
Campanula elegans.
" isophylla.
" Waldsteiniana.
Calliprora flava.
Cistus florentinus.
Erica ramulosa.
Erythræa diffusa.
Geranium Lambertii.
Gentiana septemfida *var.* cordifolia.
Lilium Krameri.
Meconopsis Wallichii.
Leontopodium alpinum.
Saxifraga Hausmani.
" odontophylla.
Silene Elizabethæ.
Sedum hirsutum.
" aizoon.
Orobanche rubra.
&c. &c.

August.—This was also an exceedingly dry month, there having been nineteen dry days. Several low night temperatures were registered for this month. The lowest readings were on the 14th, 37°; 15th, 37°; 19th, 38°; 30th, 37°; 31st, 38°. The highest morning readings were on the 10th, 66°; 18th, 62°; 19th, 65°; 22nd, 62°; 24th, 66°. East and north-east winds were prevalent. Autumn tints began to show early this season. Sugar

Maple, *Pavia flava*, and *Ampelopsis Veitchii* were well coloured by the end of the month. Seventy-six species of plants came into flower on the Rock Garden, amongst the most conspicuous were—

Calochortus pulchellus.
Calluna vulgaris fl. pl.
Clematis Jackmanni.
Cyclamen hederæfolium.
Colchicum speciosum rubrum.
Delphinium cardinale.
Gentiana ornata.
„ tibetica.
Hypericum patulum.
Montbretia Pottsii.
Origanum Tournefortii.
Polygonum capitatum.
Platycodon pumilum.
Pterocephalus Parnassi.
Senecio speciosus.
Saxifraga flagellaris.
Spiræa Bumaldi.
Scabiosa speciosa.
Veronica longifolia *var.* subsessilis, &c.

September.—Frost set in early this season. On September 1 the thermometer stood at 31°, or 1° of frost; but in several districts in Scotland 10° of frost were registered at the same date. Last year the first frost registered here occurred on October 11, when 3° of frost were registered. Other lower readings occurred, on the 11th, 33°; 26th, 33°; 27th, 26°. The highest morning readings were on the 4th, 66°; 6th, 60°; 17th, 61°; 22nd, 58°. Westerly winds were prevalent, and a good supply of rain fell, there being only ten perfectly dry days throughout the month. Dahlias and other tender plants were cut down by the 6° of frost which occurred on the 27th. Owing to the continued drought throughout the summer months many shrubs have made a second growth, and a few have flowered prematurely.

The season has been very favourable for ripening seeds of herbaceous and annual plants. Thirty species came into bloom on the Rock Garden during the month, amongst which were:—

Allium glaucum.
Crocus nudiflorus.
„ speciosus.
Coreopsis tenuifolius.
Gentiana asclepiadea alba.
Gladiolus Saundersi.
Lilium tigrinum.
Lobelia lutea.
Montbretia crocosmæflora.
Rudbeckia Newmanni.
Schizostylis coccinea.
Veronica glauco-cœrulea, &c.

October.—During October the thermometer was at or below the freezing point on four nights, indicating collectively 20° of frost. The lowest readings occurred on the 11th, 26°; 12th, 27°; 23rd, 32°; 25th, 23°; 30th, 34°. The highest morning readings were on the 2nd, 51°; 3rd, 49°; 7th, 50°; 16th, 48°. The lowest day temperature was 42° on the 22nd, and the highest 58° on the 2nd of the month. There were ten days when no rain fell, and although there was more or less rain during the remaining twenty-one days, plants, such as Rhododendrons, which were growing underneath trees in various parts of the garden, were suffering from drought until the last week of the month. Autumn tints were very fine, but of short duration, on various trees and shrubs. The brightest and best coloured of all were the different forms of hardy Azaleas, some of their leaves showing rich crimson shades, others brown and yellow. Maples, Oaks, Beech, Pyrus, Berberis, Liquidambar, and Tulip tree have also had finely coloured leaves. The brown hues which some Conifers assume at this season of the year have been most conspicuous on *Thuia aurea* and *elegantissima.* Fruit is abundant on Holly, Cotoneaster, Thorn, Yew, Euonymus, and Gaultheria. Late-flowering herbaceous plants have been very well flowered, and many are yet in good condition, amongst the best being Tritomas, Asters, Chrysanthemums, *Helleborus altifolius,* and autumn-flowering species of Crocus.

On the Rock Garden the following species came into bloom during the month, viz.:—*Crocus byzantinus, C. medius, Œnothera acaulis, Mutisia decurrens, Polygala chamæbuxus purpurea, Hepatica triloba alba.* From January 1 till the end of October 1133 species of hardy plants, including well-marked varieties, have flowered on the Rock Garden. At the same date last year 1112 had flowered.

November.—The past month of November has been generally dry and cold. A series of low readings of the thermometer were registered from the 15th till the 19th of the month. Since then open-air vegetation has gradually declined, and at the end of the month had nearly reached its lowest ebb. On nine occasions the thermometer fell below the freezing point, indicating collectively 65° of frost, as against 64° for the corresponding month last year. The lowest readings were, on the 15th, 23°; 16th, 19°; 17th, 18°; 18th, 15°; 19th, 28°. The highest morning readings were on the 3rd, 56°; 7th, 51°; 8th, 48°; 27th, 45°. The lowest day temperature was 31° on the 17th, and the highest 63° on the 3rd. The rainfall has been very light. There were no fewer than twenty-two dry days during the month. Rain fell more or less daily from the 25th till the 29th. Very few plants are in flower out of doors. On the Rock Garden only one species came into flower, viz., *Crocus hadriaticus*, and, with the exception of *Jasminum nudiflorum* and *Hamamelis virginica*, which came into flower in other parts of the garden, no others have been observed as having come into blossom during November. Although there are still a few left, which had opened previously, vegetation generally has gone sooner to rest this season than was the case last, and there are fewer plants in flower. This result is mainly due to the distribution of cold having been different. The aggregate amount of frost registered during this November is nearly the same as was registered during last November. Still, during this November the individual minimum readings have been lower in consequence of the distribution of frost having been confined to a less area, which shows that in dealing with this subject average temperatures are apt to be misleading. For all outdoor work the month has been on the whole a favourable one.

December.—The weather during the month of December has been very variable; sudden changes of temperature occurred during the greater portion, except from the 5th to the 11th, when steady frost prevailed. The thermometer was at or below the freezing point on fourteen mornings, indicating collectively 111° of frost. During the corresponding month of 1884 frost was registered on twenty mornings, the collective amount being 88° only.

The rainfall was extremely light for December. A slight fall of snow took place on the 9th and on the 29th, but on both occasions disappeared rapidly.

The lowest readings of the thermometer occurred on the 7th, 16°; 8th, 17°; 10th, 18°; 11th, 16°; 30th, 21°. The highest morning readings were on the 2nd, 44°; 14th, 44°; 16th, 47°; 17th, 47°; 31st, 44°. The lowest day temperature was 27°, on the 10th of the month; and the highest was 54°, on the 16th. So far very little injury has been done by frost, comparatively tender plants being still uninjured in the open.

The following seven species came into flower during the month on the Rock Garden, viz., *Dondia Epipactis*, *Hepatica triloba*, *Helleborus niger*, *H. niger angustifolius*, *H. torquatus*, *H. purpurascens*, and *H. orientalis*. The total number of species and well-marked varieties, chiefly of herbaceous and alpine plants, which have flowered in the Rock Garden during the past year amounts to 1141. A record has been kept showing the date when each plant opened its first flower. This is the largest number which has flowered on the Rock Garden in one year, being twenty in excess of 1884. This result has been attained more by new plants being added to the collection from various sources than by any favourable circumstances connected with the weather of the past year, which was by no means conducive to the formation of flower-buds generally. Usually the largest number of plants bloomed during the months of May and June, but last year by far the greater proportion flowered during June and July, owing to the very cold weather experienced during May.

January 1886.—The month of January 1886 has not been exceeded in severity by any month since December 1882. After the first three days, which were mild and genial, there followed a succession of severe frosts and snowstorms till the end of the month, unbroken save by an occasional flash of lightning or hailstorm, as if added to relieve the monotony. Several very low readings of the thermometer were registered. The lowest occurred on the 19th, when the glass fell to 8°, or 24° of frost, being the lowest point reached at the garden since December 15, 1882, when 4° lower was registered. Other low readings occurred on the 7th, 17°; 8th, 15°; 10th, 21°; 20th, 12°. Collectively, 158° of frost were registered for the month, as against 72° for the corresponding month last year. The highest morning readings were on the 1st, 50°; 3rd, 44°; 11th, 33°; 15th, 37°; 29th, 38°. The lowest day temperature was 28°, which occurred on the 19th, and the highest 52°, on the 1st. Snow began to fall on the 5th; a very heavy fall took place on the 10th, and at intervals till the month closed there were renewed falls. Outdoor work has in consequence been greatly interfered with. Notwithstanding the severity of the weather experienced, vegetation has not suffered to any great extent, owing to the protection afforded by snow and the dry frost-bound condition of the ground. A large number of half-hardy plants have either been killed outright or badly injured. With few exceptions, they are species which survive only during very mild winters in this district, and are never risked out of doors without our having duplicate plants to fall back on secured indoors. Common Wallflowers and East Lothian Stocks are almost destroyed, while Intermediate Stock is comparatively safe as yet. Wallflower appears to be becoming more tender than it was formerly. This may probably be due to selecting for seed, varieties having improved flowers only, little or no attention being paid to varieties having a vigorous constitution as well. Golden variegated hollies are slightly injured, showing that they are more tender than either the silver variegated or green varieties, which are not at all injured.

On the Rock Garden twelve species and varieties of plants came into flower during the month, viz., *Primula vulgaris caulescens*, *Crocus Imperati*, *Draba aizoon*, *Hepatica angulosa*, *Helleborus abschasicus*, *H. antiquorum*, *H. albicans major*, *H. olympicus*, *H. o. albus*, *H. purpurascens minor*, *H. viridis*, *H. guttatus*. Of the forty selected plants, whose dates of flowering are annually recorded to the Society, not one has opened during January, while in former years as many as sixteen have been recorded in January.

February.— The weather has been extremely wintry, with much snow and uninterrupted low temperatures; vegetation has therefore most fortunately been held well in check. Had it been otherwise, the results would have been much more disastrous than we now find them, particularly when such unusually severe weather has been protracted into the present month.

During February the thermometer was at or below the freezing point on twenty-two mornings, indicating collectively 128° of frost for the month, as compared with 67° for February 1885. The lowest readings were registered on the 3rd, 22°; 4th, 20°; 5th, 16°; 25th, 23°; 27th, 22°. The highest morning readings were on the 8th, 36°; 9th, 40°; 10th, 38°; 12th, 34°; 13th, 39°. The lowest day temperature was 30°, which occurred on the 3rd; and the highest 50°, on the 13th of the month.

Not much direct injury has been done to vegetation by frost, notwithstanding the large amount experienced. This result is due, in great measure, to the almost dormant condition in which most outdoor plants still remain, and also to the absence of extremely low readings, 16° being the lowest marking for February. Of the forty spring flowering plants, whose dates of flowering are annually recorded, the following ten came into flower, but they cannot by any means be said to have reached perfection, viz.: *Tussilago fragrans*, on February 6; *Galanthus nivalis*, on February 9; *G. plicatus*, on February 9; *Tussilago alba*, on February 10; *Corylus Avellana*, on February 10; *Eranthis hyemalis*, on February 10; *Crocus susianus*, on February 12; *Scilla præcox*, on February 13; *Leucoium vernum*, on February 17; *Scilla sibirica*, on February 17. On the Rock Garden twenty plants came into flower, amongst which were the following:—*Colchicum crociflorum*, *Crocus Sieberi*, *C. annulatus*, *Galanthus Elwesii*, *Primula vulgaris* and varieties, *P. veris* do., *Rhododendron præcox*, *Saxifraga Burseriana.*

Since March began there has been no improvement in the character of the weather, but the reverse. Besides snowstorms of unusual severity, there has been hard frost every morning without intermission. On the morning of the 7th the glass fell to 13°, or 19° of frost, which is the lowest register at the garden for the month of March since 1879, when 3° lower were registered on March 14 of that year. The total amount for the whole month at that time was 60° of frost, while during the last eleven days 89° of frost has been registered.

Outdoor work is far behind, but good progress will be made whenever a thaw comes on, as the ground is sure to be in fine working condition, owing to the mellowing influence of so much frost on the soil.

March.—This month will long be remembered as one of the coldest on record. Frost was registered on twenty-one occasions, indicating collectively 134°, as against 82° for the corresponding month last year, which was also below the average for March. The lowest readings of the thermometer occurred on the 6th, 22°; 7th, 14°; 8th, 22°; 9th, 20°; 10th, 20°. The highest morning readings were on the 22nd, 46°; 23rd, 52°; 24th, 48°; 25th, 55°; 26th, 48°. The lowest day temperature was 34°, which occurred on the 2nd, and the highest 64°, on the 23rd. Fine mild weather set in on the 18th, which continued till the 30th, during which time vegetation made rapid progress. The various species of Scilla, Crocus, Iris, and other spring flowers burst suddenly into bloom, and were extremely fine and well coloured, although of short duration. Deciduous trees and shrubs are very late in developing their leaves, many of them being nearly a month late. *Ribes sanguineum*, which usually has flowers expanded early in February, is not yet in flower. The effects of the severe winter are now becoming more apparent on many plants. Yews, Portugal and Bay Laurels, particularly old plants in exposed situations, have a scorched and blighted appearance. Several half-hardy plants, which have stood out of doors unprotected during the last two winters, are destroyed, amongst which are *Eucalyptus globulus* and species of Cistus and Ceanothus; but on the whole most plants have come through a most trying season with comparatively little injury. On the Rock Garden forty-seven species and varieties came into flower during March, being about half the number which come into flower in ordinary seasons for that month. Among the finest flowered were—*Chionodoxa Luciliæ* and *C. sardensis*, *Corydalis angustifolia*, *Crocus Olivieri*, *Daphne Mezereum*, *Erica herbacea*, *Narcissus pumilus*, *Primula denticulata* and *P. marginata*, *Saxifraga oppositifolia* and *vars.*, *S. Burseriana* and its yellow variety *Boydi*. Of the forty spring flowering plants, whose dates of flowering are annually recorded to the Society, fifteen came into flower during the month, viz.:—

Arabis albida, March 4.	Nordmannia cordifolia, March 20.
Crocus vernus, March 17.	Orobus vernus, March 28.
Daphne Mezereum, March 23.	Rhododendron atrovirens, March 23.
Erythronium dens-canis, March 26.	Scilla bifolia, March 19.
Iris reticulata, March 20.	,, ,, alba, March 21.
Narcissus pumilus, March 25.	

Scilla taurica, March 20.
Sisyrinchium grandiflorum, March 21.
Sisyrinchium album, March 21.
Symplocarpus fœtidus, March 23.

Register of Spring-Flowering Plants, showing Dates of Flowering at the Royal Botanic Garden, Edinburgh, during the years 1885 *and* 1886.

No.	Name of Plants.	First Flowers Opened.	
		1885.	1886.
1.	Adonis vernalis, ...	April 8	April 3
2.	Arabis albida, ...	Feb. 28	March 4
3.	Aubrietia grandiflora, . . .	March 8	April 6
4.	Bulbocodium vernum, . . .	Feb. 23	Feb. 27
5.	Corydalis solida, ...	April 3	April 6
6.	Corylus Avellana, ...	Feb. 4	Feb. 10
7.	Crocus susianus, ...	Feb. 18	Feb. 12
8.	„ vernus, ...	Feb. 23	March 17
9.	Daphne Mezereum, ...	Feb. 11	March 23
10.	Dondia Epipactis, . . .	Jan. 13 Dec. 30	...
11.	Draba aizoides, ...	March 30	March 31
12.	Eranthis hyemalis, ...	Feb. 14	Feb. 10
13.	Erythronium dens-canis, . . .	March 22	March 26
14.	Fritillaria imperialis, . . .	April 15	April 26
15.	Galanthus nivalis, ...	Feb. 6	Feb. 9
16.	„ plicatus, ...	Feb. 8	Feb. 9
17.	Hyoscyamus Scopolia, . . .	April 1	April 3
18.	Iris reticulata, ...	March 6	March 20
19.	Leucoium vernum, ...	Feb. 12	Feb. 17
20.	Mandragora officinalis, . . .	March 17	April 3
21.	Narcissus Pseudo-Narcissus, . .	April 8	April 6
22.	„ pumilus, ...	March 15	March 25
23.	Nordmannia cordifolia, . . .	March 1	March 20
24.	Omphalodes verna, ...	March 31	April 3
25.	Orobus vernus, ...	March 15	March 28
26.	Rhododendron atrovirens, . .	Feb. 13	March 23
27.	„ Nobleanum, . .	March 5	April 4
28.	Ribes sanguineum, ...	March 28	April 8
29.	Scilla bifolia, ...	March 10	March 19
30.	„ „ alba, ...	March 12	March 21
31.	„ præcox, ...	Feb. 25	Feb. 13
32.	„ sibirica, ...	March 1	Feb. 17
33.	„ taurica, ...	March 14	March 20
34.	Sisyrinchium grandiflorum, . .	March 9	March 21
35.	„ „ album, .	March 7	March 21
36.	Symphytum caucasicum, . . .	April 12	April 20
37.	Symplocarpus fœtidus, . . .	Feb. 20	March 23
38.	Tussilago alba, ...	Feb. 10	Feb. 10
39.	„ fragrans, ...	Jan. 7	Feb. 6
40.	„ nivea, ...	April 2	April 3

April.—During the month of April vegetation made slow progress. Comparatively little frost occurred, but a succession of dry easterly winds prevented any rapid growth from taking place. The season is unusually late, and should fine weather follow, the prospect of an abundant fruit crop will be one good result. With few exceptions, deciduous trees and shrubs had scarcely any leaves developed at the end of the month. The rainfall was light, thus rendering the ground in excellent condition for seed sowing. A few genial showers, however, are much required to assist growth. In my last report mention was made of considerable injury having been done to various plants by cold frosty winds. Several Conifers have been affected in a similar way during April, but to a greater extent. Large plants of *Biota orientalis* and its varieties are completely browned and destroyed, even such hardy plants as *Cupressus Lawsoniana*, *Thuia gigantea* and *aurea*, are more or less injured in some situations. Frost was registered on seven occasions, indicating collectively 15° of frost as against 27° for the corresponding month last year. The lowest readings were on the 10th, 27°; 12th, 30°; 24th, 30°; 29th, 31°; 30th, 27°. The highest morning readings were on the 2nd, 55°; 13th, 47°; 25th, 50°; 27th, 58°; 30th, 48°. The lowest day temperature was 45°, which occurred on the 10th, and the highest, 72°, on the 27th. The total amount of frost registered this season, up to the end of April, is 632°; for the same period last season 466° were registered. The following is the distribution for each month, viz.:—September, 1°; October, 20°; November, 65°; December, 111°; January, 158°; February, 128°; March, 134°; April, 15°. On the Rock Garden 119 species and varieties came into flower during April, being 63 less than for last April. Among the finest flowered were—

Adonis vernalis.
Anemone Pulsatilla.
Androsace carnea.
,, Laggerii.
,, brigantica.
Arnebia echioides.
Corydalis nobilis.
Dentaria enneaphylla.
Draba Mawei.
Erythronium giganteum.
,, Nuttallianum.
Narcissus Bulbocodium.
,, Graelsii.
,, Emperor
,, Empress.
,, rupicola.

Mandragora vernalis.
Muscari Argæi.
" Szovitzianum.
Ranunculus amplexicaulis.
Soldanella montana.
Trillium grandiflorum.
Primula Cashmeriana.
Primula Clusiana.
" ciliata and varieties.
" decora.
" integrifolia.
" rosea.
" Wulfeniana.

Of the forty spring flowering plants whose dates of flowering are annually recorded to the Society, twelve came into flower during the month, thus completing the list.

May.—During May slight frost occurred on three mornings, the total amount registered being 4°, while for last May a total of 17° were recorded. The lowest readings took place on the 2nd, when the thermometer fell to 30°; 13th, 35°; 16th, 32°; 20th, 34°; 27th, 30° The highest morning readings were on the 4th, 55°; 6th, 54°; 7th, 60°; 17th, 55°; 18th, 54°. The first week was mild and genial, after which cold easterly winds and heavy rains were prevalent till the end of the month. Despite the ungenial nature of the weather experienced, the foliage of forest trees and shrubs has come rapidly forward. On our dry soil the drenching rains have done much good in assisting deciduous trees and shrubs to develop clean and luxuriant foliage. By the end of the month a good many ornamental trees and shrubs were in flower, all of which are fully up to the average as regards quantity and quality of blossom. The Horse Chestnut, in particular, has not been so richly flowered for several years, having been uninjured by frost; the flowers are large and fully developed. The various species of Prunus, Pyrus, Rhododendron, Azalea, Magnolia, Lilac, single white Hawthorn, and Laburnum, also presented a rich appearance. Hardy bulbous plants generally have flowered well; the earlier kinds, however, are not forming seed so freely as they usually do.

The Rock Garden was very attractive, owing to the large number of plants in bloom throughout the month; 253 distinct species and varieties of hardy herbaceous and alpine plants came into flower, as against 178 for the same month last year. The following were amongst the most interesting, viz.:—

Andromeda fastigiata.
Anemone alpina.
,, sulphurea.
Androsace coronopifolia.
,, sarmentosa.
,, villosa.
Anthyllis erinacea.
Aubrietia Hendersoni.
Aquilegia Stuarti.
Carex Vahlii.
Cheiranthus Allioni.
Cytisus decumbens.
Coronilla minima.
Dianthus gelidus.
Dodecatheon integrifolius.
Enkianthus himalaicus.
Exarrhena Lyallii.
Gentiana acaulis.
Gentiana verna.
Geum minutum.
Iris Cengialti.
Lamium Orvala.
Meconopsis simplicifolia.
Myosotis alpestris.
Olearia Gunniana.
Primula involucrata.
,, luteola.
,, Olgæ.
,, pedemontana.
,, scotica.
,, sikkimensis.
Pentstemon Menziesii.
,, humile.
Polygonum sphærostachyum.
Silene quadridentata.
,, acaulis, &c.

June.—During the past month outdoor vegetation generally has suffered severely from the great drought which prevailed. There were twenty-one dry days during the month. The temperature was extremely variable. On several days during the latter portion of the month the thermometer reached 78° in the shade, and on the night of the 2nd it fell as low as 30°, or 2° of frost. Other low readings occurred on the 1st, 36°; 4th, 35°; 27th, 37°; 28th, 36°.

The highest morning readings were on the 5th, 60°; 7th, 65°; 19th, 65°; 20th, 65°; 28th, 62°. Hardy deciduous trees and shrubs have been prolific of bloom, and presented a rich appearance, although of short duration. Conifers have made fairly good healthy growths, and variegated varieties are remarkably well coloured. On the Rock Garden 300 species and varieties of plants came into bloom during the month, making a total of 753 for the season, as compared with 818 at the corresponding date last year. The following were amongst the most conspicuous which flowered, viz.:—

Anemone palmata.
Androsace lanuginosa Leichtlini.
Campanula abietina.
Campanula barbata.
Calceolaria Kellyana.
Cathcartia villosa.
Calochortus cœruleus.

Chamæbatia foliolosa.
Coronilla iberica.
Craspedia Richea.
Chrysobactron Hookeri.
Clintonia Andrewsiana.
Dianthus alpinus.
,, cæsius.
,, cinnabarinus.
,, neglectus.
,, superbus.
Erodium Manescavi.
Erigeron aurantiacus.
Gaillardia maxima.
Globularia cordifolia.
Houstonia serpyllifolia.
Hypoxis erecta.
Linum acuminatum.
Linnæa borealis.
Linaria pallida.
Meconopsis nepalensis.
Mulgedium alpinum.
Myosotis australis.
,, azorica.
Ononis rotundifolia.
Onosma taurica.
Orchis foliosa.
,, maculata superba.
Petrocoptis Lagascana.
Potentilla eriocarpa.
Primula farinosa.
,, mollis.
,, Parryi.
Ramondia pyrenaica.
,, serbica.
Rhododendron ferrugineum album.
Rhododendron lepidotum.
Saxifraga pyramidalis.
Sedum Hookerianum.
Silene maritima pleno.
Spiræa procumbens.
Vancouveria hexandar.
Veronica Colensoi.
,, Guthriana.
,, Lyallii.
Vicia villosa.

*On the Nature and Causes of Variation in Plants.**
By Patrick Geddes, F.R.S.E. (Plate XIV.)

(Read 8th July 1886.)

While the fact of the origin of species by evolution is no longer disputed, nor the operation of natural selection upon organic forms any longer denied, the absence of any general theory or rationale of variation in either the animal or the vegetable world is not only generally admitted, but often regarded as inevitable or even hopeless: variation to some writers being simply "spontaneous" or "accidental"; to others, if not fortuitous, at least dependent upon causes lying as yet wholly, and perhaps hopelessly, beyond our present powers of analysis.

A theory of variation must deal alike with the origin of specific distinctions and with those vaster differences which characterise the larger groups. To commence, then, with the latter, we may pose such questions as—

1. How comes an axis to be arrested to form a flower?

2. How is the evolution of the forms of inflorescence to be accounted for?

3. How does perigyny or epigyny arise from hypogyny?

4. How is the reduction of the oophore and differentiation of the sporophore to be explained among cryptogams and phanerogams, and why should the moss type be so aberrant and so comparatively arrested?

5. How did angiosperms arise from gymnosperms?

6. How did wind-fertilised flowers arise?

7. How are the forms of fungi, algæ, &c., to be explained?

Does the explanation of such questions really lie merely in the operation of natural selection upon innumerable "accidental" variations requiring separate explanation in every case, or is any constant law of variation discoverable?

Let us note the parallelism of form exhibited in many of these cases of unrelated organisms, and inquire whether this does not give us some other clue to their origin.

1. In phanerogams we find the raceme modified into the

* A preliminary outline of a more extended analysis, underlying the writer's essay on "Variation and Selection," in preparation for a forthcoming volume of the *Encyclopædia Britannica.*

umbel and the spike by arrest of the main axis or of the flower stalks respectively. Suppression of both gives the capitulum, and, as specialisation goes on, the convex flower-bearing surface of the composite becomes flattened, as in Dorstenia, and finally deeply hollowed, as in the fig. (Plate XIV. fig. A, 1–6).

2. In simple flowers an indefinite number of modified leaves is arranged round the axis, whose internodes are suppressed. The first advance is to a definite number of sepals, petals, stamens, and carpels in the arrangement called hypogynous. A carrying on of the outer parts of the axis gives the perigynous position to the stamens, and the final form is the epigynous, where stamens, petals, and sepals are all carried past the ovary, the carpels occupying the inside of a pit instead of the outside of a cone (see fig. B).

Both these cases are clearly explicable by reference to the familiar antagonism between reproduction and vegetative growth (further analysed in the writer's recent paper on "The Theory of Sex and Reproduction"—*cf. Encyclopædia Britannica*, article "Sex"—to its basis in the constructive and destructive metabolism of protoplasm). We may view in the same light the concave form of the spore-bearing surfaces in many Fungi and Algæ—for instance, Peziza or Fucus (see fig. C)—and the emarginate form of the fern Prothallus, where the sexual organs appear (fig. E).

Note also that the shortening and reduction in the inflorescence of the Coniferæ from fir-cone to yew-"berry" is parallel to that of the phanerogams. The reduction of indefinite to the various forms of definite inflorescence is another change in the economy of the phanerogam. Similar to this is the reduction and even loss of bracts, and usually of petioles and stipules in the sepals. The complete or partial loss of the calyx and petals is usually considered degenerate; but from the present economy point of view, it seems a more complete specialisation for reproduction. In getting rid of coloured and merely attractive organs, and assuming wind fertilisation, the vegetative system is still further reduced.

The lessening in the number of stamens, carpels, and ovules in all the more evolved orders of plants is a parallel case, which the reader will readily develop. A wider consideration shows the gradual shortening of the sexual generation from the Mosses onwards through the Lycopods, Equisetaceæ, Ferns, Cycads, and Coniferæ, to the phanerogams, where it is represented by pollen grain and embryo-sac alone. The comparative failure of the moss type seems thus due to an inevitably unsuccessful attempt at vegetative life on the part of the reproductive generation.

It is seen from cases such as the above-mentioned, that the reproductive axis, organ, tissue, in every case tends to become more and more shortened, depressed, or hollowed in proportion to the vegetative. In wider terms, whenever destructive changes in protoplasm predominate over constructive, the tendency is thus to produce a concave surface, as seen, for example, in the hollows of nectaries, or in the invagination of the blastosphere to form the gastrula (see fig. D).

This conception may be further developed, and shown to apply alike to the construction of the general genealogical tree, and, in particular, to the affinities of the flowering plants, and even frequently to the interpretation of the minute details of floral structure usually regarded as the product of natural selection acting on "spontaneous" local variations, nor need its application be restricted to the vegetable kingdom only.

The Botanico-Geographical Exhibition at Copenhagen in 1885, *instituted by* M. Carl Hansen, *Professor of Agriculture at the Royal Academy, Copenhagen.* By Andrew Taylor.

When delivering a course of lectures on Botanical Geography early in April 1885, it occurred to Professor Hansen that his work needed more thorough and popular illustration than that afforded by diagrams and tables when exhibiting orographic distribution, or plant migration, caused by atmospheric or oceanic currents, as well as the influence of man. The Professor accordingly instituted a small exhibition of 2000 live plants in pots, arranged so as to demonstrate to the eye the recognised geographico-botanical regions. He easily accomplished this. The State and other public botanic gardens of Copenhagen rendered much aid; but his success was mainly due to the aid of amateurs and nurserymen. The floras of the Old and New World were clearly demarcated; and each subordinate botanical province was kept separate. Particular attention was paid to labelling; it was found expedient to use different colours to indicate varied latitudes. Again, the Latin and vernacular names of each plant exhibited were given, as well as the name of the first describer, together with information as to its capacities of resisting extreme temperature and its economic uses. The Royal Geographical Society of Denmark held several conferences, and the exhibition presented special features of botanico-geographical interest, particularly in capital representations of the Cape flora, as well as that of Japan, New Holland, and Central America. The Exhibition was very popular, drawing crowds from the provinces as well as from the Danish capital. The familiar room-plants were found at once to possess fresh interests, giving in this new method of grouping unlooked-for educational training. The Copenhagen school boys in especial were amongst the most marked visitors to the Exhibition, and at its close a handsome surplus of admission money had accrued, which was handed over to the committee of the Gardeners' Mutual Benefit Society.

Professor Hansen claims no novelty for his idea. Indeed, the researches necessary to work it out, only the more thoroughly convinced him "that there is nothing new under the sun." At Kew the floras of the old and new worlds are distinctly and separately illustrated. At Edinburgh, too, as well as in the botanical gardens of Brussels, Innsbrück, and Munich, the alpine plants are arranged according to their geographical provinces. In the Botanic Gardens of Copenhagen the Danish flora is demarcated from that of North America; while in the garden of the Royal Danish Academy of Agriculture separate sections are given to the plants of Greenland as well as those of Japan. Since 1885 the "Colinderies" of London have demonstrated the idea on the gigantic scale. But the Professor only argues for modest exhibitions, which may be much more scientifically useful than our recurrent "flower shows." Even here a small exhibition of 400 species of pot-plants at Nancy in 1880, and under the patronage of the French National Congress, claims precedence. The Copenhagen Exhibition of 1885, nevertheless, has shown horticultural committees who can command the services of nurserymen and amateurs to exhibit plants in pots, that the method of botanico-geographical exposition may both incite fresh popular enthusiasm and a love for this special line of study.

The Distribution of the Marine Algæ of the Firth of Forth.

By John Rattray, M.A., B.Sc., F.R.S.E.

(Read 8th January 1885.)

The observations that have to be recorded in the present communication have been, for the most part, conducted at the Scottish Marine Station, Granton, during the years 1884–1885, where I have had the opportunity on many occasions of examining the products of numerous dredgings and trawlings carried out on board the steam yacht "Medusa," which is specially equipped with all the necessary appliances for estuarine scientific work. Facts have also been accumulated from time to time regarding various species procured by deep-sea fishing lines, and more recently by the nets used by beam trawlers. So far as these observations are of interest, they are incorporated in the sequel, it being only necessary to add with respect to them that in some instances data have thus been procured, which without their aid could hardly have been attained. Many observations, of a more or less interesting nature, have already been made on the Algæ of the estuary by among others—Greville, Lightfoot, M'Bain, Maughan, Richardson, and Walker-Arnott; and more recently numerous data have been recorded by Holmes, Batters, Magnus, Henderson, and especially by Mr George W. Traill. Most of these observers have been, however, compelled to confine their operations to the belt of shore extending between high and low water marks, the opportunity of working in greater depths with the dredge or trawl having, with few exceptions, not been enjoyed.

Apart from the large and important family of the Diatomaceæ—some of the most curious and interesting of which are not uncommon in the Firth of Forth—upwards of three hundred species of marine or brackish water Algæ have till now been recorded in this locality, the *Chlorophyceæ*, *Phæophyceæ*, and *Rhodophyceæ* being all well represented both in superficial and in bathymetrical range. The widest superficial range must, however, be assigned to the *Chlorophyceæ*, of which representatives occur as far up the Firth as the tidal influence is felt, where they gradually merge into the typical green Algæ of fresh water, while not a few of the same species occur at or a little above the tidal limits on the shores and beaches washed by the spray of the open ocean. The *Phæophyceæ*, though penetrating well up the estuary, manifestly improve both in luxuriance of growth and in fruit-bearing capacity as the purer waters of the ocean are approached, while the *Florideæ* are pre-eminently the types of truly oceanic plant vegetation.

The haunts of estuarine sea-weeds are abundant and various. For the most part they adhere to rocks or boulders of very diverse characters—volcanic and sedimentary alike. It may, however, be observed generally that rugged, rough, creek-forming, or readily decomposable rocks, carry better crops than perpendicular, smooth, or regularly outlined and more resisting cliffs or boulders. The difficulty which is experienced by the motile spores in procuring a satisfactory nidus on which they may become fully evolved is one of the chief obstacles to be overcome in the latter case, whether the smooth surface be the result of direct wave impact against a stable cliff, or of the trituration of this by shingle impelled against it by the force of the waves or tidal currents, which often so disturb the smaller boulders, that any vegetation likely to appear upon them is speedily checked and ultimately destroyed. The occurrence, however, of several species belonging to different genera on smooth boulders is often striking enough, *e.g.*, in the case of *Hildenbrandtia rubra*, *Ralfsia verrucosa*, various *Melobesiæ*, *Lithothamnia*, *Prasiola marina*, &c., and such instances point to a period of quiescence, during which the rocks or stones have not been exposed to violent wave or other action, so that the spores of the species in question have been enabled to pass the earlier stages of their development in safety on their often-shifting substrata. As examples of this, on a wider scale, the algoid flora of the opposite (east and west) sides of the May Island, where the crag and tail structure is so beautifully illustrated, may be quoted, while the more or less irregularly fissured and mammillated structure of its northern side also has a facies that contrasts readily in this respect with that of the great ravines and irregular buttresses of its southern margin.

The occurrence of many *Polysiphoniæ* (e.g., *P. parasitica*, *P. fibrata*, &c.), *Callithamnia* (e.g., *C. gracillimum*, *C. arbuscula*, *Cladophoræ* (e.g., *C. uncialis*, *C. arcta*, &c.), *Himanthalia lorea*, *Gigartina mamillosa*, and many others, on bare or shaded rocks, is also to be contrasted with the presence of other species, such as *Fuci* (e.g., *F. vesiculosus*, *F. serratus*, *F. nodosus*, &c.), *Ectocarpi* (e.g., *E. tomentosus*, *E. siliculosus*, *E. littoralis*, *E. crinitus*), various *Ceramia*, and even some forms of the elegant *Callithamnia* (e.g., *C. floridulum*), as well as *Porphyræ*, *Monostromæ*, and *Chylocladiæ* on mud-covered rocks and cliffs, as may readily be studied on almost any section of the coast of the mainland, presenting the adequate differences in its physical configuration.

The presence of species of *Enteromorpha* (e.g., *E. compressa*) and of *Callithamnion floridulum*, among many others, on sand-covered rocks, is no less striking; whilst the turbidity of the water, which in such circumstances is often so great, especially during the periods of spring tides and storms, that one cannot see beyond a few inches beneath the surface, enables one to realise the often adverse surroundings to which such forms can accommodate themselves. Moreover, the wearing and tearing influence exerted on the embedded fronds by the passage of mud and sand as these are carried on by the water has a double influence. For the most part, it is decidedly detrimental to the alga, as always tending to bring about the destruction of its tissues, which, indeed, not uncommonly occurs, more or less lacerated sea-weeds, still adhering firmly to their substratum, being of ordinary occurrence in every estuary and on every shore; but, on the other hand, this destructive operation is to a large extent frustrated by (1) the smooth external surface of the fronds, which presents the least possible resistance to bodies carried along by the current, thereby reducing as far as possible the strain exerted on its rhizoids, upon the maintenance of which its own existence so largely depends ; and (2) by its elasticity, which (*e.g.*, in the case of *Porphyræ*) is often of so pronounced a character that its limit is not easily exceeded, even by a directly applied apical strain. On the other hand, at the period of maturation of the spores, the beneficial influence of foreign bodies carried along by the water in facilitating the rupture of the spore mother-cells or sporiferous conceptacles is self-obvious. This may readily be observed in species of *Enteromorphæ*, *Monostromæ*, *Porphyræ*, *Fuci*, *Himanthaliæ*, *Sphacelariæ*, *Ulothrices*, *Bangiæ*, &c., and other similar external agents, as well as the movements of *Pectinidæ*, *Crustacea* (*Hyas*, *Stenorhynchus*, *Paguridæ*, and shore crabs), &c., cannot be overlooked in the rôle which they play in bringing about, either directly or indirectly, the emission of spores from the protuberant urn-shaped ceramidia of the *Polysphoniæ*, the globose semi-immersed and greatly protected coccidia of the *Plocamia*, the round immersed favellidia of other forms, or from the berry-like exposed favellæ of *Callithamnia* and *Ceramia*.

But such agencies, though manifestly operative at the periods of spore maturation, have had an earlier and no less significant function to perform. Professor Dodel-Port has already pointed to the importance of such Infusoria as Vorticella in aiding in the cross fertilisation of some *Florideæ*, and from the large, delicate, and readily destructible condition of the antheridia of *Callithamnion turneri*, *C. plumula*, *Plilota elegans*,* *Griffithsia corallina*, *Ceramium diaphanum*, *C. strictum*, and others, the direct influence exerted by the impact of any foreign bodies, even though inorganic, however small, in aiding the dissemination of the antherozoids, and in facilitating their application to their corresponding trichogynes, is readily demonstrable. But these agents of cross fertilisation are, at the same time,

* Compare T. H. Buffman's paper in *Jour. Quekct. Micr. Soc.*, ser. i. vol. i. No. 8, pls. x.–xii., May 1884.

so many different means for bringing about the dissemination of the species, as they facilitate the removal of any spore from the place occupied by its parent; while similarly the great degree of elasticity possessed by many species, combined with the tenacity of the rhizoids for their substrata of all forms, are sometimes the means of lifting from its bed the boulder upon which the species may be fixed, and so, by presenting a larger surface to the current, often bring about a transference of position, which is but another means of extending, it may be, the bathymetrical range of the species, which is the usual case, or its horizontal extension. Adult specimens,* in preference to younger forms, where buoyant power is less, in this way often spend a part of their existence at one given level, and other parts of it either, as is usual, at different—higher or lower—levels, or more rarely in other places at corresponding levels, and so a disturbing factor must be taken into account in dealing with the algoid zones or regions, to which further reference will be made below. The eddy gyrations of the water, moreover, which result from the passage of a current among the fronds of larger Algæ, as well as of those of medium size, have to a certain extent a well-marked tendency to cause tetraspores, and to a more limited degree zoospores, even though actively motile, to be retained either among or in the immediate vicinity of the parent weeds. They thus facilitate the formation of patches of one given species in a given locality, to the exclusion of other forms, where apparently other conditions of environment would not prevent the growth of the latter, and they thereby favour what is at first sight a distinctly *selective* or *exclusive* property possessed by many species. Among the smaller and more delicate species this tendency is well seen in the growth of patches of the filamentous forms of *Callithamnion* (e.g., *C. floridulum*, *C. rothii*, *C. gracillimum*, *C. corymbosum*, *C. arbuscula*, &c.); whilst the larger *Cladophoræ* (*C. arcta*, *C. uncialis*), and *Enteromorphæ* (e.g., *E. compressa*, *E. intestinalis*, *E. erecta*, *Laurenciæ*, *Gigartinæ*, *Phyllophoræ*, as

* In this way specimens of *Cystoclonium purpurascens*, *Delesseria alata*, *D. sinuosa*, *Plocamium coccineum*, &c., are sometimes found of unusual size on stones that have been cast up by the waves during strong gales.

well as many other forms, illustrate the same law. The large growths of *Leathesiæ* (e.g., *L. tuberiformis*), found on patches of *Corallina officinalis*, as well as of *Polysiphoniæ* (e.g., *P. fastigiata*) on *Fucus nodosus*, and other cases of Epiphytism, likewise go to show that in such instances this peculiar association is not prevented but aided by such conditions. These phenomena are most easily studied in undisturbed parts of the shore and on the islands, being well illustrated on may parts of the May Island, Inchkeith, and Fidra, and in many unfrequented shore pools on the mainland.

While some Algæ grow to great advantage on rocks in deep pools of clear water, many others are especially common in shallow and exposed pools. Various *Ceramia*, *Ptilotæ*, *Polysiphoniæ*, *Callithamnion plumula*, and *C. gracillimum*, may be chosen as examples of the former group, and among others *Halidrys siliquosa*, *Rivularia atra*, *Ulva linza*, *Monostroma latissima*, *Sphacelaria cirrhosa*, *Symploca harveyi*, *Asperococcus echinatus*, *Ectocarpus siliculosus*, *E. littoralis*, *Corallina officinalis*, *Myriotrichia clavæformis*, *Conferva tortuosa*, &c., of the latter. The somewhat rapid changes at once of exposure to light and of temperature, do not in either case act in a detrimental manner to growth; on the contrary, although in brilliant summer sunshine the temperature of such shallow pools may become relatively very high,* the formation and maturation of fruit occurs quite freely, and in still conditions a very copious evolution of gases takes place. In many cases, e.g., *Ectocarpi*, *Enteromorphæ*, *Monostromæ*, *Sphacelariæ*, &c., an elevation of temperature continued for even a short period accelerates the escape of swarmspores, it may be even by some days. Thus specimens of *Enteromorpha compressa*, gathered in the beginning of September in a fertile condition, have been experimented with in different thermal conditions. Some specimens, exposed to the ordinary external conditions in glass vessels unprotected in any manner, were found to give out swarmspores on the sixth day after collection, the average temperature during the day being 64° F., and during the night 51° F.;

* During very warm summer days the temperature of shallow high water pools have been found at low tide to be 15° F. above that of the tidal ocean water.

while others from the same gathering, kept exposed to the sunlight in a warm room, emitted their swarmspores after five days, the average temperature of the room being 77° F. Had the specimens been exposed for longer periods to such dissimilar conditions, other observations have shown that the times of maturation would have differed still more considerably. Specimens of *Ectocarpus siliculosus* and *E. littoralis*, as well as *Monostromæ*, have also been exposed in a similar manner, and in all cases those at a higher temperature have been found to discharge their swarmspores before those at a lower. In shallow pools, too, the periodic elevations of temperature of the water which occur during sunny days in summer, between the periods of high tide, act directly in accelerating the extravasation of swarmspores in many cases, and thereby have a direct influence on the possibilities of extension of the species. The unusually late period of the year at which some species are capable of producing swarmspores in certain seasons (e.g., *Ectocarpus siliculosus*, &c., in December) is also due to the mildness of the season; and, on the other hand, the meagreness in size, and in fruit-producing capacity, or the entire absence or unusually late advent of some forms (e.g., *Gloiosiphoniæ*, *Bangiæ*, species of *Callithamnion*, &c.), can often only be ascribed—just as in the case of phanerogams—to a greater rigour of weather.

It is, however, much more difficult to account for certain spasmodic appearances which are now and again met with in the case of some species (e.g., *Gloiosiphonia capillaris*, *Bangiæ*, &c.), when they occur in a given year in great profusion, bear fruit, then disappear, apparently without reason, for another period, to again occur some seasons later in their original place. It is not enough to say that the spores have been all swept away by the repeated rush of water, since at other times they withstand these movements without difficulty; neither can it be alleged that they are crowded out in their struggle with more successful rivals, nor can the influx of chemical or other ingredients into the sea at any point explain their temporary absence from any extended area, since the renewal of water by the rapid ebb and flow of the tide renders the effect of any such factor of this kind as is ever introduced of but trifling moment. Any sudden variability either in density of the water after freshets, or in its purity after storms, seems also to be inadequate to account for such phenomena.

From a comparative point of view it becomes a matter of considerable interest to compare the sizes, habit, and appearance of the same species when growing at apparently corresponding levels, but on substrata widely different from one another. Thus many species infest submerged wooden piles as well as floating blocks of wood (e.g., *Ulothrix flacca*, *Urospora penicilliformis*, *Enteromorpha compressa*, *Ectocarpi*, &c.); others are equally abundant on submerged iron or steel (e.g., *Callithamnion corymbosum*, *C. gracillimum*, *Ectocarpus siliculosus*, *Ceramium rubrum*, *C. diaphanum*, *Polysiphoniæ*, &c.); while yet other forms, which are almost invariably found growing in other Algæ or Epiphytes, are also sometimes found independent on rocky ground, or *vice versâ* (*Polysiphonia fastigiata*, *P. nigrescens*, *Mesogloia vermicularis*, *Griffithsia corallina*, &c.) In such circumstances averages of many observations have shown that the finest results of growth are found almost invariably *in the positions normal to the species in question*—that is, in such places as are most frequently occupied by the plants. The finest growths of *Polysiphonia fastigiata* have invariably been found on *Fucus nodosus* as host, while, on the other hand, *Urospora penicilliformis* grows best on floating blocks of imported wood. *Mesogloia vermicularis*, which is most commonly found on a rocky substratum, also occurs sometimes as an Epiphyte on *Polyides lumbricalis*, but its finest development has only been noted when found in the former position. In the same manner *Monostroma latissima* is usually of small size when found as an Epiphyte, though its host plants are exceedingly abundant, and the same is the case with *Callithamnion arbuscula*, its hosts being exceedingly few, while similarly by far the finest growths of *Callithamnion plumula* have been found when the plant grew in rocks — species obtained, especially on *Ceramium rubrum*, being all of but tiny size, and in a sterile condition when observed. A comparison of the results of growth in *Plocamium coccineum*, *Polysiphonia urceolata*, *Callithamnion arbuscula* and many others tend to the same result.

From time to time experiments and observations have been made on the rapidity of growth and of distribution at the marine floating laboratory of this Station, with the view of procuring some data on the facility with which the different species are capable of extending their range and of accommodating themselves to changing conditions of environment. It has already been noted that for the most part hard mammillated basaltic rocks or boulders are avoided by most species of algæ. If, however, the smooth and hard surface be more or less protected from the direct force of impact of waves, and be sufficiently shaded, as, for example, in the case of some of the deeper pot-holes* in the vicinity of Earlsferry and elsewhere, it very often bears an abundant crop, sometimes of the most delicate species of *Ceramiæ*, *Callithamniæ*, and *Polysiphoniæ*, as well as of larger forms (e.g., *Fuci*, *Laminariæ*, &c.). This is, of course, readily accounted for by the fact that the irregularities of the rock, though in themselves minute, are yet very large in relation to the very small size of the spores that seek a lodgment in them; while in other cases the settling of various forms of brackish water or shore Diatoms, such as species of *Podosphenia*, *Rhipidophora*, *Synedra*, and the commingling of *Naviculæ*, *Pinnulariæ*, and *Pleurosigmata* with these, very rapidly form a nidus on which algoid spores readily settle and germinate. I have found this to be the case with round boulders which had not been disturbed by storms for some time in the immediate vicinity of the Marine Station, as well as on others examined from Inchcolm, Inchkeith, Fidra, and the May Islands, and it has been readily proved by sinking a

* In a single pot-hole, about 6 feet deep and from 2 to 3 feet in diameter, examined for the first time by myself at Kincraig, near Earlsferry, during August 1884, beautiful growths of *Polysiphonia parasitica*, *Callithamnion gracillima*, *C. roseum*, &c., were procured at a depth of about 3 feet from the surface. The smooth margins of the hole were completely coated by a rich growth from top to bottom, where delicate fronds of *Laminaria saccharina* had reached a considerable size. At a somewhat later period Mr George W. Traill, to whom I showed the pool, examined it more minutely, scraping off the deeper forms by the delicate application of a perforated spoon applied to the end of a long stick, with the result that 68 different species were determined in it.

piece of planed wood in sea water, and leaving it exposed to the influence of the water for some time before examining it. During the later part of August and the earlier part of September 1884, I had several such pieces of wood suspended in the water from the sides of the floating laboratory, and after an interval of less than a fortnight many diatoms had become fixed to them. At this period, moreover, the specimens of *Enteromorpha compressa*, which occurred very abundantly between the levels of about $\frac{1}{8}$ to $\frac{1}{4}$ tide were rapidly discharging their swarmspores. *Porphyræ* (e.g., *P. vulgaris*) and *Ectocarpi* (e.g., *E. siliculosus* and *E. littoralis*) were also abundant in the ripe condition, but although specimens of the former did not become attached to the wood, rapid growth of both *Enteromorphæ* and *Ectocarpi* were noted. The early stages, especially of the *Enteromorphæ*, which could not be well observed on the pieces of wood, except by the general green hue soon communicated to them, were recorded from a series of experiments conducted in glass vessels in the floating laboratory. Specimens of *Enteromorpha compressa* approaching maturity were removed from their position on the shore along with the pieces of the shale upon which they grew. These were placed in cylindrical vessels of moderate size, and left for a few days in the same water, under the influence of a self-acting aerating apparatus. Small fragments of the specimens were detached and examined at intervals under the microscope. The progressive stages in the segregation of the protoplasm into zoospores, and their emission from the spore mother cells, were frequently observed.

More prolonged observations on the further development of the spores—conjugation was not seen—were carried out by placing slides with cells in the vessels containing the ripe parent plants, and allowing them to remain in close contact with the algæ for a few days. The impact of even the feeble currents, generated by the aerating apparatus against the ripe thalli, were sufficient to bring about a somewhat more active extravasation of the swarmspores, and this was several times still further accelerated by agitating the adult thalli somewhat more violently in the water. Of the very abundant swarmspores emitted many were caught on the submerged slides which were now sunk from the immediate vicinity of the plants to the bottom of the vessels. The spores were also found to accumulate in very great numbers around the margin of the bottom, but their normal heliotropic behaviour towards the light was disturbed by the injection of the currents of air through the aerating apparatus. Permanent slides of the embryo plants were mounted in weak acetic acid on November 1—twenty-two days after their extravasation from the parent thalli, and numerous measurements of the progress of growth were made during the period following their emission up till this time (see table, p. 431.) On November 1 the length of some of the embryos reached 1·00 mm., with a breadth of frond varying from 0·035 mm. towards the organic base, and in the vicinity of the origin of the rhizoids, to 0·045 mm. in the middle, from which they again tapered very slowly to the apex, which was bluntly rounded. The cells of these embryos have a very well marked and distinct character in different regions of the frond. The apical cell is in all cases plano-convex in outline, resembling either a semicircle or a segment of a sphere somewhat greater than a semicircle. The succeeding cells (twelve to fifteen in number) are bounded by approximately straight walls, where they are in contact with adjoining cells, but bulge somewhat all round the free parts, their length having to their breadth a ratio of about 2 : 3. Towards the base of this series, however, their *absolute* size increases in most cases very considerably, but their relative dimensions remain fairly constant. Bipartition now takes place, the unicellular filament being replaced by a bicellular, which is in turn soon replaced by a quadricellular—divisions of the daughter cells thus produced occurring after an interval occupied by from 3 to 4 cell lengths. Still further divisions have taken place at the middle of the young embryo, so that a cylinder of cells which in the same transverse section present considerable variability as to length and general outline is produced. Some of the cells of this cylinder are elongated with somewhat acutely rounded extremities, being from three to four times as long as broad, while others lying between these have divided by walls transverse to the axis of the filament, and are not more than twice as long as broad. In the lower part of the thallus there is a

TABLE showing the maximum lengths and breadths of embryos of *Enteromorpha compressa* during the earlier periods of growth.

Date.	Max. Length in mm.	Max. Breadth in mm.	Remarks
Sept. 8.	0·0025–0·0030	0·0025–0·0030	Spores emitted. The figures give the sizes of the spores in very weak acetic acid Some of them appear quite spherical, others are slightly ovoid. A few are elliptical, most are bluntly polyangular.
Sept. 12.	0·145	0·0065	Cell division in proximal cells. Rhizoids differentiated.
Sept. 16.	0·333	0·0150	Greatest diameter about middle of embryos
Sept. 20.	0·455	0·0200	Rhizoids rapidy elongating.
Sept. 24.	0·600	0·0250	Greatest diameter slowly passing backwards,owing to rapid elongation at the apex.
Sept. 28.	0·750	0·0350	In some specimens division has taken place in the third cell from the apex.
Nov. 1.	0·900-1·000	0·0450	Bipartition occurs on the average in the sixth cell from the apex. The cells are here bluntly quadrangular, but become elliptical towards the base, and pass by further elongation downwards into the rhizoids. Rhizoids average 0·12 to 0·15 mm. in length (=one-sixth approx. of the entire embryo). Greatest diameter of embryo distant about two-thirds of its length from the apex.

slight contraction. The cells become somewhat elongated, and pass by gradual transitions into the tiny rhizoidal protuberances, by which the embryos early become attached to their substratum. The rhizoids are in some of the mounted specimens wavy in outline, spread out in a somewhat fan-shaped manner from their origin, are closely placed, and possess somewhat ill-defined outlines. In some small embryos they attain about one-third of the entire length of the plants, but in most cases their extremities have been broken off in the course of manipulation, and their length is relatively considerably less.

At this time the distinctly green and healthy appearance of the numerous and undisturbed embryos in the glass vessels was well marked, and they rapidly increased in size up to November 20, when the observations were stopped, and when the maximum length of some of the specimens examined was 1·8 mm. The first stages in the formation of lateral protuberances which, by further cell divisions, would form ramuli, were not detected. Scrapings taken from some of the submerged pieces of wood were examined at intervals during the same period as embryos germinating in the glass vessels, the average maximum lengths and breadths of many specimens showing the same progress in growth in both cases. In the process of removal from the wood, however, the delicate and intricate rhizoids were invariably injured, but as little damage was done to the specimens as possible in their removal and in the course of their manipulation on the stage of the microscope.

On the emission of the spores their movements were at first very active. Under the microscope, when a light of feeble intensity was transmitted from the mirror, the movement did not appear to stop for at least two hours, but with a somewhat stronger illumination the swarmpores soon showed a tendency to pass into a more shady part of the field; when their activity under a moderate illumination had flagged to a considerable extent, the sudden transmission of more powerful rays for a very limited time stimulated to greater energy.

Although I have not succeeded in determining satisfactorily the exact heliotropic tendencies of these swarmspores, it is interesting to recall an observation by Borzi,*

* *Studi algologici,* Messina, 1883.

on an allied genus, to the effect that the zoogonidia of *Ulva* are positively heliotropic, whilst the conjugated zoospores have an opposite or heliophobic tendency. From the fact that, in the glass vessels where (except for the slight disturbing influence exerted by the aerating apparatus) the swarmspores were allowed to take up any position peculiar to them, they ultimately were found in greatest abundance on the side directed towards the greatest amount of light, where, however, the direct rays of the sun were never allowed to impinge, as well as from their behaviour in the field of the microscope, I am inclined to regard the existence of positive heliotropism, but on the shaded side of the vessels young embryos were also by no means wanting.

This species of *Enteromorpha* was the earliest and most tenacious occupant of the wooden surfaces, and the greatest number of observations were made on it in its earliest stages. I was, however, able by prosecuting the same methods of observation to collect many samples of *Porphyra vulgaris* in a ripe or spore-bearing condition, and to watch the emission of the swarmspores. These, however, did not germinate in captivity, nor were even the first stages of their development otherwise observed. The swarmspores of this species, however, moved more slowly and apparently more regularly than those of the *Enteromorpha*, and the movement was continued for a somewhat greater length of time.

As has already been pointed out by Rosanoff,† in the case of the *Ulvaceæ* generally, specimens of *Enteromorpha compressa*, *Monostroma latissimum*, *Ulva linza*, &c., from which the spores have been emitted, exhibit local changes of colour at the points where emission has occurred—changes which, however, cannot be regarded as primarily pathological, although subsequent circumstances now more readily bring about the rupture of the thallus at the weakened areas and sympathetic abnormal conditions in the adjoining cells.

The following table is given for the purpose of further showing the results of a series of measurements which have from time to time been made of Algæ, which have

† "Observations sur les functions et les propriétés des Pigments de deverses Algues," &c., *Mem. Soc. Imp. d. Sci. Nat. Cherbourg*, t. xiii. 1867.

grown on objects that have been submerged in sea water in a clean condition, and after exposure for definite periods been re-examined, with a view to the determination of the habit and rapidity of growth, &c.,* of the species in question :—

Name of Species.	Time of immersion on object forming means of attachment.	Average growth of Specimen in inches.	Remarks.
Monostroma latissimum, .	February to April	1·1	On iron mooring continually immersed in tidal basin.
Ulva linza	May to July	2·4	ditto.
Ectocarpus littoralis, . .	April to May	2	On fish cage, raised out of the water from time to time.
,, siliculosus, .	ditto	1·75	ditto.
,, tomentosus, .	ditto	2·5	On iron mooring continually immersed.
Laminaria saccharina, .	February to May	13	On iron hull, continually immersed.
Callithamnion plumula, .	May to July	1·75	On shale and iron work, continually immersed.
Chylocladia clavellosa, .	May to June	2·1	On iron hull, continually immersed.
Ulva lactuca, . . .	May to June	3·3	Embryo plants on exposed rocks at level of about ½ tide.
Polysiphonia nigrescens, .	April to June	1·75	On rock in tidal pool (½ tide), always immersed.
Callithamnion floccosum, .	June to August	1·2	On iron buoy off Inchkeith, always submerged.
Cladophora arctinscula, .	April to July	3·1	On exposed rock, Inchkeith.
Bryopsis plumosa, . .	April to June	2·3	In pool at about ¾ tide, Inchkeith (E. side).

By changing the external conditions, considerable variations have been produced with respect to the foregoing results. These changes have been effected by modifying

* In connection with the consideration of rapidity of growth, which, when taken in a relative light, so greatly influences the general facies of the Flora, the observations by Mr Neill on the Carr Rock, at the entrance to the Firth—a rock which is just uncovered at the lowest ebb of spring tides—are not without interest. He says:—"A stone beacon was being erected on a low rock called the Carr, near the entrance of the Firth of Forth. . . . It was at this time completely covered with the larger Algæ, especially *Fucus esculentus* and *F. digitatus*. By the necessary preparations for the beacon these were cleared off, and the rock reduced to a bare state by the beginning of November 1813, when it was obliged to be abandoned for the winter. The coating of sea-weed had at first been cut away by the workmen, the roots or bases afterwards trampled by their feet, and much of the surface of the rock had been

(1) the conditions of temperature, (2) the movements, and (3) the purity, together with the movements of the water. The first of these modifications was effected by allowing embryos to germinate in a warm room, either exclusively or intermittently; the second, by artificially producing in the glass vessel, with a strong glass rod, rapid and inconstant movements of the water; and the third, by adding previously a considerable quantity of muddy material, in order to increase friction during the movements.

The effects of an elevation of the temperature of the water by 10° F., the other conditions remaining constant were—

1. An earlier discharge of swarmspores from the adult plants by about one day, in the case of exposure to the change, extending over a fortnight, for *Enteromorpha compressa* and *Ectocarpus siliculosus.* (Compare pp. 425, 426.)

2. An elevation of the temperature of the water on alternate days only, in the case of other similar specimens, delayed the emission of swarmspores. A healthy plant in such circumstances emitted its swarmspores only four hours before some others of the same species which were in water whose temperature had never been elevated.

3. In the case of specimens growing in the ordinary water, the swarmspores were only observed in process of extravasation during the day, the temperature being higher than during the night. On several occasions specimens were examined after nightfall, but no such process was seen.

Specimens of *Monostroma latissimum*, *Enteromorpha compressa*, *E. intestinalis*, and *Ulothrix flacca* were observed in this connection, as well as ripe specimens of *Ectocarpus siliculosus* and *E. littoralis*.

4. The general effects on germination were as follows:—

chiselled. Upon returning to the Carr in May 1814, in order to recommence operations, it was matter of no slight surprise to find the surface again as completely invested with large sea-weeds as ever it was, although little more than six months had elapsed since the work had been left off, when, as already said, the rock had been cleared of weed. In particular, it was observed that many newly-produced species of *F. esculentus* measured 6 feet in length, and were already furnished with their fruit-bearing pinnæ. The common tangle, *F. digitatus*, was only about 2 feet long. It is to be observed that the specimens here alluded to were taken from that part of the surface of the rock which had been dressed off with the pick or chisel the preceding autumn; they had therefore grown from the seed."

(a) Swarmspores emitted from plants in a medium at the ordinary temperature, germinated more rapidly when transferred to a vessel of water, the temperature of which was raised through 10° Fahr.; (b) conversely, swarmspores emitted from plants in a medium at a more elevated temperature germinated more slowly when placed in a vessel of water at the ordinary temperature; (c) swarmspores placed in a vessel of water whose temperature was frequently (from five to eight times daily) changed through 20° Fahr. (*i.e.*, from the ordinary temperature t° to $t^\circ + 20^\circ$ and then back to t°), were not observed to germinate at all.

Experiments were also made with the view of determining the maximum range of degrees Fahr. through which the temperature might be raised—(α) without being again reduced, and (β) when again reduced, given but varying numbers of times, $-x$—without resulting in the destruction of the germinating power; but definite results were not attained, owing to the failure in the supply of swarmspores. At such periods, however, as these can be copiously procured, interesting results may be expected in this connection.

The effects of modifying the degree of movements of the water in which embryos of plants were growing were as follows:—

1. Movements of moderate rapidity—80 to 100 revolutions per minute—produced in a uniform direction (right to left or conversely), and especially towards the centre of the vessel, apparently produced no detrimental effect, the movements being repeated for five minutes every half-bour from 9 A.M. to 1 P.M., and again from 2 P.M. to 5.30 P.M. for four weeks. Germination proceeded normally in every way.

2. Similar movements, generated much more peripherally, had a retarding effect in a marked degree, probably because of increased concussion shocks on embryos settled around the margins of the bottom of the vessel as the motor passed nearer to them in its course through the water. The ratio of length of the young plants in the two cases being on the average as 3 : 1.

3. Irregular movements, resulting from right to left, followed rapidly by left to right courses of the motor, had still more prejudicial effects if the speed of the motor

was equal to that in the former cases. Such movements were, however, effected at reduced speeds without detriment to the embryos. The introduction of further complexities in the movements only increased the retardation of growth.

The addition of muddy material to the water, while the movements were also produced, had a detrimental effect, slower speeds of the motor through the water, either in uniform or alternately opposite or more irregular paths, producing retardation or complete cessation of growth.

The direct bearing of such observations on the general question of distribution becomes clear from the following considerations :—

1. The greater the rapidity of development of the spores after emission (whether zoogonidia, zoospores, or tetraspores), the better are the chances that the species will establish itself to the exclusion of other competing forms in the general struggle for survival, as the latter are thus forced to pass either to higher or lower levels, in order to continue their vitality.

2. The heliotropic tendencies of the swarmspores, in the first instance—*e.g.*, in conditions of perfect calm—give indications of the habit of the adult plant, and contribute in a greater or less degree to its wider distribution. Thus, positively heliotropic swarmspores may pass to a position at a considerable distance from the parent, and develop on any object presenting adequate conditions as regards surface and depth—*i.e.*, within a maximum and minimum of depth proper to the species. In cases such as the *Ulvaceæ*, where both heliotropic tendencies are manifested in succession, there is (*a*) a movement tending to dissemination, and (*b*) one tending to bring the former to an end, and to secure the rapid and safe fixation of the embryo.

3. The more rapid the evolution of any species, the greater is the influence which it exerts in acting as a resisting surface to the passage of water, bearing, it may be, many other swarmspores of the same or of different kinds, and the greater in consequence is its effect in securing the rapid covering of the substratum on which it has become fixed with other specimens of its own or other species, and thereby of influencing the dynamical efficiency of wave action. Similarly, too, it plays an important indirect

part in the process of cross-fertilisation by influencing the movements of the sometimes passively motile antherozoids, and by affording shelter for small *Amphipoda* or other creatures that by their movements aid in the dissemination both of antherozoids and of swarmspores.

4. From the physiological standpoint, the more rapid the growth of species on any given spot, the greater their influence in oxidising the water, and consequently the more active the movements of swarmspores emitted, and the greater their chances of extending distribution, ciliary action becoming less and less pronounced as the amount of oxygen decreases, and increasing in activity with its increase in volume within determinable limits.

5. In cases where, artificially or otherwise, the change of level of the water in inclosed basins becomes altered (*e.g.*, elevated), the change in the algoid facies is the more sudden in proportion as the species are more rapidly evolved. The great readiness with which specimens of *Laminaria saccharina* appear in such circumstances is especially noteworthy,

The general data of distribution may be ranged in a twofold manner, viz. (1) from a superficial or horizontal, and (2) from a bathymetrical or vertical point of view.

With respect to the bathymetrical range, J. G. Agardh,* in 1836, pointed out that on the Scandinavian coast† three algoid kingdoms could be distinguished from one another—(1) *Regnum Algarum Zoospermarum*, (2) *Regnum Algarum Olivacearum*, and (3) *Regnum Algarum Floridearum.*

Up to a depth of 20 fathoms on this coast there is a rich algoid growth, but beneath this it becomes more limited and more uniform. Indeed, at greater depths than 25 fathoms, J. E. Areschoug‡ scarcely finds anything but greatly reduced forms of *Florideæ*, especially *Delesseria sanguinea.* Moreover, Kjellman§ has recently (1878) pointed out that the earlier *kingdoms* established by Agardh are untenable, inasmuch as each "ist eine Zusam-

* J. G. Agardh, "Novitiæ Floræ Sueciæ ex Algarum familia," *Akad. Dissert.*, Lundæ, 1836.

† In all the localities here quoted the species recorded agree in a very marked manner with those found in the estuary of the Firth of Forth.

‡ J. E. Areschoug, *Phyc. Scand.*, p. 231.

§ *Bihang k. Sv. Vet., Akad. Handl.*, Bd. 5, No. 6, pp. 7, 8.

menfassung aller solcher Abschnitte des Meeresgrundes, deren Vegetation, ihrer Hauptmasse oder ihrer characteristischen Bestandtheile nach, von Algenarten zusammengesetzt ist, welche zu derselben Algenklasse gehören, und die in Hinsicht der äusseren Verhältnisse gewissermassen übereinstimmen, abgeschen davon, ob sie ein zusammenhängendes Ganzes bilden oder nicht. Ein Bezirk welche zu dem Regnum algarum Zoospermarum gehört, kann folglich in einer horizontalen, mit der Küste parallelen Richtung, an ein Gebiet grenzen, das einem der anderen Reiche zugehört. . . . . Die Ueberschaulichkeit der Vegetationsdecke des Meeresgrundes wird dadurch beeinträchtight, wozu noch kommt, dass es schwer sein dürfte, irgend eine für jedes Reich in seinem Umfang geltende Aehnlichkeit der äusseren Verhältnisse zu finden und anzugeben, und gleichfalls eine bestimmte überall wiederkehrende Verschiedenheit in dieser Hinsicht zwischen den besonderen Reichen festzusetzen."

At Öresund, A. S. Örsted* has similarly pointed out the occurrence of corresponding regions, and has assigned generally the range in depth to which each extends. Thus, (1) his *Regio algarum viridium seu Chlorospermearum* passes from high-water mark to a depth of from 2 to 5 fathoms; (2) his *Regio algarum olivacearum seu Melanospermearum* extends from 3 to 5 fathoms to from 7 to 8 fathoms; and (3) his *Regio algarum purpurearum seu Rhodospermearum* from 8 to 20 fathoms, where the general facies of the flora is of a red colour.

The line of division between the two deepest of these regions is regarded as more or less indistinct—the Laminarian region, for the most part, merging into the deeper Floridean, while only in a few places is the Rhodophyceous sharply circumscribed† from the lowest subregion of the Laminarian. Within these regions vegetative zones have also been established—zones which, however, though applicable at Öresund, cannot be applied in the eastern part of the Skager Rack.

F. R. Kjellman,‡ in referring to the vegetation zones at

* A. S. Örsted, *De Regionibus marinis.*

† A. S. Örsted, *Op. cit.*, pp. 47 and 51.

‡ *Bihang k. Sv. Vet., Akad. Handl.*, Bd. v. No. 6, p. 9.

Bohuslän, points out that the area extending between 5 or 6 and 20 fathoms must be regarded as continuous (Zusammenhängendes Gebiete), whilst it is indisputable that here too the equivalent of Örsted's *Regio viridium seu Chlorospermearum* is characterised as much by *Fucaceæ* as by '*Chlorophyllophyceæ*.'

The algoid vegetation in the sea on the west coast of Nova Zembla* has been divided by Kjellman into three great *zones* (Gebiete), viz. (1) the littoral, (2) the sublittoral, and (3) the elittoral, the line of demarcation between the first two being well defined, but that between the second and third being less distinct. As on the coast of Spitzbergen, here too a vegetation, rich both in genera and species, was found to a depth of 20 fathoms, but beyond this it became more uniform, poorer, and changed entirely in its general character.

Three *regions*—as Kjellman more recently named them—similar to those on the west coast of Nova Zembla, have been found on the north coast of Scandinavia, the lines of demarcation, however, between the sublittoral and elittoral being indistinct, and the distinction between the elittoral and littoral more indefinite than in higher latitudes.

On the north coast of Norway a Laminarian *formation* has been found in the area of division between the littoral and sublittoral regions, and assignable to the sublittoral.

On the Bohuslän coast the Laminarian *formation*, though represented close up to the water surface, appears in its greatest perfection at a depth of from 1½ to 2 fathoms, and extends to 20 fathoms (sublittoral region), the Chlorophyceæ occurring especially at a less depth (*i.e.*, in the littoral region). An elittoral region also occurs in depths greater than 20 fathoms.

The algoid vegetation on the coast of Bohuslän, which, so far as the recorded species are concerned, presents a very remarkable similarity to that of the Firth of Forth, may, from the researches of Kjellman, already referred to, be tabulated as follows—an algoid *formation being that part of the entire algoid vegetation which is distinguished by a peculiar vegetative facies* (Vegetationsgepräge):—

* Kiellman, *Murmansch. Meer. Algenv.*, p. 57.

Region.	Formation.	Types.	Depth in Fathoms.
Littoral, .	1. Ulvaceæ	Ulvae	...
	2. Fucaceæ	Fuci	...
	3. Cladostephus	Cladostephi	...
	4. Chordaria	Chordariæ	...
	5. Nemalion	Nemalion multifidum	...
	6. Porphyra	Porphyra vulgaris	...
	7. Callothrix	Callothrix scopulorum	...
Sublittoral,	1. Tilopteridæ	Phlæospora subarticulata	5-10
	2. Punctaria	Punctaria tenuissima	6-10
	3. Lithoderma	Lithothamnion polymorphum, Phyllophora brodiæi, &c.	up to 15
	4. Dichloria	Furcellaria fastigiata Dichloria viridis	5-10
	5. Chaetopteris	Chaetopteris plumosa	1-1½
	6. Furcellaria	Furcellaria fastigiata	7
	7. Lomentaria—Mesogloia	Mesogloia vermiculata Polysiphonia byssoides, &c.	10
	8. Mixed	No type predominant, but species numerous	10-15
	9. Laminaria	Laminariæ	...

During the dredging operations conducted at various parts of the estuary of the Forth, at different seasons of the year, many entire or fragmentary species have been observed. Those referred to below have been found sometimes on stones of various sizes brought up from the bottom, many have been recorded on the carapaces of Crustacea, and not a few have been dislodged from their attachment to rocks by the passage of the dredge across them. At various times forms have also been brought to light by the small beam trawl, in all cases, the largest collections were made when work was prosecuted on rocky and difficult ground. On a muddy bottom living species were not noted, except in cases where they were found attached to the tests and shells of the lower animals, or to stones and boulders recently submerged.

The table on p. 442 contains a record of species found in the vicinity of or beyond the May Island, and from this it is manifest that the most common forms found in deep water, in this neighbourhood, are Rhodophyceæ. From the fact, moreover, that the only specimens of *Nitophyllum laceratum* and *N. punctatum* observed came up as free fragments, and also from the circumstance that both have been found among drift at Dunbar, especially after storms, it would seem that they extend perhaps into as great if not greater depths than other species. A specimen of

Bonnemaisonia asparagoides was procured from 27 fathoms, and also came up in a free state. I have obtained this same species from a corresponding depth in the Clyde, in the vicinity of Millport, also in a detached condition, so that its precise limit could not be determined. It is very probable, however, that it ranges into deep water, as fragments have been observed, since the above observation

Name.	Depth.	Attachment.	Average Length in inches.	Remarks.
Alaria esculenta,	16 fms.	Rock	36 inches.	Common.
Bonnemaisonia asparagoides	27 ,,	Free	6 ,,	One specimen.
Chylocladia clavellosa,	22 ,,	Stone	6 ,,	do.
,, articulata,	12 ,,	Rock	4 ,,	Common.
Dasya coccinea,	28 ,,	Drifting	5·5 ,,	One fragment.
Delesseria alata,	20 ,,	Rock	5 ,,	A few specimens.
,, sinuosa,	24 ,,	do.	6 ,,	One specimen.
Desmarestia aculeata,	20 ,,	Drifting	19 ,,	Two fragments.
Laminaria cloustoni,	16 ,,	Rock	65 ,,	Common.
,, phyllitis,	12 ,,	do.	12 ,,	One specimen.
,, saccharina,	16 ,,	do.	47 ,,	Common.
Lithothamnion polymorphum,	20 ,,	do.	Up to 1 in. in diam.	do.
Melobesia pustulata,	Low tide	do.	Up to about 0·5 in. in diam.	Several.
Nitophyllum laceratum,	30 fms. & upwards	Drifting	3·5 in.	One specimen.
,, punctatum,	do.	do.	3 ,,	One fragment.
Odonthalia dentata,	16 fms.	Rock	7 ,,	Two specimens.
Phyllophora brodiæi,	24 ,,	Sandy ground	3·75 ,,	One specimen.
,, rubens,	16 ,,	Rock	5 ,,	Two fragments.
Plocamium coccineum,	22 ,,	do.	4·5 ,,	Several specimens.
Ptilota plumosa,	— ,,	On *Laminaria cloustoni*.	6 ,,	Specimen, most probably from deep water.
Schizymenia edulis,	12 ,,	Rock.	7 ,,	One specimen.

was made, entangled in the nets used by deep-sea trawling vessels. The fragment of *Dasya coccinea* in the table from 28 fathoms was also observed on the nets used by trawling steamers, which were conducting their work at a depth not greater than that given. The specimen was in excellent condition, of good size, and quite fresh—its range into greater depths cannot he doubted. From the circumstance that more specimens of *Nitophylla* than of any other form have been recorded from the deeper waters of the Firth, this section, which may be regarded as extending from 28 or 30 fathoms to 34 fathoms and upwards beyond the limits of the estuary seawards, may be looked upon as the *Nitophyllum* area.

Above this the *Delesseriæ* (*D. alata* and *D. sinuosa*) and specimens of *Plocamium coccineum* were procured more abundantly than any others—*Delesseria alata* being the most commonly observed, and *Plocamium coccineum* more abundantly than *Delesseria sinuosa.* Many specimens of all these have been noted entangled in deep-sea fishing lines. Fruit has been found in all of them; and as there is reason to believe that they here form a fairly distinct characteristic, this may be designated the *Delesseria-Plocamium* area. Its extent, though probably reaching into the *Nitophyllum* area, may be set down between the limits of low water and 28 fathoms, being best represented at depths extending between 16–24 fathoms. At many parts of the estuary specimens of all of these forms occur at low-water mark, *e.g.*, Inchcolm, Inchkeith, Fidra, Dunbar, Fifeness, &c., and very commonly, *e.g.,* on living crustacean carapaces even at from 12–16 fathoms. Many of the largest specimens, especially of *Delesseria sinuosa* and *Plocamium coccineum,* have been found among drift weed, and must, from their size, have come from deep water. The same also applies to several specimens of *Delesseria sanguinea* which were observed.

The Laminarian area characterised by the presence of large specimens of *L. cloustoni*, *L. saccharina*, and *Alaria esculenta*, is most distinctly defined at a depth of from 3 to 16 fathoms. In the clear deep water to the east of the May Island this zone is seen to the best advantage. In tidal pools specimens of all the representative species are common, but their growth becomes markedly smaller as their upper limit is approached. On detached stipes of *L. cloustoni*, *Melobesia laminariæ*, along with other epiphytic Algæ (e.g., *Rhodymenia palmata*, *Ptilota plumosa*, *Polysiphonia parasitica*, *Delesseria sinuosa*, *Dasya coccinea*, &c.), have been observed. The most perfectly developed specimens of the characteristic plants of this area seem to occur at a depth of about 15 fathoms. Well-formed specimens, however, often showing the characteristic stages of the renewal of the frond at the end of the stipes, occur off Inchcolm in a depth of from 3 to 4 fathoms.

Desmarestia aculeata has been repeatedly observed entangled in deep-sea nets, and is of by no means uncommon occurrence as drift weed in the crannies on the eastern side of the May Island. I have not been able definitely to assign to it any given depth at this place, but from the circumstance of its occurring in nets working at from 16 to 26 fathoms, its habitat is probably at the lower limit of the present area. Two specimens of *Desmarestia viridis* were found in similar depths as those of *D. aculeata* from this neighbourhood.

Within the limits of the Laminarian area numerous other species have been noted—the most characteristic of these are *Callithamnion plumula*, *Phyllophora brodiæi*, *Cystoclonium purpurascens*, *Delesseria alata* (small or not of more than medium size), *Callithamnion turneri*, *Phyllophora rubens*, *Chylocladia clavellosa*, *Lithothamnion polymorphum*, *Delesseria sanguinea*, *Cruoria pelita*, *Odonthalia dentata*, &c.

Occupying a situation encroaching upon the upper limits of the last-noted area, the *Phyllophoræ* must be looked upon as sufficiently characteristic of another area, having as typical species *Phyllophora brodiæi*. Its highest development may be regarded as extending between 2 and 10 fathoms. *Phyllophora brodiæi* and *P. rubens* are both common. *Corallina officinalis* has been found as the upper reaches of the area are approached. *Polysiphonia byssoides* occurs towards its lower margin. *Phyllophora membranifolia* and *Odonthalia dentata* are not unfrequent, the latter often attaining a length of 5 inches; and *Melobesia calcarea* is in some places (*e.g.*, south-west of Inchkeith) so abundant as to be quite a well-marked characteristic of its middle part. *Rhodymenia palmata* attains a moderate size here, and *Chorda filum*, which is not uncommon in many places, may be looked upon as characteristic. *Chorda tomentosa* is also present. *Fuci* (e.g., *F. serratus*, *F. platycarpus*) grow on rocks towards the upper limits, but their peculiar position must be looked upon as somewhat higher up. *Furcellaria fastigiata* and *Polyides rotundus* can also be seen at such depths on the eastern side of the May Island. *Ceramium rubrum* is not unfrequent, as well as several *Callithamnia* (e.g., *C. turneri*, *C. plumula*, &c.), off Inchmickery. *Dictyota dichotoma* has also been recorded by Lightfoot and Greville from the upper limits of this zone.

There is here a curious commingling of Phaeophyceæ and Rhodophyceæ, but it is at the same time of interest to note the absence of the best stages of development of some of those species of the latter possessing the largest and most brilliant thalli (*e.g.*, *Nitophylla*, *Delesseriæ*—*Chylocladia clavellosa*, &c.). There is, on the other hand, the introduction of several wine-coloured species (e.g., *Ceramium*, *Furcellaria*, *Polyides*, *Polysiphonia*, &c.), and of some of the more slender, often highly elastic olive-coloured *Chordæ*.

Just beneath the limit of extreme low water, and extending to a depth of from 1½ to 2 fathoms, another area may be distinguished, in which, however, not a few of the former plants occur, and which corresponds to the boundary between the *Littoral* and *Sublittoral* regions of Kjellman on the Bohuslän coast. The species found in this area include the following:—*Bangia cilaris*, *Ahnfeldtia plicata*, *Callithamnion brodiæi*, *C. strictum*, *Chorda filum*, *Cordylecladia erecta*, *Delesseria alata*, *Corallina officinalis*, *Cladostephus spongiosus*, *Cystoclonium purpurascens*, *Furcellaria fastigiata*, *Gloiosiphonia capillaris*, *Griffithsia corallina*, *G. officinalis*, *Lithothamnion polymorphum*, *Mesogloia vermicularis*, *Polysiphonia elongata*, *Ptilota elegans*, *Rhodomela lycopodioides*, *Sphacelaria plumigera*, *Rhodymenia palmata*, &c.

As this is the position in which the *Cystoclonia* are especially prominent on both coasts, from Dunbar seawards on the south side and Kincraig to Fifeness on the north, it seems right to designate it the *Cystoclonium* area. It is the representative of the *Chaetopteris* formation on the opposite shore of the North Sea, which is characterised by the presence of *Chaetopteris plumosa* associated with *Phlœospora tortilis* (see page 441).

In the more seaward parts—*e.g.*, May Island, Bass Rock, from Dunbar and Crail eastwards—a very varied and rich growth of algæ occurs between the limit of extreme low water marks of spring and neap tides. Many of the most beautiful forms of littoral Florideæ are found here, as well as a great variety of Phæophyceæ. *Alaria esculenta* is often well developed, and bears copious fruit. *Bangia* *ciliaris*—a somewhat rare form, but found sometimes epiphytic on the also somewhat rare *Phyllophora traillii* (*e.g.*, at Kilrenny), occurs. *Sphacelaria plumigera*, *Saccorhiza bulbosa* (upper limit, *e.g.*, at Inchkeith), *Ptilota elegans* (*e.g.*, Dunbar, Pittenweem), *Odonthalia dentata* (*e.g.*, Inchcolm, Inchmickery, Inchkeith, Fidra), and *Phyllophora brodiæi*, are also noteworthy, as well as *Phyllophora rubens*, *Griffithsia corallina*, and *Delesseria sanguinea*. The curious mammillated *Leathesia tuberiformis* is present, but is not specially abundant, its maximum of development as an epiphyte on *Corallina officinalis* being some feet above low-water mark, especially in some rock crannies. The delicate filamentous *Litosiphon laminariæ* occurs here at Fifeness, as well as *Melobesia laminariæ*. *Mesogloia vermicularis*, *Polyides rotundus*, *Furcelaria fastigiata*, *Ceramium rubrum*, and *C. diaphanum* are also to be found from Inchkeith eastwards. *Chondrus cripus* abounds in most localities, and *Cystoclonium purpurascens* is found here from Inchcolm to the May Island, as well as from Caroline Park and Seafield Tower to the east. *Callithamnion arbuscula* is especially abundant in this and higher zones on the Bass Rock, while on the May Island *Callithamnion polyspermum* is also very frequent.

From the abundance of Sphacelariæ and Griffithsiæ here this may be designated the *Sphacelaria-Griffithsia* area, and as characteristic species the *Sphacelaria plumigera*, *Griffithsia corallina*, *G. setacea* may be noted. It moreover must be looked upon as the inferior limit of the *littoral* region of Kjellman.

From this to the next in order—the *Corallina* area—there is an easy and gradual transition. This new belt may be looked upon as embracing the section of coast line lying between the level of three-quarter tide and low-water mark. It is especially characterised by an exuberant growth of *Leathesia tuberiformis* on the western shore of the May Island. The abundance of *Corallina officinalis* here is also no less striking. Fuci (especially *F. vesiculosus*), are common, and *Dumontia filiformis* is represented, though not so abundantly as in that next to follow. The effect of fresh water streamlets in producing a twisted, irregularly corkscrew-like appearance in this alga at this level, is very striking. Species of Ectocarpus (*E. littoralis*, *E. granulosus*, *E. fasiculatus*, *E. siliculosus*, *E. sphærophorus*, and *E. tomentosus* are now not unfrequent, and specimens of the somewhat similar *Elachistea* are common. *Lithothamnion polymorphum* and *Melobesia pustulata* are common in many places on the rocks, whilst *Mesogloia vermicularis* here reaches its uppermost limits. Many fine *Polysiphoniæ* occur (notably *P. urceolata*, *P. nigrescens*, *P. atro-rubescens*, *P. brodiæi*, &c.), of these many elegant forms are to be found in small but unexposed rivulets of water between pools, as well as in pools themselves. *Porphyra amethystea*, *P. leucosticta*, and *P. vulgaris* are fairly common, and *Polyides rotundus*, as well as *Furcellaria fastigiata* and *Chondrus crispus*, are very abundant. *Odonthalia dentata*, though present, is of much smaller size than in deeper water (*e.g.*, off May Island, Inchkeith, Fidra, &c.). *Schizymenia edulis* in the more seaward parts is frequent, and often of large size. *Rhodomela subfusca* and *R. lycopodioides* are also common in many parts, even well up the estuary (*e.g.*, at Inchmickery, Inchcolm, &c.). *Ptilota elegans* is not unfrequent, though of smaller size than in the previous zone or in still deeper water.

Here, moreover, a new feature is present in the occurrence of many forms of *Chlorophyceæ*, among which are *Monostroma latissimum*, *Porphyra amethystea*, and *P. leucosticta*. The *Enteromorphæ* (*E. compressa*, *E. intestinalis*, *E. erecta*) here reach their lowest limits, and it is noteworthy that the species diminish in size as they approach this limit. Two influences especially operate in limiting the downward distribution of these forms, namely, salinity and pressure. In specimens found at the lowest limit swarmspores are produced somewhat later than in others that occur at a high level, the plants are, moreover, of a more stunted growth, and their texture is somewhat more rigid. The influence of salinity is readily proved by the circumstance that in no case do they extend to so great depths, except along the course of streamlets of fresh water as these enter the sea. By diversion of such streamlets for a considerable time the plants may be readily placed in a condition of greater permanent salinity—their growth is thus at first checked, their rhizoids finally loose hold, and the thallus, having become more or less pathological, is carried away by the tidal waters from its position of growth. After a period of sporulation young plants will again appear along the new course of the fresh water streamlets, but will not be found along the old course if the water be continually diverted.

The influence of pressure is evidenced by its effect on the rigidity of the plants—an effect induced by the strains to which they are subjected by the passage of water across them during the ebb and flow of the tide. This increased firmness, together with the longer exposure to the influence of salt water in proportion as the position of fixation is at a lower level, and consequently the less the exposure to the heat rays of direct sunshine (the water being colder than the air in summer and early autumn), will sufficiently account for the greater lateness in the emission of swarmspores.

Chaetomorphæ (*C. aerea* and *C. melagonium*) occur here but rarely, but many *Cladophoræ* of fine growth are found. Among these may be noted *Cladophora uncialis*, *C. arcta*, *C. glaucescens*. This genus is exceedingly abundant at this and a slightly higher level among the rocky buttresses to the south of the May Island, and at several places they present a remarkable contrast to the less conspicuous species around them.

The continuity of species between the levels of a quarter and three-quarter tide over almost the entire estuary precludes the subdivision of this into more than a single area—which from the preponderance of Fucaceæ may be named the *Fucus* area. We here find the upper limits of several species, *e.g.*, *Ptilota elegans*, *Schizymenia edulis* (only in pools at the lowest reaches of this area), *Odonthalia dentata*, *Phyllophora rubens*, *P. traillii* (in dark and shallow pools well seaward), *Polysiphonia atro-rubescens*, *P. brodiæi*, *P. fastigiata* (common in many parts), *P formosa*, (*e.g.*, Fidra, in pools). *P. parasitica* (rare only in deep pot-holes or sheltered spots). *Porphyra amethystea*, *Furcellaria fastigiata*, *Ahnfeldtia plicata*, *Alaria esculenta* (at the lower reaches of the zone), *Bryopsis plumosa* (not uncommon), *Callithamnion arbuscula*, *C. hookeri*, *C. plumula* (even in muddy water in places sometimes under the influence of fresh-water rivulets at certain states of the tide), *C. polyspermum*, *C. turneri*, *C. strictum*. *Ceramium acanthonotum* occurs here in very great abundance, *e.g.*, especially on the steep sides of the Bass Rock and May Island; *Delesseria alata* seldom occurs beyond the lower levels; *Cystoclonium purpurascens* is found, however, from Inchcolm and Inchmickery eastwards. *Chorda filum* occurs, but is comparatively stunted in growth; on the other hand, *Chaetomorpha tortuosa* is especially well developed in many parts, as well as *C. melagonium*. Some *Desmarestiæ* (e.g., *D. viridis*) are found growing here, especially towards the eastern parts of the estuary, but after storms detached pieces of this species, as well as of *D. aculeata*, are very commonly found among deposited drift-weed. *Dictyosiphon fœniculaceus* and *D. hippuroides* are especially characteristic of this area and of the upper parts of that last mentioned. *Dumontia filiformis*, as well as the crumpled variety in the courses of fresh-water streamlets, is very common, and some of the deeper *Ectocarpi* (e.g., *E. fasiculatus* and *E. granulosus*) are frequent. *Elachistea scutulata* on *Himanthalia lorea* is found at the lower reaches in the more seaward parts. The Fuci (e.g., *F. ceranoides*, common near Dunbar, *F. nodosus*, *F. platycarpus* *F. serratus*, *F. vesiculosus*) are all, with the exception of *F. ceranoides* in many parts, very abundant, and from their well-marked size give a characteristic appearance to the belt. *Gelidium corneum* is common and well developed, growing on a firm exposed rocky substratum, but *Griffithsia setacea* does not extend much beyond the lower limit. *Halidrys siliquosa* is found in shallow clear rock pools here, as well as in the Enteromorpha area, about to be referred to, and in deeper belts. *Herponema velutina*, which occurs not uncommonly on *Himanthalia lorea*, is frequent in the seaward parts. The *Laurenciæ* abound on many rocky shores, and especially from Inchkeith to the east (e.g., *L. pinnatifida* and *L. hybrida*). *Melobesiæ* are not unfrequent—*Lithothamnion polymorphum* and *Melobesia pustulata*, both occur from Inchcolm to the east. They are especially well formed in places devoid of mud. *Mesogloiæ* (e.g., *M. vermicularis*, at the lower limits, and *M. virescens*), *Myrionemæ* (e.g., *M. punc-*

tiforme and *M. strangulans*) are not unfrequent from Inchkeith eastward, but the finest forms occur from Dunbar on the south and Kincraig on the north seawards. Corallines are very common (e.g., *Corallina officinalis*).

Although some of the most delicate species (e.g., *Callithamnion floridulum*, *Ceramium diaphanum*, &c.) are here found in abundant association with more robust forms, many of the most beautiful species among the *Florideæ* are especially found in the previous deeper areas; while, on the other hand, the Chlorophyceæ are now beginning to occur in far greater prominence. *Ulvaceæ* (*Monostroma latissimum*, *Ulva linza*, and *U. lactuca*) are common. *Porphyra vulgaris* is found from Cramond eastwards; *Confervæ* are frequent. *Cladophoræ* (*C. arcta*, *C. rupestris*, *C. lanosa*, *C. lætevirens*, *C. glaucescens*) are abundant in many parts, but especially so in rock pools, where the water is free from mud, and well towards the sea. The *Enteromorphæ* are here more common, especially *E. compressa* and *E. erecta.*

On the May Island (seaward side) there is a very copious development of *Chylocladia articulata* in this zone beneath a ledge of rock, in a somewhat dark secluded situation, and associated with many sponges and zoophytes.

The uppermost or *Enteromorpha* area is especially characterised throughout the entire estuary by the presence of *Chlorophyceæ.* Among these the *Enteromorphæ* are especially prominent in many parts. The circumstance, moreover, that *E. intestinalis* can survive in pools that are quite above the level of tidal influence, and which can only procure their saline constituents from spray during storms, seems to mark this genus as worthy to give a name to the belt. *Enteromorpha intestinalis* is also very common in many parts throughout the belt from Inchcolm eastwards, and is usually found in places where fresh water is entering the estuary. It thus forms a well-marked transition to the truly fresh water forms that are often found in its immediate proximity. *E. compressa* is very common all over the estuary, especially from Queensferry to the east, in this belt. It is less sensitive to the influence of fresh water than *E. intestinalis*, yet is often found associated with the latter where fresh water is dropping down from cliffs or high rocks. In such situations, moreover, it is very commonly associated with *Rhizoclonium riparium*. *Entero-morpha percursa* has been found in pools near high water in this area, which also often shows an abundance of large forms of *Monostroma latissimum*. *Prasiola marina* is a very common plant at high-water level. It differs from *Entero-morpha intestinalis* in not descending with it into deeper water, where streamlets enter the estuary. *Porphyra laci-niata* is very common from Inchcolm eastwards. It forms a well-marked characteristic on the steep and somewhat bare rocks of the Bass and May Islands. It often presents a torn appearance, and in exposed places is stunted in growth. *Porphyra vulgaris* is also found, though it often extends somewhat deeper. *Polysiphonia fastigiata* occurs, but is especially confined to the lower margin of the belt, while its lower limit is regulated by that of the Fuci, on which it especially grows. Various *Oscillatoriæ* (e.g., *O. subuliformis*, &c.) and *Lyngbyæ* (eg., *L. aestuarii*) are found throughout this area; whilst the *Myriotrichiæ* are not unfre-quent, especially from Inchkeith seawards (e.g., *Myriotri-chia clavæformis* and *M. filiformis*), and are often found associated with one another. Like those just noted, *Dictyo-siphon mesogloia* is common in this belt in many places in the more seaward parts; and *Ectocarpus siliculosus*, *E. littoralis*, *E. sphærophorus*, *E. tomentosus*, *E. brachiatus*, &c., are abundant throughout the estuary. *Fucus canalicu-latus* is especially characteristic, occurring abundantly from Inchcolm eastwards. *Ceramium diaphanum* and *C. rubrum* are still common in rock pools, but tend to decrease as they ascend in position. *Chrondus crispus*, which is abundant throughout the rest of the tidal zone, reaches the lowest part of this belt, but is of stunted growth. Many *Clado-phoræ* occur, and *Corallina officinalis* is still present, though smaller than in the Fucus zone. *Ralfsia verrucosa* and *Cruoria pellita* form here firm and tough incrustations on stones. *Asperococcus echinatus* occurs in clear shallow pools, very often in company with *Halidrys siliquosa*, espe-cially at the lower part of the belt. *Bangia fusco-purpurea*, which in some seasons is badly represented, is also found here from Caroline Park eastwards; and *Punctaria planta-ginea* occupies a position at the level of high tide on the east side of the May Island. Where logs of wood have lain for some time in the wash of the tide they often become covered with a growth of *Ulothrix flacca*, commingled with *Urospora penicilliformis,* the latter forming elegant dark-green streaks, of a somewhat glossy appearance, among the fronds of the former. *Catenella opuntia* is pre-eminently a high-water species; nor does it appear to be greatly influenced by the muddy or clear character of the waters, having been observed from Caroline Park to the eastward. *Callithamnion rothii* is very common, *e.g.*, Caroline Park and Inchcolm eastwards in this belt, especially in its lower reaches; *C. floridulum*, though present, belongs rather to the Fucus zone.

If a comparison be made at different places (*e.g.*, Inchcolm, Inchkeith, Fidra, the Bass Rock or May Island, and the corresponding north and south coasts) of the products of the various zones, *i.e.*, if the superficial extent be considered, the following general statements may be arrived at:—

I. Some species may be regarded as having a very wide or general range, among which may be noted the following:—

A. *Entermorpha area:—*

Enteromorpha intestinalis, E. compressa, Prasiola marina, Monostroma latissimum, Porphyra laciniata, P. vulgaris, Ulothrix flacca, Urospora penicilliformis, Cladophora lætivirens, &c.

B. *Fucus area:—Fucus nodosus, F. platycarpus, F. vesiculosus, F. serratus, Halidrys siliquosa, Lithothamnion polymorphum, Elachistea fucicola, Callithamnion rothii, Ectocarpus littoralis, E. siliculosus, Dumontia filiformis, Gigartina mammillosa, Polysiphonia nigrescens, P. fastigiata, Chondrus crispus* (as well as deeper), &c.

C. *Corallina area:—Corallina officinalis, Odonthalia dentata* (and deeper) *Rhodomela subfusca, Rhodymenia palmata* (or deeper), *Ralfsia verrucosa, Polyides rotundus, Leathesia tuberiformis, Petrocelis cruenta, Ceramium acanthonotum,* &c.

D. *Sphacellaria-Griffithsia area:—Furcellaria fastigiata, Chordæ, Laminaria cloustoni, L. saccharina, Cystoclonium purpurascens, Callithamnia* of various species, *Phyllophora* *membranifolia*, *Delesseria alata*, *D. sinuosa*, *Melobesia lamminariæ*, *Ptilota elegans*, &c.

With respect to this entire tidal belt, however, the following circumstances are worthy of note:—

(1) The *range*, though in all cases general, in a landward direction, as contrasted with some deeper species as already implied above, varies with regard to the three great groups. Thus the Chlorophyceæ extend furthest inland, occurring, though in diminished size, well up to the point to which tidal water passes, as in the case of *Enteromorpha*, *Ulothrix*, &c.—while they at the same time are found on shores bathed by the pure ocean water. The *Fucaceæ* have the next greatest superficial range. *Himanthalia lorea* is indeed confined to the more seaward parts, and *Fucus ceranoides* is perhaps, after it, the most limited in its range, but on the other hand, *F. nodosus* and *F. canaliculatus* pass far up the estuary; the latter has not been observed beyond Queensferry, but the former occurs as far as Grangemouth. *F. serratus* and *F. platycarpus* ascend as far as Alloa, and are of fairly large size, and the latter can be traced still higher, notwithstanding the mud which so greatly pollutes the river at this part. *Ectocarpus siliculosus* and *E. littoralis* also pass up beyond Queensferry, but their growth has never been observed to be so great as at more seaward localities. The range of the species of *Ulvaceæ* and of *Porphyræ* is also of wide extent, though like the last they disappear before the *Fuci*. *Monostroma latissimum* is more persistent than the more delicate *Ulva linza* and *U. lactuca*. Species of *Ulothrix* are of wider range, and pass gradually into similar species belonging to fresh water.

The species of *Elachistea* have a less wide range than those of Fucus, although they are often found growing on the latter.

For those belts lying below the *Enteromorpha* area, a general thinning off may, as in the latter, be observed as the estuary is ascended, and as the water becomes less deep, or as a sandy and shelly ground is replaced by mud. Thus the *Gigartina mammillosa*, which occupies a considerable vertical area at Inchkeith, Fidra, and on the adjoining coasts of the mainland, is not so extensive at

Cramond Island, Inchmickery, or Inchcolm, and still less so at or above North Queensferry, while the same is applicable to *Corallina officinalis*, *Odonthalia dentata*, *Delesseriæ*, *Polysiphoniæ*, *Ceramiæ*, and others. It is, however, remarkable that it is not always the species that is highest in the more seaward places that extends furthest in a landward direction. This occurs in the cases of *Fucus canaliculatus,* as compared with *F. platycarpus* and *F. serratus;* and it may also be noted in the case of *Laminaria cloustoni* and *L. saccharina*, as contrasted with *Alaria esculenta,* and *Saccorhiza bulbosa*, or of *Odonthalia dentata* as against *Polysiphonia urceolata*, and of *Callithamnion turneri* as against *C. plumula*, &c., the latter having been found at a depth of about twenty-five fathoms, growing on a Pecten shell, to the south of the May Island, and having also been dredged to the east of Inchmickery in a depth of from 3 to 4 fathoms. The delicate *Florideæ* become more and more abundant for a given depth as one passes from Queensferry to the May Island. The *Polysiphoniæ*, *Delesseriæ, Ceramia*, *Callithamnia*, *Griffithsiæ*, *Phyllophoræ*, *Plocamia*, &c., may all be noted in this connection.

(2) As to the *size* of specimens from different localities, but at corresponding depths within the limits of the tidal belt, many measurements have been recorded from time to time, but it may be said generally that the best data have been procured from specimens collected on the shores of the various islands, since here no disturbing influences are at work, either to artificially accelerate or retard growths, as not uncommonly happens on the shores of the mainland. In the following table the averages of the sizes taken from many specimens are given, as well as the places of growth, and the position with respect to depth :—

[Table.

Name.	Average Size in inches.	Locality.	Depth.	Mean Time of Observation.
Asperococccus echinatus	7, 7·25, 8·5	Inchkeith, Earlsferry, Caroline Park	$\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{4}$	July–Aug.
Ahnfeldtia plicata	4, 4, 4·5	Inchcolm, Inchkeith, Fidra	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	Sept.–Oct.
Bryopsis plumosa	up to 8·5	Joppa, Earlsferry	$\frac{1}{8}$, $\frac{1}{2}$	July–Aug.
Callithamnion arbuscula	3·5, 4·5, 4·5	Caroline Park, Bass Rock, Elie	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{3}{4}$	August
C. floridulum	1, 1·2, 1·2	Caroline Park, Inchkeith, Earlsferry	$\frac{1}{2}$, $\frac{3}{4}$, $\frac{3}{4}$	July–Aug.
C. floccosum	2 (average of 50)	Inchkeith Buoy	0	August
C. gracillimum	2, 2·25	Inchkeith, Earlsferry	$\frac{1}{4}$, $\frac{1}{4}$,	August
C. plumula	2, 1·2, 3	off Inchmickery, Caroline Park, off May Island	3, $\frac{3}{4}$, 20	July–Sept.
C. polyspermum	0·75, 1, 1·2, 1	Caroline Park, Inchkeith, Fidra, May Island	$\frac{3}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, $\frac{1}{2}$	August
C. rothii	0·2–0·25	Caroline Park, Inchcolm, Inchkeith, Fidra	0, 0, $\frac{1}{8}$, $\frac{1}{8}$	Sept.–Oct.
C. hookeri	2, 2·5, 2·5	Inchkeith, Fidra, Elie	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	August
Ceramium acauthonotum	0·5, 0·5, 0·8, 0·8	Inchcolm, Inchkeith, Fidra, May Island	$\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	Aug.–Sept.
C. diaphanum	3, 3·5, 3	Inchkeith, Fidra, May Island	$\frac{1}{4}$, $\frac{1}{2}$, $\frac{1}{2}$	July–Aug.
C. rubrum	4, 4, 4·5, 4	Inchcolm, Inchkeith, Fidra, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	July–Aug.
Chaetomorpha melagonium	5, 5, 5	Inchkeith, Joppa, Elie	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	July–Aug.
Chrondrus crispus	3, 4, 4, 4,	Inchcolm, Inchkeith, Fidra, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	July
Chordaria flagelliformis	7, 7, 8·5, 8	Inchcolm, Inchkeith, Fidra, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	July–Sept.
Chylocladia clavellosa	3, 4, 6	Caroline Park, Inchkeith, Fidra	$\frac{3}{4}$, $\frac{3}{4}$, 1	July–Aug.
Corallina officinalis	2·5, 4, 4·5	Inchcolm, Inchkeith, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	July–Aug.
Cystoclonium purpurascens		Inchcolm, Inchkeith, Fidra May Island	1, $\frac{3}{4}$, $\frac{3}{4}$, 1	July–Aug.

Name.	Average Size in inches.	Locality.	Depth.	Mean Time of Observation.
Delesseria alata	2, 2, 1·75, 4·5 (drift)	Inchcolm, Inchkeith, Bass Rock, May Island	1, 1, $\frac{3}{4}$, 1 (drift)	April–May
D. sinuosa	3, 3, 2, 5 (drift)	Inchcolm, Inchkeith, Bass Rock, May Island	1, 1, $\frac{3}{4}$, 1	April
Desmarestia aculeata	10, 14, 14	Inchkeith, Elie, May Island	drift, 1	August
Dumontia filiformis	7–9	Inchcolm, Inchkeith, Fidra, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$	August
Ectocarpus siliculosus	4·5, 4, 5, 5	Inchcolm, Inchkeith, Fidra, May Island	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	September
E. littoralis	5–6·5	Inchcolm, Inchkeith, Fidra, May Island	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	Aug.–Sept.
Fucus nodosus	up to 17	Alloa, Caroline Park, Inchcolm, Inchkeith, May Island	$\frac{1}{8}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	August
F. serratus	up to 14	Alloa, Inchcolm, Inchkeith, May Island,	$\frac{1}{8}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	March
Gigartina mammillosa	2, 3, 3, 4	Inchcolm, Inchkeith, Fidra, May Island	$\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$	February
Halidrys siliquosa	12, 12, 15, 14, 26	Caroline Park, Inchcolm, Inchkeith, Fidra, off Anstruther	$\frac{1}{8}$, $\frac{1}{8}$, $\frac{1}{8}$, $\frac{1}{8}$, 24	February
Himanthalia lorea	up to 20	May Island, Fifeness	$\frac{3}{4}$	August
Leathesia tuberiformis	dia. up to 1·75	Inchcolm, Inchkeith, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{3}{4}$	August
Litosiphon pusillus	up to 3	Elie	1	August
Mesogloia vermicularis	10, 12	Earlsferry, off Anstruther	1·12 fms.	August
Monostroma latissmum	5, 6, 6	Caroline Park, Inchkeith, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	May–July
Ulva linza	6, 6, 5, 6	Inchcolm, Caroline Park, Inchkeith, May Island	$\frac{1}{4}$, $\frac{1}{4}$, $\frac{1}{4}$, $\frac{1}{2}$	May–July
Nitophyllum punctatum	3·5, 4	Dunbar, off May Island	drift, 28	Aug.–Sept.
Odonthalia dentata	4, 5, 6, 5	Inchcolm, Inchkeith, Fidra, May Island	1, 1, 1, 1	June

Name.	Average Size in inches.	Locality.	Depth.	Mean Time of Observation.
Phyllophora membranifolia	2·5, 2, 3	Fidra, May Island Inchkeith,	1, 1, 1	July
Plocamium coccineum	3·5, 4·5, 8·5	Fidra, Elie, Inchcolm	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	August
Polysiphonia atrorubescens	4·5, 4, 4·5, 5	Caroline Park, Inchcolm, Inchkeith, Elie,	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	Aug.–Sept.
P. fastigiata	1·5, 1·5, 2	Caroline Park, Inchkeith, May Island.	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	July
P. parasitica	1·5, 2·5	Kincraig Pool, off May Island	$\frac{1}{4}$, 16	August
Porphyra vulgaris	8–12	Caroline Park, Inchkeith, Fidra, May Island	$\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$	Aug.–Sept.
Ptilota elegans	2·5, 3, 3	Inchcolm, Inchkeith, May Island	1, 1, 1	August
Rhodymenia palmata	7, 8·5, 7·5	Inchcolm, Inchkeith, May Island	$\frac{3}{4}$, $\frac{3}{4}$, $\frac{3}{4}$	June–Aug.
Schizymenia edulis	2·5, 2·5, 6	Inchcolm, Inchkeith, Elie	1, 1, 1	August
Sphacelaria cirrhosa	0·75–1	Inchkeith, Elie	$\frac{1}{2}$, $\frac{1}{2}$	August
Sphacelaria plumigera	1·5, 14	Joppa, Elie	1·1	February

From these and other figures the general conclusions seem to be justified that there is almost invariably an increase in average size as we advance seawards, when the same species is examined at a corresponding level within the tidal zone.

If specimens belonging to the same species be examined at different levels within that zone or in deeper water, it is possible, in many cases, from this point of view as well as from that of mere numbers, to recognise a level at which the plants grow to greater advantage than in other (higher or lower) positions. Thus, although in parts at or near high-water *Laminariæ* flourish, they are invariably of diminutive size, e.g., *L. cloustoni* and *L. flexicaulis* may only attain the length of 18 to 24 inches, while in the true Laminarian zone they are not unfrequently got up to 8 or 10 feet. *Phyllophora traillii* is of finest growth at or below the limits of lowest spring tides; but in dark crevices of rock, even though somewhat muddy, it occurs (*e.g.*, at Elie) at a somewhat higher level, and of tolerable size. The influence of light as affecting plant distribution is thus well illustrated in the case of this somewhat rare species, and it also enables us to recognise the changes of water pressure which so comparatively slender a species can endure, provided that the other conditions of environment are not of too trying a character.

Halidrys siliquosa is especially interesting in this connection. It is of very frequent occurrence in high-water tidal pools, and attains here an average size of from 12 to 15 inches. Specimens, however, dredged in 24 fathoms off Anstruther, were 26 inches long. Many other similar cases might be noted.

(3) As to *habit*, it appears generally that all the great groups are more fully formed, and present a more elegant appearance as the sea is approached. This applies to the strongly developed Phæophyceæ no less than to the Chlorophyceæ and Florideæ. The *detracting influence exerted in this respect by influx of fresh water* is very remarkable in the case of many species, as is well seen at the mouth of the Almond at Cramond, of the Esk near Musselburgh, of the Tyne at Tynninghame Sands, and elsewhere. Many of the Chlorophyceæ are less affected than others, e.g., *Rhizoclonia*, *Entermorphæ*, *Ulothrices*, *Confervæ*, &c. *Callithamniæ* and other forms of the finer Florideæ are more sensitive than many species of *Polysiphonia*, while the effect of such influences in producing almost varietal modifications in some species (*e.g.*, contortions in *Dumontia filiformis*) is remarkable. It has already been stated that it is the salinity of the water which chiefly determines the distribution of marine plants,* and the influence which this exerts in modifying the habit and in checking the downward distribution of Enteromorphæ has already been referred to.

II. There is a decided increase in number of species as we advance seawards—the finest Florideæ—*Dudresnaia coccinea*, *Nitophyllum laceratum*, *N. punctatum*, *Callithamnion gracillimum*, *C. floccosum*, *Bonnemaisonia asparagoides*, *Delesseria sanguinea*, &c., either being found exclusively in seaward parts, or exhibiting a more graceful habit and a larger number of specimens there. There are

* F. J. F. Meyen, *Grundriss der Pflanzengeographie.*

thus within the estuary areas of somewhat limited extent characterised by the presence of certain forms, and within which species having a general distribution are also well represented.

The following species may be noted, in addition to those given above, as occurring especially to the east of Inchkeith:—*Callithamnion daviesii, Callophyllis laciniata, Dasya coccinea, Desmarestia aculeata, Elachistea scutulata, Herponema velutina, Himanthalia lorea, Delesseria sanguinea, Mesogloia vermicularis, Phyllophora rubens, Punctaria tenuissima, Saccorhiza bulbosa, Symploca harveyi, Gloiosiphonia capillaris, Griffithsia corallina, G. setacea, Melobesia calcarea, M. laminariæ, Myrionema punctiforme, M. strangularis, Polysiphonia divaricata,* &c.

Many species, among which those recorded below have been identified,* were procured during dredgings carried on on board the steam-launch "Medusa," during the seasons 1884-85, the depths stated being those given in the *Nautical Guide to the Forth and Tay* for 1883.

Name of Species.	Locality.	Depth.	Remarks.
Ahnfeldtia plicata,	Inchcolm, Inchmickery, Inchkeith, off Caroline Park	3, $1\frac{1}{2}$, $4\frac{1}{2}$, $2\frac{1}{2}$	On rocks.
Alaria esculenta,	Inchkeith, May Island	4 to 16	,,
Callithamnion brodiæi,	Off Anstruther, May Island	3 to 5	,,
,, floridulum,	Inchkeith, off Caroline Park	2–2·5	,,
,, floccosum,	S. of Inchkeith.	Surface	On iron buoy.
,, hookeri,	Off Anstruther, S. of Inchkeith	3, $2\frac{3}{4}$	On *Chondrus crispus.*
,, plumula,	Inchmickery, Inchcolm, May Island	3, 10, 16	On rock.
,, polyspermum,	Inchcolm, Inchkeith, off Caroline Park	3, 4, $2\frac{1}{2}$	,,
,, turneri,	Off Anstruther	5	On *Furcellaria fastigiata.*
Ceramium acanthonotum,	Off Caroline Park, Inchcolm Inchkeith, Fidra	$2\frac{1}{2}$, 9, $3\frac{1}{2}$, $2\frac{1}{2}$	On *Ptilota elegans* and *Chondrus crispus.*
,, deslongchampsii,	Inchkeith	$2\frac{3}{4}$	On rock.
,, diaphanum,	Inchmickery, Inchcolm, off Caroline Park, Inchkeith, off Anstruther Fidra	3, $4\frac{1}{2}$, 3, $4\frac{1}{2}$, 4, 2	

* Those referred to in the table on p. 442 must also be considered in the present connection.

Name of Species.	Locality.	Depth.	Remarks.
Ceramium rubrum, . .	General, *e.g.*, Inchcolm, Inchmickery, off Caroline Park, Inchkeith, off Kirkcaldy, off Anstruther, Fidra, May Island.	2–12	On rock.
Chætomorpha melagonium, .	Inchkeith, Fidra.	1½, 1	,,
Chondrus crispus. . .	General —Inchcolm to May Island.	Low water mark to 6	,,
Chorda filum, . . .	Off Anstruther.	10	,,
,, lomentaria, . .	Inchcolm, Inchkeith, Fidra, off Anstruther	1, 2, 1, 3	,,
,, tomentosa, . .	Off Anstruther	3	,,
Chordaria flagelliformis, .	Inchcolm, Inchkeith, off Longniddry.	1½, 1, free	,,
Chylocladia clavellosa, . .	Inchcolm, Inchkeith, May Island.	4 to 22	,,
Cruoria pellita, . . .	Inchkeith, May Island.	4 to 10	On Laminaria stems.
Cystoclonium purpurascens,	Inchcolm, Inchmickery, Inchkeith to May Island, Fidra	9, 3, 5,–18, 2	On rocks and often on *Hyas coarctata.*
Delesseria alata, . . .	General	Up to 20	On rocks and Crustacea. When on latter always small.
,, sinuosa, . .	,,	Up to 24	,,
Desmarestia aculeata, . .	Inchkeith, May Island, off Anstruther	4½, 20,16	On rocks.
,, viridis, . .	Off Caroline Park, Inchkeith, Aberlady Bay.	2½, 3, free	,,
Ectocarpus granulosus, .	Off Caroline Park, Dunbar	2, free	On *Ceramium rubrum.*
Fucus serratus, . . .	General	Up to 15	On rocks.
,, platycarpus, . .	,,	,,	,,
Furcellaria fastigiata, . .	Inchcolm Inchkeith, off Anstruther	8, 4, 9	,,
Gigartina mammillosa, .	Inchkeith, off Caroline Park	3, 2	,,
Halidrys siliquosa, . .	Inchcolm, Inchmickery, Inchkeith, Fidra, off Anstruther	3, 2, 4, 1 14	,,
Delesseria sanguinea, . .	Off Dunbar, off Bass Rock Inch-	10, 15	,,
Laminaria cloustoni, . .	General	Up to 16	,,
,, saccharina, .		,,	,,
Litosiphon laminariæ, . .	Off Dunbar, Inchkeith	10, 4	On *Alaria esculenta.*
,, pusillus, . .	Off Anstruther	10	On *Chorda filum.*
Melobesia calcarea, . .	Inchkeith	4½	Dredged abundantly.
,, laminariæ, . .	May Island, Dunbar, off Bass Rock	8, 10, 15	On *Laminaria cloustoni.*

Name of Species.	Locality.	Depth.	Remarks
Lithothamnion polymorphum,	General	Up to 20	On rocks, pieces of coal and stones.
Mesogloia vermicularis, .	Off Anstruther, Bass Rock	9, 15	On rocks.
Nitophyllum laceratum, .	Off May Island	30	Drifting.
Odonthalia dentata, . .	Inchcolm, Inchmickery, Inchkeith, Bass Rock, Dunbar, off Anstruther	10, 2, 4 12, 15, 12	On rocks.
Phyllophora brodiæi, . .	Off Caroline Park, Inchkeith, Bass Rock, Dunbar, May Island	2, 4, 15, 12, 24	,,
,, membranifolia,	Off Anstruther, Inchkeith, Dunbar	8, 4, 6	,,
,, rubens, . .	Bass Rock, Dunbar, May Island.	10, 10, 16	,,
Plocamium coccineum, .	General — Dunbar, Fifeness, May Island, Inchkeith, &c.	10, free, 22, 4½	,,
Polysiphonia atrorubescens .	Off Caroline Park, Inchcolm, Inchkeith	2, 2, 3	,,
,, elongata, . .	Dunbar	6	On stones.
,, fibrata, . .	Inchkeith, Aberlady Bay, off Anstruther	2, free, free	On rocks.
,, fibrillosa, . .	Aberlady Bay, off Caroline Park	Free, 2	,,
,, formosa, . .	Inchcolm, Inchkeith	2½, 3	,,
,, nigrescens, .	Inchmickery, Inchcolm, off Caroline Park, Inchkeith	2, 4, 1¾, 2, and free	,,
,, parasitica, .	Dunbar, Aberlady Bay	10, free	,,
,, urceolata, .	Off Inchcolm, Inchkeith, May Island, &c.	2–8	On rocks and on *Laminaria cloustoni.*
Ptilota elegans, ...	General — Inchmickery, Inchkeith, Bass Rock, Dunbar, off Anstruther	Low water mark—10	On rocks.
,, plumosa, ...	May Island, Dunbar	Up to 22	On *Laminaria cloustoni.*
Rhodomela lycopodioides, .	Dunbar, off Anstruther, Bass Rock	Free	,, (drift).
Rhodymenia palmata, . .	General	Up to 12	On rocks in the algæ.
Saccorhiza bulbosa, . .	Inchkeith	4	
Schizymenia edulis, . .	Inchcolm, Inchkeith, Bass Rock, Dunbar	2–12	On rocks.
Sphacelaria plumigera, . .	Aberlady Bay, off Caroline Park	Free	,,

Among the causes that are at work in affecting the distribution of species in such estuaries, the following general summary may be given:—

(1) Heliotropic tendencies of the swarmspores (see p. 437).

(2) The physical character of the substratum as stony, rocky, sandy, muddy, &c. In the words of Meneghini,* "The ground on which algæ grow certainly exercises some influence on their nutrition, for although the greater number of the species grow indifferently on any submerged body, some occur exclusively on calcareous rock, others on granitic or basaltic. The Laminariæ and Chordæ have a preference for sandy bottoms . . . . Some species of Callithamnion grow only on rock, others are exclusively parasites of Furcellaria, just as *Polysiphonia fastigiata* is only met with on the fronds of *Fucus nodosus* . . . . But when the same species are met with in different conditions, they always exhibit in their appearance a perfectly distinctive character."

(3) The effect of storms in shifting boulders to which sea-weeds are attached. Species growing in considerable depths thus become raised or lowered in position, and in the case of a shingle-covered beach, which has not been disturbed by storms for a considerable period, the effect may be very marked.

(4) The purity of the water is also on shore localities an important factor, the influx of chemical refuse of oily or other constituents in great quantities acting as deterrants to the growth of the finer *Florideæ.* The oily scum found in some cases prevents the carrying out of the normal heliotropism of the swarmspores by impeding the freedom of their movements, besides, at the same time, producing an indifferent medium for the performance of their other vital processes.

(5) Shifting sands or deposition of mud banks are also capable of modifying the distribution of species by triturating or otherwise covering the plants, and especially in the latter case by cutting off adequate light, and by pressure.

* Meneghini, *Cenni sulla Organographie e Fisiologia delle alghe.* Padova, 1838, p. 50.

(6) As many *Rhodophyceæ* are found growing upon the carapaces of living crustacea, it follows that a more extended range than might otherwise occur may thus be acquired by a given species. It is noteworthy, however, that in such cases the sizes are invariably small.

(7) Although more difficult to determine, it cannot be doubted that the density and pressure of the water exercise an important influence. The effect of these factors is perhaps more readily seen by observing the changes in general habit assumed by species as they acquire lower levels, or by comparing certain species exposed to different salinities at corresponding levels.

In this connection the following statement by Meneghini* may be quoted :—" The very striking difference between the marine vegetation of the coast of Norway and that of the Baltic is due, according to J. G. Agardh, to the different degree of salinity of these two seas." The author adds in a footnote :—" It has been universally recognised by chemists that on this account the algæ of the Baltic contain a less proportion of iodine than those from seas of which the salinity is greater."

(8) *Temperature* has a direct influence on the time of emission of swarmspores, and generally on the rapidity of maturation of the fruit. In mild seasons the emission of such spores continues longer than usual (*e.g.*, in *Ectocarpus siliculosus*, &c.). In the Florideæ the maturation of the antherozoids is hastened, and the formation of the cystocarp takes place earlier, and may continue later than usual. If specimens of the same species from different levels are compared, the influence of longer exposure to strong sunshine (*e.g.*, in shallow pools near the level of high tide), is manifested by a somewhat earlier discharge of spores (see p. 425). Specimens of *Ectocarpus* (*E. siliculosus* and *E. littoralis*) from such pools have been compared in this respect with others from deep dark pools at the level of low tide, and in all cases the spores were found to be emitted from the former somewhat earlier than from the latter ; *Monostroma latissimum*, *Ulva linza*, *Enteromorpha intestinalis*, *E. compressa* have been observed to illustrate the same rule.

* Meneghini, *op. cit.*, pp. 50, 51.

(9) Rapid and irregular currents are unfavourable for extending distribution. This is well seen in the case of the comparatively unproductive almost perpendicular sides of the Bass Rock and the western side of the May Island, as well as in many other parts of the coast of the mainland, which are at all times exposed to the full force of the waves from deep water. The result is the removal of algæ from their substratum by the destruction of their rhizoids, or the destruction of the thalli, and the prevention of the maturation of fruit. Stunted growth is almost invariably found in such places. Specimens of *Porphyra vulgaris*, growing in an exposed situation on the Bass Rock, were examined with respect to the maturation and emission of spores at a time when other species on sheltered spots on the island of Fidra were found to be ripe. No signs of maturity were found, however, although the cells of the stunted thallus were intact, and had the normal appearance of those in a healthy plant. Even in rocky areas, the bare exposed places carry fewer plants belonging to fewer genera than do the more sheltered crevices or crannies.

(10) The bright colour of some sea-weeds seems to attract a number of animals, which aid in bringing about cross fertilisation, *e.g.*, marine Infusoria. Moreover, the movements of minute Crustacea and other small animals tend in the same direction.

(11) The effects of light are twofold—(*a*) it influences the swarmspores immediately subsequent to their emission; and (*b*) it affects the physiological activities of the mature plants. No observations have as yet been made on the penetrability of luminous rays into the extensive waters of the Forth, but from the large amount of suspended matter in the water, which, moreover, varies very greatly in amount at different times, it cannot be doubted that the rays that reach those algæ growing in the deeper parts also vary correspondingly in intensity, while all the dredgings that have been made go to show that it is those algæ whose colour is of the brightest red that occur at the greatest depths. These are succeeded by sherry-coloured species and by Phæophyceæ, in shallower, and therefore, on the whole, more luminous parts; while they, in turn, give

place to Chlorophyceæ, where the light is most intense, and most nearly simulates the conditions of ordinary land or clear fresh water vegetation.

On the general question of depth Meneghini speaks as follows :—" A hundred feet beneath the surface of the sea, living algæ are rarely met with, but some are attached to masses detached by accident from higher rocks, and these speedily perish. The number of species decreases on descending into the depths of the sea. . . . . Beyond forty feet from the surface, Ulvæ are rarely met with ; beyond sixty, there are no Ceramiæ ; beyond a hundred, no longer Fucoideæ, and the vegetable kingdom ceases, leaving the field free for animals, which are always distributed in those abysses with great richness of form and tint."

Kjellman, whilst asserting that it is at present impossible to state the causes of a difference of facies of marine vegetation at different depths, until further advances have been made in vegetable physiology and hydrography, goes on to say :—" Bis auf Weiteres müssen wir annehmen, dass an der Küste von Bohuslän noch bei einer Tiefe von 1½ bis 2 Faden die Temperatur des Meereswassers, sein Gehalt an fixen Bestandtheilen und an Gasen, der Wasserdruck, die Menge und Beschaffenheit des bis in diese Tiefe hinabdringenden Lichtes u.s.w. für die meisten der Chlorophyllophyceen und Nostocaceen vortheilhaft sind, dass aber erst in grössere Tiefe diese Verhältnisse so modificirt werden dass sie den meisten Rhodospermen-Arten angemessen und gunstig sind."

It may further be observed generally—

(1) That many species occur in localities where the external environments are subject to very much greater changes than in other areas. There is, indeed, a regular gradation in this respect (*a*) from the upper limits of the tide to the bottom of the deeper parts of the estuary, and (*b*) these changes become more pronounced as the water shallows in the more landward parts.

(2) Some marine algæ have a predilection for conditions unsuitable for almost all others, *e.g.*, *Enteromorpha intestinalis*, which occurs freely in pools above high-water mark, which acquire their saline constituents from spray only.

(3) A comparison of the various areas referred to above shows that they are by no means all of equal value with respect to number of different species, some having a rich and diverse floor, others being more uniform and poor. Generally, with certain limitations, uniformity increases with depth.

(4) The general facies of any given area, as of the entire estuary, varies in summer as compared with winter—the disappearance of many species during winter producing marked changes.

(5) Transition from one bathymetrical area to another takes place gradually, and not by any sudden or sharp lines of demarcation ; species characteristic of one being almost invariably found in other higher and lower belts, and the same is true with respect to changes observed in horizontal extension.

On Certain Points in the Morphology of Frullania and some other leafy Jungermannieæ. By Professor ALEXANDER DICKSON, M.D. (Plate XV.)

(Part of Presidential Address, delivered 10th December 1885.)

The subject I have chosen for a few special remarks, on this occasion, is one connected with the morphology of certain of the Foliose Jungermannieæ or Scale-Mosses.

In these plants Leitgeb describes the development of the shoot as taking place by the cutting off of successive segments from an apical cell. This apical cell is in the form of an inverted three-sided pyramid, and from this pyramid segments are successively cut off by septa parallel to its sides. Each cell-segment thus cut off becomes divided by a septum parallel to its free surface into two cells, of which the superficial one—which may be called the *Initial Leaf-cell*—goes to form the leaf, while the deeper one goes to form the corresponding portion of the axis.* Here we seem to have the most complete realisation of the idea of the leafy plant as built up of successive members—phyta or plant-individuals—each consisting of a leaf with a

* Leitgeb, *Untersuch, ü. d. Lebermoose,* Heft ii. p. 5.

corresponding portion of the axis—a doctrine to which I have always been disposed to adhere, however transcendental it may seem to some minds.

In the more typical forms, the shoot exhibits a markedly bilateral character, with two surfaces—a *dorsal* away from, and a *ventral* towards the surface along which the plant lies. The leaves are alternate, and are arranged in three longitudinal series (corresponding to the successive segments cut off from the three sides of the apical cell), of which two are dorsi-lateral and the third ventral. The leaves of the two dorsi-lateral series resemble each other in all respects, their insertion is more or less oblique, and they are termed *Lateral Leaves* (Pl. XV. *ll*). The leaves of the ventral series are of a different configuration, their insertion is more or less transverse, and they are termed *Amphigastria*, or *Amphigastrial Leaves* (Pl. XV. *am*).

In a great number of these bilateral forms, the lateral leaves exhibit a more or less marked division into two lobes, which, it would appear, originate from the two cells resulting from the first division of the Initial Leaf-cell. In some cases—*e.g.*, many species of *Jungermannia*—the lobes are equal and similar; but in others the upper lobe is comparatively large, while the lower one is smaller. The lower lobe is usually called the *Auricle*. This Auricle may be flat, as in *Madotheca* (*Porella*), or remarkably pouched, so as to form the curious helmet-shaped body seen in *Frullania*.

In connection with the development of the lateral branches of the Foliose Jungermannieæ, Leitgeb has made certain observations which involve questions of the greatest importance as to the relation between axis and leaf; and to these I would now direct your attention. To put the matter shortly, Leitgeb asserts that in a considerable number of these plants the lateral branch is developed from the lower of the two cells into which the Initial Leaf-cell subdivides; and that, in consequence, the lateral branch appears as replacing, and therefore being potentially equivalent to, the lower lobe of the lateral leaf: *e.g.*, in *Frullania*, *Madotheca*, *Lepidozia*, &c. In other cases, as in that of *Radula*, he asserts that only the lower portion of the lower half of the Initial Leaf-cell goes to form the lateral branch, leaving the other portion to form an auricle.

With regard to *Frullania* and *Madotheca* (*Porella*), Leitgeb gives the following explanation of his views:—

"In *Frullania*," he says, "if the leaf from whose base a branch springs be carefully examined, one is readily convinced that it wants the helmet-shaped lower lobe (the auricle), and sees that the branch arises exactly in the place of this lobe. On its ventral aspect the branch is subtended by a leaf directed obliquely towards the base of the main axis; and from its position, certainly, this leaf might be viewed as belonging to the main axis, and as representing the lower leaf-lobe, did not its form—corresponding exactly with that of the amphigastria—and the complete absence of any connection with the corresponding upper leaf-lobe make such an assumption seem questionable. The history of its development, moreover, shows that this leaf belongs to the lateral branch, being, in fact, its first leaf, of the amphigastrial series. I have given this example first because here the peculiar helmet-like form of the lower lobes prevents their being confounded with the very differently shaped amphigastria. In *Madotheca* the relations are not so manifest, since here the lower leaf-lobes pretty closely resemble the amphigastria; but here, also, a more careful examination shows that the leaflet obliquely subtending, on the ventral aspect, the place of origin of the branch is not a lower leaf-lobe belonging to the main axis, but is the first amphigastrial leaf of the lateral branch."*

In support of this view, Leitgeb appeals to the development of the parts from the segments successively cut off from the apical cell, and states that the lower half of the Initial Leaf-cell, instead of going to form a lower leaf-lobe, or auricle, assumes the character of an apical cell, and goes on to the development of a lateral branch.

If these lateral branches originate in substitution for leaf-auricles, as is stated by Leitgeb, it cannot but be regarded as very surprising, and as subversive of our ordinary ideas of the relation of leaf to axis. A philosopher, like Mr Herbert Spencer,† may propound the morphological absurdity of the substitution of flower-buds for the petals and stamens of the flower of an Umbellifer, without its calling for serious comment; but when a

* Leitgeb, "Ueber die Verzweigung der Lebermoose," *Bot. Zeit.*, 1871, pp. 557 *et seq.*

† *Principles of Biology*, vol. ii., Appendix A.

scientific botanist, skilful anatomist, and careful observer, makes a somewhat similar appeal to our faculty of wonder, it is necessary to give the matter our gravest consideration. I am not in a position to offer any criticism of the developmental evidence adduced by Leitgeb in support of his views, but the result of my examination of the adult conditions in *Frullania Tamarisci*, and *Madotheca* (*Porella*) *platyphylla*, goes far, in my opinion, to prove that the amphigastrioid scale—which, for convenience, we may call "*x*"—obliquely subtending the base of the lateral branch belongs really to the main axis, and not to the lateral branch; and further, that, in spite of its amphigastrioid appearance, this scale "*x*" is nothing but the auricle (supposed to be amissing) of the adjacent lateral leaf—which we may call "*y*." The reasons which have led me to this opinion are as follow:—

1*st.* In *Madotheca* and *Frullania*, the amphigastrioid scale "*x*" appears to spring from the main axis, much rather than from the lateral branch. This is particularly manifest in *Madotheca*, where the insertion of scale "*x*" extends down the main axis to a very considerable distance below the origin of the lateral branch.

2*nd.* It is to be noted that scale "*x*," obliquely subtending the lateral branch, as it does, is not in line with the amphigastria of the branch, as it ought to be, were it the first leaf of that series, as Leitgeb supposes.

3*rd.* Although Leitgeb's statement as to the absence of any connection between scale "*x*" and the adjacent leaf "*y*" is correct as regards *Madotheca*, yet if careful examination be made of the parts in *Frullania Tamarisci*, it will be found that in that plant the base of scale "*x*," extending obliquely outwards and downwards on the main axis, curves upwards at its outer extremity, and is there continuous with the obliquely downward extension of leaf "*y*," by a slight but quite distinctly-marked raised line or ridge (Pl. XV. fig. 2).*

4*th.* In a monstrosity of *Frullania Tamarisci* which I have the pleasure of exhibiting to you, we see a lateral

* In this plant, it is not always easy to see the space between the bases of scale "*x*" and leaf "*y*," inasmuch as in a dorsal view it is usually hidden by the lower part of leaf "*y*," while in a ventral view it is always out of sight. In cases, however, where—as in the specimen figured—the development of leaf "*y*" is somewhat feeble, it is in a dorsal view fully exposed.

branch obliquely subtended, as usual, by the somewhat bifid amphigastrioid scale "x," while if we look to the next lateral leaf vertically below that adjacent to the branch, we find that its auricle (Pl. XV. fig. 1,z) has undergone an abnormal development, is amphigastrioid and bifid, and altogether so closely resembles, in appearance and position, the scale "x," that it is almost impossible to resist the conclusion that the two are "serially homologous": in which case the scale "x" would fall to be considered as the auricle of the adjacent lateral leaf "y."

It may be considered presumption on the part of one who has not made these plants a very special subject of investigation, to offer the foregoing criticism of the views of the greatest authority in this department; yet I cannot but think that what I have observed is at least sufficient to warrant the demand for a very careful re-examination of the intermediate steps between the initial stages and the adult condition of the parts concerned; since if there is any fallacy underlying Leitgeb's views, it is probably due to some error in the observation of these steps.

Postscript.

In justice to Mr Spencer, I must admit that the morphological confusion perpetrated by him might perhaps receive some countenance in the more or less ambiguous utterances which occasionally fall even from competent botanists.

For example, Dr Masters (*Teratology*, p. 483), referring to the conflicting views held with regard to the inferior ovary and the so-called calyx-tube, says—"But this matter loses much of its importance if the morphological identity of axis and leaf-organ be conceded." Mr Spencer, indeed, refers (*Principles*, ii. pp. 37–43) to statements by Dr Masters as to the want of absolute distinction between leaf and axis; and it is possible that Dr Masters may, indirectly, be responsible for Mr Spencer's remarkable speculation.

Again, Professor Bower, in his able and valuable paper on the Comparative Morphology of the Leaf in the Vascular Cryptogams and Gymnosperms (*Phil. Trans. Roy. Soc.*, 1884, part ii. p. 569), views "the whole leaf from apex to base" "as a podium or form of axis." And in the same paper (*loc. cit.*, p. 565) he quotes with approval the following passage from Sachs (*Vorlesungen*, p. 48) :—" A typical shoot consists of the leaves and the axis, which are not really to be regarded as different organs, but fundamentally as parts only of *one* organ. . . . . In their nature, as shown by the history of their development, the leaves are fundamentally nothing more than processes, or outgrowths of the axis of the shoot."

To Professor Sachs' statement I have no objection to offer, as it appears to be a correct statement of fact; but if it were suggested that these parts—leaf and axis—are potentially equivalent, or interchangeable, it would be precisely as if a zoologist were to say that in a segmented animal—*e.g.*, a Myriapod—the trunk-segment and its radiating process or outgrowth the limb were potentially equivalent or interchangeable. No doubt, the trunk-segment and its appendage the limb are parts only of *one* structure, the body-segment or metamere (" *Somatome*" of Goodsir); but no zoologist would imagine the conversion of the trunk-segment into a limb, or *vice versa*. And it would, to my mind, be equally difficult, in the plant, to imagine the conversion of the axial portion of a shoot-segment into a leaf, or *vice versa*. And still less conceivable would be the conversion of a leaf, or part of a leaf, into a whole shoot, involved in the supposed replacement of a petal or a stamen by a whole flower, or, as in the case of *Frullania*, &c., the replacement of an " auricle" by a whole shoot. Such conversion would be comparable, in the segmented animal, to that of a limb, or process from one of the body-segments into a whole body built up of a number of such segments.

A. D.

DESCRIPTION OF PLATE XV.

ll = Lateral leaf.
au = Auricle, or lower lobe of lateral leaf.
am = Amphigastrium, or ventral leaf.
y = Lateral leaf adjacent to the origin of the branch.
x = Scale (of controverted homology) obliquely subtending the branch.
f = First lateral leaf of the branch.
rr = Rhizoids.

Frullania Tamarisci.

Fig. 1. Monstrosity. Shoot seen on *ventral* aspect, showing a branch obliquely subtended by a bifid amphigastrioid scale (x), in the ordinary way. The auricle (z), however, of the next lateral leaf vertically below that adjacent to the branch has become abnor-

mally developed as a bifid amphigastrioid scale so closely resembling the scale "x", in form and position, as to raise the presumption of the two being "serially homologous." The first lateral leaf (f) of the branch may be noted, with its upper lobe relatively very small as compared with the full-sized helmet-shaped auricle. In this figure I have not indicated the minute clavate hair (*stylus auriculi*) which is placed at the side of the auricle furthest from the upper lobe. Note also the auricles (*aú*) of two lateral leaves towards upper part of branch, developed as flat and pointed lobes.

Fig. 2. Portion of shoot, at place of origin of a branch. Seen on *dorsal* aspect. The base of leaf "y" is seen to be continuous with that of scale "x" by a raised line or ridge. At the point where the base of scale x curves up to meet that of leaf "y", there is a minute clavate hair (h) quite similar to a "*stylus auriculi.*" If, however, I am right in viewing scale "x" as the auricle, this hair cannot represent the *stylus* which, as already stated, is on the far side of the auricle from the upper leaf-lobe.

Madotheca (*Porella*) *platyphylla.*

Figs. 3 and 4. *Ventral* view of portion of stem from which a lateral branch springs. In both figures, and especially in fig. 4, the base of scale "x" extends downwards on the main axis far below the origin of the branch.

Fig. 5. *Dorsal* view of portion of shoot from which a lateral branch springs. In the specimen figured, the base of leaf "y" runs down very nearly (somewhat unusually near) to that of scale "x"; but, as regards this plant, Leitgeb's statement as to the absence of any connection between the two parts seems to be correct.

Account of a Botanical Journey to the West African Coast, with List of Plants found. By J. Rattray, M.A., B.Sc., F.R.S.E.

(Read 8th July 1886.)

The following list contains a record of the plants which I collected in the vicinity of the coast at various places on the islands and mainland of West Tropical Africa, from December 1885 to March 1886, during the cruise of the S.S. "Buccaneer." This steamer, which is the property of the Silvertown Gutta Percha and India-Rubber Company of Silvertown, Essex, was at this time engaged in sounding along the line of the new submarine telegraph cable, which is at present being constructed along the west coast of Africa; and by the liberality of the Messrs Gray of the above company, as well as by the kindness of Dr John Murray, director of H.M. "Challenger" Commission, I was privileged to accompany the expedition, and, under the supervision of J. Y. Buchanan, Esq., of the "Challenger" Expedition, to make collections both of natural history and botanical specimens.

As most of the period of four months, which elapsed from the time of my departure from Liverpool to that of my return to London, was spent at sea, but few opportunities presented themselves for making extensive collections of land plants at any place, and, moreover, such chances as did occur were somewhat encroached upon by the simultaneous attempt to form collections of such shore animals as could be obtained. The reports upon these latter, as well as upon the many other marine gatherings of surface forms, must be relegated to another place; but it is intended to present a detailed account of the marine, shore, and fresh-water *Diatomaceæ* collected during the expedition to this Society at a later period, as well as to lay before it statistics of the marine and fresh-water Algæ which were procured, and which are at present excluded.

Gatherings of plants were made at the following places on the dates undernoted:—

1. Madeira (vicinity of Funchal),	December 10, 1885.
2. Teneriffe (vicinity of Santa Cruz),	December 12, 1885, and March 28, 1886.
3. Sierra Leone, . . .	December 21, 1885.
4. Conakry (Isles de Los, W. coast of Africa), ...	December 22, 1885, and March 17, 1886.
5. Dakar (near Cape Verde), .	December 26–29, 1885.
6. Accra (N. coast of Gulf of Guinea),	January 16, 1886.
7. St Thomé Island (Gulf of Guinea),	January 25 and 31, and February 1, 1886.
8. Principe Island (Gulf of Guinea),	January 27, 1886.
9. St Paul de Loanda (E. coast of Gulf of Guinea), . .	February 10–17, 1886.

The collections made at Madeira and Teneriffe in December 1885 were unfortunately destroyed by the exposure to the very warm and humid climate of the Tropics, as they were made during the outward voyage, previous to joining the "Buccaneer" at Sierra Leone on December 22, and before it was possible to have the adequate means of preserving the specimens. The second gathering made at Santa Cruz on the homeward voyage was, however, preserved; but as no call was made at Madeira a second time, its flora is unrepresented in my collections.

On December 13, 1885, a landing was effected at Las Palmas, Gran Canaria, for a few hours, but marine Algæ and shore animals only were procured. Calls were also made at Bulama and Bassao (between Cape Verde and the Isles de Los) on December 24, 1885, and at Libreville (Gaboon River), and Bananah Creek (Congo River) on January 28 and February 7, 1886. At the last two places, however, no opportunity of landing was obtained, while at Bulama the gatherings made consisted exclusively of Algæ and shore animals, and at Bassao the time was spent in making observations on the organisms suspended in the muddy shore waters.

We arrived at Ascension Island on March 1, but owing to the size of the "rollers," which were then about 15 feet in height at the anchorage, no landing could be effected for two days. When an opportunity of landing did occur there was no time to ascend the Green Mountain, and but little vegetation, except scattered patches of Cacti, a few specimens of *Vinca rosea*, and some Portulaceous weeds, were observed. On the barren rocks even lichens are rare. Many Spongidæ and Molluscan shells were, however, found on the beach.

In the vicinity of Funchal, in addition to the wild fig (*Ficus stipulata*), the Ivy, Fuchsiæ, Aloes, Cacti, Bignoniæ, Bougainvilleæ (on garden walls), Hydrangea, Camellias, Sugar-cane, Banana, and Date Palm (*Phœnix dactylifera*), the following plants were observed:—*Zea Mays, Gladiolus segetum*, *Agave americana*, *Phormium tenax*, *Bromelia ananas*, *Pandanus odoratissimus* in gardens, along with Hedychium, Canna, &c. *Dracœna Draco* is also present, as well as Bambusæ, which, however, are said not to flower. The following commoner species were also noted:—*Ranunculus repens*, *Papaver somniferum*, *P. dubium*, *Capsella bursa-pastoris*, *Cerastium glomeratum*, *C. triviale*, *Stellaria media*, *Sagina procumbens*, *Hypericum perforatum*, *H. humifusum*, *Malva* sp., *Geranium molle*, *G. dissectum* *Lotus major*, *Trifolium minus*, *Potentilla tormentilla*, *Galium aparine*, *Centaurea melitensis*, *Achillea millefolium*, *Sonchus oleraceus*, *S. asper*, *Convolvuli*, *Thymus angustifolius*, *Lamium* *purpureum*, *Myosotis* sp., *Plantago major*, *P. lanceolata*, *Chenopodium murale*, *Laurus canariensis*, *Urtica* sp., *Panicum crus-galli Cynodon dactylon*, *Eleusine indica*, *Poa annua*, *P. trivialis*, *Cynosurus echinatus*, *Adiantum capillus-veneris*, *Polypodium vulgare*, *Aspidium* sp., *Lunularia vulgaris*.

Although, in the attempt to name the undernoted plants, a comparison was made with all the specimens of African tropical plants in the Herbarium at the Royal Botanic Garden, much uncertainty was felt with regard to many specimens. The whole collection was accordingly submitted to Professor Oliver at Kew, and the names given are those authorised by him.

	Name of Species.	Santa Cruz (Teneriffe).	Sierra Leone.	Conakry (Isles de Los).	Dakar.	St Thomé Island (Gulf of Guinea).	Principe Island (Gulf of Guinea).	St Paul de Loando.
THALAMIFLORÆ								
ANONACEÆ .	Xylopia sp.						×	
PAPAVERACEÆ .	Papaver Rhœas, *L.* . .	×						
	Argemone mexicana, *L.* .				×	×		
CRUCIFERÆ .	Sisymbrium Irio, *L.* . .	×						
	Capsella bursa-pastoris, *DC.*	×						
	Sinapis incana, *L.* . .	×						
CAPPARIDACEÆ .	Gynandropsis pentaphylla, *DC.*					×		
	Capparis tomentosa, *Lam.* .	×						
	Polanisia viscosa, *DC.* .		×					
VIOLACEÆ .	Alsodeia sp. . . .					×		
CARYOPHYLLACEÆ . .	Polycarpon tetraphyllum, *L.f.*	×						
PORTULACEÆ .	Portulaca oleraceæ, *L.* .					×		
	Sesuvium portulacastrum, *L.*							×
TAMARICACEÆ .	Tamarix sp. . . .	×						
MALVACEÆ .	Malva parviflora, *L.* . .	×						
	Sida carpinifolia, *L.f.* .					×	×	
	„ spinosa, *L.* . .		×			×		×
	„ cordifolia, *L.* . .					×		
	„ rhombifolia, *L.* . .					×		
	„ mysorensis, *W. & A.* .					×		
	Abutilon indicum, *Don.* .					×		
	Urena lobata, *L.* . .				×	×	×	
	Hibiscus surattensis, *L.* .						×	
	„ Sabdariffa, *L.* .					×		
TILIACEÆ .	Triumphetta rhomboidea, *Jacq.*					×		
ZYGOPHYLLACEÆ	Tribulus terrestris, *L.* .							×
GERANIACEÆ .	Erodium malapoides, *Willd.*	×						
MELIACEÆ .	Turræa Vogelii, *Hook. fil.* .						×	
	Melia Azedarach, *L.* . .					×		

	Name of Species.	Santa Cruz (Teneriffe).	Sierra Leone.	Conakry (Isles de Los).	Dakar.	St Thomé Island (Gulf of Guinea).	Principe Island (Gulf of Guinea.	St Paul de Loando.
ANACARDIACEÆ	Anacardium occidentale, *L.*					×		
DISCIFLORÆ								
ILICINEÆ	Monetia barlerioides, *L'Herit.*							×
CALYCIFLORÆ								
LEGUMINOSÆ	Indigofera tinctoria, *L.*							×
	,, hirsuta, *L.*					×		
	,, sp. (?)							×
	,, sp.		×					
	Uvaria picta, *Desv.*					×		
	Abrus precatorius, *L.*					×		
	Desmodium mauritian., *DC.*						×	
	Desmodium lasciocarp., *DC.*					×		
	Desmodium incanum, *DC.*					×	×	
	Scorpiurus sulcata, *L.*	×				×		
	Canavalia obtusifolia, *DC.*			×				
	Glycine javanica, *L.*					×		
	Vigna sinensis, *Endl.*				×	×		
	Pterocarp. esculent., *S.* & *T.*					×		
	Drepanocarpus lunatus, *G.P. Meyer*						×	
	Cassia tora, *L.*							
	,, sp.				×	×		
	Albizzia sp.				×			
	,, fastigiata, *E.M.* (?)			×		×	×	
	Acacia albida, *Delile*					×		
	Dialium guineense, *Willd.*				×			×
	Psoralea bituminosa, *L.*	×				×		
	Lotus sessilifolius, *L.*	×						
	Sesbania pubescens, *DC.*							
	Sesbania sp.				×	×		
	Rhynchosia sp.					×	×	
	Arachis hypogea, *L.*							
	Parkinsonia aculeata. *L.*				×			
	Cæsalpinia bonducella, *Roxb.*				×			×
	Crotalaria striata, *DC.*					×		
	,, retusa, *L.*							×
	Tephrosia purpurea, *Pers.*				×			
	Tamarindus indicus, *L.*							×
	Trifolium arvense, *L.*	×						×
	Sophora sp.	×						
ROSACEÆ	Æschynomene indica, *L.*				.	×		
CRASSULACEÆ	Rosa indica, *L.*					×	×	
	Bryophyl. calycinum, *Salisb.*							
MYRTACEÆ	Psidium pomiferum, *L.*					×		×
	Eugenia sp.					×		
MELASTOMACEÆ	Tristemma Schumacheri, *G.* and *P.*						×	
LYTHRACEÆ	Ammannia indica, *Lam.*							
ONAGRACEÆ	Jussiæa sp.				×	×		
SAMYDACEÆ	Casearia sp.				×	×	×	
CUCURBITACEÆ	Momordica charantia, *L.*					×		
FICOIDEÆ	Mesembryanthemum nodiflorum, *L.*	×						
	Aizoon canariense, *L.*	×						
UMBELLIFERÆ	Eryngium fœtidum, *L.*						×	
	Amm. majus, *L.*	×						

	Name of Species.	Santa Cruz (Teneriffe).	Sierra Leone.	Conakry (Isles de Los).	Dakar.	St Thomé Island (Gulf of Guinea).	Principe Island (Gulf of Guinea).	St Paul de Loando.
UMBELLIFERÆ .	Torilis nodosa, *L.* . .	×						
	,, anthriscus, *L.* . .	×						
MONOPETALÆ (Epigynæ) .								
RUBIACEÆ .	Oldenlandia corymbosa, *Lam.*					×		
	Coffea arabica, *L.* .					×	×	
COMPOSITÆ .	Pascalia angustifolia, *Retz.* .	×						
	Centaurea melitensis, *L.* .	×						
	,, calcitrapa, *L.* .				×			
	Pallenis spinosa, *Cass.* .	×						
	Pluchea dioscoridis, *DC.* .							×
	Volutarella Lippii (*DC.*) .	×						
	Picridium tingitanum, *Desf.* .	×						
	Melampodium sp. . .		×					
	Dichoma tomentosa, *Cass.* .							×
	Zinnia multiflora, *L.* . .					×		
	Chrysanthemum pubescens, *L.*	×						
	Blainvillea dichotoma, *Cass.*			×				
	Phagnalon saxatile, *Cass.* .	×						
	Blumea aurita, *DC.* . .		×					
	Artemisia sp. . . .	×						
	Ambrosia artemisiæfolia, *L.* .	×				×	×	
	Bidens pilosa, *L.* . .					×		
	Ageratum conyzoides, *L.* .		×			×	×	
	Sonchus oleraceus, *L.* .	×				×		
	Calendula arvensis, *L.* .	×						
	Mikania scandens, *Willd.* .			×				
CAMPANULACEÆ (Hypogynæ) .	Scævola Plumieri, *Vahl.* .					×		
JASMINACEÆ .	Jasminum auriculatum, *Vahl.*					×		
APOCYNACEÆ .	Vinca rosea, *L.* . .					×		
	Nerium Oleander, *L.* .	×				×		
BORAGINACEÆ .	Echium violaceum, *L.* .	×						
	Heliotropium undulatum, *Vahl.* . . .				×			
CONVOLVULACEÆ	Ipomæa palmatum, *Forsk.* .	×		×		×		
	,, pes-capræ, *Roth.* .					×		×
	,, Quamoclit, *L.* .					×		
SOLANACEÆ .	Solanum nigrum, *L.* . .						×	
	Nicotiana rustica, *L.* . .	×						
	Datura Metel, *L.* . .	×						
	Capsicum annuum, *L.* .					×		
	,, frutescens, *L.* .						×	
ACANTHACEÆ .	Justicia tenella, *T. Anders.* .		×					
VERBENACEÆ .	Clerodendron, inerme, *R.Br.*				×			
	Stachytarpheta indica, *Vahl.*		×					
LABIATÆ .	Ocymum Basilicum, *L.* .					×		
	Lavandula multifida, *L.* .	×						
	Hyptis spicigera, *Lam.* .				×			
	Micromeria sp. . .	×						
	Stachys hirta, *L.* . .	×						
	Leonotis nepetæfolia, *R.Br.*					×		
SCROPHULARIACEÆ .	Scoparia dulcis, *L.* . .					×		
PLANTAGINACEÆ	Plantago Coronopus, *L.* .	×						
	,, Lagopus, *L.* .	×						
APETALÆ .								
NYCTAGINACEÆ	Boerhaavia sp. . . .					×		×

	Name of Species.	Santa Cruz (Teneriffe).	Sierra Leone.	Conakry (Isles de Los).	Dakar.	St Thomé Island (Gulf of Guinea).	Principe Island (Gulf of Guinea).	St Paul de Loanda.
NYCTAGINACEÆ	Boerhaavia diffusa, *L.*					×		×
	Bougainvillea sp.							×
POLYGONACEÆ	Emex spinosa, *Camb.*	×						
	Rumex vesicarius, *L.*	×						
AMARANTACEÆ	Centema angolensis, *Hook. fil.*							×
	Philoxerus aggregatus, *Br.*			×				
	Telanthera maritima, *Mog.*					×		
	Amaranthus, sp.		×					
	,, spinosus, *L.*			×		×		
	Euxolus viridis, *Mog.*					×		
	Pupalia lapacea, *Mog.*					×		×
	Cyathula prostrata, *Blume.*			×			×	
	Alternanthera sessilis, *Br.*					×		
	,, achyrantha, *Br.*					×		
	Achyranthes aspera, *L.*					×		
	Gomphrena globosa, *L.*					×		
CHENOPODIACEÆ	Chenopodium murale, *L.*	×						
	Beta maritima, *L.*	×						
URTICACEÆ	Fleura aestuans, *Gaudich.*					×		
	Artocarpus, sp.					×		
EUPHORBIACAÆ	Phyllanthus, sp.		×			×		×
	Jatropha (?) sp					×		
	Acalypha, sp.					×		
	Euphorbia (*near*) tirucalli, *L.*							×
	,, pilulifera, *L.*					×		
	,, hypericifolia, *L.*					×		
	Codiæum variegatum, *Bl.*					×		
SANTALACEÆ	Osyris lanceolata, *Steud.*	×						
MONOCOTYLEDONES								
CANNACEÆ	Canna indica, *L.*					×		
ZINGIBERACEÆ	Zingiber, sp.			×				
DIOSCOREACEÆ	Helmia bulbifera, *Kunth,*					×		
LILIACEAÆ	Asparagus, sp.	×						
	Asphodelus ramosus, *L.*	×						
COMMELINACEÆ	Commelyna nudiflora, *L.*					×		
	Aneilema beniniense, *Kunth,*						×	
CYPERACEÆ	Cyperus rotundus, *L.*	×				×		
	,, distans, *L.*					×		
	,, ligularis, *L.*					×		
	,, sphacelatus, *Rottb.*					×		
	,, sp.		×					
	Scirpus lacustris, *L.*				×			
	,, sp.					×		
GRAMINEÆ	Stenotaphrum complanatum, *Schrank.*					×		
	Eleusine indica, *Gaertn.*			×		×		
	Dactyloctenium ægyptiacum, *Willd.*		×					
	Paspalum conjugatum, *Berg.*		×					
	Oryza sativa, *L.*			×				
	Zea Mays, *L.*					×		
	Lamarchia aurea, *Mœnch.*	×						
	Panicum (Echinochloa) crus-galli, *L.*					×		
	Panicum (Echinochloa) colonum, *L.*					×		

	Name of Species.	Santa Cruz (Teneriffe).	Sierra Leone.	Conakry (Isles de Los).	Dakar.	St Thomé Island (Gulf of Guinea).	Principe Island (Gulf of Guinea).	St Paul de Loanda.
GRAMINEÆ	Panicum maximum, *Jacq.*					×		
	,, plicatum, *Lam.*					×	×	×
	,, (*near*) plicatum, *Lam.*						×	×
	,, ovalifolium, *P. B.*						×	
	,, (Digitaria) horizontale *Meyer*,					×		
	,, sp.	×						
	,, sp.					×		
	Digitaria sp.					×		
	Chloris barbata, *Sw.*				×	×		
	Rottboellia exaltata, *L.*					×		
	Sporobolus virginicus, *Kunth*,					×		×
	,, indicus, *R. Br.*		×			×		
	Cynodon dactylon, *L.*					×		
	Bromus tectorum, *L.*	×						
	Schismus marginatus, *P. B.*	×						
	Eragrostis pilosides, *Beauv.*	×						
	,, brizoides, *Nees.*							×
	,, megastachya, *P. B.*				×	×		×
	,, poæoides, *Beauv.*	×			×	×		×
	,, sp.			×				
	,, sp.					×		
	,, (?) sp.		×					
	Pennisetum setosum, *Rich.*		×	×				
	,, sp.							
	,, sp.					×		
	,, Schimperi, *Hochst.*					×		
	,, cenchroides, *Rich.*				×			
	Aristida adscensionis, *L.*	×						
	,, sp.				×			
	,, (Stipagrostis).							×
	Avena hirsuta, *Roth.*	×						
	Penicillaria spicata, *Willd.*				×			
	Andropogon hirtus, *L.*	×	×	×	×	×		
	,, ,, *L.* var.		×					
	,, (Cymbopogon)				×			
	Heteropogon contortus, *L.*					×	×	
	Paspalum paniculatum, *L.*					×		
	,, scrobiculatum, *L.*					×		
	Cenchrus echinatus, *L.*				×			
	Olyra latifolia, *L.*					×	×	
	Oplismenus africanus, *P.B.*					×		
FILICES	Pteris biaurita, *L.*					×		
	,, atrovirens, *Willd.*					×	×	
	,, tripartita, *Sw.*					×		
	,, quadriaurita, *Retz.*		×					
	Adiantum lunulatum, *Burm.*			×				
	Nephrolepis cordifolia, *Presl.*			×				
	,, acuta, *Presl.*					×	×	
	,, sp.						×	
	Nephrodium molle, *Desv.*					×		
	,, pennigerum, *Hook.*						×	
	,, sp.					×	×	
	Polypodium irioides, *Lam.*						×	
	,, lycopodioides, *L.*						×	
	,, phymatodes, *L*						×	
	Young forms (many),			×			×	×

To the generosity of Capt. Thomson of the "Buccaneer," as well as of Messrs Little, Lever, and Stanton—the officers—I owe much, for much kindly co-operation and facilities for work, and to them my warmest thanks are freely tendered. In making some of my collections I was accompanied by Mr Lawler, an excellent member of the Cable Staff, who on several occasions rendered very efficient aid in my work, and to him, accordingly, I would now express my gratitude.

Report from the Botanical Camp Committee on the Flora of Glen Lyon. By W. Watson, M.D., and J. M. Macfarlane, D.Sc., F.R.S.E.

(Read 8th April 1886.)

In presenting this report of the work done by our members in Glen Lyon, the authors of it desire to express their warmest thanks to Mr S. Grieve, who not only originated the Committee, but has contributed very largely to the success already attending it.

Through the kindness of Mr Bullough, the proprietor, and Mr Lindsay, the tenant of Invermerran Farm, excellent accommodation and attendance were secured there for the two parties who visited the Glen. Situated at the foot of Loch Lyon, and at the junction of the Lyon with the Merran, the locality is one of the most remote on the mainland of Scotland. Far from mail coach and railway route, it is rarely visited by tourists, but it is the centre of a landscape whose hills are second to none in the richness of their botanical treasures. On the steep hill ledges too the golden eagle still builds its nest, and finds a safe retreat. A fine specimen was seen by our second party sailing round the top of Ben Vannoch.

The first company met at Invermerran on Monday evening, July 27th, and was composed of Mr Neill Fraser, Mr Brebner of Dundee, and Dr Macfarlane.

Next morning the party ascended Ben Creachean, about 3500 feet high. They proceeded up the Merran Burn, and reached a ravine on the north-east side of the hill. Passing up its sides there were noticed, in addition to the alpine plants usually found at from 1000 to 2000 feet, several early flowering ones, such as the marsh marigold, wood sorrel, and primrose, in full blossom. On reaching the top of the ravine, a descent was made to a small hill tarn on the south side of the hill fed by a rivulet from a snow wreath above, but no noteworthy plants were got. From this point a detour round the north-east shoulder of the hill brought us to the summit. Retracing our steps, we separated to explore the large corrie facing northward, and meeting on the west side, the following plants were found to have been gathered :—*Thalictrum alpinum*, *Caltha palustris* in flower, *Rubus Chamæmorus*, *Saxifraga stellaris*, *Gnaphalium dioicum*, *Salix herbacea*, *Juncus trifidus* and *triglumis*, *Carex atrata*, and *Polypodium flexile*. The discovery of another locality for *P. flexile*, in full view of its previously known home on Ben Aulder, suggests the idea of its occurrence on other of the hills which stretch along the east side of the Moor of Rannoch to the hill just named. Descending by the west side of the hill into the glen between Ben Creachean and Ben Vannoch, we soon joined the Merran Burn. On the whole, the day's results were very disappointing from a botanical point of view, the hill being too bare and dry to afford good results.

Next day, from unforeseen causes, very little hill work was done, but down the Lyon valley *Meum athamanticum*, *Habenaria chlorantha*, *Gymnadenia conopsea*, and commoner plants were noted. At a height of about 1200 feet on Meal Pubhil, the only specimens of *Asplenium viride* recorded during the visit were obtained.

On Thursday morning an early start was made for Ben Heasgarnish, a fine massive hill, 3530 feet high, facing the farm, and showing a large shady corrie on that side. This proved to be the most interesting and productive place visited. After ascending to the foot of the corrie face, we each selected separate lines of ascent. From under the huge boulders, about 2000 feet up, splendid specimens of *Polystichum lonchitis* pushed out their fronds, while an abundance of *Polypodium alpestre* grew out from between the stone crevices. About 100 feet higher, rich carpets of *Silene acaulis*, varied with *Saxifraga aizoides* and *hypnoides*, formed a fine contrast as they spread over the soaked earth and dripping stones. *Cerastium tomentosum*, *Saxifraga stellaris* and *oppositifolia*, *Saussurea alpina*, *Gnaphalium supinum*, *Bartsia alpina*, *Juncus acutiflorus* and *triglumis* were also mingled amongst these. At a height of about 2600 feet, a considerable quantity of *Cystopteris montana* was got in three localities pretty widely separated, and along with it *Saxifraga nivalis*, *Juncus trifidus*, and *Carex atrata* were also got. On the east side, about 200 feet from the summit, a very interesting set of environments was discovered. A little tarn filling a hollow, and supplied with water from a large snow wreath about 50 feet above, had its margin bordered with a dense growth of *Caltha palustris*, whose flowers formed a rich yellow carpet. Such a striking local climatic effect, seen in the height of summer after broiling days of heat, impresses on one the importance of noting local conditions as bearing on the flora and fauna of any district.

What proved to be the best "find" of our party was made by Mr Brebner while botanising along the face of the corrie. In 1810 Don reported that he had found *Carex ustulata*, Wahl, on the Breadalbane mountains, but as it had never since been confirmed, it was classed by Hooker, in his appendix to the *Student's Flora*, as "one of Don's reputed discoveries"; but three specimens, gathered by Mr Brebner and forwarded to Dr Buchanan White, have been identified by him, and confirmed by Mr A. Bennett of Croydon, as Don's plant. The smaller and more slender habit, nodding head, and different hue, all separate it in appearance from *C. atrata*, with which it might be at first confounded. And here we may be allowed to do honour to the memory of that most indefatigable of all our early Scotch alpine botanists, whose "finds," once regarded as doubtful or mistaken, are being all verified, year by year, as a more perfect knowledge of our hill flora is obtained.*

We reached our headquarters about 7 P.M., thoroughly satisfied with our day's botanising, and convinced that this hill, which has received so little attention from botanists, is worthy of all praise.

On Friday, an accident happening to one of our number, we were prevented setting out for the hills till twelveo'clock, when it was resolved to circle Ben Vannoch, 3100 feet high. Nothing of importance was gathered. On the succeeding morning an early start was made for Tyndrum station, which was reached after a tough walk under a burning sun.

* NOTE.—*6th October* 1886.—Mr Brebner, along with two accomplished botanists, revisited the spot during the past summer, and were gratified to find that *Carex ustulata* was pretty plentiful. Specimens of it are now deposited in the Herbarium at the Royal Botanic Garden.

The second party, consisting of Mr Grieve, Mr Rattray, and Dr Watson, reached Invermerran on Monday, 3rd August. On the 4th, Mr Grieve and the author walked along the south side of the loch, and the former then made his way to the summit of Craig Mohr, 3300 feet high, and found among other plants *Polygala vulgaris* var. *depressa*, *Saxifraga hypnoides* and *oppositifolia*.

On the 5th the party climbed Ben Vannoch and Ben Achallacher, the latter 3400 feet high. During the ascent from the Merran stream, great quantities of *Lysimachia nemorum* and two specimens of *Malaxis paludosa* were got. On Ben Vannoch the best plants found were *Thalictrum alpinum*, *Saxifraga stellaris*, and *Juncus trifidus*. Ben Achallacher is remarkable for its very abrupt rise from Loch Tulla on the west, and its very gentle slope on the east, down to the Old Woman's Burn (allt faillich), a tributary of the Merran. The plants got on this hill were mixed with those from Ben Vannoch; but the two are continuous, and form a single group.

On the 6th of August we ascended Ben Heasgarnish. The day was very misty, but Messrs Grieve and Rattray remained all day wandering over the hill, and reached home at 6 P.M. Among the plants found were *Gnaphalium supinum*, *Juncus acutiflorus*, and *Saxifraga nivalis*. Dense mist and several heavy showers of rain interfered with successful plant-collecting.

On the 7th, two of our number went up the Avon Glass or Grey Water to the source of one of its tributaries. One chose to climb to the top of Cham Craig, 2887 feet high, and then crossed to the flank of Craig Mohr; while the other collected plants along the whole of the west flank of Craig Mohr. *Saussurea alpina* and a very stunted form of *Systopteris fragilis* were gathered.

The author went up the Merran Water to the watershed between Glen Lyon and the Moor of Rannoch. Though the elevation was not great, the view was an exceedingly beautiful one. Crossing Meall Tionnail, the following were got:—*Alchemilla alpina*, *Galium saxatile*, *Valeriana sambucifolia*, *Hieracium murorum*, *Menyanthes trifoliata*, *Utricularia minor*, and *Hymenophyllum Wilsoni*.

The party walked down the river Lyon on the following day to Pubhil Farmhouse, when they spent some time searching for Utricularias in the low ground near the mouth of the Pubhil Burn, and were successful in getting quantities of *U. minor* and one plant of *Malaxis paludosa.* One of us then climbed Meall Pubhil, 2290 feet, and descending to the Pubhil Burn in the upper part of its course, rose again over Meal Buidh, and crossed the summit of Meall Daill, 2888 feet, finally reaching the Merran stream, which was followed to our home. On Meall Pubhil were collected *Carduus lanceolatus* and *heterophyllus*, *Orchis mascula*, and *Habenaria albida.* Another of our party, after climbing Meall an Odhar, 2648 feet, crossed on to the Grinnan hill, and then went over the Lyon river to climb Meall-a-Chall on its south bank. On it were got *Drosera anglica*, *Rubus chamæmorus*, *Veronica saxatilis*, and *Avena alpina.*

The 9th was very wet and windy, and the streams came down in high flood.

On Monday (10th) the party broke up, after a week of rather indifferent weather.

During that time Mr Grieve collected the following mosses, mostly from Ben Heasgarnish:—

Biscutella arcuta.
Polystichum commune.
Hypnum tamariscinum.
    loreum.
    Schreberi.
    squarrosum.
    cupressiforme.
    purum.
    triquetrum.
Racomitrum heterostichum.
    lanuginosum.
    protensum.
    canescens.
Dicranum squarrosum.
Philonotis fontana.
Pterygophyllum lucens.
Bartramia pomiformis.

The best plants found by the second party were:— *Draba incana, Silene acaulis, Cherleria sedoides, Dryas octopetala, Saxifraga nivalis* and *oppositifolia, Drosera anglica, Galium boreale, Utricularia minor, Listera cordata, Habenaria bifolia, Malaxis paludosa, Tofieldia palustris*, and *Cystopteris montana.* We found hundreds of two-flowered plants of *Juncus triglumis*, which we at first took for the rare *J.*

biglumis, but the round stems, channelled leaves, and short b acteæ, all proved them to be the former.

A number of *Carices* were sent by Mr Grieve to be named by Mr Bennett of Croydon. The following have been identified:—*C. dioica, pulicaris, ovalis, stellulata, vulpina, curta, atrata, vulgaris, pallescens, pulla, panicea, ampullacea, fulva, flava, pilulifera, capillaris, glauca, rigida, Hornschuhiana*, and *binervis.*

Notes on the Flora of the Island of Rum, one of the Hebrides. By SYMINGTON GRIEVE.

(Read 11th March 1886.)

Mr Grieve read a paper of considerable length, in which he narrated some of his experiences while botanising at Rum for nine days in July 1884. He also referred to the notices of the island and its botanical features mentioned by various writers during the last three centuries.

In submitting the following list of plants collected on Rum, Mr Grieve said that he had to acknowledge his obligations to Mr Arthur Bennett, Croydon, Surrey, who had kindly examined and named the Potamogetons, Carices, and Grasses. He remarks that this is the first record of *Potamogeton prælongus*, Wulf., on the west of Scotland. There is also a specimen of a peculiar form of *Carex flava*, but unfortunately the fruit is not mature enough for exact determination.

THALICTRUM alpinum, L.
minus, L.
RANUNCULUS hederaceus, L.
Flammula, L.
acris, L.
repens, L.
hirsutus, Curtis.
CALTHA palustris, L.
minor, Syme.
NYMPHÆA alba, L.
SINAPIS arvensis, L.
CARDAMINE hirsuta, L.
ARABIS petræa, Lam.
hirsuta, Brown.
COCHLEARIA officinalis, L.
DRABA incana, L.
VIOLA canina, Auct.
DROSERA rotundifolia, L.
anglica, Huds.
POLYGALA vulgaris, L.
SILENE inflata, Sm.
SILENE maritima, With.
acaulis, L.
LYCHNIS diurna, Sibth.
Flos-cuculi, L.
CERASTIUM glomeratum, Thuil.
triviale, Link.
var. holosteoides.
STELLARIA media, With.
uliginosa, Murr.
HONKENEYA peploides, Ehrh.
CHERLERIA sedoides, L.
SAGINA procumbens, L.
nodosa, Meyer.
SPERGULA arvensis, L.
MONTIA fontana, L.
HYPERICUM Androsæmum, L.
humifusum, L.
pulchrum, L.
LINUM catharticum, L.
GERANIUM molle, L.
Robertianum, L.

Erodium cicutarium, Herit.
Oxalis Acetosella, L.
Ilex Aquifolium, L.
Acer *Pseudo-platanus*, L.
Anthyllis vulneraria, L.
Trifolium pratense, L.
arvense, L.
repens, L.
Lotus corniculatus, L.
Vicia Cracca, L.
sylvatica, L.
Orobus tuberosus, L.
var. tenuifolius.
Spiræa Ulmaria, L.
Alchemilla vulgaris, L.
alpina, L.
Potentilla alpestris, Hall.
Tormentilla, Schenk.
anserina, L.
Rubus Idæus, L.
fruticosus, L.
saxatilis, L.
Geum rivale, L.
Rosa spinosissima, L.
tomentosa, Sm.
canina, L.
Cratægus Oxyacantha, L.
Pyrus Aucuparia, Gaert.
Epilobium montanum, L.
palustre, L.
alpinum, L.
Myriophyllum
alterniflorum, DC.
Callitriche Stagnalis, Scop.
var. platycarpa.
Ribes *Grossularia*, L.
Sedum Rhodiola, DC.
anglicum, Huds.
acre, L.
Saxifraga stellaris, L.
hypnoides, L.
Chrysosplenium
oppositifolium, L.
Hydrocotyle vulgaris, L.
Ægopodium Podagraria, L.
Bunium flexuosum, With.
Œnanthe crocata, L.
Ligusticum scoticum, L.
Angelica sylvestris, L.
Daucus Carota, L.
Chærophyllum sylvestre, L.
Hedera Helix, L.
Sambucus nigra, L.
Lonicera Periclymenum, L.
Galium boreale, L.
verum, L.
saxatile, L.
uliginosum, L.
Aparine, L.
Valeriana officinalis, L.
Scabiosa succisa, L.
Carduus lanceolatus, L.
palustris, L.
heterophyllus, L.
Arctium minus, Schkuhr.
Centaurea nigra, L.
Chrysanthemum segetum, L.
Leucanthemum, L.
Achillea Millefolium, L.
Ptarmica, L.
Gnaphalium supinum, L.
dioicum, L.
Senecio vulgaris, L.
Jacobæa, L.
Bellis perennis, L.
Solidago Virga-aurea, L.
Tussilago Farfara, L.
Lapsana communis, L.
Hypochœris radicata, L.
Leontodon autumnalis, L.
Taraxacum officinale, Wigg.
Hieracium Pilosella, L.
murorum, L.
cæsium, Fries.
Lobelia Dortmanna, L.
Campanula rotundifolia, L.
Vaccinium Vitis-idæa, L.
Myrtillus, L.
Erica Tetralix, L.
cinerea, L.
Calluna vulgaris, Salisb.
Fraxinus excelsior, L.
Menyanthes trifoliata, L.
Digitalis purpurea, L.

Veronica serpyllifolia, L.
officinalis, L.
Euphrasia officinalis, L.
Bartsia Odontites, Huds.
Pedicularis palustris, L.
sylvatica, L.
Rhinanthus Crista-galli, L.
Mentha hirsuta, L.
Thymus Serpyllum, Fries.
Prunella vulgaris, L.
Scutellaria galericulata, L.
minor, L.
Galeopsis versicolor, L.
Tetrahit, L.
Lamium purpureum, L.
Teucrium Scorodonia, L.
Myosotis sylvatica, Ehrh.
arvensis, Hoffm.
versicolor, Reich.
Pinguicula vulgaris, L.
lusitanica, L.
Primula vulgaris, Huds.
Lysimachia nemorum, L.
Anagallis tenella, L.
Glaux maritima, L.
Armeria maritima, Willd.
Plantago major, L.
lanceolata, L.
maritima, L.
coronopus, L.
Littorella lacustris, L.
Atriplex angustifolia, Sm.
patula.
Rumex maritimus, L.
obtusifolius, Auct.
Acetosa, L.
Acetosella, L.
Oxyria reniformis, Hook.
Polygonum aviculare, L.
Persicaria, L.
Empetrum nigrum, L.
Urtica dioica, L.
Quercus Robur, L.
Fagus sylvatica, L.
Corylus Avellana, L.
Betula alba, L.
Myrica Gale, L.
Populus alba, L.
tremula, L.
Salix cinerea, L.
aurita, L.
phylicifolia, " L.
nigricans, " Sm."
ambigua, Ehrh.
repens, L.
var. argentea.
herbacea, L.
Juniperus communis, L.
Sparganium affine, Schneiz.
Potamogeton natans, L.
polygonifolius, Pour.
prælongus, Wulf., first record in West of Scotland.
Triglochin palustre, L.
maritimum, L.
Orchis mascula, L.
latifolia, L.
maculata, L.
Gymnadenia conopsea, Brown.
albida, Rich.
Habenaria viridis, Brown.
bifolia, Bab. Man.
Listera cordata, Brown.
Iris Pseudacorus, L.
Scilla verna, Huds.
Narthecium ossifragum, Huds.
Tofieldia palustris, Huds.
Luzula sylvatica, Beck.
campestris, DC.
var. congesta.
spicata, DC.
Juncus triglumis, L.
conglomeratus, L.
effusus, L.
acutiflorus, Ehrh.
supinus, Mœnch.
var.
bufonius, L.
Gerardi, Lois.
squarrosus, L.
Schœnus nigricans, L.
Rhyncospora alba, Vahl.
Scirpus uniglumis, L.

SCIRPUS cæspitosus, L.
setaceus, L.
ERIOPHORUM
angustifolium, Roth.
CAREX pulicaris, L.
stellulata, Good.
ovalis, Good.
rigida, Good.
vulgaris, Fries.
glauca, Scop.
panicea, L.
var. sublivida, Hartm.
binervis, Sm.
fulva, Good.
flava, L.
curious variety, probably *var.* Gauda of Gay and C. lepidocarpa, Tausch.
var. minor, Toussard.
ampullacea, Good.
ANTHOXANTHUM odoratum, L.
PHLEUM pratense, L.
AGROSTIS canina, L.
alba, L.
vulgaris, With.
var. pumila.
AIRA cæspitosa, L.
var. brevifolia.
var. pseudo-alpina.
flexulosa, L.
var. montana.
HOLCUS lanatus, L.
TRIODIA decumbens, Beauv.
MOLINIA cærulea, Moench.
SCLEROCHLOA maritima, Lindl.
POA annua, L.
subcœrulea (Syme), Sm.
CYNOSURUS cristatus, L.
DACTYLIS glomerata, L.
FESTUCA ovina, L.
rubra, L.
NARDUS stricta, L.
PTERIS aquilina, L.
CRYPTOGRAMME crispa, Brown.
LOMARIA spicant, Desv.
ASPLENIUM Trichomanes, L.
marinum, L.
Adiantum-nigrum, L.
ATHYRIUM Filix-fœmina, Bernh.
CYSTOPTERIS fragilis, Bernh.
ASPIDIUM aculeatum, Sw.
lobatum.
NEPHRODIUM Filix-mas, Rich.
spinulosum, Desv.
dilatatum,Desv.
æmulum, Baker.
Oreopteris, Desv.
POLYPODIUM vulgare, L.
Phegopteris, L.
OSMUNDA regalis, L.
BOTRYCHIUM Lunaria, Sw.
LYCOPODIUM alpinum, L.
Selago, L.
SELAGINELLA Selaginoides, Gray.
EQUISETUM arvense, L.
palustre, L. *var.* alpinum
limosum, L.
arenarium.

MISCELLANEOUS CONTRIBUTIONS AND EXHIBITIONS.

SESSION 1885–86.

November 12, 1885.

Exhibition by Mr R. Lindsay, of *Mutisia decurrens* in flower; small branches, covered with fruit, of *Gaultheria carnea*, both from the open air; and seedling plants of *Eucalyptus pauciflora* and *coccifera*. He also mentioned that he had succeeded in raising seedlings from the large Eucalyptus which grew in the open air at Whittinghame, East Lothian, since 1846. The seeds were ripened this summer. This tree, which had been supposed to be *Eucalyptus viminalis*, had been determined by Sir Joseph Hooker to be *E. Gunni*, a native of Tasmania.

Exhibition of flowers sent by Mr John Campbell from his garden.

Mr Neill Fraser intimated having gathered, in September 1884, on a mountain in the neighbourhood of Pitlochrie, Perthshire, *Astragalus alpinus*, hitherto recorded as having been found at only two stations in Scotland (Clova and Braemar), and *Oxytropis campestris* only found hitherto at one station. Neither was in flower. It is possible, when further specimens are obtained, that the Oxytropis may turn out to be *Halleri*, also a very rare alpine plant; but Mr Fraser believes it to be *campestris* that he discovered.

December 10, 1885.

The Assistant Secretary read a communication on Phenological Observations, and it was considered by the Fellows that the previously appointed Phenological Committee should be resuscitated.

The Rev. Mr Tennant exhibited a tree root showing chips of stone enclosed in warty protuberances of the wood and bark.

January 14, 1886.

Exhibition of specimens and slides of *Ustilago marina* from Mr E. M. Holmes, F.L.S., and *Puccinia Buxi* from Miss C. Owen, Gorey, Ireland.

February 11, 1886.

Dr Craig exhibited a specimen of the medicinal Squill (*Scilla maritima*) which had germinated in his Materia Medica Museum, and which he presented to the Botanic Garden.

Various spring flowering plants were shown from Mr John Campbell of Ledaig.

Specimens of interesting British mosses, lichens, and seaweeds, presented to the Herbarium, were shown by Mr E. M. Holmes, who sent the following notes regarding them :—

1. *Tortula mucronata*, Lindb.—The fruit of this species is extremely local, and I have found it only on the roots of trees by the river side at Leatherhead in Surrey, and Penshurst in Kent. When growing it bears a considerable resemblance, in a wet state, to luxuriant specimens of *Tortula unguiculata*, but may easily be distinguished in the barren state from that moss by the matted red roots, which cause the tufts to cohere. Although Dr Braithwaite gives as its habitat "at roots of old trees by rivers," I have found it in abundance on clay slate rocks near Plymouth, in places where the moisture of a field drains down through the slate. The present specimen was growing in tufts on a limestone wall where a garden drains through the wall into the road outside. I have, however, never seen it in fruit on a wall, though I have watched the same place for years. It fruits on palings, or roots of trees subjected to flooding after heavy rains. In such places it grows in continuous masses.

2. Note on *Tortula nitida*, Lindb.—I first found this moss about twenty years ago on dry limestone walls at Plymouth, where it grows abundantly, but is never found in fruit. I sent specimens to the late Mr George Hunt of Manchester, who regarded it as a variety of *Trichostomum mutabile;* but feeling sure from the mode of growth of the plant, in isolated tufts on drystone walls, that it could not be that species, and noticing moreover that the leaf tips were almost invariably broken, only the very youngest being perfect, and that the leaf had a different shape and cell structure from *T. mutabile*, I sent it to Mr Mitten, who described it in the *Journal of Botany* as a new species, under the name of *Trichostomum diffractum*, April 1, 1868, p. 97. Although he had specimens previously collected by Borrer and Thwaites, they had remained unnamed until I called his attention to the plant. Subsequently, Lindberg saw Mitten's species (probably specimens collected by me and sent to Dr Braithwaite, who was subsequently visited by Lindberg), and pointed out that it was identical with a species previously described by himself under the name of *Tortula nitida*, from the shining appearance of the nerve at the back of the leaf when the moss is dry. Hence Dr Lindberg's name holds good. Lately it has been found on the Continent in fruit, which will, I believe, be figured in the next part of Dr Braithwaite's *Brit. Moss Flora.* The most northerly point at which I have found *Tortula nitida* is Dovedale, in Derbyshire, although it may occur on limestone further north. I have seen it in abundance at Plymouth, Torquay, and Lynton, in Devon—in fact, wherever there are dry-stone walls of limestone. It is also recorded from Clifton, near Bristol.

3. Note on *Pertusaria globulifera.*—This species is so rarely seen in fructification that it may be interesting to state under what conditions the fruit is produced. It is generally to be found on oak trees in mossy woods, among boulders where a mountain stream runs near by. The fruit is almost always found on patches *near the ground*, rarely higher up on the trunk, and then only in ravines where there is frequent mist and rain. I may here mention that the Pertusarias are easily recognised by chemical tests in the barren state, but it is necessary to be careful in using the chlorinated lime test. This should always be *made*, *never bought* ready made, for the reason, that to make the solution stronger for disinfecting purposes, chlorine gas is sometimes passed into it. Solution so made gives *no reaction* with lichens. It should be made by filling a bottle one-third full of chlorinated lime in *dry* powder, filling up with water, shaking the bottle, and pouring off the supernatant liquid. The solution should be made fresh when required, as it soon loses its power of giving the necessary reactions if kept long. To ascertain whether the solution is still active, the best test is a piece of the barren thallus of *Pertusaria velata*, which gives a beautiful carmine-red the moment it is touched with chlorinated lime solution. I always keep a piece on purpose to ascertain the goodness or otherwise of my test solution.

4. Note on *Lithographa dendrographa*, Nyl.—This species appears also, like Roccella, to find its northern limit in the south of England It was found in Britain first by Dr Holl, at Totnes, South Devon. Subsequently, Mr W. Curnow of Penzance detected it at Menheniot, in Cornwall. I have since found it in abundance near Stoney Cross, in the New Forest; near Studland, Dorset; near Sidmouth, Devon; and scattered widely around the shores of Torbay, from Watcombe to Brixham. It frequently occurs in company with *Lecidea carneolutea*, Turn., a very pretty species, of which I also send specimens, and which likewise seems to be a southern species in Britain. *Lithographa dendrographa* is easily recognised when *growing* by its *brownish*, thin thallus, and by the *raised*, rigid, polished margin of its lirellæ. *Opegrapha vulgata* has a whitish thallus, and less prominent margins to the lirellæ. The spores are simple in *L. dendrographa.* It almost always occurs on elm trees, rarely on ash, and grows usually at a height of from 5 to 10 feet from the ground. It was first described by Nylander in 1864.

5. Note on *Roccella phycopsis.*—This lichen being so entirely a southern species—so far as records go—a few remarks concerning it may be of interest to botanists in Scotland. It extends, according to the records given in Leighton's *Lichen Flora*, from the Channel Islands to the Isle of Wight on the east, and the Devon

coast on the west. I have found it most luxuriantly on the Lizard Head, fruiting freely, and barren at Newquay and Mortehoe, Ilfracombe and Lynton, in North Devon. On the south coast of Devon it is abundaut on the Bolt Head; occurs sparingly at Sharpstone Point, near Brixham; and in Dorsetshire I have found it abundantly on the Isle of Portland. Like *R. fuciformis*, Ach., it is only to be found on the sides of rocks sheltered from the wind, or under similar protection, in fissures of rocks. It appears to reach its northern limit at Lynton, where it is very small, and occurs sparingly. It is easily distinguished from *R. fuciformis* by a peculiarity which I have not seen mentioned in books, viz., the point of attachment of each tuft to the rock is of a dirty *yellow* colour. This feature is not present either in *R. fuciformis*, nor in any *authentic* specimens of *R. tinctoria* that I have seen. The British records concerning this last named species are incorrect, so far as regards the mainland, and I have seen no specimen from the Channel or Scilly Islands, nor can I find a genuine British specimen of it in our national Herbaria. *R. fuciformis* I have only seen in fruit from the Logar Rock, Land's End. When I visited that spot a few years ago, there were hardly any specimens left in fruit. It seems a less hardy plant, although it grows to a larger size, than *R. phycopsis*, since in North Devon it is less abundant than that species. It might be looked for on the west coast of Scotland, since *Physica flavicans* and *Physica leucomela* occur at Anglesea, and *Lecidea Ralfsii*, a Cornish species, has been found in Cumberland.

6. Note on *Gigartina Teedii.*—This pretty species appears to reach its northern limit in Britain at Torbay, the only spot on which it has been found on the mainland, although tolerably plentiful in Jersey. It grows on a sloping, sandy rock, exposed only at very low tides, and protected from the violence of the waves by a large rock in the water in front of it. It is only where the waves are thus broken that it grows, six yards square being the limit of the area of growth where I found it. In habit it differs somewhat from *G. acicularis* which grows near it. The last named species has a creeping habit, rooting along the edges and over the surfaces of sandy rocks, at low water; but *G. Teedii* grows in isolated, dense tufts arising from a central point. It has a more reddish tint than *G. acicularis.* It has not been found in fruit in England.

March 11, 1886.

Mr Symington Grieve reported regarding arrangements for summer camp work, and stated that liberty to visit Applecross had been obtained from the proprietor, Lord Middleton.

Dr J. M. Macfarlane gave an account of "The Structure and Functional Arrangements of the Leaves of Darlingtonia."

The following plants in pots were exhibited from the garden:—*Primula floribunda*, an improved form, having flowers as large again as the typical species; *Crocus Imperati albiflora*, *Crocus chrysanthus*, *Polystichum Lonchitis*, crested variety, found by Dr Craig last year.

April 8, 1886.

Microscopic exhibition of rare Algæ from the Firth of Forth, by Mr G. W. Traill.

Exhibition of plant of *Richardia æthiopica*, having a leaf coloured like a spathe; a collection of cut Orchid blooms, consisting of twenty species, from W. Sanderson, Esq., Talbot House, Ferry Road; a large and finely flowered plant of a good variety of *Primula obconica*, from P. H. Normand, Esq., Whitehill, Aberdour. From W. B. Boyd, Esq., Faldonside, came a plant of *Androsace carnea eximia* in flower; and from the Royal Botanical Garden cut flowers of *Napoleona cuspidata* from Calabar, and plants in flower of *Primula Allioni* and *P. integrifolia*, and *Saxifraga Burseriana Boydi*.

May 13, 1886.

A letter was read from Mr John Buchanan, Shiré Highlands, Africa, stating that he had only been able to send to London a small box of *Strophanthus hispidus*. He was now attempting to cultivate the plant in his plantation on Mount Lomba.

Mr Lindsay drew attention to living specimens of the following plants in flower in the Garden:—

Androsace villosa, and a Himalayan variety
  foliosa
  incisa
Andromeda fastigiata
Arnebia echioides
Arabis blepharophylla superba
Dendrobium Wardianum (a large flowered variety received from Burmah through P. N. Fraser, Esq.)
Daphne striata
Gentiana verna
  alba
Iberis petræa
Myosotis antarctica
Narcissus triandrus
Petrocallis pyrenaica
Polygala chamæbuxus purpurea
Primula denticulata erosoides
  farinosa
  involucrata
  mollis
  Parryi
  prolifera
  Stuartii
  Warei
  Olgæ
Saxifraga purpurascens
Sarracenia flava
  Chelsoni

Specimen sheets of plants intended for class teaching, and dissected to show the different organs, like those exhibited in the Museum, were laid on the table. These were sent by Mr Buysmann, the preparer, and the thanks of the Society were awarded to that gentleman.

June 10, 1886.

Flowering specimens of the undernoted plants were exhibited by Mr Lindsay :—

Aster Stracheyi, dwarf creeping species from Himalaya
Allium Karataviense
    Ostrowskyanum
Campanula abietina
Coronilla minima
Cypripedium macranthum
Dracophyllum Traversii
Delphinium Brunonianum
Erigeron aurantiacus
Fritillaria kamtschatica
Gastronema sanguineum
Globularia nana
Houstonia cœrulea
Leontopodium alpinum, Himalayan form
Lychnis alpina
Lychnis lapponica
    Lagascæ
Linaria origanifolia
Myosotis alpestris
Onosma taurica
Primula elliptica
    longiscapa
    prolifera
    Rusbyi
Pinguicula alpina
Pentstemon Menziesii
Ramondia pyrenaica
Ranunculus biloba
Saxifraga cæsia
    odontophylla
    longifolia

July 8, 1886.

It was agreed to convey the congratulations of the Fellows to the Honorary Secretary, Professor Sir Douglas Maclagan, on his reception of Knighthood.

Professor Dickson exhibited specimens of Lake Balls formed from interlaced filaments of *Cladophora ægagropila*, which had been gathered in South Uist by Mr G. W. Barclay, and presented by him to the Garden (see *Proc. Roy. Soc. Edin.*, 1886).

Professor Dickson also showed Brazil Nut Fruits. Mr Boyd brought forward interesting flowers from his garden at Faldonside.

OFFICE-BEARERS.

At the General Meeting held on Thursday, 12th November 1885, the following Office-Bearers for 1885–86 were elected :—

PRESIDENT.

Professor DICKSON, M.D., LL.D., F.R.S.E.

VICE-PRESIDENTS.

WILLIAM B. BOYD of Faldonside.
THOMAS ALEXANDER GOLDIE BALFOUR, M.D., F.R.C.P.E., F.R.S.E.
ALEXANDER BUCHAN, A.M., F.R.S.E.
HUGH CLEGHORN, M.D., F.R.S.E.

COUNCILLORS.

Rev. JOHN MACMURTRIE, M.A.
ROBERT LINDSAY.
PATRICK GEDDES, F.R.S.E.
SYMINGTON GRIEVE.
ANDREW TAYLOR, F.C.S.
WILLIAM SANDERSON.
Rev. J. M. ROBERTSON, M.A.
ROBERT GRAY, F.R.S.E.
WILLIAM CRAIG, M.D., C.M., F.R.C.S.E., F.R.S.E.
WILLIAM WATSON, M.D.

Honorary Secretary—Professor DOUGLAS MACLAGAN, M.D., F.R.S.E.
Honorary Curator—The PROFESSOR OF BOTANY.
Foreign Secretary—ANDREW P. AITKEN, M.A., D.Sc., F.R.S.E.
Honorary Treasurer—PATRICK NEILL FRASER.
Assistant-Secretary—JOHN M. MACFARLANE, D.Sc., F.R.S.E.

LOCAL SECRETARIES.

Aberdeen—STEPHEN A. WILSON of North Kinmundy.
Berwick—PHILIP W. MACLAGAN, M.D.
Birmingham—GEORGE A. PANTON, F.L.S., 95 Colmore Row.
Calcutta—JOHN ANDERSON, M.D., F.L.S.
,, GEORGE KING, M.D., Botanic Garden.
Cambridge—CHARLES C. BABINGTON, M.A., F.R.S., Professor of Botany.
,, ARTHUR EVANS, M.A.
Croydon.—A. BENNETT, F.L.S.
Dublin—W. R. M'NAB, M.D., F.L.S., Professor of Botany, Roy. Col. Science.
Dumfries—JAMES GILCHRIST, M.D.
Exeter—THOMAS SHAPTER, M.D.
Fife—J. T. BOSWELL, LL.D., F.L.S., of Balmuto, Kirkcaldy.
Greenock—DONALD M'RAILD, M.D.
Kilbarchan—Rev. G. ALISON.
London—WILLIAM CARRUTHERS, F.R.S., F.L.S., British Museum.
London, Brixton—JOHN ARCHIBALD, M.B., C.M., F.R.C.S.E.
Manchester—BENJAMIN CARRINGTON, M.D., Eccles.

Melbourne, Australia—Baron FERDINAND VON MUELLER, M.D.
Nairn—WILLIAM ALEX. STABLES.
Norfolk—JOHN LOWE, M.D., King's Lynn.
Nova Scotia—GEORGE LAWSON, LL.D., Dalhousie.
Ottawa, Ontario—W. R. RIDDELL, B.Sc., B.A., Prov. Normal School.
Oxford—Professor BAYLEY BALFOUR, M.D., D.Sc., F.R.SS. L. & E.
Perth—F. B. WHITE, M.D., F.L.S.
Punjab, India—W. COLDSTREAM, B.A., B.Sc.
Saharunpore, India—J. F. DUTHIE, B.A., F.L.S., Botanic Garden.
Shrewsbury—Rev. W. A. LEIGHTON, B.A., F.L.S.
Silloth—JOHN LEITCH, M.B., C.M.
Wellington, New Zealand—JAMES HECTOR, M.D., F.R.SS. L. & E.
Wolverhampton—JOHN FRASER, M.A., M.D.
Zanzibar—Sir JOHN KIRK, M.D., F.L.S.

Fellows elected, Session 1885–86.

1885.

Nov. 12. J. M. TURNBULL, Edinburgh—*Res. Fellow.*
G. F. SCOTT ELLIOT, B.A., Edinburgh—*Res. Fellow.*
Dec. 10. FRED. DELPINO, Genoa—*Hon. Fellow.*
P. DUCHARTRE, Paris—*Hon. Fellow.*
GRAND'EURY, St Etienne—*Hon. Fellow.*
F. HILDEBRAND, Freiburg—*Hon. Fellow.*
S. SCHWENDENER, Berlin—*Hon. Fellow.*
PH. VAN. TIEGHEN, Paris—*Hon. Fellow.*
E. WARMING, Copenhagen—*Hon. Fellow.*
J. T. BOSWELL, Fife—*Hon. Fellow.*
W. E. DIXON, Edinburgh—*Associate.*
JAMES GREIG, Dollar—*Associate.*

1886.

Jan. 14. WILLIAM COATS, Edinburgh—*Res. Fellow.*
RICHARD SPRUCE, Yorkshire—*Hon. Fellow.*
AD. ENGLER, Kiel—*For. Fellow.*
G. HABERLANDT, Gratz—*For. Fellow.*
ED. JANCZEWSKI, Cracow—*For. Fellow.*
A. KERNER, Vienna—*For. Fellow.*
MAX LEICHTLIN, Baden-Baden—*For. Fellow.*
H. LEITGEB, Gratz—*For. Fellow.*
CH. LUERSSEN, Leipzig—*For. Fellow.*
W. PFEFFER, Tubingen—*For. Fellow.*
M. TREUB, Buitenzorg—*For. Fellow.*
GEO. WINTER, Leipzig—*For. Fellow.*
Feb. 11. D. M'GLASHAN, Edinburgh—*Res. Fellow.*
ALEX. SOMERVILLE, B.Sc., Glasgow—*Non.-Res. Fellow.*
Mar. 11. A. BENNETT, Croydon—*Associate.*
REV. D. LANDSBROUGH, Kilmarnock—*Associate.*
G. W. TRAILL, Joppa—*Associate.*
THOMAS WALKER, Carluke—*Associate.*
April 8. J. R. HILL, Edinburgh—*Res. Fellow.*
June 10. GEO. BELL, Edinburgh—*Res. Fellow.*

ADDITIONS

TO THE

LIBRARY, HERBARIUM, AND MUSEUM,

AT THE

ROYAL BOTANIC GARDEN, EDINBURGH,

FROM 1ST OCTOBER 1885 TO 1ST OCTOBER 1886.

LIBRARY.

BOOKS.

CANNON, H. W. Annual Report of the Comptroller, 1885.—*From the Comptroller.*

GRAY, ASA, M.D. Botany of the Northern United States, 1848.—*From Mr Thomas Walker, Carluke.*

FLÜCKIGER, Dr F. A. LA MORTOLA. Description of the Garden of Thomas Hanbury, Esq.—*From Thomas Hanbury.*

FROBELL, JULIUS, and OSWALD HEER. Mittheilungen aus dem Gebiste der Theoretischen Erdkiende.—*From Mr Thomas Walker, Carluke.*

KIDSTON, ROBERT, F.L.S. Catalogue of Palæozoic Plants in the British Museum.—*From the Trustees.*

MUELLER, FERD. VON. Eucalyptographia.—*From Dr W. Stewart.*

——— Select Extra-Tropical Plants.—*From the Author.*

PFEIFFER, Dr LUDWIG. Synonymia Botanica.—*From Mr Robert Lindsay.*

RAY, Lieut. P. H. Report of the Expedition to Point Barrow, Alaska.—*From the U.S. Government.*

THEIS, ALEXANDRE DE. Glossaire de Botanique, 1810.—*From Mr Thomas Walker, Carluke.*

THURMAN, JULES. Essai de Phytostatique. Vol. I.—*From Mr Thomas Walker, Carluke.*

TOLSTOI, LEON. What I Believe.—*From the Author.*

WHITFIELD, ROBERT P. Monograph IX., U.S. Geol. Survey. Brachiopoda and Lamellibranchiata of Raritan Clays and Greensand Marks of New Jersey.—*From the U.S. Government.*

——— Fifth Annual Report, 1883, 1884.—*From the U.S. Government.*

PAMPHLETS, REPRINTS FROM SCIENTIFIC PUBLICATIONS, &c.

Bornet, Ed. Algues de Madagascar ricolteés, par M. Ch. Thiebaut.
Bornet and Flahault. Note sur le genre Aulosira.
Cantly, N. Report on Straits Settlements, Forest Department.
Cohn, Prof. Ferd. Berichte über die Thätigkeit der botanischen Section der Schlesischen Gesellschaft.
Gay, Fr. Note sur les Conjuguées du midi de la France.
Haberlandt, Dr G. (1) Ueber Scheitelzellwachsthum bei den Phanerogamen.
——— (2) Zur physiologischen Anatomie der Milchröhren.
Hoffmann, Prof. H. (1) Phänologische Beobachtungen.
——— (2) Resultate du wichtigsten pflanzen-phänologischen Beobachtungen in Europa.
——— (3) Separat-abdruck aus "Gartenflora."
Hoffmann and Ihre. Beiträge zur Phänologie.
Janczewski, Prof. Ed. (1) Nasy Spadix Pomony.
——— (2) Develop. des Bourgeons dans les Prêles.
——— (3) Ascobolus furfuraceus.
——— (4) Notes on some Nostocaceae.
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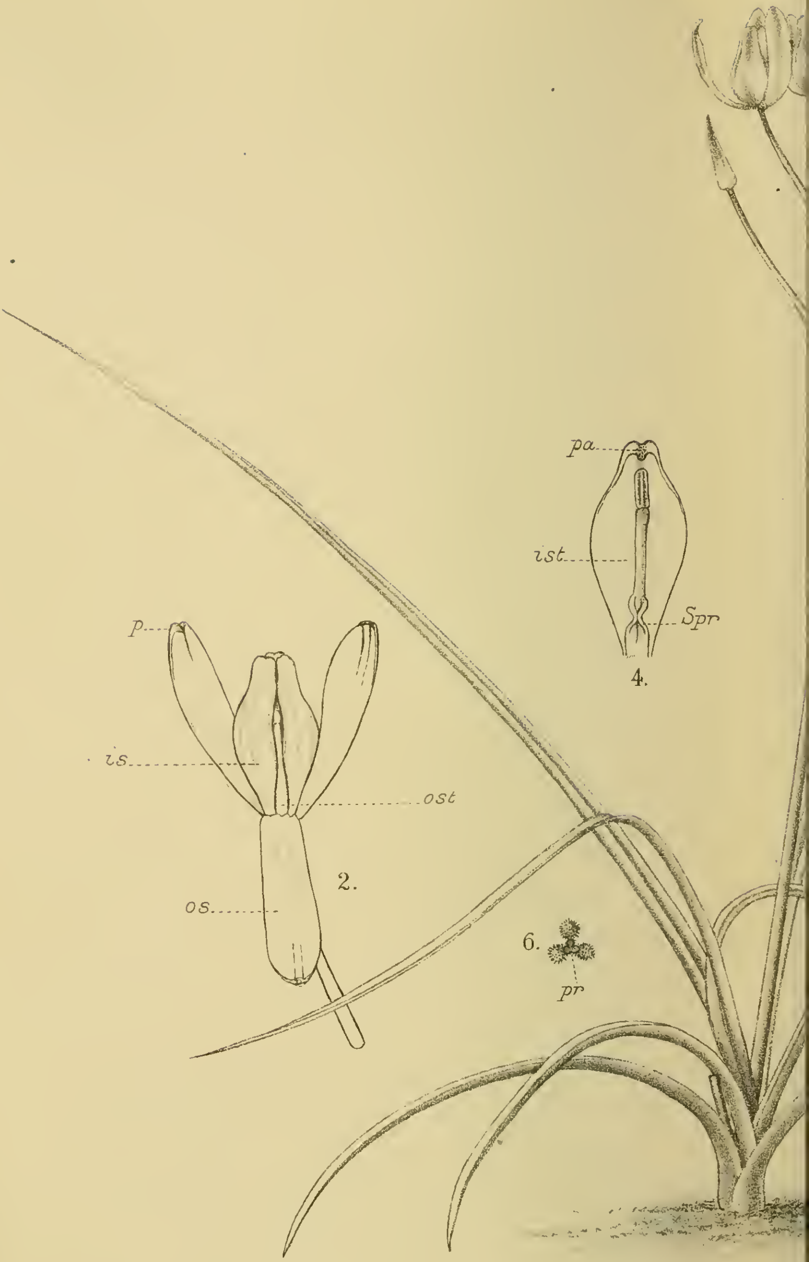

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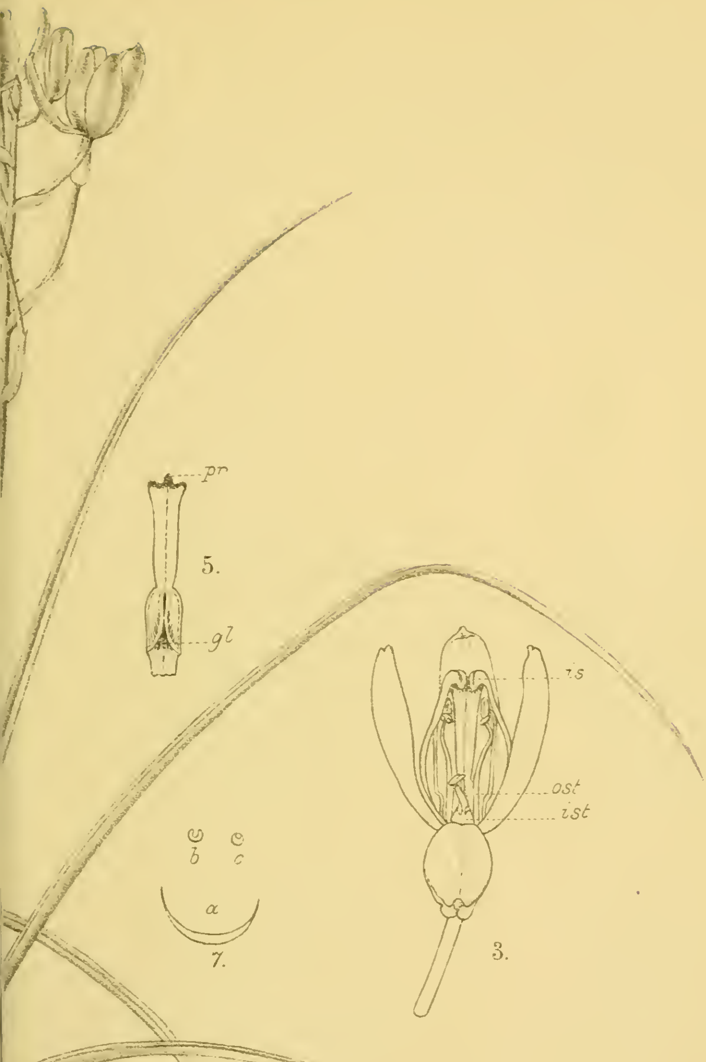

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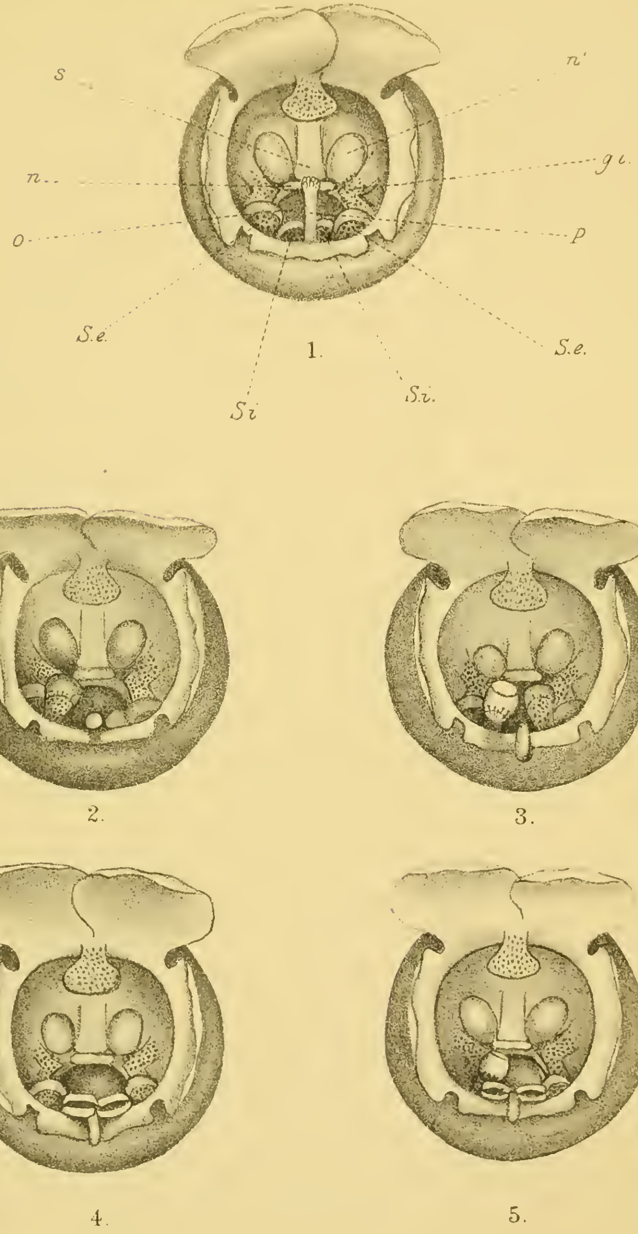

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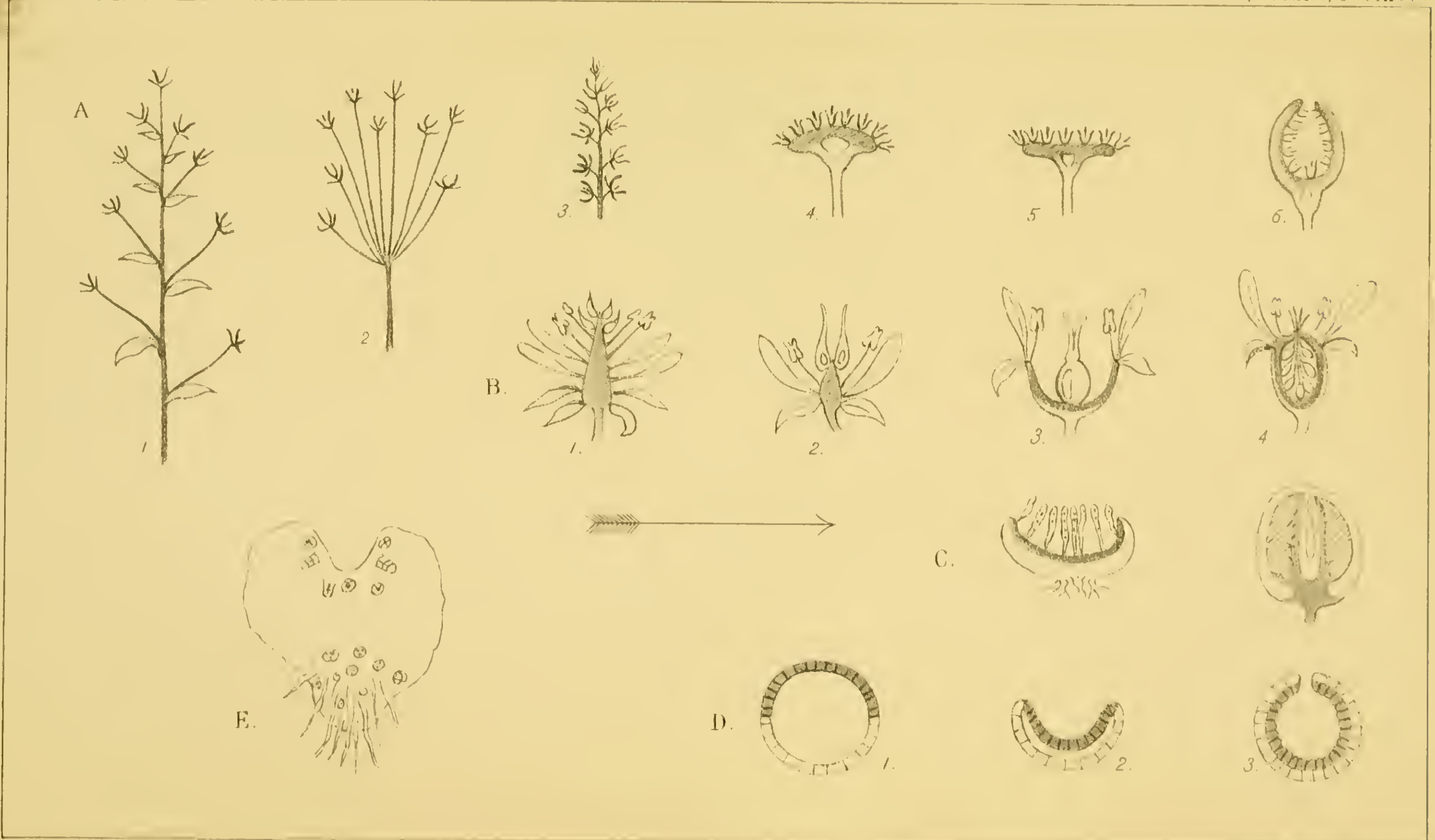

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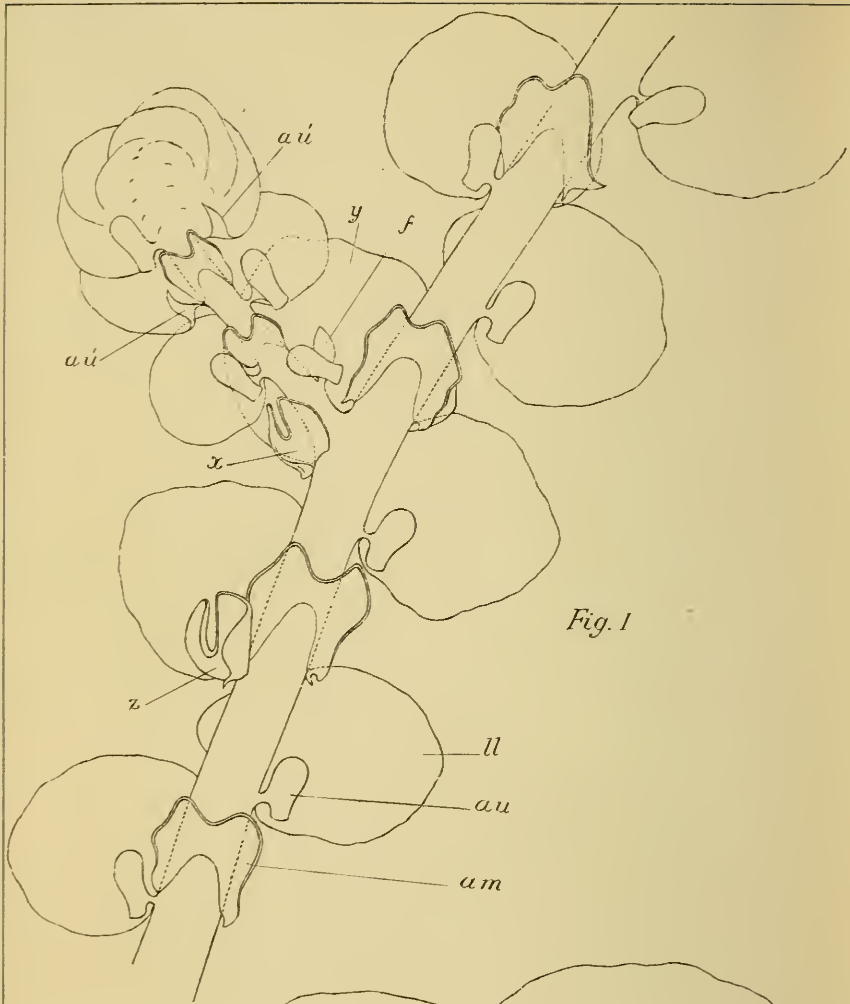

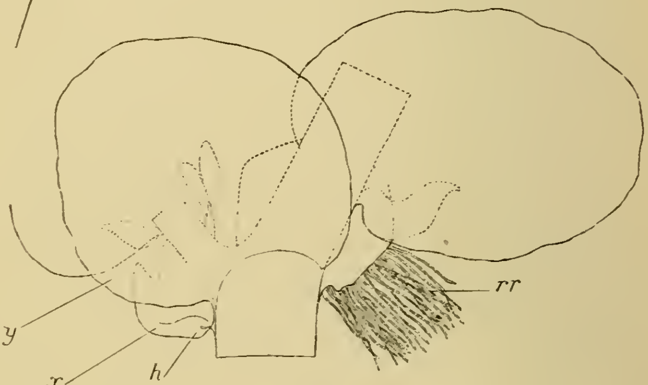

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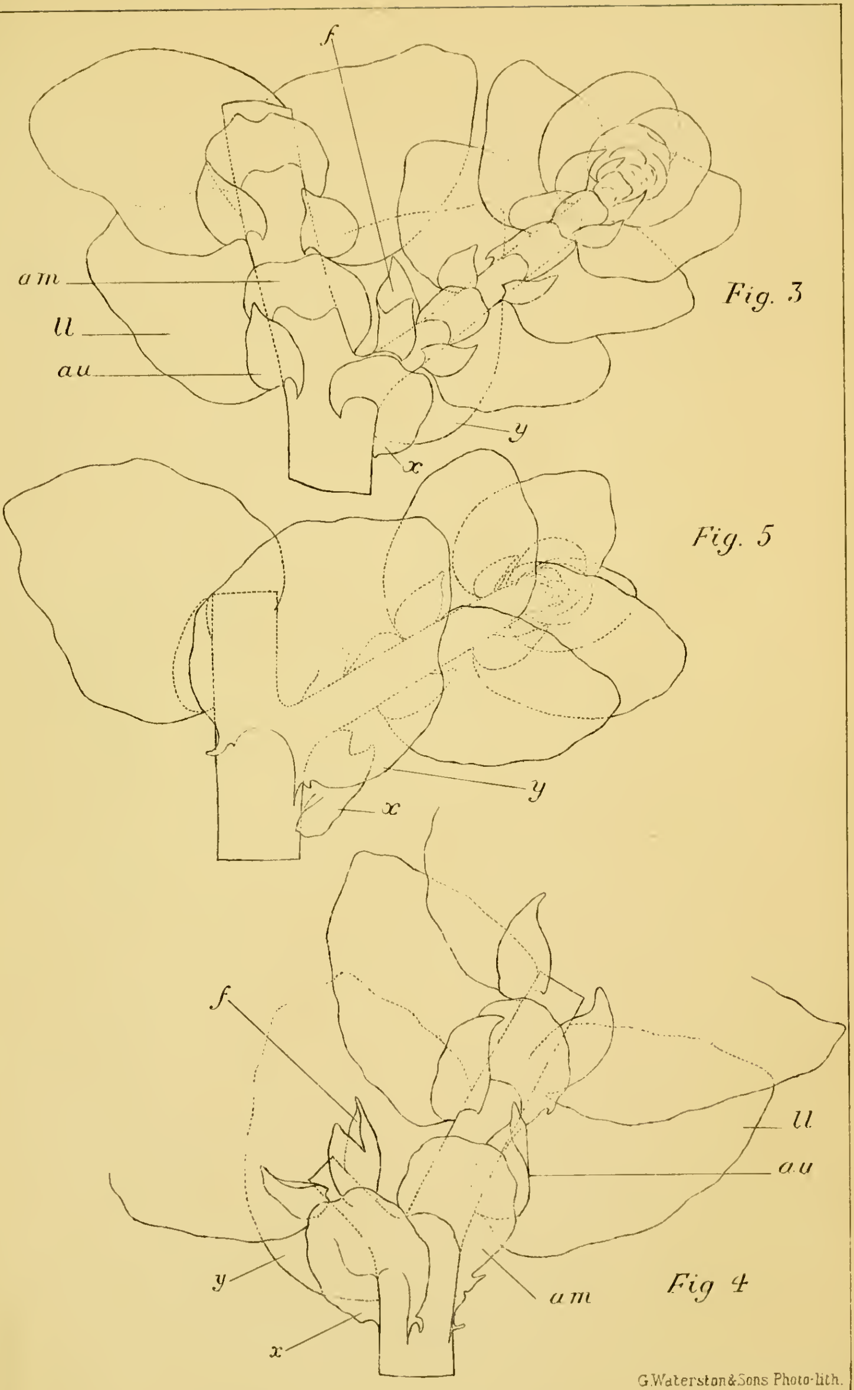

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