# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH.

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OF THE

# BOTANICAL SOCIETY OF EDINBURGH.



VOLUME XIX.

INCLUDING SESSIONS LV. TO LVII.

(1890-91 TO 1892-93).

*WITH FIVE PLATES, SIX WOODCUTS, AND ONE ZINCOGRAPH.*



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# BOTANICAL SOCIETY OF EDINBURGH.

## SESSION LV.

### MEETING OF THE SOCIETY,

Thursday, November 13, 1890.

ROBERT LINDSAY, Esq., President, in the Chair.

The following Officers of the Society were elected for the Session 1890–91 :—

PRESIDENT.

ROBERT LINDSAY, Royal Botanic Garden.

VICE-PRESIDENTS.

THOMAS A. G. BALFOUR, M.D., F.R.S.E., F.R.C.P.E.

MALCOLM DUNN, Dalkeith Palace Gardens.

DAVID CHRISTISON, M.D., F.S.A. Scot.

Professor F. O. BOWER, D.Sc., F.R.S.E., F.L.S.

COUNCILLORS.

HUGH CLEGHORN, M.D., LL.D., F.R.S.E.

GEORGE BIRD.

JOHN METHVEN.

WILLIAM CRAIG, M.D., F.R.S.E., F.R.C.S.E.

J. E. T. AITCHISON, M.D., LL.D., C.I.E., F.R.S.

ANDREW TAYLOR, F.R.P.S.

WILLIAM MURRAY.

WILLIAM B. BOYD of Faldonside.

WILLIAM SOMERVILLE, Dr Œc., B.Sc., F.R.S.E.

JOHN M. MACFARLANE, D.Sc., F.R.S.E.





Issued March 1891.

*Honorary Secretary*—Professor Sir 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.
*Treasurer*—PATRICK NEILL FRASER.
*Assistant-Secretary*—JOHN WILSON, D.Sc.
*Artist*—DAVID CHRISTISON, M.D., F.S.A. Scot.
*Auditor*—THOMAS BOND SPRAGUE, M.A., F.R.S.E.

## LOCAL SECRETARIES.

*Aberdeen*—STEPHEN A. WILSON of North Kinmundy.
„ Professor J. W. H. TRAIL, M.A., M.D.
*Berwick*—PHILIP W. MACLAGAN, M.D.
„ FRANCIS M. NORMAN, R.N.
*Birmingham*—GEORGE A. PANTON, F.L.S., 73 Westfield Road.
*Bridge of Allan*—ALEXANDER PATERSON, M.D.
*Calcutta*—GEORGE KING, M.D., F.R.S., Botanic Garden.
*Cambridge*—CHARLES C. BABINGTON, M.A., F.R.S., Professor of Botany.
„ ARTHUR EVANS, M.A.
*Chirnside*—CHARLES STUART, M.D.
*Croydon*—A. BENNETT, F.L.S.
*Glasgow*—Professor F. O. BOWER, D.Sc., F.L.S.
*Kelso*—Rev. DAVID PAUL, M.A., Roxburgh Manse.
*Kilbarchan*—Rev. G. ALISON.
*Leicester*—JOHN ARCHIBALD, M.D.
*London*—WILLIAM CARRUTHERS, F.R.S., F.L.S., British Museum.
„ E. M. HOLMES, F.L.S., F.R.H.S.
*Manchester*—BENJAMIN CARRINGTON, M.D., Eccles.
*Melbourne, Australia*—Baron FERDINAND VON MUELLER, M.D.
*Nova Scotia*—Professor GEORGE LAWSON, LL.D., Dalhousie.
*Ottawa, Ontario*—W. R. RIDDELL, B.Sc., B.A., Prov. Normal School.
*Perth*—F. BUCHANAN WHITE, M.D., F.L.S.
*Saharunpore, India*—J. F. DUTHIE, B.A., F.L.S.
*Silloth*—JOHN LEITCH, M.B., C.M.
*St Andrews*—Professor M'INTOSH, M.D., F.R.SS. Lond. and Edin.
*Wellington, New Zealand*—Sir JAMES HECTOR, M.D., K.C.M.G., F.R.SS. Lond. and Edin.
*Wolverhampton*—JOHN FRASER, M.A., M.D.

Mr R. LINDSAY thanked the Society for the honour of re-election as President.

Numerous presents to the Library, the Museum, and the Herbarium at the Royal Botanic Garden were announced.*

The PRESIDENT directed the attention of the Society to the exceptional extent and value of the presents of books—some of which were exhibited—recently added to the Library. The greater part of the presents came from the Library of the late Mr John Ball, F.R.S., well known as an Alpine traveller and botanist, who, dying October 21, 1889, bequeathed his Herbarium and Botanical Library "to Sir Joseph Dalton Hooker, the Director of the Royal Botanical Gardens at Kew for the time being, and to the President of the Royal Society of London for the time being, requesting them to give the same Herbarium and Library to such person or persons or public institution in this country, the British Colonies, or elsewhere in the world, as they or any two of them may select, with the sole object of promoting the knowledge of natural science, subject to the condition that the Keeper of the Royal Herbarium at Kew may, in the first place, select any specimens or books that may be desirable for that Institution." The Edinburgh Botanic Garden has been so fortunate as to obtain the gift from the trustees. The Library has already been received, and the Herbarium, a very extensive one, will in due course be added to the collection at the Botanic Garden.

Dr WILLIAM CRAIG communicated to the Society the news of the death of William Thomson, F.R.C.S.E., Fellow of the Society.

Dr WM. CRAIG recorded the occurrence of *Fistulina hepatica* on the trunk of *Castanea vesca* in his garden in Edinburgh. He pointed out that the plant is known to occur on *Castanea vesca*, var. *americana*, in the United

* An official list of these will appear in future in the Annual Report upon the Garden by the Keeper, and a list of them will not therefore be printed in the Society's publications.

States,* but has not been reported before now on the chestnut in Britain.

Dr PATERSON exhibited fine inflorescences of *Cymbidium giganteum*, of *Vanda suavis* variety, and of *Epidendron* sp., from his garden at Bridge of Allan.

Mr JOHN CAMPBELL exhibited blooms of *Rhododendron Nobleanum*, *Cytisus fragrans*, *Veronica Andersoni* var., *Passiflora cærulea*, and a branch of *Olearia moschata* cut from plants growing in open air in his garden at Ledaig, Argyleshire.

Mr W. B. BOYD exhibited plants of *Galanthus nivalis*, var. *octobrensis*, in flower; also of *Aspidium Lonchitis*, Sw., with crested fronds, originally found by Dr Wm. Craig near Loch Awe, grown in his garden at Faldonside, Melrose.

The CURATOR exhibited *Iris Bakeriana* and *Cuscuta reflexa*, in flower, from the Royal Botanic Garden.

The following Papers were read:—

DISTRIBUTION OF THE SCLERENCHYMA-ELEMENTS IN SOME LEAVES. By JAMES TERRAS, B.Sc.

Mr Terras described and exhibited, in the lantern microscope, preparations of various leaves showing the arrangement of the sclerenchyma-elements. The chief points shown were:—Amongst Coniferæ, the hypodermal stereome-layers and stellate mesophyllic ideoblasts, of *Araucaria imbricata*, *Dammara robusta* and *Sciadopitys verticillata*, and in *Podocarpus elegantissimus*, the hypodermal stereome-layer and the transverse ideoblastic lattice-work in the mesophyll parallel to the surface of the leaf, both of which are absent in *P. ferruginea*. Amongst Proteaceæ, the hypodermal stereome-network in *Banksia integrifolia*, which is absent in *B. serrata*, and the stagshorn-like ideoblasts in *Hakea saligna* and *H. gibbosa*, which are absent in *H. eucalyptoides*.

* Farlow and Seymour, Provisional Host Index of the Fungi of the United States, part ii., 1890, Cambridge, U.S.A.

Amongst Oleaceæ, the stereome-network of *Olea europæa*, which is absent in all other species examined, and the stagshorn-like ideoblasts of *Olea ilicifolia*, *Phillyrea latifolia*, *P. ovata*, *P. decora* and *Osmanthus ilicifolius*, which are absent in *Olea europæa* and in the species of *Chionanthus* and *Notanea* examined. Amongst *Ternstrœmiaceæ*, both the stellate and the stagshorn-like ideoblasts of *Camellia japonica*, of which the former are alone present in *Camellia axillaris*, and the latter alone are present in *Thea Bohea*.

The Floral Structure of Tacca cristata, Jack. By John Wilson, D.Sc., Curator of the Herbarium and Library, Royal Botanic Garden, Edinburgh.

Dr Wilson stated that the structure of the style and stigma led him to consider that the fertilisation of this plant was effected by ants, and not, as Delpino suggested, in the same way as in *Aspidistra*.

On Temperature and Vegetation in the Royal Botanic Garden, during July, August, September, and October 1890.* By Robert Lindsay, Curator of the Garden.

JULY.

The weather during July was extremely cool and unsettled. The lowest night temperature was 40°, which occurred

* It has been the practice for many years of the Curator of the Royal Botanic Garden, Edinburgh, to record in the Society's Transactions the condition from month to month of vegetation in the garden, and to refer to the temperature and weather noted in the garden during the month. The temperature and weather records have not professed strict accuracy, temperature having been always taken from exposed thermometers not marking fractions of a degree, without correction, and fixed in a position where they could readily be tampered with. These reports, while they have served a useful purpose in directing attention to relationship between temperature and vegetation, and have contributed to the interest of the monthly meetings of the Society, are evidently wanting as trustworthy records upon which scientific deductions could be based, and for purposes of comparison and in order to obtain, if possible, an approximate estimate of the import of the past records, there will be published for a time, along with the notes of the Curator on vegetation, a table of readings for the month of the exposed thermometers, as well as the monthly register of meteorological phenomena, which is now carefully taken from certified instruments erected in the garden.—Isaac Bayley Balfour, Keeper of the Royal Botanic Garden, Edinburgh.

on the 7th of the month, and the highest 51°, on the 21st. The lowest day temperature was 61°, on the 1st, and the highest 75°, on the 13th. Roses were in good condition near the end of the month. On the rock-garden, 204 species and well-marked varieties of plants came into flower, as against 258 for the corresponding month last year. Amongst the most interesting were:—*Campanula barbata, C. garganica, Calochortus luteus, Gentiana ornata, G. punctata, Galax aphylla, Galium rubrum, Geranium Lambertii, Erica Mackaiana, E. ramulosa, Erythræa diffusa, Hypericum coris, Lilium auratum, L. Krameri, Meconopsis Wallichii, Micromeria piperella, Orobanche rubra, Primula capitata, P. cortusoides, Spiræa astilboides, S. Bumalda, Teucrium pyrenaicum, Tricyrtis australis, Veratrum Maackii, Veronica glauco-cœrulea.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during July 1890.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 46° | 47° | 61° | 17th | 48° | 55° | 71° |
| 2nd | 44 | 54 | 64 | 18th | 45 | 59 | 68 |
| 3rd | 44 | 46 | 64 | 19th | 48 | 64 | 69 |
| 4th | 41 | 52 | 66 | 20th | 41 | 60 | 73 |
| 5th | 42 | 64 | 67 | 21st | 51 | 63 | 74 |
| 6th | 48 | 58 | 68 | 22nd | 48 | 59 | 67 |
| 7th | 40 | 60 | 65 | 23rd | 48 | 55 | 71 |
| 8th | 42 | 45 | 65 | 24th | 47 | 61 | 69 |
| 9th | 44 | 58 | 68 | 25th | 45 | 58 | 70 |
| 10th | 41 | 62 | 69 | 26th | 43 | 62 | 75 |
| 11th | 43 | 51 | 68 | 27th | 49 | 60 | 73 |
| 12th | 41 | 51 | 66 | 28th | 49 | 61 | 68 |
| 13th | 48 | 60 | 75 | 29th | 47 | 57 | 72 |
| 14th | 44 | 51 | 69 | 30th | 50 | 60 | 74 |
| 15th | 46 | 66 | 69 | 31st | 51 | 62 | 74 |
| 16th | 42 | 57 | 68 | | | | |

[TABLE

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of July 1890.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 ft. above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| 1 | 29·510 | 58°·7 | 49°·8 | 50°·3 | 48°·5 | E. | Nim. | 10 | E. | 0·020 |
| 2 | 29·662 | 56·8 | 47·4 | 53·5 | 48·6 | N.W. | Cum. | 10 | N.W. | 0·140 |
| 3 | 29·664 | 59·8 | 47·7 | 48·6 | 47·2 | N.E. | Nim. | 10 | N.E. | 0·128 |
| 4 | 29·694 | 55·7 | 45·0 | 54·3 | 52·1 | N.W. | Nim. | 10 | N.W. | 0·010 |
| 5 | 29·674 | 59·9 | 47·0 | 58·2 | 52·1 | N.W. | Cum. | 6 | N.W. | 0·115 |
| 6 | 29·740 | 62·1 | 49·9 | 55·3 | 50·1 | N.W. | Cum. | 10 | N.W. | 0·060 |
| 7 | 29·686 | 62·7 | 44·0 | 59·5 | 53·0 | N.W. | Cum. | 6 | N.W. | 0·545 |
| 8 | 29·318 | 60·6 | 45·4 | 48·0 | 46·8 | N.W. | Cum. | 10 | N.W. | 0.002 |
| 9 | 29·512 | 63·7 | 46·7 | 58·7 | 52·8 | W. | Cum. | 4 | W. | 0·019 |
| 10 | 29·833 | 65·0 | 44·1 | 58·8 | 52·0 | N.W. | Cum. | 9 | N.W. | 0·015 |
| 11 | 29·921 | 62·6 | 47·5 | 52·7 | 47·7 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 12 | 29·729 | 61·0 | 43·5 | 53·1 | 49·1 | W. | Cum. | 10 | W. | 0·160 |
| 13 | 29·443 | 61·8 | 56·9 | 58·1 | 57·0 | W. | Cum. | 10 | W. | 0·014 |
| 14 | 29·360 | 69·0 | 56·0 | 61·8 | 56·5 | W. | Cum. | 6 | W. | 0·085 |
| 15 | 29·616 | 65·4 | 48·6 | 60·6 | 55·1 | W. | Cum. | 10 | W. | 0·004 |
| 16 | 30·007 | 65·7 | 45·7 | 57·0 | 53·3 | W. | Cum. | 2 | W. | 0·000 |
| 17 | 29·985 | 62·1 | 52·1 | 56·0 | 54·0 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 18 | 29·718 | 64·3 | 48·9 | 58·5 | 54·3 | W. | Cum. | 10 | W. | 0·080 |
| 19 | 29·972 | 62·0 | 51·1 | 57·9 | 52·2 | N.E. | Cum. | 2 | N.E. | 0·000 |
| 20 | 30·153 | 62·9 | 44·5 | 58·1 | 53·8 | W. | Cum. | 5 | W. | 0·125 |
| 21 | 29·992 | 67·3 | 55·0 | 66·7 | 62·7 | W. | Cum. | 2 | W. | 0·002 |
| 22 | 29·850 | 70·9 | 51·0 | 60·8 | 54·9 | W. | Cir. Cum.<br>Cum. | 2<br>2 | N.<br>W. | 0·000 |
| 23 | 29·802 | 65·0 | 50·5 | 64·7 | 60·1 | W. | Cum. | 4 | W. | 0·009 |
| 24 | 29·777 | 69·0 | 50·3 | 62·8 | 55·9 | N.W. | Cum. | 3 | N.W. | 0·000 |
| 25 | 29·909 | 67·3 | 43·2 | 59·0 | 53·4 | N.W. | Cum. | 4 | N.W. | 0·002 |
| 26 | 29·676 | 61·2 | 47·0 | 61·2 | 57·9 | S.W. | Cum. | 10 | S.W. | 0·050 |
| 27 | 29·634 | 70·0 | 51·9 | 60·3 | 55·9 | W. | Cum. | 10 | W. | 0·124 |
| 28 | 29·554 | 66·6 | 52·4 | 62·0 | 55·2 | W. | Cum. | 9 | W. | 0·005 |
| 29 | 29·754 | 65·7 | 50·6 | 57·2 | 52·4 | W. | Cum. | 10 | W. | 0·216 |
| 30 | 29·550 | 67·8 | 54·5 | 61·9 | 58·9 | W. | Cum. | 10 | W. | 0·211 |
| 31 | 29·635 | 69·7 | 54·4 | 63·5 | 58·0 | W. | Cum. | 9 | W. | 0·078 |

Barometer.—Highest Reading, on the 20th, =30·153. Lowest Reading, on the 8th, =29·318. Difference, or Monthly Range, =0·835. Mean=29·720.

S. R. Thermometers.—Highest Reading, on the 22nd, =70°·9. Lowest Reading, on the 25th, =43°·2. Difference, or Monthly Range, =27°·7. Mean of all the Highest=63°·9. Mean of all the Lowest=49°·1. Difference, or Mean Daily Range, =14°·8. Mean Temperature of Month=56°·5.

Hygrometer.—Mean of Dry Bulb=58°·0. Mean of Wet Bulb=53°·6.

Rainfall.—Number of days on which Rain fell=25. Amount of Fall, in inches, =2·219.

## AUGUST.

Like the preceding month, August was cold and changeable, with copious falls of rain, rendering it very unfavourable for garden work. The lowest night temperature during this month was 35°, which occurred on the 31st, and the highest, 54°, on the 16th. The lowest day temperature was 59°, on the 11th, and the highest, 76°, on the 5th. On the rock-garden eighty-one species came into flower as against ninety-nine during last August. Amongst the most conspicuous were:—*Aster sikkimensis, Bahia lanata, Carlina acaulis, Coreopsis verticillata, Gentiana alba, G. Wallichii, Hypericum patulum, Lobelia syphilitica, Monarda Kalmiana, Olearia Haastii, Senecio speciosus, Stokesia cyanea, Sedum Ewersii, Veronica longifolia subsessilis.*

Readings of exposed Thermometer at the Rock Garden of the Royal Botanic Garden, Edinburgh, during August 1890.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 47° | 62° | 73° | 17th | 50° | 55° | 63° |
| 2nd | 51 | 59 | 72 | 18th | 45 | 60 | 73 |
| 3rd | 47 | 60 | 72 | 19th | 46 | 61 | 68 |
| 4th | 48 | 63 | 76 | 20th | 43 | 54 | 69 |
| 5th | 51 | 63 | 76 | 21st | 49 | 57 | 65 |
| 6th | 49 | 61 | 70 | 22nd | 44 | 54 | 63 |
| 7th | 51 | 61 | 71 | 23rd | 45 | 47 | 64 |
| 8th | 48 | 56 | 69 | 24th | 39 | 55 | 65 |
| 9th | 45 | 55 | 69 | 25th | 39 | 54 | 65 |
| 10th | 54 | 59 | 71 | 26th | 45 | 51 | 62 |
| 11th | 52 | 54 | 59 | 27th | 42 | 47 | 60 |
| 12th | 53 | 55 | 63 | 28th | 41 | 54 | 65 |
| 13th | 50 | 52 | 64 | 29th | 37 | 58 | 62 |
| 14th | 47 | 63 | 69 | 30th | 40 | 45 | 64 |
| 15th | 49 | 58 | 66 | 31st | 35 | 55 | 66 |
| 16th | 45 | 58 | 66 | | | | |

[TABLE

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of August 1890.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·741 | 68·6 | 51·0 | 61·3 | 57·9 | W. | Cum. | 8 | W. | 0·035 |
| 2 | 29·871 | 66·8 | 54·4 | 59·6 | 56·5 | E. | Cum. | 10 | E. | 0·000 |
| 3 | 30·001 | 66·5 | 49·9 | 60·1 | 55·9 | W. | Cum. | 4 | W. | 0·010 |
| 4 | 29·970 | 67·8 | 59·2 | 64·3 | 61·3 | W. | Cum. | 10 | W. | 0·000 |
| 5 | 29·983 | 71·6 | 62·0 | 71·6 | 64·9 | W. | Cum. | 2 | W. | 0·000 |
| 6 | 30·025 | 74·3 | 53·2 | 60·1 | 55·7 | W. | Cum. | 8 | W. | 0·000 |
| 7 | 30·117 | 64·0 | 54·2 | 59·7 | 56·8 | N.E. | Cum. | 3 | S.E. | 0·000 |
| 8 | 30·145 | 65·8 | 51·9 | 56·6 | 50·0 | E. | Cum. | 8 | E. | 0·000 |
| 9 | 30·125 | 64·1 | 50·6 | 56·8 | 54·2 | E. | Cum. | 10 | E. | 0·000 |
| 10 | 29·920 | 62·8 | 55·6 | 61·9 | 58·9 | E. | Cum. | 5 | E. | 0·070 |
| 11 | 29·610 | 66·6 | 55·6 | 56·2 | 55·9 | N.E. | Nim. | 10 | N.E. | 0·240 |
| 12 | 29·669 | 57·8 | 55·6 | 56·2 | 55·8 | N.E. | Nim. | 10 | N.E. | 1·327 |
| 13 | 29·678 | 58·8 | 52·9 | 54·1 | 52·9 | N.E. | Cum. | 10 | N.E. | 0·012 |
| 14 | 29·541 | 60·1 | 51·7 | 58·0 | 55·0 | W. | Cum. | 10 | W. | 0·105 |
| 15 | 28·986 | 64·5 | 52·8 | 58·7 | 55·9 | S.W. | Cum. | 10 | S.W. | 0·004 |
| 16 | 29·379 | 62·0 | 47·1 | 58·2 | 53·0 | W. | Cum. | 8 | W. | 0·030 |
| 17 | 29·509 | 63·4 | 52·1 | 59·2 | 55·4 | W. | Cum. | 5 | W. | 0·090 |
| 18 | 29·749 | 65·8 | 46·1 | 56·5 | 53·4 | W. | Cum. | 9 | W. | 0·000 |
| 19 | 29·828 | 64·7 | 51·7 | 57·5 | 53·1 | E. | Cum. | 5 | E. | 0·008 |
| 20 | 29·682 | 63·6 | 46·3 | 55·2 | 52·2 | W. | Cum. | 10 | W. | 0·006 |
| 21 | 29·657 | 65·6 | 52·0 | 59·1 | 56·2 | W. | Cum. | 8 | W. | 0·030 |
| 22 | 29·708 | 61·8 | 47·2 | 56·7 | 51·8 | W. | Cum. | 4 | W. | 0·437 |
| 23 | 29·476 | 61·7 | 49·0 | 50·8 | 50·2 | N.W. | Cum. | 9 | N.W. | 0·218 |
| 24 | 29·512 | 60·0 | 41·0 | 56·8 | 52·0 | W. | Cum. | 1 | W. | 0·002 |
| 25 | 29·437 | 60·0 | 43·0 | 54·5 | 52·0 | N.W. | Cum. | 10 | N.W. | 0·200 |
| 26 | 29·136 | 61·7 | 47·8 | 53·0 | 51·0 | W. | Cum. | 10 | W. | 0·087 |
| 27 | 29·144 | 59·6 | 43·7 | 50·2 | 49·5 | S.W. | Nim. | 10 | S.W. | 0·025 |
| 28 | 29·642 | 57·4 | 45·1 | 55·8 | 54·6 | N.W. | Cir.Cum. | 4 | Calm. | 0·045 |
| 29 | 29·839 | 61·8 | 39·0 | 53·6 | 48·8 | N.W. | ... | 0 | ... | 0·069 |
| 30 | 30·050 | 58·6 | 44·0 | 48·0 | 43·9 | N.W. | Cum. | 1 | N.W. | 0·002 |
| 31 | 30·152 | 58·8 | 38·6 | 52·5 | 46·8 | N. | ... | 0 | ... | 0·000 |

Barometer.—Highest Reading, on the 31st, =30·152. Lowest Reading, on the 15th, =28·986. Difference, or Monthly Range, =1·166. Mean=29·719.

S. R. Thermometers.—Highest Reading, on the 6th, =74°·3. Lowest Reading, on the 24th, =41°·0. Difference, or Monthly Range, =33°·3. Mean of all the Highest=63°·4. Mean of all the Lowest=49°·8. Difference, or Mean Daily Range, =13°·6. Mean Temperature of Month=56°·6.

Hygrometer.—Mean of Dry Bulb=57°·2. Mean of Wet Bulb=53°·9.

Rainfall.—Number of Days on which Rain fell=21. Amount of Fall, in inches, =2·962.

## SEPTEMBER.

September was a most favourable month, being unusually warm and dry for the time of year. No frost occurred; there was a fair amount of bright sunshine, and for gardening work was all that could be desired. The lowest night temperature was 38°, which occurred on the 1st, and the highest, 56°, on the 4th of the month. The lowest day temperature was 59°, on the 31st, and the highest, 80°, on the 16th.

Herbaceous plants and annuals flowered extremely well, and were at their best during this month. The earlier flowering kinds ripened an abundant crop of good seeds, which were gathered in fine condition.

Roses flowered very freely during September, the blossoms being equal to those developed earlier in the season. On the rock-garden forty-seven plants came into flower as against thirty-eight during the corresponding month last year, amongst which were the following:—*Andromeda japonica, Arenaria montana, Aster spectabilis, Crinum Moorei, Crocus Imperati, C. nudiflorus, Gaultheria nummularifolia, Geranium Wilfredii, Gladiolus Saundersii, Kniphofia nobilis, Linaria anticaria, Palmerelia debilis,* &c.

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during September 1890.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 38° | 54° | 59° | 16th | 45° | 58° | 80° |
| 2nd | 49 | 60 | 69 | 17th | 52 | 57 | 73 |
| 3rd | 52 | 60 | 70 | 18th | 53 | 58 | 64 |
| 4th | 56 | 60 | 71 | 19th | 51 | 56 | 67 |
| 5th | 52 | 63 | 72 | 20th | 50 | 55 | 68 |
| 6th | 45 | 59 | 73 | 21st | 45 | 55 | 72 |
| 7th | 43 | 68 | 73 | 22nd | 44 | 55 | 69 |
| 8th | 45 | 65 | 79 | 23rd | 50 | 55 | 62 |
| 9th | 54 | 67 | 79 | 24th | 47 | 58 | 67 |
| 10th | 41 | 53 | 64 | 25th | 42 | 57 | 60 |
| 11th | 50 | 64 | 69 | 26th | 47 | 58 | 66 |
| 12th | 46 | 60 | 68 | 27th | 56 | 59 | 65 |
| 13th | 39 | 49 | 70 | 28th | 47 | 56 | 65 |
| 14th | 43 | 56 | 72 | 29th | 47 | 54 | 61 |
| 15th | 42 | 61 | 77 | 30th | 44 | 46 | 51 |

[Table

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of September 1890.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 30·041 | 59·8 | 41·3 | 55·2 | 50·1 | W. | Cum. | 10 | W. | 0·309 |
| 2 | 29·897 | 62·0 | 57·8 | 62·0 | 59·3 | W. | Cum. | 10 | W. | 0·078 |
| 3 | 29·926 | 64·9 | 55·6 | 62·0 | 60·1 | W. | Cum. | 10 | W. | 0·008 |
| 4 | 30·051 | 67·3 | 59·1 | 61·5 | 59·5 | W. | Cum. | 10 | W. | 0·000 |
| 5 | 30·226 | 67·6 | 48·9 | 58·9 | 56·0 | W. | Cum. | 9 | W. | 0·000 |
| 6 | 30·314 | 68·8 | 54·5 | 61·3 | 56·8 | W. | ... | 0 | ... | 0·000 |
| 7 | 30·366 | 67·8 | 46·0 | 60·3 | 56·1 | W. | ... | 0 | ... | 0·000 |
| 8 | 30·221 | 70·7 | 49·1 | 62·3 | 58·9 | W. | Cum. St. | 10 | W. | 0·000 |
| 9 | 30·019 | 74·4 | 58·1 | 62·6 | 60·0 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 10 | 29·987 | 69·6 | 43·4 | 54·0 | 51·3 | Calm | { Cir.Cum. / Cum. | 4 / 6 } | Calm | 0·000 |
| 11 | 29·722 | 63·6 | 52·6 | 62·8 | 58·0 | N.W. | { Cir.Cum. / Cum. | 2 / 4 | Calm / N.W. } | 0·000 |
| 12 | 30·125 | 68·0 | 48·5 | 60·3 | 56·0 | N.W. | Cir. Cum. | 4 | N.W. | 0·000 |
| 13 | 30·035 | 68·6 | 43·1 | 51·6 | 50·3 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 14 | 30·024 | 65·0 | 46·8 | 58·6 | 56·2 | S.E. | Cir. Cum. | 2 | S.E. | 0·000 |
| 15 | 29·883 | 68·3 | 45·1 | 57·7 | 54·6 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 16 | 29·768 | 71·0 | 49·7 | 58·4 | 55·2 | Calm | Cum. | 10 | Calm | 0·000 |
| 17 | 29·698 | 72·1 | 54·3 | 58·3 | 55·6 | S.E. | Cum. | 10 | S.E. | 0·242 |
| 18 | 29·611 | 69·7 | 55·7 | 59·0 | 58·6 | S.W. | Cum. | 10 | S.W. | 0·009 |
| 19 | 29·683 | 68·6 | 50·8 | 56·6 | 55·0 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 20 | 29·532 | 61·1 | 54·7 | 56·6 | 54·7 | S.E. | Cum. | 10 | S.E. | 0·125 |
| 21 | 29·445 | 63·7 | 49·6 | 56·5 | 51·9 | S. | Cum. | 9 | S. | 0·000 |
| 22 | 29·376 | 63·8 | 48·6 | 56·2 | 53·2 | S.W. | Cum. | 5 | S.W. | 0·002 |
| 23 | 29·736 | 65·0 | 53·9 | 56·5 | 55·0 | W. | Cum. | 10 | W. | 0·000 |
| 24 | 29·769 | 59·8 | 49·2 | 57·8 | 55·2 | W. | Cum. | 10 | W. | 0·002 |
| 25 | 30·180 | 63·8 | 45·0 | 55·7 | 51·1 | W. | Cum. | 9 | W. | 0·110 |
| 26 | 29·975 | 60·8 | 52·6 | 60·3 | 58·4 | W. | Cum. | 10 | W. | 0·002 |
| 27 | 30·084 | 63·9 | 58·7 | 61·0 | 59·0 | W. | Cum. | 10 | W. | 0·045 |
| 28 | 29·963 | 63·8 | 55·1 | 58·9 | 55·6 | N.W. | Cum. | 9 | N.W. | 0·000 |
| 29 | 29·692 | 63·0 | 49·7 | 54·8 | 51·5 | S.W. | Cum. | 10 | S.W. | 0·175 |
| 30 | 29·601 | 58·7 | 46·6 | 48·0 | 47·0 | W. | Nim. | 10 | W. | 1·364 |

Barometer.—Highest Reading, on the 7th,=30·366. Lowest Reading, on the 22nd,=29·376. Difference, or Monthly Range,=0·990. Mean=29·898.

S. R. Thermometers.—Highest Reading, on the 9th,=74°·4. Lowest Reading, on the 1st=41°·3. Difference, or Monthly Range,=33°·1. Mean of all the Highest =65°·8. Mean of all the Lowest=50°·8. Difference, or Mean Daily Range,=15°·0. Mean Temperature of Month=58°·3.

Hygrometer.—Mean of Dry Bulb=58°·2. Mean of Wet Bulb=55°·3.

Rainfall.—Number of Days on which Rain fell=13. Amount of Fall, in inches, =2·471.

## OCTOBER.

The month of October was changeable and unsettled, but was a favourable month on the whole. The first frost this season took place on the morning of the 2nd, when the glass registered 32°. The thermometer was at or below the freezing-point on eight occasions, indicating collectively 19° of frost for the month. The lowest readings were on the 19th, 30°; 20th, 30°; 26th, 29°; 27th, 29°; 28th, 23°. The lowest day reading was 42°, on the 27th, and the highest, 68°, on the 12th.

Herbaceous plants continued to flower in fine condition till about the end of the month. The most effective were the various species of Aster or Michaelmas Daisies, Helianthus, Rudbeckias, and other Compositæ, also Japanese Anemones and Kniphofias. All tender plants, such as Dahlias, Pelargoniums, Calceolarias, &c., were destroyed by the severe frost on the 28th.

Leaves of deciduous trees fell off early in the month, and, as a rule, were not so well coloured as usual, many having fallen off in a green state. Autumnal tints have been much less interesting than usual this season, owing to the poor summer we have experienced. Hardy Rhododendrons, Azaleas, and Andromedas are well set with flower-buds for next year. Holly and Hawthorn have an abundant supply of fruit, in marked contrast to their barren condition last year. Trees and shrubs generally have fruited well this season.

On the rock-garden twenty-three species came into flower during October, as against thirteen for October 1889. The total number which have flowered since January 1 to the end of October is 1154; during the same period last year 1473 had flowered—a difference of 319, which must be ascribed to the bad summer.

Amongst the most conspicuous in flower were:—*Helleborus altifolius*, *Gentiana Kurroo*, *Caryopteris Mastacanthus*, *Saxifraga Fortunei*, *Oxalis lobata*, *Hypericum cuneatum*, *Gynerium argenteum*, *Liatris odoratissimus*, *Nardostachys Jatamansi*, *Veronica chathamica*, *Crocus asturicus*, *C. annulatus*, *C. medius*, *Schizostylis coccineus*, *Shuttleworthia pulchella*, &c.

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during October 1890.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 46° | 54° | 57° | 17th | 36° | 48° | 56° |
| 2nd | 32 | 49 | 54 | 18th | 40 | 47 | 53 |
| 3rd | 41 | 56 | 61 | 19th | 30 | 38 | 56 |
| 4th | 53 | 55 | 63 | 20th | 30 | 40 | 50 |
| 5th | 55 | 57 | 67 | 21st | 42 | 46 | 52 |
| 6th | 47 | 51 | 60 | 22nd | 45 | 47 | 60 |
| 7th | 42 | 49 | 62 | 23rd | 45 | 51 | 57 |
| 8th | 32 | 49 | 57 | 24th | 48 | 52 | 59 |
| 9th | 36 | 49 | 63 | 25th | 41 | 43 | 47 |
| 10th | 42 | 48 | 65 | 26th | 29 | 30 | 45 |
| 11th | 54 | 57 | 64 | 27th | 29 | 33 | 42 |
| 12th | 54 | 58 | 68 | 28th | 23 | 32 | 43 |
| 13th | 43 | 53 | 65 | 29th | 35 | 50 | 58 |
| 14th | 48 | 54 | 64 | 30th | 32 | 37 | 51 |
| 15th | 40 | 44 | 62 | 31st | 40 | 48 | 52 |
| 16th | 37 | 42 | 53 | | | | |

[TABLE

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of October 1890.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·260 | 57·1 | 46·7 | 53·0 | 50·2 | N.W. | Cum. | 8 | N.W. | 0·152 |
| 2 | 30·153 | 57·0 | 34·1 | 45·3 | 42·1 | W. | ... | 0 | ... | 0·022 |
| 3 | 29·743 | 57·8 | 45·0 | 57·8 | 54·2 | W. | Cum. | 10 | W. | 0·029 |
| 4 | 29·883 | 59·7 | 54·9 | 56·0 | 53·6 | W. | Cum. | 5 | W. | 0·000 |
| 5 | 29·826 | 61·0 | 55·7 | 58·6 | 56·8 | W. | Cum. | 10 | W. | 0·008 |
| 6 | 29·749 | 63·7 | 49·7 | 52·6 | 48·6 | W. | Cir. Cum. | 2 | W. | 0·015 |
| 7 | 29·797 | 57·5 | 45·9 | 50·3 | 48·8 | W. | Cum. | 10 | W. | 0·000 |
| 8 | 30·374 | 55·5 | 36·8 | 45·3 | 43·6 | W. | Cir. Cum. | 2 | E. | 0·000 |
| 9 | 30·198 | 53·0 | 39·9 | 51·6 | 48·6 | W. | ... | 0 | ... | 0·000 |
| 10 | 30·090 | 59·7 | 51·0 | 58·4 | 56·1 | W. | Cir.Cum.<br>Cum. | 4<br>1 | W.<br>W. | 0·000 |
| 11 | 30·065 | 62·5 | 55·6 | 57·8 | 55·4 | W. | Cum. | 10 | W. | 0·000 |
| 12 | 30·184 | 61·6 | 55·9 | 58·3 | 55·0 | W. | Cum. | 8 | W. | 0·000 |
| 13 | 30·156 | 65·3 | 46·2 | 55·1 | 52·0 | W. | Cum. | 10 | W. | 0·000 |
| 14 | 29·883 | 55·8 | 51·8 | 55·5 | 53·5 | W. | Cum. | 10 | W. | 0·218 |
| 15 | 29·297 | 61·6 | 48·4 | 45·7 | 43·7 | W. | ... | 0 | ... | 0·070 |
| 16 | 29·309 | 50·3 | 39·1 | 44·7 | 40·6 | W. | Cir. Cum. | 6 | N. | 0·000 |
| 17 | 29·694 | 51·0 | 38·2 | 48·2 | 43·8 | W. | Cir. Cum. | 4 | N.W. | 0·000 |
| 18 | 30·010 | 54·2 | 42·5 | 46·8 | 42·2 | N. | ... | 0 | ... | 0·000 |
| 19 | 30·202 | 52·7 | 32·8 | 39·9 | 38·1 | N.W. | Cum. | 10 | N.W. | 0·060 |
| 20 | 30·167 | 51·9 | 37·5 | 43·2 | 43·0 | W. | Cum. St. | 10 | W. | 0·048 |
| 21 | 30·211 | 48·2 | 43·0 | 48·5 | 48·2 | N.E. | Cum. St. | 10 | N.E. | 0·025 |
| 22 | 30·359 | 51·5 | 47·1 | 49·9 | 49·0 | W. | Cum. | 10 | W. | 0·000 |
| 23 | 30·323 | 55·8 | 47·5 | 52·6 | 51·3 | W. | Cum. | 9 | W. | 0·000 |
| 24 | 29·806 | 54·6 | 51·0 | 54·0 | 51·6 | W. | Cir.Cum.<br>Cum. | 2<br>3 | W.<br>W. | 0·000 |
| 25 | 29·537 | 57·7 | 44·1 | 46·1 | 45·0 | W. | Cum. | 10 | W. | 0·410 |
| 26 | 29·355 | 47·2 | 31·8 | 33·2 | 32·9 | N.W. | Cum. | 2 | N.W. | 0·162 |
| 27 | 29·832 | 42·4 | 32·0 | 35·8 | 31·9 | N.W. | ... | 0 | .. | 0·000 |
| 28 | 29·939 | 39·9 | 26·7 | 34·8 | 31·8 | W. | Cum. | 10 | W. | 0·020 |
| 29 | 29·414 | 53·7 | 33·8 | 52·8 | 51·2 | W. | Nim. | 10 | W. | 0·012 |
| 30 | 29·849 | 56·5 | 34·2 | 37·6 | 36·7 | W. | Cir. | 1 | N. | 0·475 |
| 31 | 29·335 | 48·8 | 36·6 | 49·0 | 48·9 | W. | Cum. St. | 10 | W. | 0·615 |

Barometer.—Highest Reading, on the 8th, =30·374. Lowest Reading, on the 1st, =29·260. Difference, or Monthly Range, =1·114. Mean=29·871.

S. R. Thermometers.—Highest Reading, on the 13th, =65°·3. Lowest Reading, on the 28th, =26°·7. Difference, or Monthly Range, =38°·6. Mean of all the Highest =54°·9. Mean of all the Lowest=43°·1. Difference, or Mean Daily Range, =11°·8. Mean Temperature of Month=49°·0.

Hygrometer.—Mean of Dry Bulb=49°·0. Mean of Wet Bulb=46°·7.

Rainfall.—Number of Days on which Rain, or Snow, fell=16. Amount of Fall, in inches, =2·341.

First fall of Snow for season on night of 25th.

## MEETING OF THE SOCIETY,

Thursday, December 11, 1890.

Robert Lindsay, President, in the Chair.

Hugh F. C. Cleghorn, M.D., F.L.S., F.R.S.E., was elected Honorary British Fellow in room of Rev. Miles Joseph Berkeley, F.R.S., deceased.

J. C. Wright, F.R.S.E., Richard Brown, C.A., George Hunter, M.D., F.R.C.S.E., M.R.C.P.E., John Wilson, D.Sc., and Robert A. Robertson, M.A., B.Sc., were elected Resident Fellows of the Society.

John Wilson, D.Sc., and Robert A. Robertson, M.A., B.Sc., were admitted Resident Fellows of the Society.

Presents to the Library, Museum and Herbarium at the Royal Botanic Garden were announced.

D. Somerville exhibited branches of *Pinus sylvestris*, bearing trifoliar instead of the usual bifoliar spurs, and shoots of *Acer pseudo-platanus*, from the stump of a felled tree, which, owing to the excess of nutriment available, had developed ternary instead of binary whorls of leaves.

The following Papers were read:—

Excursion of the Scottish Alpine Botanical Club to Connemara, in August 1890. By William Craig, M.D., F.R.S.E., F.R.C.S.E., Secretary of the Club.

On Monday, 4th August, the following members of the Scottish Alpine Botanical Club—viz., William B. Boyd, Vice-President; Dr A. P. Aitken, Dr Charles Stuart, Rev. David Paul, Robert Lindsay, George H. Potts, Rev. W. W. Peyton, and Dr William Craig—left Edinburgh at 4 p.m. for the West of Ireland. We travelled by the Caledonian Railway as far

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as Greenock, and through the kindness of our late esteemed member, Mr Archibald Gibson, a fine saloon carriage was provided for our party by the Caledonian Railway. At Greenock we embarked on board the steamer "Duke of Leinster" for Dublin, and through the kindness of my brother, Mr James Craig of Greenock, the whole of the state berths were reserved for the members of the Club. The night was very calm, which added greatly to the comfort of some members of the party. We reached Dublin about midday on Tuesday, 5th August, and took up our abode at the Gresham Hotel. Here we were joined by another member, Mr P. Neill Fraser, who had travelled *viâ* London and Holyhead to Dublin. After luncheon we visited Glasnevin, and were kindly shown through the houses and grounds by Mr Moore, the curator. We next visited Trinity College Gardens, and were conducted through them by the foreman, in the absence of the curator, Mr Burbidge, who had waited all forenoon for us, but had to leave before our arrival owing to ill-health. Mr Moore of Glasnevin dined with us in the evening. The Club enjoyed very much their visit to these beautiful gardens.

Wednesday, 6th August.—We left Dublin this morning at 7.40 A.M. with the limited mail for Westport, a town on the West Coast of Ireland, in County Mayo. We reached Westport at 12.40 P.M., having previously secured accommodation in the Railway Hotel. This is the principal hotel in the town, but is a long way from the railway, and thus belies its name.

Westport is a small town on the Carrowbeg River, and is close to the sea near the head of Clew Bay.

After luncheon, we resolved to visit and examine botanically Croagh Patrick, a mountain 2510 feet high, and situated about 6 miles to the south-west of Westport. This is the highest mountain in the district, and is by some regarded as the most northerly of the twelve Pins. It is not, however, in Connemara, but in Mayo. It is a fine hill with a beautiful conical top, and has many hallowed associations attached to it. It is *the* sacred mountain of Ireland. Its name implies that it is dedicated to the memory of St Patrick, the patron saint of the island. From most parts of Ireland pilgrimages are annually made to this famous mountain. About 500 feet below the summit, on the public path which leads up to the top, is a small mound or cairn, at which the pilgrims rest and attend to their devotions, and where those turn who are unable to ascend to the summit. On the top is a shelter surmounted by a crude cross, and a very large number of cairns are all round the top—each with its own religious history. On the Ordnance Survey map the shelter is marked, "Temple Patrick."

Having engaged two conveyances, we left Westport about 2 P.M., driving through the private grounds of the Marquess of Sligo. In these grounds we picked *Œnanthe crocata*, L.; and a specimen of *Senecio aquaticus*, Huds.; very large and luxuriant. After leaving these grounds, the road lay along the shore. On the walls on the side of the road we saw abundance of *Cotyledon Umbilicus*, L.; *Ceterach officinarum*, Desv.; and *Asplenium Trichomanes*, L. Having reached the foot of the mountain, we left our conveyances at a small village till our return. We ascended at first by the side of a small stream, and very soon saw abundance of *Jasione montana*, L.; *Anagallis tenella*, L.; and that most lovely of heaths, *Dabeocia polifolia*, Don, a plant which many of us picked for the first time. On our way up the mountain we picked some fine specimens of white *Erica Tetralix*, L.; and white *Erica cinerea*, L. We kept the footpath the most of the way to the top. The last 500 feet is a very steep climb. About 500 feet below the summit we found *Saxifraga umbrosa*, L., and on the summit it was very abundant. *Armeria vulgaris*, Willd., was also very abundant on the summit. Five members of the Club were at the top of Croagh Patrick, and were well rewarded for all their toils by the magnificent view from the summit. The day was particularly fine, and consequently our view very extensive. To the north lay Clew Bay, studded with its "hundred islands." Clare Island, at the mouth of Clew Bay, was well seen, and in the far north was seen Achill Island, famed for its "mountain and ocean scenery of wildest character." To the south were seen the twelve Pins of Connemara, with "mighty Mweelrea," the highest of the range, a mountain 2688 feet high, situated on the north of Killary Bay.

Of the five members who went to the top three descended by a most rugged and difficult path, the greater part of the way being over loose stones. They got no plants of any interest. The other two descended by a more easterly path, and got into a damp ravine in which some good plants were found. This descent was very easy, and moreover took us to the best botanising ground on the hill. Among the plants collected may be mentioned:—*Thalictrum alpinum,* L.—a rare plant in Ireland; *Pinguicula lusitanica,* L.; *Salix herbacea,* L.; *Juniperus nana,* Willd.; *Triglochin palustre,* L.; *Rhynchospora alba,* Vahl; *Schœnus nigricans,* L.; *Asplenium Ruta-muraria,* L.; *A. Trichomanes,* L.; *A. viride,* Huds.; *A. Adiantum-nigrum,* L. Some good varieties of this fern were found, among which may be mentioned the variety *Serpentini.* We had not time to examine the mountain thoroughly. We got back to our hotel in good time for dinner, all highly delighted with our first day's excursion.

In the evening a business meeting of the Club was held, when Dr J. M. Macfarlane was elected a member. Dr Macfarlane is well known as a distinguished and enthusiastic botanist, and will be a great acquisition to the Club.

Thursday, 7th August.—We left Westport for Clifden this morning at 9 A.M. We secured seats on the public car. The driver had great difficulty in getting all our luggage packed on the car. However, he succeeded. There were only three passengers on the car besides the members of the Club, and some of their luggage had to be left in Westport till next day. Several others had to be refused seats on the car. One of our party, to use the words of the late Professor Balfour, when describing his last visit to Connemara, was "perched up among the luggage in the centre." The day was very warm, and we were exposed to the rays of a burning sun. On the roadside we saw large quantities of *Hypericum elodes,* Huds.; *Rhynchospora alba,* Vahl; *Schœnus nigricans,* L.; &c. Our first halting-place was Leenane, a beautiful spot at the head of Killary Bay, 18 Irish miles from Westport. Here we had half an hour for luncheon. At Leenane we particularly admired the beauty and profusion of two introduced plants—*Fuchsia Riccartonii* and *Escallonia macrantha.* These two plants are extensively cultivated all along this portion of the west coast of Ireland, and for miles along the roadside we saw beautiful hedges of fuchsias. At Leenane we had our luggage transferred to another car which was to take us on the remainder of our journey. Shortly after leaving Leenane we saw on the roadside *Hypericum Androsæmum*, L., and some good plants of *Asplenium Trichomanes*, var. *cristatum*. Our next halting-place was Letterfrack, a small village beautifully situated on the sea to the south of Ballynakill Harbour. On our way we drove through the famous Kylemore Pass, the road running along the side of Kylemore Lake, and close by the palatial residence of Mr Mitchell Henry. At Letterfrack we changed horses and started on the last stage of our day's journey. Whilst the horses were being changed we had an opportunity of inspecting the so-called Connemara diamonds, which are simply crystallised quartz. They are abundant on the Diamond Pin, a hill near the town. From Letterfrack to Clifden is 8 Irish miles, and the drive somewhat dreary. On walking up a long, steep hill, we were surprised to find the whole road swarming with small winged ants, and for at least a mile the road was literally living with these insects. We reached Clifden between 6 and 7 P.M., and took up our abode in Mullarkey's Hotel, the principal one in town. Clifden is the capital of Connemara, and is close upon an arm of the sea. It is famed for its serpentine quarries. Beautiful ornaments of this stone are made by an old man, who boasts that he is of Highland descent. Many of these are very beautiful, and most of our party made purchases.

Friday, 8th August.—To-day we were accompanied in our excursion by Mr R. J. Bodkin, who belongs to the locality. Mr Bodkin is a student of medicine, and a former pupil of mine. As he knew the locality well he was of great service to us. Our excursion to-day was to the neighbourhood of Ballinaboy Bridge, about 2 miles to the south of Clifden, specially to search for *Erica ciliaris*. It was at this bridge that the late Professor Balfour and Professor Dickson looked for *E. ciliaris* in 1874. Professor Balfour was confident that this was the bridge at which he had gathered the plant in 1852. We searched most carefully about the bridge and all the neighbourhood, but could see nothing of it nor *E. Mackayi*. I have some doubts if it was here that Professor Balfour found it, because in his notes taken at the time, in 1852, he says:—"Near Craigga More, in marshy ground, on the left-hand side of the road, and in hollow ground, we gathered *Erica ciliaris.*" This bridge is not *near* Craigga More, but at least 7 miles distant. Craigga More is near Roundstone, and several specimens in the University Herbarium are labelled "near Roundstone." The plant gathered by Professor Balfour in 1852 was undoubtedly the true *E. ciliaris*, L.

The day was again fine, and we had a pleasant and successful excursion. Near Ballinaboy Bridge, far from any house, we saw an old quarry full of *Escallonia macrantha*, growing most luxuriantly, and in fine flower. Among the plants collected may be mentioned:—*Nymphæa alba*, L., very abundant; *Hypericum pulchrum*, L.; *H. elodes*, Huds.; *Ulex Gallii*, Planch, very abundant, and in fine flower; *Drosera rotundifolia*, L.; *D. intermedia*, Hayne; *Œnanthe crocata*, L.; *Lobelia dortmanna*, L.; *Jasione montana*, L.; *Erica cinerea*, L., var. *alba*; *Dabeocia polifolia*, Don, everywhere very abundant, and in beautiful flower; *Anagallis tenella*, L.; *Samolus Valerandi*, L.; *Erythræa Centaurium*, Pers.; *Pinguicula lusitanica*, L.; *Utricularia intermedia*, Hayne, and *U. minor*, L.—both in fine flower; *Mentha piperita*, Huds.; *Eriocaulon septangulare*, With.; *Sparganium natans*, L.; *Triglochin palustre*, L.; *T. maritimum*, L.; *Naias flexilis*, Rostkov; *Scirpus fluitans*, L.; *Rhynchospora alba*, Vahl; *R. fusca*, R. and S., a rare plant, but found in several places in this excursion; *Schœnus nigricans*, L.; *Cladium Mariscus*, Br.; *Carex vesicaria*, L.; *Asplenium Trichomanes*, L.; *A. Adiantum-nigrum*, L.; *Ceterach officinarum*, Desv.; *Scolopendrium vulgare*, Sm.; *Nephrodium æmulum*, Baker, and *Osmunda regalis*, L., very abundant through Connemara. It is worthy of mention that *Lythrum Salicaria*, L., was everywhere very abundant, and grew most luxuriantly, sometimes whole acres could be seen covered with this plant, and in beautiful flower, giving quite a characteristic appearance to the landscape.

In our excursion to-day, we met Professor Pye, of Galway, who kindly entertained the club to luncheon at his country house, near Clifden.

Saturday, 9th August.—After an early breakfast we left Clifden with all our luggage for Roundstone. We hired a large car, which accommodated the whole party, as well as our luggage. Roundstone is about 10 or 12 miles south-west from Clifden. It is close upon the sea. At Roundstone we left our luggage at the hotel with Mr John Kelly, the friend of the late Professor Balfour. This is a most deserted-looking hotel. It contains fourteen bedrooms, but nobody ever stays in it. We were told that lately all the inhabitants, except two or three, became total abstainers. And, yet, the place had a melancholy interest to us all. Here we met the veritable John Kelly, who gave Professors Balfour and Dickson, the two first Presidents of the Club, such a "warm reception" in 1874. Here, too, many eminent botanists have frequently resided. Mr Kelly was glad to see us, and pointed out the way up the hill to get the rare plants. Having left our luggage in the custody of Mr Kelly, we visited Urrisbeg, a hill behind Roundstone, 987 feet high, with many tops, very rocky and very boggy. We had no guide, "Tommy," the guide who pointed out *Erica mediterranea* to Professors Balfour and Dickson, having died two years ago. We, however, ascended the mountain, keeping the directions so minutely described by Balfour in the 12th volume of our *Transactions*, and went direct to the station for *Erica mediterranea*, L. We found plenty of it, and even all the way down to the foot of the mountain on the other side from Roundstone, especially along the banks of the stream. We went down to a fresh-water lake, Lough Bollard, to search for *Adiantum Capillus-Veneris*, L. We found it in small quantity, and the plants very small. Professor Balfour, in 1874, found it on a limestone rock on the east of this same lough. He says:—"There was a great deal growing on the rock, but fortunately for the habitat it is impossible to get at the roots." This does not correspond very well with our station, for the rock on which we found it was only 4 or 5 feet high. We afterwards ascended to the summit, but as the day was hazy we had not the fine view that Professor Balfour so well described in the 12th volume of our *Transactions*. On the top we found abundance of *Sedum anglicum*, Huds., in fine flower. Among other plants collected may be mentioned:—*Lotus major*, Sm.; *Habenaria bifolia*, Br.; *Alisma ranunculoides*, L.; *Rhyncospora fusca*, R. and S.; *Cladium Mariscus*, Br.;

*Carex limosa,* L.; *Hymenophyllum unilaterale,* Willd.; *Nephrodium æmulum,* Baker; and *Osmunda regalis,* L.

We got back to the hotel about 5 P.M., and after some refreshments started in four cars for Cashel. We had previously arranged with Mr J. J. O'Loghlen to send conveyances to Roundstone to convey to his hotel ourselves and our luggage.

One of our party on the hill met a man who said he knew the station for *Erica Mackayi,* Hook.; and promised to go for a specimen, and meet us on the road about 2 miles from Roundstone. When we met him he had gathered a quantity of it on a small knoll quite near, and pointed out the hill to us. We found that this was Craigga More, where Professor Balfour and others had gathered the plant on former occasions. We resolved to come back on Monday and gather the plant for ourselves. The drive of 10 miles to Cashel Hotel was soon accomplished. On passing Ballynahinch Bridge we saw some *Ceterach officinarum,* Desv. Cashel Hotel was built in 1889, and stands on a commanding site near the sea, and is one of the most charming hotels the club has visited. The landlord, Mr J. J. O'Loghlen, is a man of great energy, and is the most influential person for many miles around. We had the whole hotel to ourselves, and he exerted his utmost to make us comfortable. From Cashel Hotel as a centre, all the good botanising ground of Connemara may be visited, and for comforts of every description the hotel is unsurpassed. It is worthy of note that this was the only portion of Ireland visited, where the people never beg.

Monday, 11th August.—The day was again very fine. In the forenoon some of the party enjoyed a fine sail in Mr O'Loghlen's yacht on the bay; whilst others botanised Cashel Hill, a mountain 1024 feet high, immediately behind the hotel. The only plants of any note found on the hill were *Saxifraga umbrosa,* which was very abundant, and *Hymenophyllum unilaterale,* Willd. Along the roadside we picked *Lotus major,* Sm.; *Agrimonia Eupatoria,* L.; and *Lycopus europæus,* L.; *Dabeocia polifolia,* Don, and *Osmunda regalis,* L., were everywhere very abundant. In the afternoon some of the party drove back to Craigga More to search for *Erica Mackayi,* Hook., and other heaths. Craigga

More is a small knoll, 201 feet above sea level. We were only about an hour on the ground. We found plenty of *Erica Mackayi*, Hook., in fine flower, but failed to find *E. ciliaris*, but we had not time to examine the district thoroughly. We gathered some curious forms or varieties of heaths, especially one, first picked by Dr Stuart, and afterwards by all the other members of the party, which appears to be different from anything we had previously seen. This form is in cultivation by several members of the club, including Mr Lindsay at the Royal Botanic Garden, and so abundant opportunity will be afforded of determining its relation to other species and varieties. Dr Macfarlane has kindly undertaken to examine its miscroscopic structure with a view to assist in its identification.

Tuesday, 12th August.—The day was again fine, and about 9 A.M. we started in four cars for Galway—a drive of 40 or 50 miles. We went the greater part of the way by the coast road, and had a good view of the Arran Isles. About half-way to Galway we saw on the road side abundance of *Anthemis nobilis*, L. We reached Galway about 6 P.M., and took up our abode in the railway hotel, adjoining the railway station—a hotel whose chief recommendation was its size.

Wednesday, 13th August.—Mr Lindsay had to leave this morning for Edinburgh to the great regret of us all. During our stay in Galway we had the pleasure of the company of Professor D'Arcy Thompson of Dundee, who was spending his holidays in Galway. He was of great service to the club, and acted as our guide. In the forenoon we visited Salt Hill, and the shore to the west of the town. Among the plants collected may be mentioned:—*Cerastium arvense*, L.; *Spergularia rubra*, Pers.; *Dryas octopetala*, L.; *Agrimonia Eupatoria*, L.; *Helosciadium nodiflorum*, Reichb.; *Carlina vulgaris*, L.; *Statice bahusiensis*, Fries; *Samolus Valerandi*, L.; *Chlora perfoliata*, L.; *Erythræa Centaurium*, Pers.; *E. littoralis*, Fries; *Gentiana campestris*, L.; *G. Amarella*, L.; *Gentiana verna*, L.; Mr Paul found one plant of *G. verna* in flower. *Salicornia herbacea*, L.; *Orchis pryramidalis*, L.; *Habenaria bifolia*, Br.; *Juncus maritimus*, Sm.; *Scirpus maritimus*, L.

In the afternoon we visited the rocks at the foot of Loch

Corrib, about 4 miles from Galway. The rocks here are all limestone, and of that peculiar formation we had seen about Hutton Roof Crags in England. Among the plants collected may be mentioned:—*Aquilegia vulgaris,* L., apparently quite wild; *Frankenia lævis,* L., *a very rare plant,* and not previously recorded from Ireland; *Geranium lucidum,* L.; *Saxifraga tridactylites,* L.; *Bryonia dioica,* L.; *Sanicula europæa,* L.; *Cornus sanguinea,* L.; *Asperula cynanchica,* L.; *Bidens cernua,* L.; *Lithospermun officinale,* L.; *Euphorbia exigua,* L., very abundant; *Sparganium simplex,* Huds.; *Typha latifolia,* L., and *Alisma ranunculoides,* L.; *Ceterach officinarum,* Desv., was very abundant all over the rocks, and in some places actually formed the whole turf. Some very large plants were obtained. *Scolopendium vulgare* was very abundant.

Thursday, 14th August.—To-day we resolved to visit the rocks in County Clare. Having hired a fishing-boat we crossed Galway Bay to Clare. The wind was contrary, and it was after midday before we got across. We had a long walk along the coast to Ballyvaughan, where we were to get the steamer back to Galway about 5.30 P.M., and had to cross a ferry on our journey. The country is one of great interest to the botanist, the rocks being all of that peculiar formation of limestone met with at the foot of Loch Corrib. We had not time to examine the rocks properly, and, moreover, the afternoon was wet, the only wet day we experienced during our trip. Nevertheless we obtained some good plants, among which may be mentioned:—*Geranium lucidum,* L.; *Dryas octopetala,* L.; *Sambucus Ebulus,* L., very abundant in two places; *Rubia peregrina,* L.; *Asperula cynanchica,* L.; *Statice Limonium,* L.; *Chlora perfoliata,* L.; *Gentiana verna,* L.; *Orchis pyramidalis,* L.; *Adiantum Capillus-Veneris,* L., was found in quantity by Mr Potts, and the plants were very fine. Some good crested varieties of *Asplenium Trichomanes,* L., were got, and *Ceterach officinarum,* Desv., was very abundant.

We reached Ballyvaughan in good time for the steamer to Galway, and here may be said to have ended our excursion. Dr Aitken, Mr Peyton, and Mr Potts left for Dublin at midnight with the mail train. The rest of the party left Galway next morning at 10.30 A.M., and reached Dublin about 4 P.M.

After dinner we left Dublin with the same steamer in which we went, viz., "Duke of Leinster." We occupied again the State berths. The passage home was very enjoyable, and we reached Greenock in time for the 9 A.M. train for Edinburgh, where we arrived at 11 A.M., all highly delighted with our first trip to the Emerald Isle.

Professor Bayley Balfour remarked that the form of corolla of the curious *Erica* referred to by Dr Craig inclined him to look for some relationship with *Erica mediterranea.*

Dr Craig pointed out that the station for *Erica mediterranea* was quite 5 miles away from the spot where the *Erica* was gathered.

Dr Macfarlane considered, as the result of his examination of specimens, that the form of *Erica* found was no hybrid, but only a form, like *E. Mackayi*, of *E. Tetralix.* He promised to lay a fuller statement of his views before the Society after he had more carefully examined specimens.

## The Effects of Cultivation on Allium vineale, Linn. By John H. Wilson, D.Sc., Curator of the Herbarium and Library, Royal Botanic Garden, Edinburgh.

One of the most notable features in the flora of the neighbourhood of St Andrews is the occurrence of *Allium vineale* on the top of the old Abbey wall, and nowhere else. The wall is a fine substantial piece of masonry enclosing the Abbey grounds. It is 18 to 20 feet high and 3½ feet broad. At intervals there are round or quadrangular turrets of varying dimensions. The top throughout its whole length is to some extent demolished, and in most places is covered with sandy debris which affords holding for grass, stonecrop, dandelions, and a few other flowering plants. *Allium vineale* is found along the greater part of the wall, in some places occurring in considerable quantity, the globose heads borne on the delicate stalks giving in summer a characteristic outline to the ruin. The wall where it is highest skirts the harbour. The top is there rather bare, and the soil is composed of a very fibrous, compact turf, filled with sand and lime. In summer it is very hot and dry.

From the many interesting historical associations connected with the place, one is led to think of the means by which the plant first established itself on the dry wall-top, and how many years it has been in possession. With regard to both points I have no data. It extends a distance of at least four hundred yards. Although not now found elsewhere in the neighbourhood, there may have been a time, and that comparatively recent, when it grew close by. At the present time a roadway extends along one side of nearly the whole length of the wall, so that seeds and bulbils which may fall on that side have little chance of surviving. On the other side there is either well-worked garden ground or healthy pasture, which is usually grazed.

The plant is admirably adapted to its locality. The leaves are very narrow and offer little resistance to the wind. The scape, though tall, is wiry and strong. The bulb being invested with a very thick, dry felt of old tunics, and sunk a considerable depth in the turfy soil, is more favourably circumstanced than one might be inclined to suppose.

On the wall the height of the stem varies considerably. It may attain 18 inches. The head is single, so far as I have observed, and is probably formed of bulbils only. It was too late in the season to ascertain whether any flowers appeared mixed with the bulbils, when I determined to bring this note before the Society.

The question of the bulbiliferous and non-bulbiliferous condition of the genus is an interesting one. In Hooker's *Student's Flora* (3rd edition, 1876), three varieties of *A. vineale* are given :—*A. vineale* proper, having the heads composed of flowers and bulbils ; *A. capsuliferum*, with heads of flowers only ; and *A. compactum*, with heads of bulbils only. *A. compactum* is stated to be the common form. Its heads are described as one or two together. It is probable that our form corresponds with *A. compactum*.

Bentham* considers *A. vineale* "very near *A. sphærocephalum*, and perhaps only the bulb-bearing form of that species." *A. sphærocephalum* is found in Britain near Bristol only. The other British species which bear bulbils are *A. oleraceum*, *A. Scorodoprasum*, and *A. Ampeloprasum*. The last named, according to Hooker, appears in three varieties :—*A. Ampelo-*

* Handbook of the British Flora, 4th edition, p. 487.

*prasum* proper, with no bulbils; *A. bulbiferum*, with few bulbils; and *A. Babingtonii*, with few flowers and very many bulbils. Bentham remarks* that *A. Babingtonii* "is a variety with sessile bulbs in the umbel in lieu of the flowers, a character which it loses by cultivation."

It would appear then that the bulbil-bearing tendency is directly correlated with the conditions under which the species grow. Can the correlation be traced? Is it a greater drain on the nutritive functions of the plant to bear flowers and fruit with seed than bulbils which are vegetative buds of a kind?

In *A. Ampeloprasum*, variety *Babingtonii*, increase of nutrition, such as may safely be assumed as the outcome of cultivation, apparently leads to the production of flowers rather than bulbils. Unfortunately, however, for any hypothesis one might advance based upon this case, the reverse is seen as the result of cultivation of *A. vineale*, and many species which are bulbiferous in nature continue in this condition under cultivation in the Royal Botanic Garden.

A number of specimens of *A. vineale* were taken a year past in June from the old wall at St Andrews, and planted in the University Botanic Garden, St Andrews. They stood over the summer of 1889 without showing any remarkable feature, but during last summer they assumed quite unusual proportions. The scape was 2½ feet in height, and the leaves proportionately long and stout. The heads, formed entirely of bulbils, with no trace of a flower, were composed in some cases of five or six sub-globose divisions, each borne on a stalk formed by the splitting—not branching—of the top of the scape. In the fully-developed condition the outward curvature of the split portions was very considerable. The splitting is evidently due primarily to the mechanical effect of the bulbils pressing against one another in growth.

Here the effects of cultivation have led to increased bulbil-bearing, not to the production of flower; a case when increased nutrition tends to heighten the vegetative rather than the reproductive powers.

It is possible that *A. vineale* in its dry habitat may be more safely propagated by bulbils than by seeds, and thus in course of time become more prone to bear bulbils. Having

* Op. cit. p. 485.

become entirely bulbil-bearing, cultivation aids the process. What effect, however, cultivation would have on the purely flower-bearing variety, or that with both bulbils and flowers, is a matter to be settled by experiment.

In the inflorescence of this *Allium* there are two propagative agencies in oscillation. The result in one direction is the normal production of flower and seed, in the other the production of bulbils, representations in miniature of the parent bulb underground.

The cultivated bulb is about thrice the size of that in the wild form. In November, when new leaves of the plants on the wall were 5 inches in length, those in the garden were 2 feet. The roots of the latter, however, were shorter than those of the former.

*Postscript.*—Since the above was communicated to the Society, Professor Bayley Balfour has directed my attention to a note by M. Clos * referring to the subject of the rupture of the peduncle. He found examples at Fontainbleau and Toulouse having trilobed capitula of bulbils only, each capitulum borne on a split branch of the scape. He regards the tripartition as accidental.

## NOTES ON THE FLORA OF THE MOFFAT DISTRICT FOR 1890. By J. THORBURN JOHNSTONE, Moffat.

The following plants are all new additions to the Flora of this district for this season, while *Potentilla alpestris, Salix ambigua,* and *S. cinerea* × *nigricans* are new records for the county of Dumfries as well.

*Teesdalia nudicaulis,* R. Br. Sand-beds on Evan and Annan Water.

*Sagina nodosa,* L. Craigmichen Scaurs.

*Potentilla alpestris,* Hall. fil. Blacks Hope and Midlaw Burn, June 22, 1890. It occurs at an elevation of from 1500 to 1700 feet, and is growing pretty freely where it is got.

*Rosa spinosissima,* L. Gathered at Saddleback Crag, Corrieferron Hope, July 28. Elevation, 1250 ft.

*Senecio viscosus,* L., Aug. 18. Beattock Station.

* Bulletin de la Société Botanique de France, tom. xxxiv. p. 196.

*Pyrola secunda*, L., July 13. Moffat Water. This is a new station for this plant; it is not now found at any of its previously recorded stations.

*Veronica polita*, Fr. Crooks fields, May 9.

*Stachys Betonica*, Benth., Sept. 7. Moffat Water. A new station for it, as it does not now occur at any of its former stations.

*Euphorbia Peplus*, L. Casual plant in own garden, where there were over a dozen plants of it growing this season.

*Salix triandra*, L. Annan Water at Putts.

„ *Cinerea* × *nigricans*. Gudeshaw Wood.

„ *phylicifolia*, L. Beerholm.

„ *nigricans*, Sm. Blacks Hope.

„ *ambigua*, Ehrh. Annan Water at Putts.

*Juncus supinus*, Moench, var. Well Hill.

*Carex ampullacea*, Good. Well Hill.

On Temperature and Vegetation at the Botanic Garden, Glasgow, during November 1890. By Robert Bullen, Curator of the Garden.

The temperature was at or below the freezing point on eighteen mornings during the month, giving a total of 31° of frost, 25° of which were registered during the nights of the 26th and 27th. With these exceptions the mean temperature was high for the season. The month was an exceedingly dull and wet one, and the rainfall heavy. On the 27th the day temperature was not higher than 30°; on the 28th and 29th, 32°. All other readings were comparatively high, consequently what little hail or snow fell soon vanished. Lawn grass continued to grow fast until the middle of the month. The excessively wet state of the ground retarded outdoor work considerably.

On Temperature and Vegetation at the Royal Botanic Garden, Edinburgh, during November 1890. By Robert Lindsay, Curator of the Garden.

During November, the thermometer was at or below the freezing point on 16 mornings, indicating collectively 80° of frost for the month, as against 38° for the corresponding month last year. Not since 1880 has so much frost occurred during November.

A heavy fall of snow took place on the 26th, which lay on the ground till the end of the month. The lowest readings of the thermometer were on the 16th, 27°; 27th, 19°; 28th, 19°; 29th, 18°; 30th, 22°. The lowest day reading was 31° on the 28th, and the highest 60° on the 19th.

Out-door vegetation is in an almost dormant condition now. Only two species of plants came into flower during the month on the Rock Garden, viz., *Crocus Salzmanni* and *C. cancellatus;* and with the exception of *Helleborus niger altifolius*, *Polygala Chamæbuxus*, and *Lithospermum prostratum*, no others are in flower in good condition.

Of berry-bearing plants the most conspicuous and effective are the various varieties of *Pernettya mucronata.* The berries are about the size of the Holly, the colours vary very much, numerous shades of red, lilac and white, being represented. The plant is a native of Magellan, is very hardy, and ought to be much more widely cultivated than it is at present. In seasons when Holly berries are scarce, the *Pernettya* forms an excellent substitute.

Readings of exposed Thermometers at the Rock Garden of the Royal Botanic Garden, Edinburgh, during November 1890.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 36° | 40° | 53° | 16th | 27° | 34° | 40° |
| 2nd | 40 | 45 | 54 | 17th | 28 | 29 | 42 |
| 3rd | 30 | 32 | 45 | 18th | 36 | 42 | 53 |
| 4th | 32 | 34 | 47 | 19th | 37 | 54 | 60 |
| 5th | 32 | 38 | 51 | 20th | 38 | 45 | 53 |
| 6th | 33 | 41 | 48 | 21st | 48 | 51 | 53 |
| 7th | 37 | 40 | 46 | 22nd | 36 | 42 | 51 |
| 8th | 29 | 45 | 52 | 23rd | 44 | 46 | 48 |
| 9th | 35 | 36 | 44 | 24th | 34 | 36 | 44 |
| 10th | 27 | 30 | 45 | 25th | 30 | 35 | 41 |
| 11th | 30 | 40 | 47 | 26th | 29 | 30 | 46 |
| 12th | 28 | 35 | 43 | 27th | 19 | 25 | 33 |
| 13th | 39 | 41 | 51 | 28th | 19 | 24 | 31 |
| 14th | 32 | 38 | 46 | 29th | 18 | 27 | 33 |
| 15th | 35 | 38 | 51 | 30th | 22 | 38 | 48 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of November 1890.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·607 | 50·0 | 39·0 | 41·8 | 41·0 | N.W. | Cum. | 4 | N.W. | 0·225 |
| 2 | 28·836 | 53·7 | 41·1 | 47·2 | 45·0 | W. | Cir. | 6 | S. | 0·000 |
| 3 | 29·434 | 50·4 | 32·1 | 33·8 | 33·1 | N.W. | Cum. | 5 | N.W. | 0·060 |
| 4 | 29·063 | 42·9 | 33·1 | 36·8 | 36·5 | W. | ... | 0 | ... | 0·008 |
| 5 | 29·540 | 44·5 | 36·0 | 38·9 | 37·4 | N. | Cum. | 6 | N. | 0·000 |
| 6 | 29·551 | 42·9 | 36·2 | 42·9 | 40·8 | S. | Cir. Cum. | 9 | N.W. | 0·760 |
| 7 | 28·969 | 43·5 | 41·0 | 43·5 | 42·8 | N.W. | Nim. | 10 | N.W. | 0·045 |
| 8 | 29·280 | 47·6 | 32·3 | 47·6 | 45·0 | W. | Cir. Cum. | 8 | W. | 0·930 |
| 9 | 29·276 | 50·8 | 39·0 | 39·4 | 39·0 | N.W. | Nim. | 10 | N.W. | 0·420 |
| 10 | 29·562 | 43·7 | 31·0 | 33·2 | 33·0 | E. | ... | 0 | ... | 0·010 |
| 11 | 29·273 | 44·3 | 32·7 | 41·9 | 39·8 | S.E. | Cum. | 10 | S.E. | 0·000 |
| 12 | 29·537 | 44·5 | 32·0 | 35·5 | 35·0 | S.E. | Cum. | 5 | S.E. | 0·050 |
| 13 | 29·645 | 46·9 | 35·0 | 43·0 | 40·8 | S.E. | ... | 0 | ... | 0·002 |
| 14 | 29·813 | 48·0 | 34·5 | 41·5 | 40·3 | S.E. | Cum. | 10 | S.E. | 0·385 |
| 15 | 30·019 | 54·8 | 37·5 | 40·2 | 38·8 | W. | ... | 0 | ... | 0·005 |
| 16 | 30·051 | 48·3 | 30·8 | 34·3 | 34·1 | S. | Cum. | 10 | S. | 0·052 |
| 17 | 30·226 | 42·0 | 32·4 | 32·8 | 32·8 | W. | Cum. | 10 | W. | 0·140 |
| 18 | 30·170 | 51·9 | 32·1 | 43·2 | 43·2 | N.W. | ... | 0 | ... | 0·005 |
| 19 | 30·155 | 55·1 | 38·2 | 55·1 | 53·2 | W. | Cum. | 10 | W. | 0·080 |
| 20 | 30·234 | 57·8 | 41·2 | 47·5 | 45·8 | W. | Cum. | 9 | W. | 0·038 |
| 21 | 29·741 | 55·3 | 46·8 | 52·2 | 51·0 | W. | Cum. | 10 | W. | 0·118 |
| 22 | 29·736 | 52·8 | 39·0 | 44·0 | 41·5 | W. | Cum. | 10 | W. | 0·165 |
| 23 | 29·274 | 52·6 | 43·5 | 47·8 | 44·5 | W. | Cum. | 10 | W. | 0·295 |
| 24 | 29·360 | 46·9 | 36·5 | 37·4 | 35·1 | N.W. | ... | 0 | ... | 0·120 |
| 25 | 29·819 | 41·6 | 32·0 | 37·0 | 36·5 | S.E. | Cum. | 10 | S.E. | 0·010 |
| 26 | 30·267 | 41·1 | 32·1 | 33·0 | 32·8 | N.E. | Cum. | 10 | N.E. | 0·050 |
| 27 | 30·181 | 33·7 | 22·0 | 25·0 | 23·9 | S.W. | Nim. | 10 | S.W. | 0·038 |
| 28 | 30·184 | 34·4 | 22·3 | 23·5 | 22·4 | N.E. | Cum. | 4 | N.E. | 0·000 |
| 29 | 30·135 | 29·5 | 20·2 | 29·5 | 28·5 | N.W. | Cum. | 10 | N.W. | 0·255 |
| 30 | 29·852 | 41·7 | 25·2 | 41·7 | 39·7 | W. | Cum. | 10 | W. | 0·005 |

Barometer.—Highest Reading, on the 26th, = 30·267. Lowest Reading, on the 2nd, = 28·836. Difference, or Monthly Range, = 1·431. Mean, = 29·693.

S. R. Thermometers.—Highest Reading, on the 20th, = 57°·8. Lowest Reading, on the 29th, = 20°·2. Difference, or Monthly Range, = 37°·6. Mean of all the Highest = 46°·4. Mean of all the Lowest = 34°·2. Difference, or Mean Daily Range, = 12°·2. Mean Temperature of Month = 40°·3.

Hygrometer.—Mean of Dry Bulb = 39°·7. Mean of Wet Bulb = 38°·4.

Rainfall.—Number of Days on which Rain, or Snow, fell = 26. Amount of Fall, in inches, = 4·271.

Professor BAYLEY BALFOUR communicated the substance of a letter from Professor Gairdner of Glasgow, in which he stated that he had been much interested in certain statements of the Rev. Dr William Allman of Kilmacrenan, Donegal, made to him some years ago regarding *Digitalis.* He had invited Dr Allman to make a note of his observations, and the following communication regarding the plant had reached Professor Gairdner:—"As to the *Digitalis,* what I told you rested solely on my own observation, and is as follows:—Hereabouts, and from this on to Creeslough, there is plenty of Foxglove; from thence on to beyond Dunfanaghy, none at all (about which there can be no mistake, as I lived in the latter place for nearly sixteen years, and here for seventeen); the only way for accounting for which is, of course, the nature of the soil, that in this neighbourhood (apart from the boulder-clay) being formed chiefly of disintegrated quartzite of gneiss. Whereas, from that on, there is plenty of limestone, and the other rock is chiefly mica-schist." . . . "The quartzite continues on past Creeslough, and therefore the absence of the Foxglove is caused by the presence of the limestone. Indeed, I recollect having read in some botanical work that lime is inimical to *Digitalis,* and to some other indigenous plant, whose name I forget; but I made the observation myself very many years previously."

In the vicinity of Edinburgh, so far as the experience of members present went, the Foxglove is found in abundance chiefly on decomposed igneous rocks.*

Dr J. M. MACFARLANE made the following communication:—The following extracts from a long and graphic letter lately received by me from Mr J. Graham Kerr will be read

* Thurmann (Essai de Physostatique, ii. 169) speaks of *Digitalis purpurea* as a plant diminishing in regions where the rocks are dysgeogenous (*i.e.*, do not readily form a soil), and as being affected by the mechanical condition more than by the chemical. At the same time, he points out that it is absent from many lime soils. Contejean (Ann. Sc. Nat., sér. 6. ii. (1875), 301) includes it amongst plants which can propagate on calcareous soils, but less vigorously than on soils deprived of lime. Professor Bower points out that *Digitalis* is comparatively scarce, if not entirely absent from, the magnesian limestone of Yorkshire, while it is present on the grit. (Note added in the Press).

with interest by many outside the circle of the writer's friends. The region traversed by our adventurous Fellow is one hitherto quite unknown to the civilised world, and promises to yield results of great value to all branches of science, and not least to Botany. Mr Kerr, it may be remembered, was appointed naturalist to the Pilcomayo Expedition, led by Captain Page, to explore the river Pilcomayo with a view to establishing a trade waterway from the Argentine Republic to Bolivia, and sailed from this country in June of 1889. Since his arrival in South America he has pursued his biological inquiries with great enthusiasm, and, considering the difficulties encountered, with marked success. A letter was received from him by Professor Bayley Balfour about a year ago, and was published in "The Ibis" for July 1890. The one from which extracts are now published forms a continuation of his narrative. It will be a matter of congratulation to all that the fears expressed by him regarding his collected specimens, books, &c., may not be realised, as we learn, from a later letter received by his father, that assistance had arrived, and should the water in the river rise to a slight extent the boats would be able to descend the river.

" S.S. 'Bolivia,' Rio Pilcomayo,
Lat. 24° 50′ S. approx.,
*Oct.* 26, 1890.

"I take this chance of sending you just a line to tell you that I am alive, and that we are all here comparatively safe.

"I came here rather having the idea that in this 'Gran Chaco' I should find a garden of Eden, teeming with natural riches, animal and vegetable. Instead I find what is to a great extent a desert, not so much as regards *quantity* of vegetation, &c., as variety. All nature, especially in its botanical aspect, presents that tameness, that uniformity, so characteristic of many of the great grass-covered plains of the earth—whether the pampas of Buenos Ayres, or the llanos of the Orinoco. The typical scene in the Chaco is an apparently limitless level plain, spread out in all directions into the distance, clothed with a breast-high growth of thick and coarse grasses, and thickly studded with fan palms averaging 20 to 30, but occasionally reaching as much as 90 feet in height. Frequently not another tree or bush is visible—nothing but on all sides that endless vista of palms, at first so weird and strange, and later so monotonous. We are still in spring-time here, and although we have had some warm days (*e.g.* while I write the thermometer registers 99° Fahr. in the shade), yet we have occasional cold nights, which retard vegetation, and so I can only give you a very meagre account of the botany of the place. In the open palm forest amongst the grass, three of the most conspicuous flowers are verbenas, one with bright scarlet flowers, the other two with corollas of a lilac colour. The first and one of the others are common in the pampas as well. Another very characteristic pampas plant which one finds here, although much less abundantly, is a pretty yellow-flowered *Oxalis*, in size resembling our common little *Oxalis* at home. Compositæ abound, especially tubulifloral *Gnaphalium*-like forms, which are individually very numerous, but one misses the great development of thistles so characteristic of the pampas. Malvaceæ are an equally conspicuous family in number of species as well as individuals—mostly yellow-flowered. One beautiful dwarf species is of a purple-carmine colour. A little white-flowered Asclepiad and a fine yellow-flowered *Iris* are other noticeable plants in the open Palmas. But although much of the Chaco is covered with this open palm forest there is yet some variety formed by the presence of occasional bands and patches of dicotyledonous forest. A very large part of these is made up of spiny Acacias and other trees of the sub-family Mimoseæ only, and very few of which I have been lucky enough to catch in flower owing to our being fixed in our present position. These patches of forest or 'Monte duro' as they are called, are composed in great part of small trees 20 feet or so in height—Acacias, Adenantheræ, and Myrtaceæ, while here and there a solitary taller tree shoots up above the usual level, most commonly a *Tecoma*-like tree with large yellow flowers. The ground beneath and among the lower trees is covered by a spiny and impenetrable growth of Cacti and more especially Bromeliaceæ, viz., two species of 'Caraguata.' The commonest of these, a plant with a large spike of bright red bracted flowers, is of great practical importance, for the sheathing bases of the leaves contain a store of cool, fresh water — the collected rains and dews—which one can drink by cutting the leaves in a particular way. Either this or an allied species also supplies the Indians with a most excellent fibre, out of which they spin rope of great strength, thread, &c., and make rough cloth also. I shall have some interesting specimens of this to show you when I get home. The caraguata also serves the Indians with food; the young leaf bases and the pine-apple-like fruit are both edible when cooked, although the latter possesses a disagreeable acridity when raw. By the way, one of the chief of the many wants I have felt on this expedition is the absence of anybody who knows anything whatever as to the uses or qualities or even names of the vegetable productions of their country. Besides these two large Bromeliaceæ, there are also several small epiphytic Tillandsioid forms, with very pretty flowers. Lianas are abundant in the woods, but I have not yet found any in flower; several however, appear to belong to Bignoniaciæ. So much for the 'Monta duro.' Along the margins of the rivers, trees also occur, of a comparatively few species, with soft timber. The two commonest of these are called 'Timbo blanco' (*Paullinia* ?), a rather ugly tree with white flower heads, and the 'Mandu vira' (cæsalpinioid). Also more or less along the margin of the rivers runs a strip of bush and jungle—a tangled mass of thorny bushes, covered with creepers and twining passion flowers. I should have liked to give you a longer and very much better account of the vegetation here, but must plead as my excuses, first, the earliness of the season, and secondly, my not having any works of reference.

"We arrived at this our present position upon June 12th, having been brought to an absolute stop owing to the almost complete dessication of the river. About that time our want of provisions began to make itself felt, and it was finally decided to build a canoe and send down for fresh provisions. Upon June 27th, Captain Zorilla, Page's second in command, departed in the canoe, got down all right, and hearing that a revolution had broken out, hurried off to Buenos Ayres. Before going, he took no means whatever of sending us the provisions; in fact, he appears not to have said a word to any one about our predicament. Then Page himself became unwell, and he hurried off down stream, dying on the way upon August 4th, before reaching the mouth of the river. Meanwhile our provisions were being gradually but surely exhausted, even by our starvation rations. We were all getting thin and extremely weak. Then towards the beginning of September, the doctor, an intelligent and enthusiastic young Italian, began to fall a victim to all the hardships he had suffered, and finally, on September 8th, he died, my time having been a good deal occupied in nursing the poor chap. We buried the doctor the same afternoon by the margin of a little 'monte.' Then upon the 18th of September Indians appeared—a party of twelve Tobas, including two caciques, presenting themselves about sunset. They were friendly, and after staying a couple of days, departed, saying they would come again next moon. Of them more anon. The next date, October 4th, will be a red-letter day to all of us, for on it we were rescued from the death which was staring us in the face, by a military relief party sent by the Argentine Government.

"I had been out with my rifle from early dawn looking for deer along with Pool, our steward and photographer. We were returning to the ship, tired and weary and devoured by mosquitoes, after an unsuccessful hunt. As we got about a hundred yards from the boat we heard an extraordinary sound, which so took our breath away that it was a fraction of a second before we realised that it was a bugle call, and that relief was at hand. We rushed off towards the boat, reaching it just in time to hear the jingle of accoutrements, and a moment later to see a file of men approaching on mule-back at a trot. These, it transpired, were a party of twenty men of the 12th Regiment of cavalry, who had been sent out to look for us, and with them two of the men who had gone down with Page, and had acted as guides to the relief expedition. They told us the various news from below, and how all sorts of stories were afloat about us —that we had all been massacred by Indians—that we had starved to death—or that we were dying of scurvy. How an expedition of 30 men had started off to our relief three months ago and had never been heard of since; and how the Paraguayan Government had heard of our plight, and threatened to send a relief party itself if the Argentine Government did not do so forthwith; and finally how this party of men had been got together with some difficulty, owing to all the troops having been drawn to the scenes of fighting in the revolution, had set out, bringing 10 bullocks and 40 mules, and a supply of antiscorbutic medicines, &c., and after a toilsome march of 30 days, having lost their way badly, they had at last reached us. They brought word of the big revolution down below, and also of Page's death, and consequently the termination of the expedition. The next day young Page left the ship, taking a few soldiers as escort, and made his way safely down the Paraguay *en route* for Buenos Ayres. In a couple of days another party of soldiers goes down, and to them I entrust this letter, and hope it will reach you safely. I can scarcely say much as to the future. I had intended to spend some time in Paraguay, but this expedition has been so prolonged, that I fear I shall have to return home at once on leaving the river. However, that won't be for several months, and I don't expect to be back before April or May at the earliest. . . .

"Looking back upon the time I have spent on this expedition, I see a great extent of time wasted, but can also count a few points in which I have managed to further my scientific education. In particular as regards geographical distribution I have been able at least to form some faint idea as to what that means. Of taxonomy, especially ornithological, I have also much clearer ideas than before. But one of the chief intellectual gains I have made is on the views of human nature which have been forced upon me. I have seen it in some of its worst aspects, and finally I have seen it in its pure and natural form, unspoilt and unadulterated by so-called civilisation—in other words, I have come to know what is the meaning of the phrase 'noble savage,' for I have seen among these red-skinned warriors a race of 'gentlemen'—a race of brothers, ethically and socially a most interesting set. I shall in a few words tell you something about these red men, as they appeared to us on their last visit, when we had a whole tribe, numbering considerably over a hundred fighting men, about thirty of their women, and a number of children. In the first place, these Indians belonged to the Toba nation, famous as being the most powerful, the most warlike, and the most deeply treacherous of all the nations of the Gran Chaco. With them were three caciques or chiefs, one of which held the other two under his sway. The former cacique, Manoel, or in his own language Chordai iti was a small delicately-formed man, of fair complexion, beautifully proportioned, and of the slim build characteristic of the Guaranis of Paraguay, one of which he really was. Although small physically he had a very intellectual look, was very intelligent, and the iron will shown in his eyes explained the sway he held over all other chiefs for many days' journey around. He appeared at the head of his warriors quite unarmed, clad in a tiger skin coat, and walked up to us with a majestic mein, as one accustomed to lead men. We had him in to dine with us during the time he stayed, so I had considerable opportunities of studying his character. The other two caciques on the other hand, Lyaniteroi and Xwhynache, were typical Tobas, evidently as inferior to Manoel in mental as they exceeded him in bodily calibre. Now as to the 'jinetes' or warriors. Never was I so taken with any set of men—splendidly built, many of them were extremely handsome fellows. They varied much in stature, some being short, while on the other hand a large proportion of them ranged from 5 feet 11 inches to 6 feet 2 inches in height, and broad in proportion. Their skins were of a dusky red colour. The majority of them wore merely a strip of coarse striped caraguata cloth about their loins, forming a sort of petticoat reaching to about the knees. Around their waist was suspended a bag of the same material in which they carried their travelling requisites, their sticks for producing fire, a comb, a few raw fibres of caraguata, and various other little articles. They wore their hair thick and luxuriant, cut off at the level of the shoulders, and forming a fringe over the forehead in front. Ornamenting their heads most of them had beautiful ostrich plumes, while round their ankles and arms they had also frequently bands of feathers or furs. About their neck many wore necklaces made of mother-of-pearl, or of round berries, from which was sometimes suspended a sweet and soft-toned little whistle of hard wood. Their faces in the morning were plain, but during siesta, their time for toilet, they would get themselves up in full dress, painting their faces with a bright red clay, and also with bands of black passing down the nose and radiating from the mouth. I got on splendidly with these fellows, and it was very amusing to see the way in which they would come and lay their heads upon one's shoulder, or put their arms around one's neck in the most affectionate manner possible. One evening cacique Chordai iti beckoned me with an air of mystery to follow him, which I did, wondering what was coming. I soon found out, for producing his paint, he set to work upon my face, and in a short time he had transformed me into a most malignant looking red-skin, amongst the emphatic shouts and grunts of approval from his followers. If I were at all an impressionable person I should have entirely lost my heart to the 'Chinas,' or as the scoffing scientist would say, 'Homo ferus var Toba,'— ♀, for they were a very taking-looking set of little women. They were all small and delicately made, with as a rule fine features and beautiful figures, and every movement full of natural grace, perhaps due in part to the absence of restraint in the way of costume, as they wore just the same costume as the men—a strip of caraguata cloth folded round their waist so as to form a short petticoat. The chief difference in their 'get up' from that of the men was that they were tatooed, the custom being to tatoo the girls when they arrive at the age of puberty. These women are made to work, and when on the march they may be seen carrying the household gear on their backs, steadying their steps with the paddle of the canoe, while the lord and master carries nothing but his weapons. The Tobas live by hunting and fishing, and do not cultivate the ground. Their chief weapon both in war and in the chase is the bow and arrow—the bow very strongly made, of the dense heart-wood of various of the trees, with a string of twisted deer hide. The shafts of the arrows are made of cane, and the head of dense and heavy heart-wood of such trees as "cascaranda." The head of the arrow is very long, and is frequently serrated or toothed. Besides these ordinary arrows, each Indian has, as a rule, a few with larger iron heads, which he uses for the bigger and nobler game. Another of the Tobas' weapons is the terrible 'macána,' a short and heavy club of the same hard and heavy heart-wood, with a single blow of which he dashes out the brains of his enemy. However, all these things you will be more interested in when you have seen and handled them yourself. As I have mentioned several times, I was deeply attracted by the personality of these Indians, and cannot help thinking what a delightful thing it would be were one able to come and settle amongst these people, and teach them the goods of civilisation without its numberless vices; in fact, to add civilisation to nature, not to substitute it. Some of their social traits were very charming as well as touching. When any one got a supply say of tobacco from on board, he would at once divide it up with all his fellows; if he were given a plate of food as for himself, he would insist on sharing it with his companions. One day we gave a little boy a large piece of quince, 'dulce,' as a reward for his fetching some birds. He took it gleefully on shore; then seeing a big fellow looking at it as if he would like some, he at once broke it in two and gave half to his big 'brother,' and immediately after repeated the process—all the while with a look on his face as if he really thought that 'it is better to give than to receive.' I have mentioned this particular instance because it occurred in a boy of about ten, and was so remarkable to me; but the same beautiful spirit, socialistic, or call it what you like, was visible in all the transactions of the Indians during their stay. . . .

"I am sitting writing by the light of the full moon upon the upper deck of the 'Bolivia.' The air is warm and balmy, and filled with the croakings and chirpings of frogs and crickets; and as it is now near midnight, I must adjourn till to-morrow.

"27*th*.—This morning I shall just add a few odds and ends to this letter. I have enjoyed perfect health up here, and have had no real illness, unless one can so call the great weakness and utter incapability of doing anything whatever from which I suffered during the starvation period. I have never once found it unpleasantly warm since I arrived in South America—the highest temperature we have had (106° Fahr. in the shade) being one of the most delightful days I have ever experienced. On the other hand, I have suffered greatly from the cold on several occasions during the past winter, on some nights being quite unable to sleep although having over me a thick rug, an ulster, and the whole of my wardrobe. The cold was sometimes most intense, especially about sunrise, the mercury falling to below zero centigrade. The Chaco is famous for its insect pests, which, however, during the winter disappeared almost entirely, and are only now beginning to make themselves felt again. The worst of them is the 'Polvorino,' a fly so small as to be almost invisible, but the intensity of whose bite quite throws that of the mosquitoe into the shade. I have collected but few insects, as they disappeared to a great extent during winter. I have got a fair collection of birds, and the herbarium, although still small, is now beginning, with the advent of spring, to develop a little. The absolute want of any water-tight place on board I have found very objectionable, and have already on one occasion found nearly the entire collection of plants ruined. I have now adopted the plan of keeping it as far as possible in the open air when it is dry, and bringing it down to the saloon when the air is damp.

"Now as to the present and the future. We are at present resting at this point, being utterly unable to move owing to the river being almost completely dried up. The military party came up with instructions to take us off on mule-back, abandoning the steamer; but we, especially I, as you may well understand, are loth to leave the ship. For me it would mean simply losing all my collections, books, everything, as there are just enough mules to take ourselves off. So a commission of half a dozen men is to be sent down to the mouth of the river to wire to the owners of the vessel for instructions. So you will see that the future is rather doubtful for me. I may be down to the Rio Paraguay within a month or two *minus* collections, clothes, &c., or I may not be down for several months—preferably the latter; for I shall certainly stick to the boat if I can possibly manage it. I should be much disappointed to have to leave before midsummer, by which time most of the plants will be in flower and many in fruit.

"Now I shall wind up this tedious scrawl with all best wishes to you and yours. How delightful it will be to get amongst you all . . . how delicious it will be to have a talk with scientific people again. Except Dr Hermann Burmeister, I have not seen one since I arrived in South America. I suppose all sorts of wonderful things have taken place in the time I have been here. I have, of course, received no communication from the outer world, not even from my friends, much less the scientific world, for about a year, and one is appalled to think how utterly out of date and what an ignoramus one will be when one gets home."

## MEETING OF THE SOCIETY,

Thursday, January 8, 1891.

ROBERT LINDSAY, President, in the Chair.

Dr HUGH F. C. CLEGHORN, who was elected an honorary British Fellow at the last meeting of the Society, expressed his appreciation of the honour he had received from the Society, and intimated his intention to present to the Herbarium at the Royal Botanic Garden his collection of dried specimens of plants, and to the Library any botanical books in his possession that are wanting in the Library at the Royal Botanic Garden.

The President, on behalf of the Society, tendered thanks for this generous offer to Dr Cleghorn.

J. MELVIN LOWSON, B.Sc., and W. MAXWELL TRESS, were elected Resident Fellows of the Society.

RICHARD BROWN, C.A., and J. MELVIN LOWSON, B.Sc., were admitted Resident Fellows of the Society.

Presents to the Library, the Museum, and the Herbarium at the Royal Botanic Garden were announced.

The following Papers were read:—

### NOTE ON THE RELATION OF THE DENSITY OF THE NUTRIENT MEDIUM TO THE MACROSCOPIC FORM OF BACTERIAL GROWTH. By ALEXANDER EDINGTON, M.B., C.M., Syme Fellow; Assistant to the Professor of Surgery, Edinburgh University Lecturer on Bacteriology, Edinburgh Medical School, and Lecturer on Comparative Pathology, New Veterinary College Edinburgh.

(With Woodcuts, 1–5.)

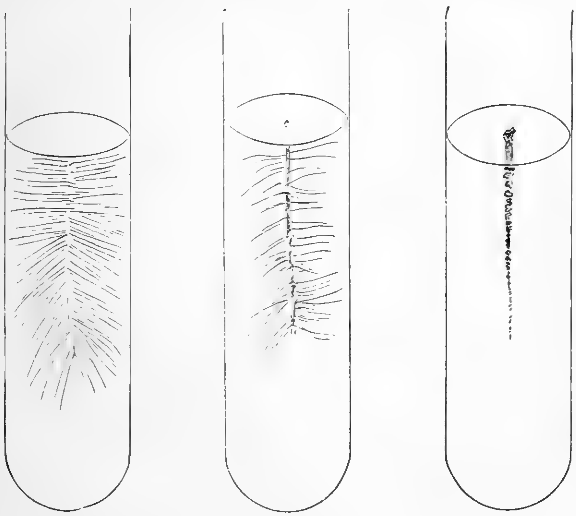
Great importance has been attached to the question whether, in the case of the lower fungi, and more especially of the bacteria, the different varieties and species are to be looked upon as absolutely distinct and constant in their possession of definite morphological characters and physiological properties, or whether these attributes of form and function which are known to us, and upon which as a basis rests our descriptive terminology, may not be liable to great variation dependent upon their external environment. We know, for instance, that the beautiful red pigment, which is always present in a cultivation of the *Micrococcus prodigiosus* under ordinary circumstances, may be absolutely wanting if the supply of oxygen is entirely withheld.

But if, however, from such a cultivation, kept up for innumerable generations without oxygen, a fresh culture is established to which oxygen is admitted, then we shall at once find that the red pigment is again formed in a normal amount. It has been lately stated that this organism, if grown in gelatinous media to which a minute percentage of phenol is added, loses the power of producing its pigment, and cannot again recover it. If this be so, and it has not been yet incontestably proved, then we should be much more readily prepared to believe the possibility of innumerable varieties being transmitted with more or less constant qualities under the direct influence of an unnatural environment. This convenient doctrine, however, is not likely to find general acceptance, inasmuch as the observations of the most reliable workers tend more and more to show that the bacteria are in their ultimate species more or less constant and immutable.

In this note attention is called to the fact that the form of growth of certain bacteria, if not of all, is liable to well-defined differences, according to the kind of nutrient medium upon which it is grown, and perhaps in greater degree to the density of this medium, if it be a semi-solid, and if the growth takes place as much in its substance as upon its surface. The organism to which one might look as exemplifying this is the *Bacillus arborescens,* found as a saprophyte upon the desquamating skin of scarlatinal patients (British Medical Journal, June 1886).

If one makes an inoculation of this organism into Koch's gelatine peptone, in which gelatine is present to the extent of 5 per cent., then the resulting growth will radiate from the needle track as a centre, forming in this way a most beautiful arborescence, and will not show any definite growth in the needle-track itself. If, however, one uses a gelatine

Fig. 1. Fig. 2. Fig. 3.



Diagrams illustrating the growth of *Bacillus arborescens* in gelatine of varying density. Fig. 1 in 5 per cent; Fig. 2 in 7·5 per cent; Fig. 3 in 10 per cent.

of 7·5 per cent., this arborescence will be somewhat coarser and less copious, and in the track of the needle there will be an evident growth of a denser kind.

If a still stronger gelatine be used, 10 per cent., then no arborescence at all will be found, but instead a firm, dense, coherent growth in the track of the needle, and slightly heaped above its site. Between these two culture forms, the 5 and the 10 per cent., we thus have nothing at all in common, and one ignorant of these facts would be certain of their being indeed altogether different organisms. In much the same way the familiar characteristic growth of the *Pneumococcus* of Friedlander, which consists in a nailhead-like growth upon the surface of the gelatine, can only be got in a strong gelatine. If a weaker gelatine is made use of, the surface growth tends to spread more over the surface of the medium, and hence to be not at all characteristic.

Dependent upon the temperature of the room in which the medium is placed, we shall further find that its strength, as regards the gelatigenous power, will be subject to great modification. With us here we find that in the winter a 5 per cent. gelatine is quite as firm as is a 7·5 gelatine in the summer. If, however, one goes farther south, the gelatine

Fig. 4.

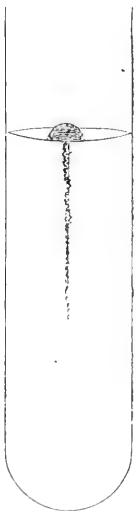


Fig. 5.

Diagrams illustrating the growth of *Pneumococcus* in gelatine of varying density. Fig. 4 in 5 per cent.; Fig. 5 in 10 per cent.

must be increased in order to obtain firmness. Thus, as the form of growth varies in relation to the gelatigenous density, if an observer cultivated the *Bacillus arborescens* in a very warm climate, in a 10 per cent. gelatine, he should obtain an arborescent growth. If such a growth was then described as obtained in a medium of that density, and if one obtained similar material and attempted to corroborate the observer's description working in this country, then it is self-evident that his attempts would end in failure, owing to the fact that in our country a 5 per cent. gelatine is just as firm as a 10 per cent. gelatine in a warmer country.

Such observations show to us the absolute necessity not only of carefully recording the nature of the medium with which our work is made, but also of registering most accurately the daily temperatures of the place in which the cultivation is made. If this be consistently adopted, the result will be that a greater possibility of constant growth-characteristics will accrue, and the identification of species in the light of previous descriptions will be more readily accomplished.

In conclusion, the use of this organism (*B. arborescens*) might be suggested in all bacteriological laboratories as a test for the gelatigenous power of the media in use. The practical utility of this suggestion is the more manifest when we consider that dependent upon the amount of boiling to which the gelatine is subjected, the gelatigenous power will vary, and as it is quite impossible at present to give any standard for the amount of boiling which should be adopted, it is necessary to be able conveniently to discover the gelatigenous power in the medium when it has been prepared for use.

## ON THE STRUCTURE OF TMESIPTERIS FORSTERI, Endl. By J. MELVIN LOWSON, M.A., B.Sc.

The author described at length the structure of this plant in the mature state, which is now growing in the Royal Botanic Garden, pointing out differences between his interpretation of the facts and the statements made by Bertrand, based upon the examination of dried material.

Dr WILSON, commenting on a remark that the gametophyte of *Tmesipteris* was as yet unknown and that the allied *Psilotum* was permanently apogamous, stated that in course of the preceding year he learned from Dr Macleod of Ghent that the germination of the spores of *Psilotum* had been recorded there, but that, unfortunately, the phases of germination and development of the sexual generation had not been described by the observer who noticed the fact.

## METHODS OF DIFFERENTIAL NUCLEOLAR STAINING.
By GUSTAV MANN.

As far as I am able to ascertain, Guignard* was the first to describe a differential nucleolar stain by a certain mixture of methyl-green and fuchsin, but he does not specify any proportion of admixture, though he repeatedly mentions the fact of the differentiation. I am unable to follow him in his method, and, notwithstanding many trials have failed to get his differential stain, namely, the chromatin-elements of the nucleus green and the nucleolus red by means of methyl-green and fuchsin.

While endeavouring to stain the nucleolus and indo-nucleolus differentially, my attention was drawn by Dr Macfarlane to heliocin as a good nuclear stain for *Spirogyra*. By extending its action in combination with aniline-blue to other tissues, I have succeeded in obtaining an excellent differentiation :—

METHOD.—Tissues, both vegetable and animal, preferably fixed by my picro-corrosive method,† are treated for ten minutes in a saturated solution of heliocin in 50 per cent. alcohol, the sections are then transferred for from five to fifteen minutes to a saturated watery solution of anilin-blue. The superfluous stain is rapidly washed off by distilled water, and the sections placed again for one to two minutes in the heliocin-solution, dehydrated, cleared by resinified turpentine, and mounted in turpentine-balsam.

EFFECT.—The whole of the cell and the nucleus blue, the nucleolus red. In karyokinetic figures the cell and nuclear barrel are stained blue, the nuclear plate, monaster and diasters stained red.‡

The chemical constitution of the heliocin I used I am unable to find out; when dry it is a brick-red powder, readily soluble in water, slightly so in absolute alcohol, and in each case showing no fluorescence. A watery solution is

* Ann. Sc. Nat., sér. 6, vol. xx. p. 318.

† See Trans. Bot. Soc. Edin., vol. xviii. (1890) p. 432.

‡ I may state that in dividing cells of the root of *Nymphæa alba*, we may stain the whole of the cell pink, and the nuclear plate, monasters and diasters blue, by treating sections first with alcoholic eosin and then with alcoholic methylene-blue.

of an orange brick-red colour. My friend Mr Terras was kind enough to test this heliocin chemically, and found it to act thus:—

The dye dissolves in concentrated sulphuric acid with a red orange colour, which on boiling becomes dark brown. Water added to the dark brown fluid does not produce any precipitate. Hydrochloric acid added to the solution in water gives no precipitate, and does not change the colour. Zinc dust added to the acid solution decolorises it in the cold easily, and the colour does not return on exposure to the air. Strong caustic potash added to the watery solution of the dye produces no change either in the cold or when boiled. Zinc dust added to the alkaline solution decolorises it in the cold.

Besides the heliocin just described another one is in the market, a dark brownish-red powder soluble in water, with a distinct fluoroscence, readily soluble in alcohol, and giving the reactions of true eosins.

One should endeavour to get the heliocin first described, for it makes a beautiful contrast with the blue, and allows one to study the finer structure of nucleoli.

Should either of the two heliocins not be obtainable, any of the eosins, or erythrosins, may be substituted, when treating vegetable tissues, while for animal tissues safranin makes a tolerably good substitute.

Another differential stain is got by placing living tissues for at least a week in a saturated picric acid solution of absolute alcohol, to which that variety of nigrosine known as alcohol-soluble nigrosine has been added. After-staining the sections with eosin or Kleinenberg's hæmatoxylin causes the nigrosine to be replaced by either dye leaving only the nucleolus of a greenish-blue colour.

Dr MACFARLANE remarked that Mr Mann's investigation tended to confirm observations he had communicated to the Society some years ago, in which he recorded the existence of an endo-nucleolus as a constant body, and pointed out the importance of the nucleolus itself as a definite and important factor within the nucleus. His observations had been as yet altogether passed over by workers, alike on the vegetable and the animal side; but he still held the views he had formerly enunciated, and he hoped Mr Mann would be able yet to discover a differential stain for the endo-nucleolus in addition to that for the nucleolus he had announced to the Society.

COMMENTARIES ON BRITISH PLANTS. No. I. — THE COARSE ANATOMY OF THE WOOD OF THE STEMS OF BRITISH PLANTS. By Prof. BAYLEY BALFOUR and Dr MUIRHEAD MACFARLANE.

The authors stated that they had been for long engaged in preparing an account of the morphology of British plants, and that their attention having more recently been directed to the structure of woods, they now exhibited to the Society by means of the lantern, the structure of the wood of plants sindigenous to or naturalised in Britain. Projections of the wood of the following plants were then exhibited on the screen :—*Juniperus communis, Pinus sylvestris, Taxus baccata, Clematis Vitalba, Berberis vulgaris, Cheiranthus Cheiri, Helianthemum vulgare, Tamarix gallica, Hypericum Androsæmum, Hypericum calycinum, Lavatera arborea, Tilia europæa, Ilex Aquifolium, Euonymus europæus, Rhamnus catharticus, Rhamnus Frangula, Acer campestre, Acer Pseudoplatanus.*

A continuation of this exhibition was postponed to a subsequent meeting of the Society.

ON TEMPERATURE AND VEGETATION AT THE ROYAL BOTANIC GARDEN, EDINBURGH, DURING THE MONTH OF DECEMBER 1890. By ROBERT LINDSAY, Curator of the Garden.

The month of December was, on the whole, a favourable one. A good deal of frost occurred during the month, but not so severe as to do much injury to vegetation. Comparatively tender plants are, so far, uninjured in the open ground. No snow fell, and there was a very light rainfall. The thermometer was at or below the freezing point on twenty occasions, the aggregate amount of frost registered being 121°, as against 70° for the corresponding month of 1889. The lowest readings occurred on the 10th, 20°; 19th, 22°; 20th, 22°; 21st, 20°; 22nd, 17°. The lowest day temperature was 30°, on the 13th; and the highest, 56°, on the 1st. Not a single plant came into flower on the Rock Garden during December. The total number of species and well-marked varieties which have flowered on the Rock Garden during the year 1890 amounts to 1353, being 131 less than during 1888. The deficiency occurred during the months of June and July. The largest number of plants came into flower during May. Usually by far the greatest proportion blooms in June. The number of species which came into flower each month was as follows:—January, 37; February, 25; March, 73; April, 150; May, 365; June, 346; July, 204; August, 81; September 47; October, 23; November 2; December 0:—total, 1353. A record has been kept, showing the date when each plant was first observed in flower.

Readings of exposed Thermometers at the Rock Garden of the Royal Botanic Garden, Edinburgh, during December 1890.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 44° | 49° | 56° | 17th | 32° | 34° | 38° |
| 2nd | 45 | 46 | 51 | 18th | 28 | 29 | 34 |
| 3rd | 35 | 38 | 44 | 19th | 22 | 28 | 35 |
| 4th | 33 | 37 | 42 | 20th | 22 | 25 | 36 |
| 5th | 35 | 38 | 42 | 21st | 20 | 22 | 35 |
| 6th | 35 | 38 | 43 | 22nd | 17 | 25 | 36 |
| 7th | 26 | 33 | 41 | 23rd | 30 | 38 | 43 |
| 8th | 32 | 35 | 45 | 24th | 30 | 36 | 42 |
| 9th | 33 | 34 | 38 | 25th | 27 | 28 | 40 |
| 10th | 20 | 28 | 38 | 26th | 29 | 35 | 40 |
| 11th | 28 | 34 | 39 | 27th | 31 | 33 | 38 |
| 12th | 27 | 35 | 40 | 28th | 32 | 35 | 38 |
| 13th | 27 | 29 | 30 | 29th | 25 | 30 | 38 |
| 14th | 19 | 27 | 39 | 30th | 33 | 36 | 38 |
| 15th | 29 | 35 | 43 | 31st | 33 | 35 | 39 |
| 16th | 33 | 35 | 39 | | | | |

[TABLE

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of December 1890.

Distance from Sea 1 mile. Height of Cistern of Barometer above Mean Sea-level 71·5 feet. Hour of Observation 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | S. R. Thermometers Min. | Hygrometer. Dry. | Hygrometer. Wet. | Direction of Wind. | Clouds. Kind. | Clouds. Amount. | Clouds. Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·769 | 51·7 | 41·1 | 50·8 | 49·2 | W. | ... | 0 | ... | 0·185 |
| 2 | 29·698 | 53·7 | 47·0 | 47·5 | 47·2 | W. | Nim. | 10 | W. | 0·820 |
| 3 | 29·753 | 49·5 | 38·2 | 40·1 | 37·9 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 4 | 29·993 | 42·9 | 36·1 | 39·1 | 36·7 | E. | Cum. | 10 | E. | 0·050 |
| 5 | 29·969 | 42·0 | 38·8 | 40·5 | 37·1 | E. | Cum. | 10 | E. | 0·000 |
| 6 | 30·122 | 41·1 | 37·9 | 40·0 | 36·2 | E. | Cum. | 10 | E. | 0·042 |
| 7 | 30·183 | 41·0 | 31·0 | 35·0 | 34·8 | E. | Cum. | 10 | E. | 0·000 |
| 8 | 30·067 | 40·0 | 34·2 | 37·1 | 34·8 | E. | Cum. | 10 | E. | 0·000 |
| 9 | 29·978 | 41·6 | 35·6 | 36·0 | 34·3 | E. | Cum. | 10 | E. | 0·000 |
| 10 | 30·143 | 36·7 | 24·5 | 31·0 | 29·2 | W. | Cum. | 10 | W. | 0·000 |
| 11 | 30·004 | 38·9 | 30·2 | 34·5 | 34·0 | S.W. | Cum. | 4 | S.W. | 0·000 |
| 12 | 30·057 | 39·1 | 31·0 | 36·8 | 36·8 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 13 | 29·957 | 37·0 | 28·8 | 30·2 | 30·2 | S.W. | Nim. | 10 | S.W. | 0·000 |
| 14 | 29·933 | 30·1 | 22·8 | 28·4 | 28·0 | W. | Cum.-St. | 10 | W. | 0·000 |
| 15 | 29·678 | 38·9 | 27·8 | 37·2 | 35·6 | N. | Cum. | 10 | N. | 0·052 |
| 16 | 29·891 | 42·2 | 36·0 | 37·1 | 34·4 | E. | Cum. | 10 | E. | 0·000 |
| 17 | 29·949 | 38·3 | 34·9 | 35·7 | 33·2 | S. | Cum. | 10 | S. | 0·000 |
| 18 | 29·739 | 37·2 | 31·4 | 32·7 | 29·5 | S.E. | Cum. | 5 | S.E. | 0·000 |
| 19 | 29·242 | 32·7 | 25·3 | 30·8 | 29·0 | E. | Cum. | 10 | E. | 0·000 |
| 20 | 29·704 | 31·9 | 26·2 | 27·6 | 26·9 | W. | Cum. | 10 | W. | 0·000 |
| 21 | 30·237 | 34·7 | 23·8 | 24·9 | 23·4 | W. | ... | 0 | ... | 0·000 |
| 22 | 30·132 | 39·3 | 21·1 | 30·0 | 29·0 | W. | Cum. | 5 | W. | 0·128 |
| 23 | 29·743 | 40·7 | 30·0 | 39·8 | 38·0 | W. | Cum. | 10 | W. | 0·000 |
| 24 | 30·237 | 42·0 | 30·3 | 31·1 | 30·9 | W. | ... | 0 | ... | 0·000 |
| 25 | 30·069 | 37·1 | 28·7 | 37·1 | 36·2 | S.W. | Cum. | 10 | S.W. | 0·070 |
| 26 | 30·400 | 37·9 | 32·2 | 37·8 | 34·6 | E. | Cum. | 9 | E. | 0·055 |
| 27 | 30·387 | 40·1 | 35·0 | 35·8 | 35·2 | E. | Cum. | 10 | E. | 0·015 |
| 28 | 30·262 | 37·0 | 34·7 | 36·0 | 34·7 | E. | Cum. | 8 | E. | 0·005 |
| 29 | 30·366 | 35·9 | 30·2 | 33·0 | 32·7 | N.E. | Cum. | 10 | N.E. | 0·010 |
| 30 | 30·531 | 37·8 | 32·2 | 37·8 | 34·4 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 31 | 30·342 | 37·9 | 36·1 | 37·1 | 33·9 | E. | Cum. | 10 | E. | 0·000 |

Barometer.—Highest Reading, on the 30th, =30·531. Lowest Reading, on the 19th, =29·242. Difference, or Monthly Range, =1·289. Mean=30°·017.

S. R. Thermometers.—Highest Reading, on the 2nd, =53°·7. Lowest Reading, on the 22nd, =21°·1. Difference, or Monthly Range, =32°·6. Mean of all the Highest =39°·6. Mean of all the Lowest=32°·0. Difference, or Mean Daily Range, =7°·6. Mean Temperature of Month=35°·8.

Hygrometer.—Mean of Dry Bulb=35°·8. Mean of Wet Bulb=34°·1.

Rainfall.—Number of Days on which Rain fell=11. Amount of Fall, in inches, =1·432.

On TEMPERATURE and VEGETATION at the BOTANIC GARDEN, GLASGOW, during NOVEMBER 1890. By ROBERT BULLEN, Curator of the Garden.

Frost was registered on twenty-three nights during the month. With two or three exceptions the temperature on other nights was either at or near the freezing point; the total readings for the month gave 115°, the lowest readings were 18° and 17° or 14° and 15° of frost during the nights of the 20th and 21st. 15° of frost is the lowest temperature registered here since December 1886, when 17° of frost was recorded, and a total of 191° for twenty-eight nights. The very light frosts and fine days experienced during the first half of the month were very favourable to out-door work of all kinds; the latter half was more winter like, with dark and foggy weather, but little rain or snow, and altogether we had a fine month, and in singular contrast to the very severe frosts and snowstorms experienced in various parts of England, especially in the south, where the temperature in several places has fallen near to zero. In the north of Scotland, near the town of Wick, a correspondent of a Glasgow paper writes: "We have in the garden roses and all sorts of flowers in full bloom, and strawberries full size (but not ripe). I never saw the like before." Personally I had some doubts of the accuracy of the statement, and wrote to a gentleman whom I could rely upon for the truth. Reply as follows: "The paragraph you send is in the main correct; the temperature only once or twice fell to freezing point; roses are in bloom, but as to strawberries I cannot speak, but our weather has recently been very remarkable for its mildness." To-night, January 3, it is very pleasant.

## MEETING OF THE SOCIETY,

Thursday, February 12, 1891.

ROBERT LINDSAY, President, in the Chair.

ALEXANDER EDDINGTON, M.B., and J. PENTLAND SMITH, M.A., B.Sc., were elected Resident Fellows of the Society.

THOMAS JAMIESON was elected non-Resident Fellow of the Society.

CHARLES TAYLOR was elected Associate of the Society.

Presents to the Library, Museum, and Herbarium, at the Royal Botanic Garden, were announced.

The CURATOR exhibited specimens of *Galanthus Fosteri*, *Iris stylosa*, and *Hamamelis japonica*, all in flower, from the Royal Botanic Garden.

Professor BAYLEY BALFOUR exhibited a specimen of Prince wood (*Cordia ?*) bored by beetles, presented to the Museum of the Royal Botanic Garden by Dr Underwood, Foo-choo. He also showed a section of a stem of copper beech, with the characteristic reddish pink coloration of the outer layers of the alburnum, which is due to a red sap filling especially the cells of the uniseriate medullary rays.

Mr JAMES GRIEVE exhibited specimens of *Calluna vulgaris*, which bears both purple and white flowers on the same plant; and also a golden variety of the same species.

Mr FORGAN stated that, at the request of Professor Balfour he had made a microscopic front for the oxyhydrogen lantern which the Professor was to use that evening.

Issued March 1891.

There was nothing new about the apparatus except this, that he had put on the front of it an iris diaphragm of the newest design, which he believed to be the first time it was used in this way. The effect it had was this, that by a simple turn of the lever handle the size of the disc on the screen could be reduced from full aperture to any extent, and in this way any portion of an object on the screen could be brought more prominently into view when the image was restricted to that particular part. The iris diaphragm was no new invention. The first who used it, so far as he was aware, was the optician Ramsden, of London, about the end of last century. He employed a couple of brass plates with rectangular apertures cut in each. These plates were made to approach and recede from each other by mechanical means, so that the apertures in each met and gradually closed. The opening, however, was not a round one. Ramsden applied this to the telescope only, and the use of it does not appear to have been brought prominently into notice until Mr Wales, an American optician, adapted a diaphragm of this kind to his microscopes about the time of the Centennial Exhibition in America. He, however, constructed his iris in a different way. He had a short tube, the upper part of which was shaped like a cone inside. Into this conical portion a piece of thin tube, split into a number of leaves, was made to screw up and down by a simple arrangement. The split leaves were thus compelled to overlap each other and close the aperture. This produced a very nearly round hole, varying in size according to the degree to which the overlap took place. This form is still made and used in the cheaper form of microscopes, such as the "Star" microscope, by Messrs Beck & Beck of London.

The iris now shown, however, is made in a different way. Thin steel plates, about 1-100 of an inch thick, and very like the shape of one's bent finger, and varying in number from 10 to 15, are fixed at one end by a pin through each, and on which they are all made to turn close together by means of pieces attached to the other end of each plate, working in a second slotted circular frame. This form of iris was first made in a ruder way by means of four plates only, but these merely gave a near approach to a circle. That now shown is one made by Messrs Watson & Son of London, on the plan adopted by Zeiss of Jena, and now universally used in the construction of iris diaphragms by all opticians. The mechanism for working the plates requires a less breadth of surrounding ring, and therefore occupies less space than formerly, and when the plates are about a dozen or more in number, the aperture is about a perfect circle. No first-class microscope is now made without an iris, which is the most perfect and rapid microscope shutter made. The ring is so narrow that various makers now put them inside the mounts of photographic lenses, only the end of the lever being outside the tube. They are also placed by some makers, such as Messrs Cooke of York, in front of large telescope objectives to enable the observer to reduce the aperture when required. The iris is one of these small time-saving accessories to an instrument which those who once have experienced its use would not readily do without.

Mr E. M. HOLMES sent for exhibition specimens of *Geaster striatus*, D.C., and wrote :—The plant was met with near Sevenoaks, in Kent, in October, growing among the stems of a hazel bush which had been cut down on a bank in front of a hedge. The hedge had been trimmed, and the bushes on the level bank (about a yard across) had been cut close to the ground. The *Geaster* looked so like scattered chips of hazel bark which were lying with it, that had it not been for the nearly globular inner peridium I should not have noticed the plant. I mention these details to show how easily a plant, considered rare, might not really be so rare as is supposed, but might be overlooked. In all the plants, even the smallest that I saw, the outer peridium was already expanded, and the point of attachment to the ground not visible, on account of the recurved segments having raised the plant from the ground. *Geaster striatus* is reported from Yarmouth, and as growing among sand. The soil in the lane where the plant grew at Sevenoaks is a sandy loam on greensand formation. The species resemble *G. limbatus*, Fr., but differs in the mouth being prominent, conical and sulcato-striate, instead of depressed and fimbriato-pilose. In *Geaster Bryantii* Berk., which also resembles it, there is a channel round the top of the peduncle, which is not present in *G. striatus*.

Mr E. M. Holmes also sent for exhibition specimens of *Mollia fragilis*, Lindl., along with the following comments:—In Braithwaite's *British Moss Flora* (pp. 254–5) this moss is stated to occur on "wet mountain rocks," and the localities there given are Ben Lawers, Clova, Ben Laoigh (Perth), and Roundstone (Connemara). It is stated to be very like *Mollia tortuosa*, but distinguished by its "straight leaves with longly excurrent triangular nerve." During a visit to Tent's Muir sands, near the mouth of the Tay, last August, under the guidance of Mr W. Smith of Arbroath, I went to see *Distichium inclinatum* and *Catascopium nigritum in situ*, so as to observe their mode of growth, and the character of the ground they prefer. Whilst searching for these plants we found a moss which, to the naked eye, looked almost exactly like a *Campylopus*, growing in similar dense tufts, and having the secund habit and shining narrow leaves of that genus. But I noticed that the leaves were nearly all broken at the tips, a character possessed, so far as I remember, by only three of our native mosses—*Barbula sinuosa*, *Mollia nitida*, and *Mollia fragilis*. The first two species are both remarkably crisped when dry, and quite different in habit from *Mollia fragilis*. On placing a leaf of the Tent's Muir plant under the microscope, it was evidently *Mollia fragilis*, and showed the hyaline cells at the base of the leaf characteristic of the section to which this species belongs.* This is the only feature in which it approaches *Mollia tortuosa*. It has not the least resemblance to it in habit. It is indeed so like a *Campylopus* that Schimper first gave it the manuscript name of *Campylopus Hartmanni*, and Bicchi sent it in fruit to Schimper as *Dicranum falcatum!* The point of interest, however, to which I desire to direct attention is the occurrence of this moss at the level of the sea, and within a few (100 at most) yards from the sea at high tide. It may be pointed out, in relation to this fact however, that Schimper (*Synopsis*, p. 220) states that it grows "in rupibus siccis atque in uliginosis litorum maris" ("prope Gevaliam Sueciæ"). On Tent's Muir it grew in damp sand, which doubtless is slightly calcareous from the abundance of shells in it. It is difficult to understand how the moss could have arrived in the place

* See Brit. Moss Flora, tab. xxxviii. fig. 9.

where we found it, except through the agency of birds that frequent both shore and mountain, since it has never been found in fruit in this country, and the fruit is extremely rare on the Continent.*

Dr R. Braithwaite suggests that the moss is *M. tortuosa* var. δ. *fragilifolia* of Juratzka, of which I have not seen the type specimen, nor has Dr Braithwaite. I have, however, seen the plant which the latter calls by this name, through the kindness of Mr C. P. Hobkirk, who sent me a portion of the same specimen that he gave to Dr Braithwaite. This was gathered by Dr Stirton on walls at Killin, and possesses the crisped character of the leaves of *Mollia tortuosa*, but the fragile tips of and papillose cells of *M. fragilis*, and might well be considered a hybrid between the two species (except for the fact of the rare production of fruit of both plants), as *M. fragilis* grows near by on Ben Lawers. Dr Stirton, however, has described it as a distinct species under the name of *Tortula thrausta*. It is not identical with the Tent's Muir plant, from which it differs in its crisped leaves, with margins obviously undulated when the plant is moistened.

The following papers were read:—

COMMENTARIES ON BRITISH PLANTS, No. 1.—THE COARSE ANATOMY OF THE WOOD OF TREES AND SHRUBS (continuation). By Professor BAYLEY BALFOUR and Dr J. MUIRHEAD MACFARLANE. (With lantern illustration of structure.)

In continuation of their account of the structure of the wood of trees and shrubs indigenous or naturalised in Britain, the authors described and projected on the lantern-screen sections of the wood of the following plants:—*Genista anglica*, *G. tinctoria*, *Ulex europæus*, *Cytisus Scoparius*, *Prunus com-*

* At the same time, but in a different spot, we were fortunate enough to meet with *Bryum calophyllum*, R. Br., and *Bryum Warneum*, Bland., and *B. lacustre*, Bland. These mosses are easily distinguished in the fresh state by the naked eye, but by no means so easily when dried. We also met with *Riccia crystallina*. *Bryum Marratii* also grows there, but is not in fruit until October or the end of September.

*munis, P. Avium, P. Cerasus, P. Padus, Dryas octopetala, Potentilla fragariastrum, Rosa rubiginosa, Rosa canina, Pyrus torminalis, P. Aria, P. Aucuparia, P. communis, P. malus, Cratægus Oxyacantha, Cotoneaster vulgaris, Ribes Grossularia, R. alpinum, R. nigrum, R. rubrum, Hedera Helix, Cornus sanguinea.*

The continuation of this exhibition was postponed to a subsequent meeting of the Society.

The lantern used in the exhibition had, adapted to its micro-front, the iris-diaphragm referred to by Mr Forgan (see page 53).

An interesting and exceptional condition in the stem of a plant of *Hedera Helix* was pointed out. In the pith, which normally is composed of uniform cells, a formation of cambium had taken place opposite each of the primary vascular bundles, from which a number of secondary tissue cells had been cut off. The wood in the vicinity of the pith showed signs of disintegration, and the presence of this adventitious cambium might be attributed to an attempt at the formation of a protective layer.

## An Examination of some Ericas collected by the Scottish Alpine Botanical Club in Connemara during 1890. By J. Muirhead Macfarlane, D.Sc., F.R.S.E.

(With Plate I.)

During the past year I carefully examined the British Ericas both by naked eye, lens, and microscopically, with the object of determining, if possible, the exact relations of the disputed form *E. Mackayi*. The interesting finds made by the members of the Scottish Alpine Botanical Club, in the home of the plant have induced me to bring together my observations, and to supplement these by a comparison of known forms with what is undoubtedly a new and striking addition to the list.

Few plants exhibit less tendency to variation than Heaths, whether in the wild or cultivated state. It therefore becomes a matter of some importance to note such variations, to attempt to summarize the new features of variation, to record the relative abundance and natural surroundings of the plant, and to ascertain, if possible, whether such variations appear to be constant or are perpetuated by seed.

It is only by the laborious collection of such data over a wide field, and comparison of them by many observers, that a real solution of some of the more difficult evolutionary problems may eventually be hoped for.

But, hitherto, such variations have almost entirely been examined by the naked eye or hand lens only, and the study of them has been greatly left to the group of botanists often contemptuously spoken of as "species-mongers." My aim will be to show that detailed microscopic examination is necessary if we are to appreciate fully their value in unfolding to us the relation which one species bears to another.

The Galway region of Ireland has proved exceptionally rich in Ericas, for there have already been recorded *E. ciliaris*, *E. mediterranea*, *E. cinerea*, *E. Tetralix*, and *E. Mackayi*, while there now falls to be added that form mentioned by Dr Craig at last meeting as having been first observed by Dr Stuart, and for specimens of which I am indebted to Mr Boyd and Mr Lindsay. I shall deal with these in the order mentioned.

*E. ciliaris*.—First recorded from Cornwall.* This species was found at Roundstone in 1846 by Mr J. F. Bergin, and by Professor Balfour in 1852. Two sheets of it occur in the herbarium of the Royal Botanic Garden, Edinburgh, one in Professor Balfour's writing, "near Roundstone, August 1852." Another with label, "Herb., Trin. Coll., Dublin," from the same locality but bearing no date, nor have I identified the writing as yet. I may here state that *E. Watsoni*, from Cornwall, is a perfectly blended histological reproduction of its parents, *E. ciliaris* and *E. Tetralix*.

*E. mediterranea*.—This species is found a few miles from the locality above given for *E. ciliaris;* and, as stated by Professor Babington in 1836, "it is in the greatest plenty, occupying the valley for more than a mile, and growing in tufts of from one to two feet in height." The members of the club can confirm this description.

*E. cinerea*.—As is usually the case on heaths, this species is very abundant about Roundstone.

* Cybele Hibernica, 1866.

*E. Tetralix.*—This being one of the parents of *E. Watsoni,* I examined by naked eye and microscopically a large series of examples from different localities during the past summer, and concluded that it was about as stable and unvarying a plant as one could select. Having made this statement I will now compare it with the two remaining and doubtful types.

*E. Mackayi.*—This form was discovered in 1835 by Mr W. Maccalla and Mr Ogilby,* and sent by the former to Dr Mackay, the discoverer of *E. mediterranea,* who at once saw that it differed considerably from the typical *E. Tetralix.* When forwarded for examination to Sir W. Hooker, it was named by him *E. Mackayi*; and after being gathered *in situ* by Professor Babington in 1835, it was named by him in 1836 *E. Mackayiana,*† so that the former name has preference. In the herbarium of the Royal Botanic Garden, Edinburgh, sheets from Professor Babington bear date August 1836, but this must either have been a mistake—unless he again visited the locality during the succeeding year—or the dates must have been altered, as seems to me in some instances to have been the case. A sheet from Dr Mackay bears no date. Sheets from Professors Graham and Balfour, and also from Dr Sibbald, all bearing date 1838, occur; also from Professor Balfour 1852, and from Mr Moore 1869. Mr Mackay, in forwarding his plant to Sir William Hooker, says, "The plant I send you resembles most, in size, mode of growth, and form of its leaves, which have glandular hairs, *Erica ciliaris,* in the disposition of its foliage and flowers, however, it is quite different; the former being arranged pretty generally in fours or occasionally in fives, in a whorl, and in the flowers which are in small terminal umbels. The corolla, which is shorter than that of *E. ciliaris,* is not contracted at the limb." Sir W. Hooker (p. 158), and later, H. C. Watson (p. 225), regarded it as a probable hybrid between *E. Tetralix* and *E. ciliaris.* Professor Babington, after describing it, and showing that it resembled both *E. Tetralix* and *E. ciliaris* in certain features, says, "There appears to be some doubt as to the specific distinctness of this plant, several of our best botanists (who have not seen it in its native

* Hooker's Companion to the Botanical Magazine, vol. i. p. 158.

† Trans. Linn. Soc., vol. ix. p. 119.

locality) being of opinion that it is only a very marked variety of *E. Tetralix.* I cannot, however, concur in that idea, as I noticed no intermediate states, although the latter was growing in the greatest luxuriance within a few yards of *E. Mackayiana.*" In Hooker and Arnott's *Flora* (6th edition, 1850) the following occurs :—" This, which is sometimes called *E. Mackaiana*, was first found in Ireland by Mr Wm. Maccalla and Mr Ogilby, and distinguished by Dr Mackay, and in the same year it was discovered on the Sierra del Perel, in Asturia, by M. Durien. The broad, almost exactly ovate, leaves, with a great proportion of nearly white surface beneath, would seem, at first sight, to distinguish this specifically from the preceding; to which it may be added, according to Mr Babington, that the upper surface of the leaves and their midrib are always glabrous, while these parts are downy in *E. Tetralix.* Perhaps, however, it may prove, by cultivation, to be only a more glabrous form, with larger foliage."

Moore and More * regard it as probably a hybrid. Sir J. Hooker ranks it as a sub-sp. of *Tetralix*, while Focke † says, "This plant is evidently a hybrid of *E. Tetralix*; the other parent is probably *E. ciliaris* (or *E. mediterranea* or *E. cinerea.*)

From my comparison of plant hybrids, I may safely say that if this be a hybrid it will be intermediate, microscopically, between its parents. That one of these is *E. Tetralix* could not be doubted. That the other parent cannot be *E. cinerea* or *E. mediterranea*, the structure of the leaf alone would make certain, even though we took no note of other and more divergent peculiarities.

As indicated by Babington, *E. ciliaris* considerably resembles it in the naked eye leaf-appearance, but, like the hybrid *E. Watsoni* of similar parentage, we should expect a unilateral, racemose infloresence, an irregular, instead of, as in our specimen, a regular corolla, reduced anther-tails, &c.; but the microscopic structure completely confirms the idea that these are not related, for, if we selected the leaf alone in *E. ciliaris*, we find that the glandular cilia are arranged in two rows on each edge of the quite flat leaf, not in a

* Cybele Hibernica, 1866.

† Die Pflanzen-Mischlinge, 1881.

single row, as in *E. Tetralix* and the two now being examined. The vascular bundle of the midrib shows a pretty large sclerenchyma growth on its upper side, but none or very little below. Hooker states that the cilia of the sepals are not gland-tipped, but all specimens of *E. Mackayi* that I have obtained shew these. I believe he referred here to Dr Stuart's type, which exhibits this peculiarity. The corolla is always regular and ovate-urceolate, as in *E. Tetralix.* The stamens in *E. Mackayi* and *E. Tetralix* have anther-tails, and in all that I have examined they are of equal length, or nearly so. The ovary of *E. Mackayi* is usually stated to be glabrous, but microscopically one finds hairs like those of *E. Tetralix,* but fewer and very much shorter. The style and stigma in both resemble each other, I regard it, therefore, with Hooker, as a well-marked variety or sub-species of *E. Tetralix,* differing in most of the characters he gives, but further, in the leaf being flat, the circum-stomatic epidermal processes longer, the sclerenchyma of the vascular bundles decidedly stronger below than above, the sepals ovate-acuminate with glandular-ciliate margins, and in the ovary being only slightly hairy.

I now pass to the form first found by Dr Stuart. Mr Lindsay informs me that it occurred quite near the area of rather dry, rocky ground, on which *E. Mackayi* grows, but in the rather boggy part adjoining the more natural habitat of *E. Tetralix.* Now it is curious to note that Babington's attention was arrested by the probable effects of environment, for he says *E. Tetralix* gradually dwindled in proportion to dryness of soil, and that *E. Mackayiana* did the same; when leaving the rock it encroached upon the bog by which it was surrounded, and on which its ally was remarkably flourishing, neither of them changing at all in character, but only in size and luxuriance. The specimens obtained covered an area of several square feet, and show greater difference in appearance and structure from *E. Tetralix* or *E. Mackayi* than do either of these from the other.

When examined with a lens the leaves are quite glabrous, and entirely devoid of the glandular cilia so well developed in the two just described. On microscopic examination, however, one to three small glandular cilia on the petiole may be seen, and at regular intervals along the leaf-margin are minute serrations, each developing a short hair, which I regard as the undoubted rudiment of the glandular cilia.

On transverse section (fig. 3) we find that the outline of the leaf is intermediate between that of *E. Tetralix* and of *E. Mackayi;* but the hairs round the stomata are equal in length to those of the latter, as if this were correlated in both with flatter leaf-surface, as compared with *E. Tetralix.*

But the floral parts exhibit special divergence from the others. The sepals are oval spathulate, and bear 7–9 long cilia devoid of gland-tips. The corolla is tubular, the free tips of the petals are expanded or reflexed, and the veins strongly marked, so that the blossom more resembles some of the Cape Heaths or Epacrids. The anthers have tails nearly or quite as long as in *E. Tetralix* or *E. Mackayi.* The ovary shows a flat or depressed apex and is glabrous, or has minute hairs over the top; the style is strongly exserted, and the stigma is flat or slightly rounded. The stigmatic hairs are much shorter than in its allies. I must therefore conclude that this is a very pronounced type of divergence from *E. Tetralix,* though the points of divergence do not lead to any other British form.

I may therefore be permitted to propose that it be named *Erica Tetralix,* sub-species *Stuarti,* as a small tribute to the enthusiasm and botanical discrimination of our Fellow, Dr Stuart.

But there is cultivated in gardens a form the exact origin of which I cannot trace, but which is named *E. Tetralix* var. *Lawsoniana.* Now, in every point of structure it is quite intermediate between *E. Mackayi* and *E. Stuarti,* the leaves as well as the sepals having non-glandular cilia. The corolla is tubular-urceolate, the anthers are tailed, the ovary is spherical or slightly depressed at the apex, and the style is strongly exserted.

Accepting the usual systematic character of *E. Tetralix,* we thus obtain four sub-species:—

Sub-species 1.—*Tetralix* proper; leaves strongly revolute, hairy above, glandular-ciliate, stomatic hairs minute; sepals oblong lanceolate glandular-ciliate; corolla ovoid urceolate; ovary spherical, hairy, and with glandular cilia; style slightly exserted.

Sub-species 2.—*Mackayi,* Hook; leaves nearly flat, glabrous except at tip, glandular-ciliate, stomatic hairs twice as long as in last; sepals ovate lanceolate, glandular-ciliate; corolla ovate; ovary spherical, glabrous or very slightly hairy; style exserted.

Sub-species 3.—*Lawsoniana*, Hort.; leaves slightly revolute, glabrous, and with long non-glandular cilia, stomatic hairs as in last; sepals oblong, slightly constricted in middle, and with non-glandular cilia; corolla tubular ovate; ovary nearly spherical, glabrous; style strongly exserted.

Sub-section 4.—*Stuarti*, Macf.; leaves half revolute, glabrous, with minute aborted cilia or marginal hairs, stomatic hairs as in two last; sepals oblong spathulate, with non-glandular cilia; corolla tubular, mouth open; ovary depressed, glabrous; style strongly exserted.

It is worthy of note that these, like most sub-species, deviate from the type condition, not in one or two structural details only, confined to one part of the plant, but that the whole organism seems to participate to a greater or less degree, in the tendency to variability when such occurs. In attempting to account for evolutionary change this is of the greatest moment.

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## EXPLANATION OF PLATE I.

### Illustrating Dr Macfarlane's Paper on Irish Ericas.

Fig. 1. Transverse section of leaf of *E. Tetralix*.
Fig. 2. „ „ *E. Tetralix*, sub-sp. *Mackayi*.
Fig. 3. „ „ *E. Tetralix*, sub-sp. *Stuarti*.
Fig. 4, *a*. Flower of *E. Tetralix*, enlarged 7 times.
*b*. „ „ sub-sp. *Mackayi*, enlarged 7 times.
*c*. „ „ „ *Lawsoniana*, „
*d*. „ „ „ *Stuarti*, „

Fig. 1.

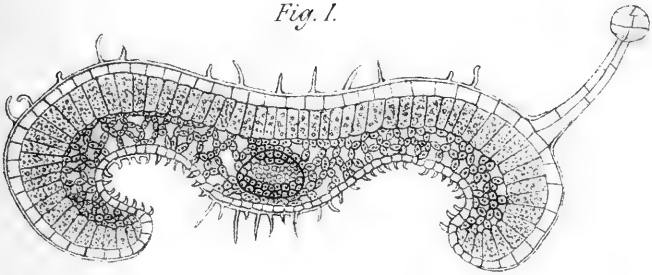


Fig. 2.

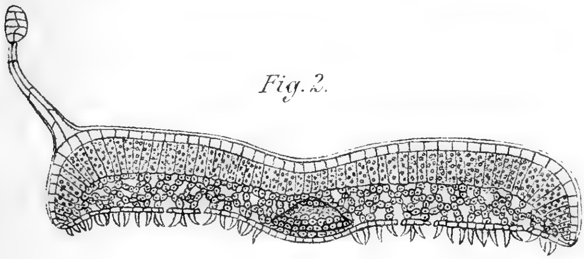


Fig. 3.

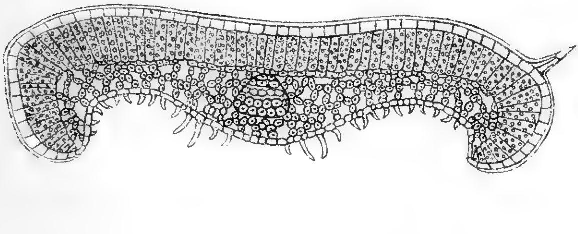
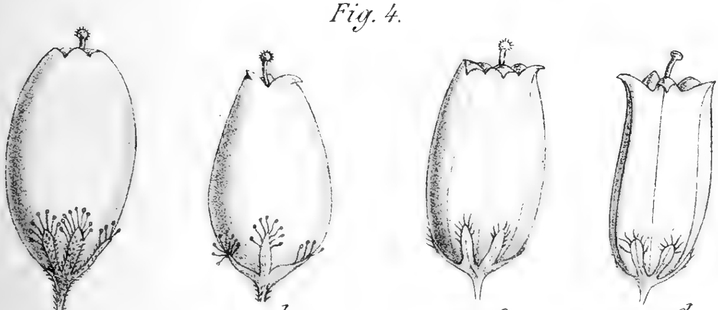


Fig. 4.




J. M. McF. et J. H. del.

F. Huth, Lith[r] Edin[r]

MACFARLANE.— ON ERICAS.

## POTATO DISEASE AND PARASITISM. By A. STEPHEN WILSON, North Kinmundy.

In The Gardener's Chronicle of October 7, 1882, I published an account of certain bodies I had discovered in the under side of the leaves of the potato, in all parts of the stems, but especially near the nodes, and in the tubers, especially around the eyes. These bodies I provisionally called sclerotiets, believing them to be analogous to the true sclerotia of various fungi. From subsequent observation and consideration, I have seen reason to alter my first views; and I now propose to call these bodies granules of mucoplasm. They are translucent microscopic globular bodies, coated with oxalate of lime, and infest all parts of the potato-plant, and are also to be found profusely under the skin of the tomato. My observations seem to authorise me to say, that from these granules in germination arises the mycelium of *Peronospora infestans*, and thus the disease in the tissue of the potato may break out at any part of the plant, or at all parts simultaneously, without translocation. Those granules of mucoplasm may be best seen in an early stage by germinating resting-spores on a glass slide; from the threads of mycelium arising from these there are exuded along the sides of the threads masses of granular plasm, and in those masses, after a while, the grains assume a globular form, and throw out fresh threads of mycelium—the granules are, in fact, equivalent to spores. Now, as the resting-spores are not parasitic, but live and germinate in the soil or in any dead matter, it is contact with the mucoplasm exuded from their fresh mycelium which originates the parasitism of *P. infestans* in the potato. And I think there are various analogies to warrant the conclusion that it is the invasion of the potato-plant by this parasite which is really the cause of the potato-tubers themselves. Various botanists have held that tubering in such plants is a mark of a diseased condition. I shall mention only one analogy. The galls called Devonshire galls, which grow in great numbers sometimes on the buds of oaks and some other trees, are simply fleshified buds; the leaves, instead of spreading out into a thin palm, become inspissated with the juices of the tree, and are thus agglomerated into a globular woody mass like a tuber. It is true, the cause of them is not vegetable but animal. One of the gall-midges deposits along with its egg a certain plasm, and this diverts the juices and tissues of the bud into an abnormal mass called a gall. In the same way the granules of *P. infestans,* invading the underground buds of the potato-stems, divert the starch of the plants into tubers. And as these tubers are infested in all parts, but particularly around the eyes, with the mucoplasm-granules, the germinal elements of the parasite are carried from one race of potatoes to the following, and from one season and country to another, not requiring invasion from without for new displays of the disease. Many trees are similarly haunted by their peculiar parasites, the plasm of which is carried by subdivision in the growing tissue from one season's leaves to another. And hence the impossibility of curing the disease of the coffee plant. Records exist of narrow escape from extirpation of some of our forest-trees by leaf-parasites. When once the young seedling has its roots invaded by the mucoplasm of its proper parasite, the parasite and the host go on leading a symbiotic life as long as the host lives, the parasite sometimes breaking out and fruiting itself, and sometimes lying quiescent in its mucoplasm granules. This theory fully explains all the phenomena of such parasitism; while the theory that assumes spores to be carried by the wind from one plant to another is destitute of a philosophy, and wholly shirks the question of where the first spore comes from. For resting-spores or any element of the non-parasitic system of a fungus do not give rise to the conidia of the fruited and matured parasite; they give rise only to the mycelium and mucoplasm, which is the true initial stage of the parasite, the form in which it can alone be absorbed into the higher plant. And this theory will also help to explain the transmission of the parasites of animal and human diseases from one generation to another.

## DEVELOPMENT OF THE MACROSPORANGIUM IN *Myosurus minimus*, Linn. PART I. By GUSTAV MANN.

The author pointed out that in *Myosurus minimus* and in *Ranunculus sceleratus* the cells of the periblem-layer elongate greatly in the developing nucellus, forming a mass of archesporial tissue; the central cell of this tissue, *i.e.*, the one opposite the plerome-element, outstrips the others in growth, its nucleus becomes of large size, the nucleolus remaining small, and by division it gives rise to three or four cells, which may be placed differently according to external conditions, such as pressure on the developing nucellus, &c., but which are mostly arranged in a vertical row. This row, the result of division of the physiological archesporial cell, is surrounded by cells derived from the non-physiological archesporial cells. All the walls of this row show gelatinous swelling, the walls of the cell giving rise to the embryo-sac included, except the wall abutting on the plerome-element. The reason for the greater development of the physiological archesporial cell, as also of that special cell which gives rise to the embryo-sac, is the greater supply of nourishment brought to these two cells by the plerome-elements, with which they lie in immediate contact; in support of this view may be urged the fact that in the developing sporangia of *Selaginella* and *Tmesipteris* the spore-tissue next the stalk develops quicker than that at the apex of the sporangium.

## ON TEMPERATURE AND VEGETATION AT THE BOTANIC GARDEN, GLASGOW, during JANUARY 1891. By ROBERT BULLEN, Curator.

Frost was registered on twenty nights during the month, and on several other nights the mercury was little above the freezing point; generally the readings were light, the total for the twenty nights being only 119°. The lowest reading was 13° during the night of the 17th. On five days the mercury remained at or a little below the freezing point. Dull, sunless weather and light fogs were frequent, and but little rain until the latter part of the month. The greatest depth of snow was 2 inches during the night of the 20th.

A gale of exceptional severity raged over this part of the country on the last day of the month, doing considerable damage over whole districts of country; otherwise the month was a fine one, as compared with that experienced in England and Europe generally.

Vegetation is in a more dormant state than in any previous January since 1886.

## ON TEMPERATURE AND VEGETATION AT THE ROYAL BOTANIC GARDEN during JANUARY 1891. By ROBERT LINDSAY, Curator.

During the past month of January, the weather experienced was more severe than it has been for that month since 1886; still, we have no such disastrous frosts to record as have been prevalent in the south of England. The thermometer was at or below the freezing point on seventeen occasions, indicating collectively 126° of frost for the month, as against 45° for the corresponding month last year. The lowest readings occurred on the 7th, 20°; 8th, 18°; 10th, 22°; 18th, 19°; 23rd, 21°. The lowest day temperature was 33° on the 21st, and the highest 53° on the 28th. West and south-west winds were prevalent. Rain fell on nine days, and snow on six days, during the month. The continuance of dull, cold weather has had the effect of retarding the flowering of spring plants considerably. Of the forty selected plants whose dates of flowering are annually recorded to the Society, the following five came into flower, viz.: *Rhododendron atrovirens,* on January 21; *Tussilago fragrans,* January 26; *Dondia Epipactis,* January 30; *Galanthus plicatus,* January 30; *G. nivalis,* January 31. At the same date last year as many as eighteen were in flower. On the Rock Garden only six plants came into flower during January, viz.: *Helleborus atrorubens, H. purpurascens, Primula inflata, Dondia Epipactis, Galanthus plicatus,* and

*Erica herbacea alba.* In January 1890, there were thirty-seven in flower. The only plants much injured by frost, so far, are *Veronica Lindleyana*, *V. Andersoni parviflora*, and *Eucalyptus globulus* and *E. coccifera.* Throughout the garden the most conspicuous plants in flower are *Jasminum nudiflorum*, *Hamamelis japonica*, *Cydonia japonica*, *Erica herbacea alba*, and varieties of *Helleborus niger*.

Readings of exposed Thermometers at the Rock Garden of the Royal Botanic Garden, Edinburgh, during January 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 35° | 36° | 43° | 17th | 23° | 28° | 37° |
| 2nd | 26 | 33 | 39 | 18th | 19 | 27 | 38 |
| 3rd | 33 | 35 | 42 | 19th | 29 | 30 | 40 |
| 4th | 34 | 37 | 42 | 20th | 30 | 40 | 45 |
| 5th | 24 | 27 | 39 | 21st | 23 | 24 | 33 |
| 6th | 23 | 26 | 34 | 22nd | 33 | 37 | 42 |
| 7th | 20 | 29 | 38 | 23rd | 21 | 42 | 50 |
| 8th | 18 | 29 | 36 | 24th | 33 | 37 | 42 |
| 9th | 26 | 27 | 34 | 25th | 28 | 38 | 44 |
| 10th | 22 | 30 | 38 | 26th | 33 | 43 | 49 |
| 11th | 29 | 39 | 47 | 27th | 38 | 47 | 53 |
| 12th | 37 | 42 | 48 | 28th | 38 | 47 | 53 |
| 13th | 38 | 40 | 49 | 29th | 34 | 40 | 50 |
| 14th | 30 | 35 | 39 | 30th | 35 | 38 | 47 |
| 15th | 27 | 33 | 42 | 31st | 34 | 40 | 44 |
| 16th | 33 | 34 | 43 | | | | |

[TABLE.

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of January 1891.

Distance from Sea 1 mile. Height of Cistern of Barometer above Mean Sea-level 71·5 feet. Hour of Observation 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 30·133 | 37·9 | 36·0 | 37·3 | 35·8 | S.E. | Cum. | 9 | S.E. | 0·012 |
| 2 | 30·109 | 39·9 | 30·0 | 35·0 | 35·0 | N.W. | Cum. St. | 10 | N.W. | 0·002 |
| 3 | 30·069 | 37·9 | 34·4 | 37·3 | 37·3 | S.E. | Cum. St. | 10 | S.E. | 0·122 |
| 4 | 30·024 | 41·1 | 35·5 | 38·9 | 37·9 | N.E. | Nim. | 10 | N.E. | 0·000 |
| 5 | 30·317 | 38·9 | 28·8 | 31·7 | 29·8 | N. | ... | 0 | ... | 0·000 |
| 6 | 30·472 | 36·4 | 27·7 | 29·1 | 27·8 | N.W. | Cum. | 9 | N.W. | 0·000 |
| 7 | 30·221 | 37·7 | 28·2 | 31·5 | 30·2 | N.W. | Cum. | 9 | N.W. | 0·000 |
| 8 | 29·711 | 35·5 | 21·0 | 31·5 | 30·5 | S.E. | Cum. | 2 | W. | 0·000 |
| 9 | 29·939 | 35·1 | 29·2 | 29·8 | 29·0 | W. | Cum. | 6 | W. | 0·000 |
| 10 | 30·311 | 32·9 | 25·0 | 32·9 | 31·7 | S.W. | Cum. | 9 | S.W. | 0·000 |
| 11 | 30·253 | 42·0 | 31·9 | 42·0 | 39·2 | W. | Cum. | 10 | W. | 0·000 |
| 12 | 30·459 | 45·6 | 41·5 | 44·4 | 43·8 | W. | Cum. | 10 | W. | 0·000 |
| 13 | 30·539 | 47·2 | 41·0 | 41·5 | 39·6 | W. | ... | 0 | ... | 0·010 |
| 14 | 30·635 | 47·8 | 34·1 | 36·5 | 32·2 | N. | Cum. | 1 | N. | 0·000 |
| 15 | 30·512 | 37·3 | 24·2 | 34·8 | 32·0 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 16 | 30·201 | 41·1 | 34·0 | 36·1 | 34·5 | N. | Cum. | 10 | N. | 0·000 |
| 17 | 30·307 | 37·0 | 28·0 | 29·8 | 28·9 | W. | Cum. | 8 | N.E. | 0·000 |
| 18 | 30·339 | 32·9 | 23·5 | 27·9 | 26·3 | N.W. | Cum. | 9 | N.W. | 0·000 |
| 19 | 30·010 | 33·2 | 26·8 | 33·2 | 32·2 | W. | Nim. | 10 | W. | 0·028 |
| 20 | 29·271 | 42·5 | 32·9 | 42·5 | 40·6 | S.W. | Nim. | 10 | S.W. | 0·076 |
| 21 | 29·196 | 43·7 | 26·1 | 26·7 | 26·7 | W. | ... | 0 | ... | 0 000 |
| 22 | 29·155 | 34·7 | 26·2 | 30·9 | 30·2 | W. | ... | 0 | ... | 0·022 |
| 23 | 29·078 | 44·7 | 25·8 | 43·8 | 41·8 | W. | Cum. | 1 | W. | 0·058 |
| 24 | 29·166 | 39·7 | 38·9 | 37·6 | 36·3 | W. | Cum. | 8 | W. | 0·000 |
| 25 | 29·655 | 41·3 | 32·4 | 37·8 | 34·6 | W. | ... | 0 | ... | 0·031 |
| 26 | 29·581 | 45·0 | 36·8 | 45·0 | 41·9 | W. | Cum. | 10 | W. | 0·065 |
| 27 | 29·478 | 48·9 | 40·1 | 40·6 | 38·9 | W. | ... | 0 | ... | 0·018 |
| 28 | 29·515 | 47·0 | 39·2 | 47·0 | 44·1 | S.W. | Cum. | 10 | S.W. | 0·010 |
| 29 | 29·512 | 51·3 | 38·0 | 42·8 | 40·8 | S.W. | Cum. | 10 | S.W. | 0·040 |
| 30 | 29·683 | 47·8 | 36·3 | 40·5 | 39·1 | W. | Cum. | 8 | W. | 0·016 |
| 31 | 29·255 | 44·1 | 37·2 | 43·4 | 39·9 | S.W. | Nim. | 5 | S.W. | 0·051 |

Barometer.—Highest Reading, on the 14th, =30·635. Lowest Reading, on the 23rd, =29·078. Difference, or Monthly Range, =1·557. Mean=29·908.

S. R. Thermometers.—Highest Reading, on the 29th, =51°·3. Lowest Reading, on the 8th, =21°·0. Difference, or Monthly Range, =30°·3. Mean of all the Highest =41°·0. Mean of all the Lowest=32°·0. Difference, or Mean Daily Range, =8°·9. Mean Temperature of Month=36°·4.

Hygrometer.—Mean of Dry Bulb=36°·8. Mean of Wet Bulb=35°·1.

Rainfall.—Number of Days on which Rain, or Snow, fell=15 Amount of Fall, in inches, =0·561.

## MEETING OF THE SOCIETY,

Thursday, March 12, 1891.

ROBERT LINDSAY, President, in the Chair.

WILLIAM G. SMITH was elected Resident Fellow of the Society.

GEORGE HUNTER, M.D., F.R.C.S.E., was admitted Resident Fellow of the Society.

The volume of Transactions of the Society in Session 1889–90 (Vol. XVIII.) was laid on the table. The president directed the attention of members to the many interesting and valuable communications contained in it.

Presents to the Library, Herbarium, and Museum at the Royal Botanic Garden were announced.

Mr MALCOLM DUNN exhibited shoots of *Sciadopitys verticillata,* bearing cones, with ripe seeds, from plants grown in Surrey, and remarked that the earliest record of the Umbrella Pine is that of Thunberg, in 1784, who describes it in his Flora Japonica as a species of yew, under the name of *Taxus verticillata.* Many years after that date its true character was determined by Siebold, who gave it the scientific name it now bears, *Sciadopitys verticillata,* which is a literal translation of the popular Japanese name, "Parasol Pine." In Veitch's Manual of the Coniferæ, 1881, it is said that "its restricted habitat and comparative paucity of numbers are significant facts in its present condition. Found wild only in one locality of limited extent—on Mount Kojasanin, in the Island of Nippon—and in proximity to a dense population in a country in which the forests are rapidly disappearing, the fate of the *Sciadopitys* will not remain long in suspense." The tree grows to a height of upwards of 100 feet, with a stem 10 to 12 feet in circum-

Issued April 1891.

ference. It is much planted around temples and other sacred places, as well as in the private grounds of the wealthy Japanese, and forms a handsome and attractive feature in the landscape. It is also a valuable timber tree, as the specimens of it exhibited at the Forestry Exhibition at Edinburgh in 1884, by the Government of Japan, clearly showed, by the excellent quality of the wood and the large size of some of the planks, which were nearly 3 feet across.

The first living plant was introduced to England in 1853 by Mr Thomas Lobb, plant-collector for Messrs Veitch of Exeter, who obtained it from the garden of the Dutch Governor of Java. It arrived at the Exeter Nursery in a sickly condition, and ultimately died. Eight years afterwards, in 1861, cones and seeds were sent home from Japan by Mr John Gould Veitch to Messrs James Veitch & Sons of Chelsea, and from these most of the finest specimens of the Umbrella Pine now growing in the British Isles were raised. In the same year, 1861, it was also sent from Japan by Mr Robert Fortune to Mr Standish of Bagshot, Surrey.

It has proved perfectly hardy in Britain since its introduction thirty years ago, coming through our severest winters quite uninjured; but its rate of growth is rather slow, seldom exceeding 8 or 9 inches in a year. It forms a handsome small tree, and is always an object of interest on a lawn or in ornamental grounds from its pleasing aspect and the curious umbrella-like arrangement of its leaves, or rather cladodes. Among the finest specimens in Britain is a very handsome one belonging to Messrs Veitch of Chelsea, growing in their Coombe Wood Nursery, near Kingston-on-Thames. It is one of the plants raised from the seeds sent home in 1861 by Mr J. G. Veitch; and so also, I believe, was the fine specimen exhibited by the firm at the Forestry Exhibition in 1884. Of the many Umbrella Pines growing in the Pinetums and Ornamental Grounds in the United Kingdom, I am not aware of any having yet reached a height of 15 feet, except it be the one referred to at Coombe Wood. We have a nice small specimen in the gardens at Dalkeith, planted about ten years ago. It is growing in a light loam, on an open gravelly subsoil. It has always been healthy, was about 18 inches high when planted, and is now over 5 feet in height, growing on an average about 6 inches annually. For the past three years it has produced, every season, a few male flowers, but no female cones have yet appeared.

When the Umbrella Pine attains to some size in this country, and fully displays its peculiarly attractive characteristics, it is sure to receive much more attention as a useful ornamental conifer and a highly interesting evergreen tree.

Dr WILLIAM WATSON, referring to the occurrence of the Parasol Pine in Japan, said that it occurred abundantly along the coast, and is generally cultivated in the vicinity of towns and villages.

Mr MALCOLM DUNN also exhibited specimens of *Polyporus sanguineus*, Fr., from the Knysna Forests, Cape Colony.

The CURATOR exhibited *Angræcum citratum*, *Galanthus nivalis*, var. *flavescens*, and *Saxifraga Burseriana*, var. *Boydi*, in flower, from the Royal Botanic Garden. The last mentioned plant came originally from Mr J. Boyd of Cherrytrees, and is supposed to be a natural hybrid between *S. Burseriana* and *S. aretioides;* but as there was no plant of *S. aretioides* in Mr Boyd's garden at the time when the supposed hybrid was recognised, there is room for doubt as to its parentage, and the Curator hoped that Dr Macfarlane might be able to settle the point by examination of the microscopic structure of the plants.

The Rev. Mr PAUL exhibited maize cobs, showing differently coloured grains, which he had brought from British Guiana; also a spathe of *Manicaria imbricata*.

Professor BAYLEY BALFOUR referred to young flower shoots of the hare's tail cotton grass, *Eriophorum vaginatum*, which had been sent from Sutherlandshire for identification as specimens of the plant on which sheep live chiefly from the end of February until the spring of the new grass, and to the abundance of which it is said the Sutherlandshire sheep farms owe their superior value.

Mr MALCOLM DUNN remarked that in Ireland the value of this plant was recognised as a food for stock before the shooting of the grass.

The following Papers were read:—

Characteristic Views of British Guiana Vegetation. By Rev. David Paul, M.A.

The author described the aspects of vegetation in British Guiana as he had seen it during a visit to the country in 1890, and exhibited on the lantern-screen a series of photographs taken by himself, illustrating his description.

Commentaries on British Plants. No. I. The Coarse Anatomy of the Wood of Trees and Shrubs (*conclusion*). By Professor Bayley Balfour and Dr J. Muirhead Macfarlane.

In conclusion of their account of the structure of the wood of trees and shrubs indigenous or naturalised in Britain, the authors described and projected on the lantern-screen sections of the wood of the following plants:—*Lonicera Periclymenum*, *L. Xylosteum*, *Viburnum Opulus*, *V. Lantana*, *Sambucus nigra*, *Vaccinium Myrtillus*, *Calluna vulgaris*, *Erica Tetralix*, *E. vagans*, *Fraxinus excelsior*, *Ligustrum vulgare*, *Lycium barbarum*, *Thymus Serpyllum*, *Daphne Mezereum*, *D. Laureola*, *Hippophae rhamnoides*, *Viscum album*, *Buxus sempervirens*, *Empetrum nigrum*, *Ulmus montana*, *U. campestris*, *Salix alba*, *Populus nigra*, *P. tremula*, *Betula alba*, *Alnus glutinosa*, *Carpinus Betulus*, *Corylus Avellana*, *Fagus sylvatica*, *Castanea vesca*, *Quercus pedunculata*.

The Glandular Stipules of Larrea Mexicana, Moric. By Dr John H. Wilson.

The author exhibited dried specimens of this plant, the Creasote bush of Mexico and adjacent regions of America, which secretes an odorous substance, giving origin to the popular name; and he referred to the place and manner of the secretion.

RECORDS OF SCOTTISH PLANTS IN 1890. By ARTHUR BENNETT, Croydon.

Following up the *resumé* I gave last year of the plants recorded from "additional counties" in Scotland during 1889, I now notice the principal ones of 1890.

There are two plants to record that have not been reported for Scotland before, though one of these was found in 1889, *i.e.*, *Rubus Sprengelli*, in Wigton and Kirkcudbright, by Mr C. Bailey of Manchester, and determined by Mr J. G. Baker of Kew.

The other, *Utricularia neglecta*, Lehm., was gathered in Dumfries by Mr J. Cowie, and sent to me by Mr J. Fingland. This is sparsely distributed over the south and south-central portion of England. The nearest county to Scotland I have seen specimens from is Cheshire, gathered by the late Mr A. Croall of Stirling.

Commencing with the south, Dumfries has yielded—either as new records or confirmations of old reports—some very interesting species, the principal of which are:—*Potentilla alpestris, Saxifraga nivalis, Hieracium sparsifolium* and *argenteum, Malaxis paludosa, Carex atrata,* and *C. pulla.*

Kirkcudbright—*Vicia lutea* and *Rubus Sprengelli.*

Mr M'Andrew has continued his examination of Wigton, and added many species, among them *Vicia lutea, Rosa mollis, Utricularia vulgaris,* and perhaps *U. Bremii.*

For Ayr, Mr L. Watt has gathered *Carex Boenninghausiana.*

To Stirling a very large number have been added—seventy-six species, besides many others that are escapes; and Colonel Stirling and Mr R. Kidston have filled up a large number of desiderata to its flora.

The three Perth vice-counties show a few additions—*Poa nemoralis* at 3000 feet on Ben Lawers, (P. Ewing !) takes this species 1400 feet higher than on record hitherto.

To Westerness (W. Inverness) Mr S. Macvicar has added forty-five species, *Nuphar intermedium, Vicia Orobus, Erythræa littoralis,* and *Orobanche rubra* being among the most interesting.

To Dumbarton Mr L. Watt has added eleven species; to E. Ross, Messrs Marshall and Hanbury, thirty-six species, *Ligusticum scoticum*, *Hieracium caledonicum*, Hanb., *Potamogeton heterophyllus* being among them. In E. Sutherland the same botanists have filled up twenty-four gaps; and in W. Sutherland seven—*Potamogeton prælongus* and *Melica nutans* being of much interest.

To the Outer Hebrides Mr W. S. Duncan, a resident on the islands, has been able to send me specimens of *Subularia aquatica*, from, if not the same station as Macgillivray (1830) recorded it, very near to it; besides this, he records twenty-three other additions to these interesting islands.

To the Shetlands Mr W. H. Beeby has added many interesting species; and I shall here enumerate them fully, as I think that, when our flora comes to be studied in relation to other northern floras, and also to other parts of our own country (such as the Outer Hebrides), every species that inhabits the Shetlands will be found to be of high interest. Mr Beeby has gathered as additional records—*Ranunculus Baudotti*, *R. trichophyllus*, and *R. Stevani*, *Papaver Lamottei*, *Subularia aquatica*, *Brassica alba*, *Arenaria serpyllifolia*, *Radiola Millegrana*, *Geranium Robertianum*, *Arctium intermedium* (?), *Rhinanthus major* (a confirmation), *Veronica Buxbaumii*, *Mentha aquatica*, *Utricularia minor* and *intermedia*, *Rumex propinquus*, J. E. Aresch., *R. pratensis*, *Euphorbia Peplus*, *Potamogeton pusillus*, *Scirpus fluitans*, and *multicaulis;* while Mr A. H. Evans has added *Scandix Pecten-veneris*, *Carduus* "*nutans*," and *Ranunculus hederaceus.*

To Caithness, I regret to say, I have no additions to report; and the death of Mr T. Henderson (of whom a very feeling and kindly notice appeared in the Northern Ensign) will leave a blank not easily filled, as probably no one knew the plants of Caithness better than he did.

Contrary to my expectations, the number for 1890 exceeded those of 1889; and it certainly is a cause for gratification that the number is so well sustained by my correspondents and friends to whom alone any value there may be in them is due.

*Summary of Records from Scotch Counties in 1890.*

| No. | | | No. | | |
|---|---|---|---|---|---|
| | | | | Brought forward, | 164 |
| 72. | Dumfries, | 30 | 95. | Elgin, | 1 |
| 73 | Kirkcudbright, | 4 | 96. | Easterness (E. Inverness), | 13 |
| 74. | Wigton, | 33 | 97. | Westerness (W. Inverness), | 45 |
| 75. | Ayr, | 2 | 98. | Argyle, | 6 |
| 76. | Renfrew, | 1 | 99. | Dumbarton, | 11 |
| 77. | Lanark, | 2 | 100. | Clyde Isles, | 2 |
| 80. | Roxburgh, | 1 | 105. | Ross, W., | 18 |
| 84. | Linlithgow, | 1 | 106. | „ E., | 36 |
| 86. | Stirling, | 76 | 107. | Sutherland, E., | 24 |
| 87. | Perth, W., | 3 | 108. | „ W., | 7 |
| 88. | „ M., | 5 | 110. | Outer Hebrides, | 24 |
| 89. | „ E., | 4 | 112. | Shetland Isles, | 24 |
| 90. | Forfar, | 1 | | | |
| 92. | Aberdeen, S., | 1 | | | |
| | Carry forward, | 164 | | Total, | 375 |

ON TEMPERATURE AND VEGETATION AT THE ROYAL BOTANIC GARDEN, during FEBRUARY 1891. By ROBERT LINDSAY, Curator of the Garden.

The month of February has been remarkable for the fine, dry, and mild weather which prevailed. Such dry, warm weather is perhaps without parallel in the history of the month. Vegetation generally is not so well forward as might have been expected from the genial nature of the weather experienced. A large number of spring flowers are in blossom, but in every case they are later in coming into flower than they were last year. Ribes, Thorns, Lilacs, and other hardy shrubs are just starting into growth. The thermometer was at or below freezing-point on twelve mornings, indicating collectively 79° of frost for the month, as against 101° for the corresponding month last year. The lowest readings occurred on the 12th, 25°; 19th, 25°; 20th, 24°; 26th, 24°; 27th, 20°. The lowest day temperature was 42° on the 13th, and the highest 59° on the 24th. Of the forty spring flowering plants whose dates of flowering are annually recorded, the following fourteen came into flower, viz.:—*Corylus Avellana* on February 6th, *Crocus Susianus* on 7th, *Scilla præcox* on 8th, *Leucojum vernum* on 7th, *Tussilago* *alba* on 10th, *Eranthis hyemalis* on 11th, *Scilla sibirica* on 12th, *Symplocarpus fœtidus* on 12th, *Tussilago nivea* on 16th, *Daphne Mezereum* on 17th, *Crocus vernus* on 18th, *Arabis albida* on 17th, *Nordmannia cordifolia* on 19th, *Bulbocodium vernum*, on 25th.

On the rock-garden thirty-nine species came into flower during the month, as against twenty-five during February 1890. Amongst the finest in blossom were:—*Colchicum crociflorum, Crocus imperati, Crocus Olivieri, Daphne Blagayana, Hepatica angulosa, Hyacinthus azureus, Iris Sophonensis, Narcissus minimus, Primula denticulata, Ranunculus anemonoides, Saxifraga Burseriana, Saxifraga imbricata.*

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during February 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 29° | 35° | 46° | 15th | 39° | 45° | 56° |
| 2nd | 34 | 45 | 51 | 16th | 34 | 39 | 55 |
| 3rd | 45 | 47 | 54 | 17th | 39 | 42 | 51 |
| 4th | 33 | 37 | 48 | 18th | 40 | 42 | 50 |
| 5th | 36 | 40 | 49 | 19th | 25 | 29 | 55 |
| 6th | 40 | 43 | 51 | 20th | 24 | 27 | 46 |
| 7th | 38 | 42 | 46 | 21st | 27 | 28 | 42 |
| 8th | 35 | 41 | 47 | 22nd | 28 | 41 | 51 |
| 9th | 25 | 32 | 46 | 23rd | 29 | 32 | 51 |
| 10th | 30 | 38 | 45 | 24th | 31 | 38 | 59 |
| 11th | 37 | 45 | 53 | 25th | 27 | 33 | 55 |
| 12th | 25 | 32 | 45 | 26th | 24 | 26 | 48 |
| 13th | 30 | 34 | 42 | 27th | 20 | 27 | 44 |
| 14th | 35 | 43 | 52 | 28th | 27 | 42 | 53 |

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of February 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 ft. above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30·061 | 43°·7 | 30°·3 | 33°·7 | 32°·3 | W. | ... | 0 | ... | 0·002 |
| 2 | 30·200 | 47·4 | 32·7 | 47·4 | 45·5 | W. | Cum. | 10 | W. | 0·000 |
| 3 | 30·152 | 50·8 | 47·0 | 49·9 | 48·1 | W. | Nim. | 10 | W. | 0·075 |
| 4 | 30·576 | 52·5 | 36·2 | 38·2 | 38·1 | W. | Cir. St. | 1 | N.W. | 0·000 |
| 5 | 30·519 | 46·3 | 37·8 | 41·8 | 40·1 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 6 | 30·405 | 47·4 | 41·2 | 45·2 | 44·1 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 7 | 30·325 | 49·4 | 42·0 | 43·7 | 40·9 | W. | Cum. | 10 | W. | 0·000 |
| 8 | 30·351 | 44·8 | 35·4 | 36·8 | 36·0 | S.W. | Cir. | 5 | S.W. | 0·000 |
| 9 | 30·305 | 43·7 | 27·8 | 32·7 | 30·8 | W. | Cir. St. | 5 | W. | 0·000 |
| 10 | 30·093 | 42·5 | 31·6 | 40·1 | 38·7 | W. | Cir. St. | 8 | W. | 0·000 |
| 11 | 29·803 | 47·5 | 39·8 | 47·5 | 46·1 | W. | Cum. | 10 | W. | 0·020 |
| 12 | 30·192 | 51·1 | 30·0 | 33·2 | 31·9 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 13 | 30·465 | 42·6 | 32·0 | 35·0 | 33·7 | N.E. | Cum. | 10 | N. | 0·014 |
| 14 | 30·369 | 44·9 | 35·3 | 44·9 | 44·2 | W. | Cum. | 4 | W. | 0·002 |
| 15 | 30·400 | 49·7 | 41·1 | 44·3 | 44·3 | W. | { Cir. St. / Cir. } | 3 / 2 | W. | 0·000 |
| 16 | 30·419 | 52·6 | 37·7 | 42·0 | 40·0 | W. | Cum. | 10 | W. | 0·000 |
| 17 | 30·514 | 50·9 | 41·3 | 44·0 | 42·4 | W. | Cum. | 10 | W. | 0·000 |
| 18 | 30·524 | 48·0 | 42·7 | 48·0 | 46·7 | W. | Cum. | 10 | W. | 0·000 |
| 19 | 30·460 | 46·5 | 29·0 | 31·8 | 31·6 | W. | ... | 0 | ... | 0·000 |
| 20 | 30·305 | 49·7 | 28·0 | 30·2 | 29·4 | W. | ... | 0 | ... | 0·000 |
| 21 | 30·231 | 41·9 | 29·0 | 29·8 | 29·7 | W. | Fog. | 10 | W. | 0·030 |
| 22 | 30·162 | 40·7 | 29·0 | 38·9 | 38·0 | S.E. | Cum. | 10 | W. | 0·000 |
| 23 | 30·269 | 49·6 | 32·2 | 34·7 | 34·2 | W. | Fog. | 10 | W. | 0·000 |
| 24 | 30·306 | 49·2 | 34·0 | 39·1 | 38·1 | W. | Cir. St. | 10 | W. | 0·000 |
| 25 | 30·098 | 50·5 | 31·6 | 35·0 | 34·2 | S.E. | ... | 0 | ... | 0·000 |
| 26 | 29·875 | 53·7 | 28·1 | 29·6 | 29·2 | W. | ... | 0 | ... | 0·000 |
| 27 | 30·099 | 46·1 | 23·1 | 28·8 | 28·4 | N.W. | ... | 0 | ... | 0·000 |
| 28 | 29·972 | 45·1 | 28·0 | 44·2 | 41·2 | W. | Cir. St. | 10 | W. | 0·010 |

Barometer.—Highest Reading, on the 4th, =30·576. Lowest Reading, on the 11th, =29·803. Difference, or Monthly Range, =0·773. Mean=30·266.

S. R. Thermometers.—Highest Reading, on the 26th, =53°·7. Lowest Reading, on the 27th, =23°·1. Difference, or Monthly Range, =30°·6. Mean of all the Highest=47°·5. Mean of all the Lowest=34°·1. Difference, or Mean Daily Range, =13°·4. Mean Temperature of Month=40°·8.

Hygrometer.—Mean of Dry Bulb=38°·9. Mean of Wet Bulb=37°·8.

Rainfall.—Number of days on which Rain fell=7. Amount of Fall, in inches, =0·153.

On Temperature and Vegetation in the Botanic Garden, Glasgow, during February 1891. By Robert Bullen, Curator of the Garden.

The weather generally was dull, and fogs were frequent, consequently the sun's rays were little felt, particularly towards the latter part of the month; but taken as a whole, a more genial and favourable month has not been experienced for many years, being comparatively free of all wet or wintry associations. Frost was registered on fifteen mornings; the lowest reading was 7° on the morning of the 9th. The total frost was 55°. The day readings were all high, the mean being higher than for any corresponding month since 1884. There was just sufficient frost to prevent undue excitement in vegetation, which was little further advanced than at the close of the last month.

Professor Bayley Balfour communicated the following extract from a letter he had received from Mr Graham Kerr, Naturalist to the Pilcomayo Expedition:—

"S.S. 'Bolivia,' Rio Pilcomayo,
December 12, 1890.

"In its physical features the Gran Chaco, at least in the portion traversed by us, presents many points of resemblance to the Llanos of the Orinocco. We have a flat plain, stretching out in all directions, covered with tall and waving grass, and, as a rule, thickly dotted with 'carandai' fan-palms—a region, as the discoloured lowered portion of the palm-stems tells us, liable to frequent if not annual inundation to the extent of several feet. The grasses belong to several but not very numerous distinct species, many of which are common to the Pampas of Buenos Ayres; and amongst them may be found an interesting and characteristic herbaceous flora. Of course I can only give you the merest outline of this, as I have no botanical work of reference with me. Several plants common in the Buenos Ayres Pampas occur here again, in particular the two verbenas—the scarlet flowered and the purple flowered one—are here just as abundant and as characteristic as they are in the south. A third species, also with purple flowers, but in which the leaves are of linear shape, is also very common. Of other Bicarpellates, a convolvulus with large white flowers creeps over the ground in all directions, a small *Nicotiana*-like plant with white flowers, and a little asclepiad, are all common—

scattered about amongst the grass. Very abundant is a small rubiaceous plant, very much resembling our common woodruff at home. Compositæ abound, and two species are particularly conspicuous—two yellow marigolds. Malvaceæ are also very abundant—about half a dozen species almost equally so—one of them a most lovely little flower of the deepest crimson. Of Monocotyledons, a beautiful yellow *Iris* claims attention. These, then, are the flowers which form a conspicuous feature in the vegetation of the palm-forest. For a few weeks they dot the ground in all directions, while occasionally one encounters an expanse of open literally carpeted with crimson mallows, scarlet and purple vervains, yellow marigolds, or clover-like mimosas.

"This 'palmar,' or palm-forest type of vegetation, is that which covers the largest area—it extends, in fact, over thousands of square miles. Another very distinct type is that of dicotyledonous forest, but this is here confined to comparatively limited patches of wood, many of them in the form of narrow belts, running more or less parallel with the course of the river. Such woods are called by the Argentines 'monte duro,' for the reason that they are composed almost entirely of trees possessing very dense and hard heart-wood. The surface of the ground generally slopes gradually up to these montes, and they appear to be but little subject to inundation. On entering such a piece of forest in this neighbourhood one finds oneself in a dense wood, composed of small and slender trees, merely some 15–20 feet in height, and growing so close together and so entangled as to make it scarcely possible to make one's way through them. Most of these trees belong, in this neighbourhood, to the kind called 'ñanga pirú' in Guarani, 'arrayan' in provincial Argentine, a myrtaceous tree, with white flower and small red fruit, looking externally very much like a miniature tomato, and of delicate flavour. Its leaves are used as a substitute for tea—a very poor one, in my opinion. A couple of spiny acacias, a 'coulterie,' a shrub called 'pata,' and one or two other Myrtaceæ go, though in much lesser numbers, to form, along with the arrayan, the bulk of the forest. These are scarcely worthy of the name of trees. At intervals, however, we have really fine forest trees, which tower aloft to a height of 50 or 60 feet above the general level of the trees below. These belong to various but about here comparatively few species—the 'palo cruz,' (?) a tall, slender bignoniaceous tree, with large yellow *Tecoma*-like flowers; the 'quebracho' (*Aspidosperma* sp. ?); and the 'guayacan' (Leguminosæ) are, perhaps, the most conspicuous. The latter is a magnificent timber, its heart-wood dark and heavy and very strong. The ground within the margin of the forest is dry, and is in most places thickly grown with two large and very characteristic Bromeliaceæ, both, I believe, species of 'karagnatá.' The first of these is the 'caragnaté' proper, a plant bearing a dense spike of purple-petalled and red-bracted flowers, and a somewhat pine-apple-like fruit. What makes it a most useful plant is, that its large hollow leaf-axils serve to store up the rains and dews, so that, when all the country around is parched up, one can always get a drink of clear cool water if one is within reach of a clump of monte. The other species the Argentines with us call 'chagnar,' but I am very much puzzled as to whether it really is this; for 'chagnar' is the name applied to the plant from which the Indians obtain the fibre which they use for textile purposes, and, as far as I can make out, the Indians appear to say that it is some other plant. I have endeavoured to get the Indians to bring me specimens of the plant which they use, but hitherto without success. I sincerely hope that I shall be able to really settle the matter before I leave the Chaco, as it is both important and interesting. This species of caragnata differs from the first in its leaves being much more stiff and rigid, and the spines which beset their margins much larger. Its flowers are white and fleshy, and the leaves surrounding the flower-head are of a bright scarlet colour. Owing to the dryness of the interior of the forest one sees very few ferns, and epiphytes are not in very great numbers. A large aroid, a little yellow orchid, and a couple of tillandsias are the most abundant.

"What one may call a third type of vegetation is to be found forming a zone along each bank of the river, where the ground is low lying, and often marshy. Here we have a band of dicotyledonous trees; two species of considerable size, and pre-eminently numerous; one, mimoseaceous, with white flowers, the 'timbó atá' or 'timbo blanco'; the other, with small yellow papilionaceous flower and a large almond-like edible fruit, the 'mandu virá.' Along with these occur other species of smaller size, such as 'mangabá cina cina' and 'espinollo.' This zone is further characterised by the dense thickets and brush, overgrown and intertwined with convolvuli, asclepiads, and passifloras. Lying parallel to the river, especially along its western branch, are more or less extensive ranges of marsh-swamps. These are overgrown with a dense growth of tall bulrushes; the occasional pools of water bear a floating carpet of a species of *Pistia;* while about their margins the long grass is studded and varied by the yellow flowers of a cannaceous plant, and the beautiful large pink bell of a tall mallow. I have been able to give you merely these few vague words about the botanical appearance of the country, as owing to want of space I was unable to bring any work of reference with me. So I shall now pass on to the zoological features, about which I am more able to speak, and in which I know you take so deep an interest. Even of these, however, I am as yet quite unable to give a regularly systematic account, and I think it will be the least boring method to you if I merely take the different physical departments of the region—the palm-forest, the monte, and the swamps—and mention such of their inhabitants as would force themselves on one's attention during the course of a ramble or series of rambles through them.

"Starting from the Bolivia one naturally follows the course of the river for some distance, its dry bed forming a good road for walking. Running along on the damp mud, picking up stray insects, one sees large numbers of little yellow-breasted Tyrannidæ (*Machetornis rixosa,* Vieill), and here and there a little sandpiper or yellowshank. The bushes along the river margin for some distance do not appear to have many inhabitants, until suddenly one hears a regular babel of chirps in all keys and tones, and looking up one finds over a considerable area every bush swarming with little perching birds. In fact, all the Passeres of the neighbourhood appear to collect together in these parties for the purpose of food-hunting. One there sees tiny little Mniotiltidæ (*Parula pitiayumi,* Vieill., *Geothlypis velata,* Vieill., *Basileuterus auricapillus,* Sw.) and greenlets, mingling with tanagers and finches of varied species. Of the tanagers one is struck by the colouring of the uniform pale blue *Tanagra sayaca,* Linn., the deep blue and yellow of *T. bonariensis,* Gm., and the uniform vivid scarlet of Azara's tanager (*Pyranga Azaræ,* d'Orb.); while three larger species are equally noticeable from their great numbers, although their plumage is of dull and sober hue (*Saltator similis,* d'Orb. et Lafr., *S. cœrulescens,* Vieill, and *S. aurantii rostris,* Vieill.). Finches are not particularly numerous in species, but they make up for this by their numbers of individuals—three species are in immense numbers—a sober little sparrow, but little gayer than our sparrow at home (*Zonotrichea pileata,* Bodd.), and the two beautiful little cardinal finches, whose plumage is above dark grey, beneath white, and with a head-piece of vivid scarlet, which in one case forms a tall-pointed cowl-like crest (*Paroaria capitata,* d'Orb. et Lafr., and *P. cucullata,* Lath.).

"Certain families of birds peculiar to the New World are very conspicuous, and especially to one like myself, accustomed to the Old World facies of bird-fauna. One of these families is that of the tronpials (*Icteridæ*). One is astonished at the numbers of black starling-like birds one sees. There are but few song-birds here, but now, as it is early morning, one's ear is suddenly caught by a string of preliminary notes of the most exquisite character—pure and deep and flute-like, and one composes oneself to listen to the wonderful melody when it suddenly, without a moment's warning, ends up in a most unmusical miauw-like cry. One goes up and finds the performer to be the white-billed cassique (*Cassicus albirostris*), with plumage of black and yellow. Its larger relative, *Cassicus solitarius,* Vieill., has a similarly rich voice; its song is very short, but it does not end it up in the absurd fashion of *C. albirostris.* In almost every bush one sees hopping about a pair of Formicaridæ (*Thamnophilus major,* Vieill.), with a curious cat-like cry, of which the male is conspicuous in plumage of black and white and bright red irides, while the female has a more sober-coloured plumage of reddish-brown. Such are a few of the birds which people the bushes all around us. We pass on through the long grass, and passing over the brow of a little eminence we suddenly come into full view of one of the mammalian inhabitants, a big stag about the size of our red deer, and of similar colour, walking slowly along, pausing every few moments to listen anxiously for any sound indicative of the presence of enemies. This is the large marsh-deer (*Cervus paludosus*, Desm.) called 'cierbo' by the Argentines, 'guazu pucú' by the Guaranis, and 'chigeranyegóh' by the Toba Indians. They are large and powerful animals, and are not so shy and watchful as their smaller congeners, and are to be found chiefly in this 'littoral' zone of vegetation, where they graze amongst the tall and rich grasses, and make their lairs amongst the tangled thickets. If one is fortunate, one may also get a glimpse of one the big carnivores, *e.g.*, of the great red wolf (*Canis jubatus*), the 'agnará guazu,' or 'kalŭk' of the Tobas; while on our way along the river-bed it is more than likely that we see in the soft mud the fresh trail of the jaguar, although the animal himself is rarely to be seen. Now leaving the river, we strike out into the palmar, the open savannah-like expanse of the palm-forest. Here our attention is at once attracted by a fresh series of bird-species. Flying over our head, with harsh screams, pass flocks of small parrakeets (*Bolborhynchus monachus*, Bodd., *Conurus acuticaudatus*, Vieill., and two unknown species); from a hollow palm-stem close by suddenly emerge two large yellow-fronted parrots (*Chrysotis aestiva*, Linn.), with loud and indignant cries of 'caa, caa,' expressing in the most amusing fashion anger and remonstrance; and we may also see a small flock of Maximilian's parrot flying rapidly along. We see in the distance the dark outline of the monte, and towards this we direct our steps. As we pass along we notice the large trail of the nandú on the ground; in the distance a flock of black-faced ibises are feeding, heralding our approach with loud and metallic cry; while amongst the grass one will see suddenly dart off to one side a little cavy or noisy lizard. The camp is dotted all around with low termite-hills, and occasionally stretching between two adjoining palms one will notice with admiration the wonderful system of cables and guys which marks the site of one of the little cities of the black and scarlet social spider, whose inhabitants are just now retiring to rest after their night's work. Far away up against the blue sky, reduced to mere specks, one sees vultures, and eagles, and buzzards; below, one hears the long drawn and plaintive whistle of the great tinamu (*Rhynchotus rufescens*, Temm.). As one approaches the monte a toucan (*Rhamphastos toco*, Gm.) flies out of one of the trees, carrying its great yellow and crimson beak stretched out straight in front of it; while from another tree one hears a series of shrill screams, at first subdued, and then becoming louder and higher pitched, which tells us that our approach is watched with alarm by the 'charata' (*Ortalis canicollis*, Wagl.), a guan, a little smaller than a pheasant, a characteristic inhabitant of the monte. One of the most characteristic of all the animal sounds of the Chaco is the voice of the charata. The morning silence is suddenly broken by a cry of extraordinary harshness, a sort of very loud rattle resembling the syllables 'cha-ca-ra-tá.' This is immediately answered by other birds at a little distance, then all unite together, producing a most extraordinary din. These concerts are heard most frequently during the morning, but occasionally also during the night and day at other times. One of the most characteristic family of birds inhabitating the monte as well as the palmar, is that of the woodpeckers. Wherever one happens to be, one has merely to stop and listen, and he is almost certain, in one direction or another, to hear the steady tap tap indicative of the 'carpintero,' and the carpintero attract attention not more by their numbers than by their interesting habits and wonderful plumage. They vary immensely in size, from Boies woodpecker, a giant whose plumage is black, with a creamy buff tippet and gorgeous pointed scarlet cowl, down to a tiny unknown little bigger than a humming bird. In colour, too, they vary greatly, and their coloration appears to be of remarkable interest. I have up to the present encountered, I believe, a dozen species, of which five or six are additional to the known Argentine fauna. In the monte one's attention is drawn by another family, in habits very similar to the last, but differing greatly in every other respect, that of the dendrocolaptids, one of the most characteristic families of South American birds. One scarcely comes across a single large dicotyledonous tree which has not one of these curious brown birds hopping in a spiral line up their trunk, probing with its beak into every crevice in search of insects. Two of these woodhewers are very abundant, *Xiphocolaptes major*, Vieill., and what I take to be *Picolaptes angustirostris*, Vieill., while a third species, apparently also a *Picolaptes*, is remarkable for its most extraordinary bill, which is slender, curved downwards like an ibis, and enormously long, about as long as the whole body of the bird. Besides these true Dendrocolaptinæ, two other sections of the family are represented; the Furnariinæ, by the common oven-bird (*F. rufus*, Gm.), which was so common at Mate Grande, here less numerous, however; and the Synallaxinæ, by several spinetails, and a *Phacellodomus*. Flying about amongst the low trees bordering the monte, one may disturb a flock of some of the remarkable aberrant Cuculidæ, peculiar to America. The common and jay-like *Guira piririgna*, Vieill., so common in the Pampas, is here equally abundant; but we find in addition two curious crow-like cuckoos, two species of the genus *Crotophaga*, anatomically so interesting. The first of these is *C. ani*, Linn., which is constantly to be met with in small flocks amongst the bushes, uttering a characteristic clear, somewhat curlew-like cry, as it flies off. The other species I considered a splendid find. I only met with it a short time ago, and had great trouble to get a couple of specimens. I don't know what species it can be, but it is a magnificent bird, about the size of a rook, with immensely long tail, and plumage of deep black, fairly resplendent with metallic reflections of deep blue and dark green, rivalling in the richness of its shades the rifle bird of Australia, which I have always regarded as one of my beaux ideals of avian beauty. The other two cuckoos I have found are *Piaya cayana*, Linn., and a true *Coccyzus* (*C. melanocoryphus*, Vieill.).

"As we pass along the margin of the monte one may come in sight of a small troop of *Dicotyles torquatus*, F. Cuv., the collared peccary, burrowing in the ground for the roots which form their food; or may suddenly see just within the edge of the wood the head and neck of the beautiful little 'guazu virá' (*Cervus simplicicornis*, Illig.), as it stands motionless as a statue gazing at us, trusting to its absolute stillness and dulness of colouring to escape observation. In these so-limited patches of forest, monkeys are almost absent; the only one I have seen is the mirikina (*Nyctipithecus trivirgatus*, F. Cuv.), one of these curious little nocturnal monkeys which Humboldt met with in the north, and which, if I remember rightly, Bates also mentions. Leaving the monte now we pass on to the extensive range of marshes or 'esteros' bounding the 'brazo occidental.' Pushing our way quietly through the tall bulrushes, we come upon a sequestered little lagunite, covered with the usual carpet of *Pistia*, and surrounded by bulrushes. We just catch a glimpse of the large and beautiful though plainly-coloured ypecahá rail (*Aramides ypecaha*, Vieill.); a pair of big chajás (*Channa chavaria*, Linn.), fly off with loud and harsh screams; a small flock of jacanas (*Parra jacana*, Linn.) also fly off, and the pool is left apparently lifeless, until, on looking more closely, one detects here and there the glistening head of a motionless jacaré.

"Now I am beginning to feel that this bare list of animals, even though confining itself to the more prominent ones, is getting particularly stale and uninteresting, so I will rapidly wind up, merely mentioning that I have omitted to mention the beautiful kingfishers (*Ceryle torquata*, Linn., *C. amazona*, Lath., and *C. americana*, Gm.) which flit along the river; the herons and egrets which may be found perched by its margin; the great muscovy ducks; the occasional cormorant (*Phalacrocorax brasiliensis*, Gm.); or the huge jabirn, which one may find standing motionless on one leg, his head and great beak resting upon his breast, as if in silent meditation—appropriate guardian of some small and lonely pool. In my letter to you from Mate Grande, I think I mentioned the wonderful concert of animal voices which is to be heard at night in the Pampas.* You may think that I would have the same to describe here, but in much more varied and accentuated form, owing to our greatly lower latitude. But, on the contrary, it is not

* An extract from this letter was published in the 'Ibis' for July 1890.

so. In this parched and withered region, even with its tropical climate, one does not find the extraordinary exuberance of life, especially as regards birds and amphibians, which one meets with in the damp and laguna-studded Pampas. Here the nights are marked by a solemn stillness, which is broken only at intervals by animal voices; by the deep and sepulchral converse of a pair of the great nacurutù owl (*Bubo virginianus*, Gm.); the soft and plaintive 'tūrūrū hū hū' of the smaller 'choliba' owl (*Scops brasilianus*, Gm.); the harsh accents of the charata; or the most extrordinary sound of all, the wild and despairing shrieks of the ypecahá. While a few frogs in the distance, and a solitary cricket close by, make a more continuous though less accentuated accompaniment. Cicadas are conspicuous by their absence, and fire-flies are few in number and small in size, in all which respects we have a most striking contrast with the luxuriant and well-watered riverain regions of the Paraguay and Paraná."

## MEETING OF THE SOCIETY,

Thursday, April 9, 1891.

Robert Lindsay, President, in the Chair.

William Maxwell Tress was admitted Resident Fellow of the Society.

Presents to the Library, Herbarium, and Museum at the Royal Botanic Garden were announced.

Dr Hugh F. C. Cleghorn exhibited a series of photographs illustrating the method of gathering the fruit of the Date Palm at Port Said, and referred to the character of the species and varieties of *Phœnix*, and to their distribution and their uses.

The Curator exhibited *Saxifraga retusa*, *S. oppositifolia*, var., *Corbularia tenuifolia*, *Soldanella Clusii*, *Epigæa repens*, *Rhododendron ciliatum* × *R. Edgeworthii*, *Phyllocladus rhomboidalis* ♂, and *Phyllocladus trichomanoides* ♀, in flower, from the Royal Botanic Garden.

Mr Paxton exhibited flowers of both sexes of *Viscum album*.

The following Papers were read:—

### Development of the Macrosporangium of Myosurus minimus, Linn. Part II.* By Gustav Mann.

The cell giving rise to the embryo-sac increases in size, and a vacuole makes its appearance at the anterior end close to the nucleus; the vacuole increases in dimension, and thus helps to bring about the rapid growth of the future embryo-sac. The primary nucleus divides, and now the vacuole lies in the centre of the cell; ultimately eight nuclei are formed, three of which at either end acquire cell-walls, while two nuclei

* For Part I. see page 67.



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remain in a central protoplasmic bag. The cells of the egg-apparatus, as well as the antipodal cells, are at first spherical on their surface next the cavity of the embryo-sac, but later the antipodal cells become concave. The two nuclei in the protoplasmic bag conjugate thus:—The nucleus from the antipodal end travels towards the sister-nucleus of the ovum; each of the nuclei shows a large nucleolus with two small bodies with a dark central granule, reminding one of two polar bodies; the two nuclei come in contact, and become flattened against one another, thus showing their indifference; then the nucleolus from the antipodal nucleus conjugates with the nucleolus of the sister-nucleus of the ovum, the former divesting itself of a nucleolar bag. After conjugation a remarkable series of changes takes place in the newly-formed nucleolus of the endosperm-nucleus, but my researches are not quite finished in this direction.

## An Account of Pressler's Growth-Borer. By Prof. William Somerville, D.Œc., B.Sc., F.R.S.E.

(With Woodcut 6.)

This useful little instrument is the invention of the late Dr Max Pressler, Professor of Applied Mathematics in the Saxon School of Forestry at Tharand. Although still retaining its essential characters, it has been improved as regards a few minor details by Dr Neumeister, Pressler's successor in Tharand. The agents for its sale are the publishing firm of Moritz Perles, 4 Seiler Gasse, Vienna, and Th. Thomas, 3 Thal Strasse, Leipzig. It was formerly made in three sizes, but now only in two—viz., size A, the shallow borer for use upon both hard and soft-wooded trees, and size B, the deep borer, for use in the case of soft-wooded trees only. The former costs 13s. 6d., and can sample the wood to a depth of about $2\frac{1}{2}$ inches, while the latter costs 17s., and can pierce soft wood to a depth of about 6 inches. For ordinary purposes I much prefer the shallow borer. It is shorter, and is therefore more convenient both to carry and to use, and it is less liable to break. It certainly does not sample soft wood to so great a depth as the other, but in the majority of cases one does not require to investigate the wood to a greater depth than $2\frac{1}{2}$ inches. Along with the instrument, at the prices quoted, are supplied a book of directions, a magnifying glass of low power, and a bottle of red aniline crystals, besides two necessary accessories, which will be described presently.

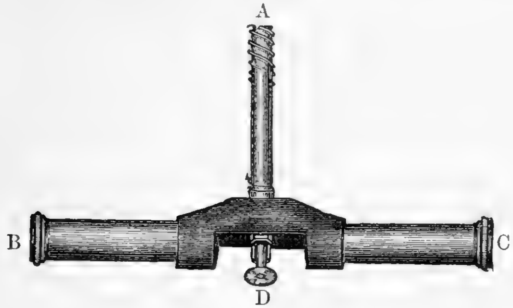


Fig. 6.

Shortly described, the instrument consists of a hollow handle B, C, into which, after removal of the screw-cap B, the boring-tube and accessories fit when not in use. The other end (C) of the handle is also provided with a screw-cap, which closes a small chamber designed to contain some lubricant, such as lard, the application of which to the boring-tube facilitates its entrance into hard wood, and also prevents its rusting.

The actual borer consists of a tube of hardened steel (A, D),* whose internal diameter is slightly greater at D than at A. This facilitates the withdrawal of the little cylinder of wood that it is desired to extract from the tree. The end of the borer at A has a cutting edge, and for about an inch back from this extremity it is furnished externally with three threads of a cutting screw.

When it is desired to use the instrument, the boring-tube is withdrawn from its receptacle, and is fitted into a slot in the middle of the handle. It is then pressed against the tree, being steadied, if necessary, by the left hand till it has fairly caught the wood, into which it is forced by the rotating motion imparted to the screw by turning the handle.

Having inserted the borer to the desired depth a steel pin, of the same length as the borer, with a large flattened brass head is brought into requisition. This pin is convex

* At D the pin and brass trough are seen projecting from the tube.

on one side and flat on the other, and on the flat side is provided with a number of shallow notches, while on the convex side it is graded with millimetres and centimetres so as to serve for measuring the breadth of the rings.

This pin is pushed in between the little cylinder of wood and the wall of the borer, with its notched side turned towards the former until the wood is firmly wedged against the borer; when, on the instrument being reversed through half a turn, the cylinder of wood loses its connection with the tree at the end A of the borer. It is next desirable, though not generally necessary, to rotate the instrument one full turn from left to right, which has the effect of forcing the piece of wood well up into the tube.

The handle (B, C) is next pulled back so as to become detached from the borer, and as the pin, on account of its large head, cannot pass through the slot, it, along with the cylinder of wood, is withdrawn from the tube, and the first part of the operation, which usually takes about half a minute, is completed.

As it comes from the tree the little cylinder does not show the rings very distinctly, so it is laid in a small brass trough, and a thin slice is removed by a sharp knife in such a way that the fibres are cut at right angles to their length, which leaves the rings distinctly visible.

When the borer has been withdrawn from the tree a hole of the diameter of $\frac{1}{4}$ inch is left, which, in the case of dicotyledonous trees, may be closed by a little grafting wax or other antiseptic, but in the case of conifers the resinous exudation makes any dressing unnecessary.

The practical and scientific uses of the instrument are very various, and need here only be indicated. The effect upon trees of thinning, pruning, or any other arboricultural or sylvicultural operation, can be ascertained by examining the rate of growth a year or two after the trees have been subjected to the new conditions, and comparing it, upon the same little cylinder, with the growth of the trees before the operation was performed. One thereby obtains a very decided indication as to whether or not the trees have been benefited by the operation, and whether it should be carried further, or has already been carried too far.

Similarly we can quickly determine the annual growth in volume of trees, and thus know whether it is more profitable to fell or retain them.

Then, from a scientific point of view, the instrument may be employed for determining the commencement, progress, and conclusion of growth as affected by species, weather, elevation, exposure, &c. Lately it has been much used by Hartig and others in connection with pathological experiments. With its assistance the wood of a healthy tree can be easily infected with the mycelium of a destructive fungus, and then the progress of the latter can be watched, and its effects noted. To do this it is necessary to take a small cylinder of wood from the infected area of a diseased tree, and, having removed a corresponding cylinder from a sound tree, the former, with the contained mycelia, is substituted for the latter, and a little grafting wax is applied to the wound to prevent the evaporation of water.

By experimenting in this way, too, it can be proved whether an unhealthy tree is really suffering from a fungus which may be present upon it, or whether the latter is not merely a secondary phenomenon.

## On Temperature and Vegetation at the Royal Botanic Garden, Edinburgh, during the month of March 1891. By Robert Lindsay, Curator of the Garden.

March has been the most severe and trying of any month this winter. The thermometer was at or below the freezing-point on twenty occasions, the total amount of frost for the month was 130° as against 49° for the corresponding month last year. The lowest readings occurred on the 9th, 15°; 10th, 15°; 12th, 19°; 13th, 20°; 14th, 19°. The lowest day temperature was 38° on the 10th, and the highest 57° on the 1st. Vegetation, generally, has made very little progress. Deciduous trees and shrubs are scarcely any further advanced than they were at the close of last month. The flower buds of *Rhododendron Nobleanum* and *R. præcox* were completely destroyed by frost on the 9th of the month. A good many plants have suffered severe injury. Stocks and wallflowers have been nearly all killed. Several species of *Cistus*, *Ceanothus*, *Eucalyptus*, *Olearia*, and shrubby *Veronica* are among the worst injured, but the full extent of the injury will be better known next month. Of the forty spring flowering plants whose dates of flowering are annually recorded the following eleven came into flower:—*Rhododendron Nobleanum* (March 1st), *Scilla bifolia* (3d), *S. bifolia taurica* (5th), *Iris reticulata* (6th), *Mandragora vernalis* (14th), *Scilla bifolia alba* (14th), *Narcissus pumilus* (19th), *Sisyrinchium grandiflorum* (23rd), *S. grandiflorum album* (28th), *Orobus vernus* (29th), *Ribes sanguineum* (31st). On the rock-garden forty species and varieties came into bloom as against seventy-three for the corresponding month last year. The most interesting were:—*Chionodoxa Lucilliæ, Ch. sardensis, Corydalis angustifolia, Daphne Phillipiana, Dentaria enneaphylla, Doronicum caucasicum, Draba Mawii, Polygala Chamæbuxus purpurea, Saxifraga Burseriana Boydii, S. crassifolia, S. juniperina, S. lutea purpurea, S. oppositifolia, S. sancta, Soldanella montana.*

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during March 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 42° | 51° | 57° | 17th | 33° | 35° | 42° |
| 2nd | 37 | 41 | 43 | 18th | 37 | 38 | 45 |
| 3rd | 30 | 34 | 45 | 19th | 31 | 35 | 47 |
| 4th | 35 | 48 | 54 | 20th | 29 | 39 | 46 |
| 5th | 35 | 45 | 51 | 21st | 29 | 37 | 45 |
| 6th | 36 | 41 | 47 | 22nd | 34 | 40 | 44 |
| 7th | 22 | 29 | 40 | 23rd | 28 | 40 | 53 |
| 8th | 25 | 30 | 40 | 24th | 32 | 39 | 49 |
| 9th | 15 | 25 | 43 | 25th | 35 | 40 | 48 |
| 10th | 15 | 32 | 31 | 26th | 30 | 38 | 46 |
| 11th | 27 | 30 | 40 | 27th | 29 | 34 | 46 |
| 12th | 19 | 27 | 45 | 28th | 33 | 41 | 48 |
| 13th | 20 | 31 | 45 | 29th | 32 | 44 | 51 |
| 14th | 19 | 30 | 46 | 30th | 26 | 35 | 46 |
| 15th | 25 | 34 | 40 | 31st | 25 | 44 | 51 |
| 16th | 34 | 36 | 40 | | | | |

[TABLE

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of March 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·807 | 51·9 | 43·2 | 51·9 | 49·9 | W. | Cum. | 6 | W. | 0·002 |
| 2 | 29·744 | 54·8 | 41·8 | 43·5 | 39·9 | W. | ... | 0 | ... | 0·020 |
| 3 | 29·901 | 46·6 | 32·7 | 35·9 | 33·1 | W. | ... | 0 | ... | 0·002 |
| 4 | 29·752 | 49·6 | 35·4 | 49·6 | 46·1 | W. | Cum. | 10 | W. | 0·000 |
| 5 | 29·814 | 53·0 | 42·0 | 46·9 | 43·8 | N.W. | Cir. St.<br>Cum. | 8<br>1 | N.W. | 0·035 |
| 6 | 29·570 | 49·1 | 40·0 | 41·1 | 38·9 | W. | Cum. | 1 | W. | 0·007 |
| 7 | 29·587 | 44·7 | 24·0 | 30·3 | 29·0 | N.W. | Cum. | 5 | N.W. | 0·065 |
| 8 | 29·670 | 37·8 | 28·2 | 31·7 | 28·0 | N.E. | Cir. | 2 | S.W. | 0·000 |
| 9 | 29·866 | 36·9 | 17·8 | 29·1 | 24·9 | W. | ... | 0 | ... | 0·000 |
| 10 | 29·572 | 40·5 | 19·8 | 31·4 | 27·6 | W. | Cir. | 4 | Calm. | 0·030 |
| 11 | 29·476 | 36·9 | 29·0 | 32·8 | 31·3 | N.E. | Cum. | 10 | N.E. | 0·005 |
| 12 | 29·646 | 39·3 | 22·1 | 28·3 | 26·1 | W. | Cir. St. | 4 | N. | 0·000 |
| 13 | 29·879 | 42·6 | 24·4 | 32·9 | 30·0 | W. | Cum. | 9 | N.E. | 0·000 |
| 14 | 29·850 | 42·1 | 23·0 | 30·7 | 28·9 | E. | Cir. | 5 | W. | 0·000 |
| 15 | 29·262 | 40·7 | 28·2 | 34·4 | 31·4 | S.E. | Cum. | 10 | S.W. | 0·362 |
| 16 | 29·401 | 39·7 | 33·9 | 39·0 | 38·1 | E. | Nim. | 10 | E. | 1·555 |
| 17 | 29·726 | 39·3 | 35·9 | 37·2 | 36·8 | E. | Nim. | 10 | E. | 0·235 |
| 18 | 30·039 | 41·0 | 35·9 | 39·8 | 37·5 | N.E. | Cum. | 10 | N.E. | 0·005 |
| 19 | 29·934 | 41·9 | 35·4 | 36·6 | 33·2 | N. | Cum. | 10 | N. | 0·000 |
| 20 | 29·752 | 42·1 | 32·5 | 41·0 | 37·0 | N.E. | Cum. | 5 | N.E. | 0·000 |
| 21 | 29·895 | 44·9 | 32·0 | 38·2 | 35·9 | N.W. | Cum. | 10 | N. | 0·000 |
| 22 | 29·917 | 40·9 | 30·0 | 40·2 | 37·0 | W. | ... | 0 | ... | 0·000 |
| 23 | 29·789 | 47·0 | 33·0 | 42·1 | 39·0 | W. | Cum. | 10 | W. | 0·078 |
| 24 | 29·528 | 50·5 | 34·7 | 40·6 | 38·3 | W. | Cum. | 9 | W. | 0·210 |
| 25 | 29·211 | 47·8 | 38·0 | 41·4 | 40·0 | W. | Cir.<br>Cum. | 2<br>1 | W. | 0·175 |
| 26 | 29·201 | 45·9 | 32·6 | 38·8 | 35·3 | W. | Cum. | 3 | W. | 0·000 |
| 27 | 29·372 | 44·7 | 31·4 | 36·3 | 33·2 | W. | Cum. | 10 | W. | 0·000 |
| 28 | 29·699 | 43·9 | 35·0 | 42·5 | 37·8 | N. | Cir.<br>Cum. | 2<br>2 | N. | 0·015 |
| 29 | 29·628 | 45·4 | 35·0 | 37·4 | 33·0 | N. | Cum. | 5 | N. | 0·000 |
| 30 | 29·743 | 45·1 | 29·2 | 37·1 | 32·1 | N. | Cum. | 10 | N. | 0·000 |
| 31 | 29·940 | 42·7 | 29·1 | 40·2 | 36·1 | N.E. | Cum. | 3 | N.E. | 0·000 |

Barometer.—Highest Reading, on the 18th, =30·039. Lowest Reading, on the 26th, =29·201. Difference, or Monthly Range, =0·838. Mean=29·683.

S. R. Thermometers.—Highest Reading, on the 2nd, =54°·8. Lowest Reading, on the 9th, =17°·8. Difference, or Monthly Range, =32°·7. Mean of all the Highest =44°·2. Mean of all the Lowest=31°·8. Difference, or Mean Daily Range, =12°·4. Mean Temperature of Month=38°·0.

Hygrometer.—Mean of Dry Bulb=38°·0. Mean of Wet Bulb=35°·1.

Rainfall.—Number of Days on which Rain, or Snow, fell=16. Amount of Fall, in inches, =2·801.

## ON TEMPERATURE AND VEGETATION IN THE BOTANIC GARDEN, GLASGOW, during March 1891. By ROBERT BULLEN, Curator of the Garden.

This was the most wintry month experienced in this part of the country. Frost was registered fifteen times; the lowest reading (on a shaded thermometer at three feet from the ground) was 19° or 13° of frost during the night of the 9th. Total reading 80°.

Stormy weather prevailed almost throughout, consequently vegetation generally is in a more backward state than usual, especially considering the comparatively favourable winter. To all appearance there will be an abundant bloom on deciduous trees and shrubs.

## MEETING OF THE SOCIETY,

Thursday, May 14, 1891.

Robert Lindsay, President, in the Chair.

Thomas Berwick was elected Resident Fellow of the Society.

Dr Edouard de Regel, Director of the Imperial Botanic Garden, St Petersburg; Dr Adolph Engler, Professor of Botany, and Director of the Royal Botanic Garden, Berlin; Dr Max Cornu, Director of the Jardin des Plantes, Paris; Dr Robert Hartig, Professor of Forestry, Munich, were, on the recommendation of the Council, chosen Foreign Honorary Fellows of the Society.

Augustine Henry, M.D., Imperial Customs Service, China, was, on the recommendation of the Council, chosen Corresponding Fellow of the Society.

The death of Dr Carl Wilhelm von Nægeli, Professor of Botany at Munich, a Foreign Honorary Fellow of the Society, was announced.

The Treasurer submitted the following Statement of Accounts for Session 1889-90:—

Receipts.

| | £ | s. | d. |
|---|---|---|---|
| Annual Subscriptions, 1889-90, 74 at 15s., | £55 | 10 | 0 |
| Do. do. 1888-89, 1 | 0 | 15 | 0 |
| Compositions for Life Membership, 6 at £6, 6s., | 37 | 16 | 0 |
| Transactions sold, | 2 | 3 | 4 |
| Interest received, | 7 | 8 | 8 |
| Receipts, | £103 | 13 | 0 |
| Balance of Payments, | 100 | 11 | 3 |
| | £204 | 4 | 3 |

Issued July 1891.

PAYMENTS.

| | | | |
|---|---|---|---|
| Printing Transactions, Billets, &c., . . . . | £147 | 17 | 11 |
| Lithographing Plates ii., iii., iv., v., vi., and Engraving woodcuts, . . . . . . . | 15 | 0 | 6 |
| Assistant Secretary's Salary, . . . . . | 15 | 0 | 0 |
| Do., balance of last year's Salary, | 10 | 0 | 0 |
| Rooms for Meetings, and Teas, . . . . . | 6 | 2 | 0 |
| Commission paid to Collector, . . . . . | 1 | 18 | 1 |
| Postages, Carriages, &c., . . . . . . | 7 | 14 | 9 |
| Sundries, . . . . . . . . . . | 0 | 11 | 0 |
| | £204 | 4 | 3 |

STATE OF FUNDS.

| | | | | | | |
|---|---|---|---|---|---|---|
| Amount of Funds at close of Session 1888-89, | £164 | 4 | 8 | | | |
| Decrease during Session 1889-90, . . . . | 100 | 11 | 3 | | | |
| | | | | £63 | 13 | 5 |
| Being:—Sum on Deposit Receipt with Union Bank of Scotland, . . | £60 | 0 | 0 | | | |
| Sum on Current Account with do. . | 4 | 5 | 4 | | | |
| | £64 | 5 | 4 | | | |
| Less sum due to Treasurer, . | 0 | 11 | 11 | | | |
| | | | | 63 | 13 | 5 |

EDINBURGH, 1*st May* 1891.—I have compared the above Account of the Treasurer with the Cash Book and Vouchers, and List of Members, and find them correct. T. B. SPRAGUE, *Auditor.*

In explanation of the decrease in the Funds of the Society during the session, it was pointed out that there had been an unusual expenditure incurred in the publication of the volume of the Transactions, which was nearly three times as large as usual, and contained a number of papers of exceptional interest.

Presents to the Library at the Royal Botanic Garden were announced.

Mr MALCOLM DUNN exhibited specimens of several genera of hardy Japanese shrubs grown in the gardens at Dalkeith, and in describing them remarked that they were all of an interesting and useful character, from the ornamental nature of their fruit, flowers, or foliage, features which existed in a remarkable degree among the numerous beautiful plants introduced from Japan. Illustrative of those bearing ornamental fruit, three varieties of *Aucuba japonica* in berry were shown—namely, *A. j. maculata,* the old *Aucuba japonica* of gardens; *A. j. vera nana;* and *A. j. var.*, a large green-leaved form; along with a specimen in flower of a strong growing green-leaved male plant. The specimens of *A. j. maculata* and *A. j. vera nana* were from bushes growing fully one hundred yards away from any male plant. The old variety had never previously borne berries at Dalkeith. The green-leaved male and female varieties were raised at Dalkeith in 1885, from seeds borne by a plant of *A. j. vera nana,* a dwarf variety, which fruits very freely, the pollen-bearing parent being unknown. About two-thirds of the seedlings were males. The females have produced berries for the past three seasons, some of them in great profusion, the berries varying from almost perfectly round to a longish oval, and all of a brilliant red colour.

The old variety, the *Aucuba japonica,* or Spotted Laurel, was introduced from Japan in 1873. Other varieties were known to exist, but only the female plant was then introduced. It has long been well known among us as one of the best of shrubs for growing with success amid the dust and smoke of cities, and is a special favourite with the planter of ornamental grounds in town and country. For some time after its introduction it was not supposed to be hardy, and was grown in glass houses, like many other introductions from distant countries at that period. It soon proved to be among the hardiest as well as one of the most beautiful of evergreen shrubs, and has long been grown in every garden of any pretensions in this country. Till within the last quarter of a century, however, its fruit was never produced, because of the absence of the pollen-bearing parent. This was at last introduced by those enterprising plant collectors, Robert Fortune and John G. Veitch, who sent home several varieties of the male *Aucuba* from Japan in 1861. Now the berries are becoming common where the male plant is grown near the old female variety; and as the seedlings produced appear to be very fertile, we may look forward to the time when all the old Spotted Laurels will carry a rich load of crimson berries.

Another specimen exhibited bearing fruit was *Skimmia Foremani,* a supposed hybrid, *S. fragrans* × *S. oblata,* raised by Mr Fred. Foreman, Eskbank Nursery, Dalkeith, which carries its large conical clusters of showy crimson berries on the end of the season's growth, and well above the foliage, rendering it a very effective shrub in ornamental grounds. The berries are very persistent, the old berries being still fresh and bright, while the young are about full grown ; in fact, at Eskbank Nursery the crop of three seasons is seen on the plant at the same time. Seedlings of this *Skimmia* are as vigorous and fertile as the parents, but the males largely predominate. Females are, however, readily raised from cuttings ; and as the plant becomes better known, it is certain to be a favourite with the ornamental planter. *Skimmia japonica* is equally hardy, and prolific of berries of a bright red colour, and is a very pretty and interesting dwarf shrub of Japanese origin.

Specimens of *Cydonia japonica,* the Japan Quince, were also shown. The typical scarlet flowered variety were introduced from Japan in 1815, and is well known as a brilliant early spring-flowering plant, generally grown against a wall ; but it, and the white variety, of which a specimen was also exhibited, thrive well and flower freely as bushes at Dalkeith. *Cydonia Maulei* is also a profuse spring-flowering plant, but of a more slender habit, and is best trained against a low wall, where its orange-red blossoms have a very pleasing effect.

Specimens of *Euonymus japonicus* and *Acer palmatum* were exhibited in further illustration of the rich colours and beautiful forms of the foliage of Japanese shrubs. The varieties of *Euonymus japonicus* exhibited include such beautiful leaved forms as *albo-marginatus, aureo-marginatus, latifolius albo-variegatus, latifolius aureo-variegatus, angustifolius,* and *radicans variegatus.* The Japanese maples exhibited were *Acer palmatum* (syn. *polymorphum*), *atropurpureum, A. p. dissectum,* and *A. p. elegans,* all conspicuous by the rich tints of their young foliage, which has a very striking effect among the quieter shades of foliage displayed by shrubs in general. The species was introduced from Japan in 1822; but for the finer foliaged varieties we are indebted to Messrs Veitch of Chelsea, who have introduced them to commerce within the past quarter of a century.

Professor Bayley Balfour exhibited living specimens of *Matthiola sinuata*, *Viola* sp., *Dipsacus ferox*, *Statice Limonium*, *Beta maritima*, *Crithmum maritimum*, and *Juncus acutus*, collected by him on the Braunton Burrows in North Devon during a visit to that district in April; also painted models to illustrate the modes of branching of plants.

Mr Sanderson exhibited fine blooms of *Masdevallia Wagnerii*, *M. Houttiana*, *M. chimera*, *Cypripedium caudatum*, and var. *roseum*, *Odontoglossum vexillarium*, *O. Œrstedii*, *Tricopilia coccinea*, *Burlingtonia candida*, and *Dendrobium superbum*.

Specimens of *Richardia æthiopica* with a double spathe were exhibited from James Dewar, Esq. of Lassodie.

Mr Grieve exhibited specimens in flower of *Aucuba japonica salicifolia*, and *Rhododendron glaucum* × *R. ciliatum*.

The Curator exhibited in flower from the Royal Botanic Garden, *Ranunculus cortusæfolius*, *Menzesia empetriformis* *Pinguicula caudata*, *Saxifraga Cotyledon*, *S. Macnabiana*, *Rhododendron Dalhousiæ* × *R. Gibsoni*, *R. Nuttalii*, *Primula Reidi*.

The following papers were read:—

## The Weekly Rate of Girth-Increase in Certain Trees, and its Relation to the Growth of the Leaves and Twigs. By David Christison, M.D., V.P. Bot. Soc. Ed.

In the years 1888, 1889, and 1890 I carried out a series of observations on young trees in the Royal Botanic Garden and Arboretum of Edinburgh, with the view of ascertaining—

1. The precise time when girth-increase begins and ends.

2. The progressive rate of girth-increase in the growing season.
3. The correlation between it and development of the new shoots.

To ascertain these points I aimed at fortnightly observations in 1888 and 1889, and at weekly ones in 1890. Bad weather, my distance from the Garden, and other causes interfered with the regularity of the measurements, however, so that in 1888 and 1889 the periods varied between twelve and eighteen days, and in 1890 the weekly intervals were strictly observed only in July, August, and September, when the measurements were kindly taken for me by my brother Mr John Christison, and by Messrs Lindsay and Richardson of the Botanic Garden. Fortunately, however, I had taken observations much more frequently than weekly in March, April, May, and June of that year, so it was easy to reduce them to weekly values, and thus to equalise the intervals for the whole season.

In experiments at such frequent intervals, more delicate measurements were necessary than I had used in my previous annual and monthly observations, and I recorded to the fortieth instead of to the twentieth of an inch. This was done by using a Chesterman steel-tape, graduated to tenths of an inch, the intermediate degrees being estimated by eye, which, after a little practice, can be done with wonderful accuracy. But in experiments this season I am using a Chesterman tape graduated to millimetres. I may mention, for the benefit of any one who may wish to make similar delicate observations, that to ensure accuracy, I have had the "Ring" squared and reckoned in the graduation. The squared "Ring" is also made somewhat wider than the tape, so that it can be held in position by the nail of the forefinger a little below the level of the tape. Thus the tape can be brought fairly over the "Ring" and read off, where it crosses its outer straight margin.

Great care was also necessary in selecting suitable trees for such delicate records. They were all young, perhaps between ten and twenty years of age, and known to be quick growers. As far as possible, trees with smooth cylindrical stems were chosen, as it is only in such that measurements to the fortieth of an inch are at all reliable.

## I.—The Precise Limits of Girth-Increase at the beginning and end of the Growing Season.

The general limits of seasonal girth-increase in many species of trees in the Botanic Garden, and at Craigiehall, near Edinburgh, as far as monthly observations go, were determined by my father and myself, and the results communicated to this Society and the Royal Society of Edinburgh in various papers since 1880. The present observations, therefore, are a natural sequel to the earlier ones, with the object of attaining to greater precision. As the weekly observations of 1890 give much more precise results than the fortnightly ones of the two previous years, I give only the former.

### (*a*) Period of the Commencement of Girth-Increase in Spring.

The results, as given in Table I., being derived from weekly observations, are, of course, only approximative, but they cannot be more than a few days in excess of the truth. They show a considerable range, the various examples of the Pinaceæ starting between the 6th April and 3rd May, and the Deciduous trees between 20th April and 17th May. Nos. 19, 76, and 88 may have been in an abnormal condition, as, without appearing unhealthy, they grew at a much slower rate than their average for three previous years. Probably the start was unusually soon, as the early spring months were mild, and vegetation made rapid progress in March and April.

### (*b*) Period of the Cessation of Girth-Increase in Autumn.

The range lay between September 20th and October 11th in the Pinaceæ, and between August 23rd and September 27th in the Deciduous trees.

### (*c*) Duration of the Season of Girth-Increase.

The range varied between twenty and twenty-seven weeks in the Pinaceæ, and between nineteen and twenty-two weeks in the Deciduous trees.

The periods given in this review are those marked by undoubtedly reliable results, but it is necessary to observe that in a considerable number of the trees there appeared to be a period of fluctuating results—slight increases alternating with slight decreases—both before and after the period of reliable increase. Whether these fluctuations were real, or were simply due to errors of observation, may be doubted, and further trials are necessary to settle the point.

The numbers in the first column of this and subsequent Tables are the numbers painted on the trees for identification.

Table I.—Periods of Girth-Increase in 1890.

| | Began. | Ended. | Duration. |
|---|---|---|---|
| 8. Abies Lowiana | April 6th | October 11th | 27 weeks |
| 2. Pinus excelsa | ,, | ,, | 27 ,, |
| 91. Abies grandis | April 13th | ,, | 26 ,, |
| 66. Abies Douglasii | April 20th | September 27th | 23 ,, |
| 26. Pinus Pinaster | May 3rd | September 20th | 20 ,, |
| 93 and 94. Ulmus campestris | April 20th | ,, | 22 ,, |
| 76. Populus fastigiata | April 27th | ,, | 21 ,, |
| 74. Acer pseudoplatanus | May 3rd | August 23rd | 16 ,, |
| 19. Cratægus Oxyacantha | May 10th | September 20th | 19 ,, |
| 88. Alnus glutinosa | ,, | September 13th | 18 ,, |
| 80. Æsculus Hippocastanum | May 17th | ,, | 17 ,, |
| 22. Prunus Padus | ,, | September 27th | 19 ,, |

As the observations on the same trees in 1888 and 1889 were at fortnightly intervals or more, and are consequently less precise, it is unnecessary to give them at length, but it may be stated that they confirm the results for 1890. I give, however, the record of the start in girth-increase for several other trees which were observed in 1888.

| | | | |
|---|---|---|---|
| *39. Cedrus africana, | started between | April 16th and April 30th. |
| 6. Abies Douglasii, | ,, | ,, ,, ,, |
| 92. Abies Lowiana, | ,, | ,, ,, ,, |
| 71. Acer pseudoplatanus, | ,, | April 30th and May 14th. |
| 87. Populus fastigiata, | ,, | ,, ,, ,, |
| 23. Fraxinus excelsior, | ,, | ,, ,, ,, |
| *82. Betula alba, | ,, | May 14th and May 31st. |
| *7. Fagus sylvatica, | ,, | ,, ,, ,, |

* Older trees than the others, but healthy, and quick growers.

## II.—Progress of Girth-Increase through the Growing Season.

As the observations in 1888 and 1889 were less frequent and precise than those in 1890, I shall fully consider the latter first, showing afterwards, in a more general way, how far the results are confirmed by those of the earlier years.

Table II. gives the results for 1890, and is divided into three parts. The first gives the results in five healthy and fairly vigorous young pines; the second, in five vigorous young deciduous trees; and the third, in three other deciduous trees, which, although ascertained to be quick growers for three years previously, for some reason or another, and without any appearance of unhealthiness, fell off very much in their girth-increase in 1890, and therefore might not be following in that year their normal course. The numbers in the Table, and which I shall use in the text, represent thousandths of an inch.

### A. Pinaceæ.

1890.—Taking first the combined results for the five trees, it is very evident that the progress of girth-increase was not, as might be expected, a steady rise towards a maximum in midsummer, followed by a steady decline towards the end of autumn. On the contrary, after a steady rise from 40 in the first week of April to 440 in the third week of May, there was a sudden fall to 185, and although a rally from this very low figure took place immediately, yet the weekly results continue to be low for no less than ten weeks, never once approaching very near the 440 of the third week in May, and falling in one week to a minimum of 125. It was not till the first week in August that the amount again reached 400 and upwards, after which the results were on the whole large till the 20th of September. These strange results will be more easily appreciated by arranging the figures in fortnightly periods, and reproducing them from the Table:—

90, 300, 600, 750, 545, 665, 400, 350, 700, 700, 550, 775, 375, 175.

# TABLE II.

| | April. | | | | May. | | | | | June. | | | | July. | | | | August. | | | | | September. | | | | October. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 | 13 | 20 | 27 | 3 | 10 | 17 | 24 | 31 | 7 | 14 | 21 | 28 | 5 | 12 | 19 | 26 | 2 | 9 | 16 | 23 | 30 | 6 | 13 | 20 | 27 | 6 | 11 |
| 8. Abies Lowiana | 15 | 30 | 20 | 30 | 80 | 105 | 110 | 125 | 110 | 135 | 105 | 90 | 30 | 65 | 25 | 50 | 50 | 100 | 125 | 50 | 125 | 50 | 100 | 125 | 100 | 0 | 25 | 25 |
| 91. Abies grandis | . | 20 | 80 | 65 | 60 | 90 | 60 | 50 | 0 | 0 | 55 | 35 | 35 | 50 | 25 | 75 | 100 | 100 | 175 | 75 | 125 | 50 | 150 | 100 | 100 | 50 | 25 | 50 |
| 66. Abies Douglasii | . | . | 25 | 60 | 40 | 65 | 60 | 75 | 25 | 75 | 75 | 5 | 20 | 50 | 50 | 25 | 75 | 75 | 100 | 75 | 75 | 25 | 50 | 100 | 50 | 25 | 25 | 25 |
| 2. Pinus excelsa | 25 | 0 | 0 | 20 | 55 | 55 | 55 | 90 | 25 | 85 | 80 | 85 | 75 | 50 | 25 | 50 | 50 | 75 | 50 | 50 | 75 | 0 | 25 | 75 | 25 | 0 | −25 | 25 |
| 26. Pinus Pinaster | . | . | . | . | 25 | 25 | 25 | 100 | 25 | 65 | 50 | 85 | 15 | 10 | 0 | 25 | 50 | 25 | 0 | 0 | 25 | 0 | 25 | 25 | 25 | 0 | −25 | 25 |
| Tl. weekly periods | 40 | 50 | 125 | 175 | 260 | 340 | 310 | 440 | 185 | 360 | 365 | 300 | 175 | 225 | 125 | 225 | 325 | 375 | 450 | 250 | 425 | 125 | 350 | 425 | 300 | 75 | 25 | 150 |
| ,, fortnightly ,, | 90 | | 300 | | 600 | | 750 | | 545 | | 665 | | 400 | | 350 | | 700 | | 700 | | 550 | | 775 | | 375 | | 175 | |
| ,, periods of 4 weeks | 390 | | | | 1350 | | | | 1210 | | | | 750 | | | | 1400 | | | | 1325 | | | | 550 | | | |

| | April. | | | | May. | | | | | June. | | | | July. | | | | August. | | | | | September. | | | | October. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 93. Ulmus camp. | . | . | 15 | 35 | 40 | 90 | 30 | 100 | 65 | 130 | 155 | 85 | 135 | 70 | 75 | 100 | 125 | 100 | 150 | 100 | 25 | 25 | 25 | 75 | 25 | 0 | 0 | −50 |
| 94. Do. | . | . | 15 | 15 | 20 | 40 | 45 | 55 | 85 | 165 | 150 | 95 | 120 | 45 | 75 | 100 | 50 | 50 | 50 | 75 | 50 | 0 | 50 | 50 | 25 | 0 | −25 | 25 |
| 74. Acer pseudopl. | . | . | . | . | 25 | 15 | 60 | 115 | 85 | 140 | 110 | 170 | 140 | 90 | 125 | 150 | 75 | 100 | 50 | 25 | 75 | 0 | −25 | 25 | 0 | 25 | 0 | 0 |
| 22. Prunus Padus | . | . | . | . | . | . | 25 | 25 | 25 | 105 | 110 | 110 | 85 | 90 | 100 | 100 | 100 | 100 | 125 | 50 | 75 | 0 | 0 | 25 | 25 | 25 | −25 | 0 |
| 80. Æsculus Hippoc. | . | . | . | . | . | . | 15 | 65 | 20 | 85 | 110 | 110 | 85 | 90 | 50 | 150 | 100 | 75 | 100 | 75 | 50 | 25 | 25 | 50 | 0 | 0 | −25 | 0 |
| Tl. weekly periods | 0 | 0 | 30 | 50 | 85 | 115 | 175 | 360 | 300 | 625 | 635 | 570 | 565 | 385 | 425 | 600 | 450 | 425 | 475 | 325 | 275 | 50 | 75 | 225 | 75 | 0 | 75 | 25 |
| ,, fortnightly ,, | 30 | | | 135 | | 320 | | 660 | | 1260 | | 1135 | | 810 | | 1050 | | 900 | | 600 | | 125 | | 300 | | | | |
| ,, periods of 4 weeks | 165 | | | | | 980 | | | | 2395 | | | | 1860 | | | | 1500 | | | | 425 | | | | | | |

| | April. | | | | May. | | | | | June. | | | | July. | | | | August. | | | | | September. | | | | October. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38. Alnus glutinosa | . | . | . | . | . | 50 | 25 | 25 | 25 | 25 | 0 | 125 | −25 | 25 | 100 | 0 | 100 | 0 | −50 | 25 | 0 | 0 | −25 | 50 | 0 | 0 | −25 | 25 |
| 19. Cratægus Oxyac. | . | . | . | . | . | 50 | 0 | 70 | 20 | 75 | 135 | 65 | 90 | 35 | 100 | 0 | 50 | 25 | 25 | 50 | 100 | 0 | −50 | 50 | 100 | −25 | −25 | 25 |
| 76. Populus fastigiata | Slow fluctuating increase of 100 in April and May. | | | | | | | | | . | . | 30 | 20 | 50 | 100 | 150 | 175 | 175 | 150 | 100 | 150 | 50 | 50 | 50 | 25 | −25 | −25 | 25 |

Among other points that come out is the notable one that the fortnightly minimum (400), after growth was fairly established in Spring, and before its final decline in Autumn, fell in June–July, or the height of summer, and the maximum (775) as late as the first half of September.

The same general results appear when the numbers are arranged in periods of four weeks:—390, 1350, 1210, 750, 1400, 1325, 550. Here the minimum (750) appears in the very middle of the season, with on either side two periods, each of which has not far from double its amount.

But it is also evident that the depression does not occur in the trees simultaneously. Hence, in the mass, the results tend somewhat to neutralise each other; and if we take the trees individually, the contrasts come out more strongly, at least in *Abies Lowiana* and *A. grandis*, the most vigorous in look, and the quickest growers of them all. The fortnightly figures are as follows:—

Abies Lowiana, 45, 50, 185, 235, 245, 195, 95, 75, 150, 175, 175, 225, 100, 50.
,, grandis, 20, 145, 150, 110, 0, 90, 85, 100, 200, 250, 175, 250, 150, 75.

In *Abies Lowiana* there is a rise from 45 to a maximum of 245, followed by a great and prolonged fall to a minimum of 75, and a rise to a second maximum of 225 late in autumn. Similarly, in *Abies grandis*, there is a spring rise from 20 to 150, a summer fall to zero, and an autumn rise to 250. But the fall takes place much earlier in *A. grandis* than in *A. Lowiana*, the minimum of the former falling on 24th May–7th June, and of the latter on 5th–19th July. The same phenomena are nearly as well marked in *Abies Douglasii*, but its fortnightly minimum falls on 14th–28th June. In *Pinus excelsa* the phenomena are less marked and regular. There is a tolerably well-marked retardation all through July, but the subsequent rally is much less than in the others. In *Pinus Pinaster* the same tendency can be traced, although still more feebly, but it is a lanky, less vigorous tree, and fell off much in its girth-increase in 1890.

1888 and 1889.—It may be asked, Are the apparent anomalies of 1890 not accidental,—due to some special cause in the season? Fortunately, we have the means of testing this by observations on three of the same trees in 1888 and 1889, and in two other pines which were under observation in 1888 only. The intervals of observation were both longer and more irregular in the two former years than in 1890, and the results are therefore not so precise and reliable, but still they are quite sufficient to serve as a general test of the results for the latter year. In the Table No. III. I have reduced the results for the different periods to daily rates of increase, expressed in ten-thousandths of an inch, so as to make them comparable with each other.

As the results for the different trees vary much, and to a considerable extent neutralise each other in sum, it will be better to consider each tree separately.

No. 8. *Abies Lowiana* behaved in 1888 and 1889 very much as in 1890: the rate rose to a maximum early in summer, fell off very much for a long period in midsummer, and rose to a second maximum well on in autumn. No. 92 of the same species followed a quite similar course in 1888, the only year in which it was under observation, and to a more marked degree, as increase stopped entirely in the first fortnight of August, and became very vigorous for six weeks thereafter.

No. 91. *Abies grandis* behaved in 1888 much as in 1890. In both years it took a fortnight of total rest early in summer. In 1889 a sensible depression only was recorded about the same date, but a total rest might have been shown by more frequent observations.

TABLE III.

1888.

| No. | Ap. 16 to Ap. 30. 15 days. | May 1 to May 14. 14 days. | May 15 to May 31. 17 days. | June 1 to June 16. 16 days. | June 17 to July 4. 18 days. | July 5 to July 16. 12 days. | July 17 to Aug. 1. 16 days. | Aug. 2 to Aug. 16. 15 days. | Aug. 17 to Sep. 1. 16 days. | Sep. 2 to Oct. 1. 30 days. |
|---|---|---|---|---|---|---|---|---|---|---|
| 8. Abies Lowiana, | 35 | 140 | 176 | 125 | 55 | 83 | 31 | 66 | 125 | 66 |
| 91. ,, grandis, | 35 | 107 | 82 | 0 | 27 | 83 | 31 | 66 | 125 | 100 |
| 26. Pinus Pinaster, | 35 | 70 | 117 | 63 | 110 | 83 | 63 | 0 | 63 | 0 |
| 92. Abies Lowiana, | 35 | 70 | 205 | 156 | 110 | 83 | 63 | 0 | 156 | 83 |
| 6. ,, Douglasii, | 35 | 70 | 88 | 31 | 83 | 41 | 31 | 0 | 93 | 0 |

1889.

| No. | Mar. 26 to Ap. 16. 22 days. | Ap. 17 to Ap. 29. 13 days. | Ap. 30 to May 13. 14 days. | May 14 to June 3. 21 days. | June 4 to June 29. 26 days. | June 30 to July 15. 16 days. | July 16 to July 31. 16 days. | Aug. 1 to Aug. 31. 31 days. | Sep. 1 to Sep. 30. 30 days. |
|---|---|---|---|---|---|---|---|---|---|
| 8. Abies Lowiana, | 25 | 0 | 71 | 166 | 135 | 62 | 93 | 161 | 96 |
| 91. ,, grandis, | 25 | 71 | 71 | 47 | 57 | 125 | 93 | 161 | 64 |
| 26. Pinus Pinaster, | 0 | 35 | 35 | 95 | 76 | 31 | 31 | 48 | 0 |

No. 6. *Abies Douglasii* was only observed in 1888. It was more irregular at first, but had a marked depression from July 4 to August 16, ceasing to increase altogether in the last fortnight of the period. Its subsequent rally was comparatively feeble.

No. 26. *Pinus Pinaster.* The same remarks hold good with regard to this tree, which, like the last, was inferior in vigour to the others, having increased in girth only $\frac{3}{4}$ of an inch, while they increased from $1\frac{1}{4}$ to $1\frac{3}{4}$ inch annually.

On the whole, it is evident that the remarkable midsummer halt was no mere accident of 1890, as it was equally well marked in the same and in other pines in 1888 and 1889. The period of depression varied much, however, in the different trees, and even in the same trees in different years, although possibly in some species it tends to be always later than in others,—in *Abies Lowiana* than in *Abies grandis*, for example. The following Table gives the approximate fortnightly period of the minima in illustration of this:—

Incidence of Summer Minima.

| No. | | 1888. | 1889. | 1890. |
|---|---|---|---|---|
| 8. | Abies Lowiana | July 16 to Aug. 1 | June 29 to July 15 | July 5 to July 19 |
| 92. | Do. | | | Aug. 1 to Aug. 16 |
| 91. | Abies grandis | May 31 to June 16 | | May 24 to June 7 |
| 6. | ,, Douglasii | May 31 to June 16 | | |
| 66. | ,, Do. | | | June 14 to June 28 |
| 2. | Pinus excelsa | | | June 28 to July 12 |
| 26. | ,, Pinaster | | June 29 to July 15 | June 28 to July 12 |

## B. Deciduous Group.

1890.—The progress of girth-increase in the group of five quick-growing deciduous trees does not show by any means the same strong contrasts as in the pinaceous group; at the same time, in the former, as in the latter, there is no steady rise and fall, with the maximum in midsummer, as might be expected. The weekly rise is pretty steady to the absolute maximum of 635 in mid-June, but this is followed by a gradual decrease to 385 in the beginning of July. In two weeks it rises again to 600, but after that declines to about 450 for three weeks till August 9th, after which it rapidly falls to the end of the season, which is on the 20th September. Taking fortnightly periods, there is a midsummer depression of 810, preceded by a fortnight at 1135, and followed by one at 1050. This period corresponds with the deepest part of the long depression in the Pinaceæ. It is also remarkable that the severe fall of the latter in the last week of May is represented in the deciduous group by an evident check in the weekly rise to the maximum. One member of the deciduous group, however, was exempted from each of these depressions, one of the elms in May, and the cherry in June–July. As the deciduous trees were under observation for only one year, and as the results are not strongly marked, further experiments are necessary before a decided opinion can be expressed as to the progress of their seasonal growth.

### C. Abnormal (?) Deciduous Group, 1890.

It was not deemed advisable to take the three trees in this group along with the other deciduous trees, as, although healthy looking, they grew at a rate much below their average for the previous three years. In the case of the alder and hawthorn the failure was all through the growing season, and the irregularity of their weekly growth is very striking (Table II.). The poplar failed in the first half of the season only. To the end of June it increased only 0·15 in. instead of 0·50 as in the previous year. These trees all flowered profusely, but so did the two elms and the cherry, which maintained their girth-increase unimpaired.

## III.—The relation between Girth-Increase and the Growth of the Buds and Twigs.

In 1888 a comparison was made between girth-increase and the growth in size of the top shoot of the Pinaceæ, ascertained by measuring-rods, which can be fairly accurately done up to a height of 10 or 12 feet. All the trees seemed healthy and vigorous, and were easily measured except the araucaria, which was not very reliable, owing to the roughness of the stem, and the top shoot of which, although healthy, grew only 5 inches in the season. The results are given in Table IVa. As the observations were at unequal intervals, I have reduced the totals for each period to the daily rate of growth.

Table IVa.—Comparative Increase in Height and Girth, 1888.

| | Ap. 16 to Ap. 30. 15 days. | May 1 to May 14. 14 days | May 15 to May 31. 17 days. | June 1 to June 16. 16 days. | June 17 to July 4. 18 days. | July 5 to July 16. 12 days. | July 17 to Aug. 1. 16 days. | Aug. 2 to Aug. 16. 15 days. | Aug. 17 to Sep. 1. 16 days. | Sep. 2 to Oct. 1. 30 days. | Total Inches. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. Height.** | | | | | | | | | | | |
| No. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | |
| 8. Abies Lowiana, | 0 | 0 | 0 | 1·00 | 3·50 | 4·50 | 3·50 | 1·50 | 1·25 | 0 | 15·25 |
| 92. Do. | 0 | 0 | 0·50 | 0 | 2·00 | 4·00 | 5·50 | 3·75 | 2·25 | 0 | 18·00 |
| 91. Abies grandis, | 0 | 0 | 1·25 | 1·75 | 4·00 | 1·75 | 1·50 | 1·25 | 0·25 | 0 | 11·75 |
| 6. Abies Douglasii, | 0 | 0 | 0·50 | 0 | 5·75 | 4·75 | 2·75 | 0·50 | 0·75 | 0 | 15·00 |
| 26. Pinus Pinaster, | 0 | 0·50 | 2·00 | 2·50 | 8·00 | 3·25 | 3·50 | 2·00 | 0 | 0 | 21·75 |
| 64. Araucaria imbricata, | 0 | 0 | 0·25 | 0·75 | 2·00 | 0 | 1·50 | 0 | 0·50 | 0 | 5·00 |
| Total, . . . . | 0 | 0·50 | 4·50 | 6·00 | 25·25 | 18·25 | 18·25 | 9·00 | 5·00 | 0 | 86·75 |
| Average per day, | | 0·03 | 0·26 | 0·37 | 1·40 | 1·52 | 1·14 | 0·60 | 0·30 | | |
| **B. Girth.** | | | | | | | | | | | |
| No. | | | | | | | | | | | |
| 8. Abies Lowiana, | 0·05 | ·20 | ·30 | ·20 | ·10 | ·10 | ·05 | ·10 | ·20 | ·20 | 1·50 |
| 92. Do. | 0·05 | ·10 | ·35 | ·25 | ·20 | ·10 | ·10 | 0 | ·25 | ·25 | 1·65 |
| 91. Abies grandis, | 0·05 | ·15 | ·15 | 0 | ·05 | ·10 | ·05 | ·10 | ·20 | ·30 | 1·15 |
| 6. Abies Douglasii, | 0·05 | ·10 | ·15 | ·05 | ·15 | ·05 | ·05 | 0 | ·15 | 0 | 0·75 |
| 26. Pinus Pinaster, | 0·05 | ·10 | ·20 | ·10 | ·20 | ·10 | ·10 | 0 | ·10 | 0 | 0·95 |
| 64. Araucaria imbricata, | 0 | ·10 | ·15 | ·05 | ·10 | ·10 | 0 | 0 | ·05 | ·05 | 0·60 |
| Total, . . . . | 0·25 | 0·75 | 1·30 | 0·65 | 0·80 | 0·55 | 0·35 | 0·20 | 0·95 | 0·80 | 6·60 |
| Average per day, | ·018 | ·053 | ·076 | ·040 | ·044 | ·046 | ·022 | ·013 | ·059 | ·026 | |

The following are some of the chief results to be deduced from the Table:—

Increase in girth began much sooner and ended much later than growth of the top shoot. This was true both of the trees individually and as a whole. The difference must amount to about two months.

Dividing the growing season into three periods of two months each, the following rough result is obtained:—

| Percentage of Increase. | | | | |
|---|---|---|---|---|
| | April and May. | June and July. | August and September. | April to September. |
| Girth, . . | 35 | 35 | 30 | 100 |
| Top shoot, . | 6 | 78 | 16 | 100 |

By arranging the periods somewhat differently, equally striking contrasts are obtained. Thus, in the six weeks from 4th July to 16th August, the percentage of girth-increase was only 16, while that of top-shoot growth was 52.

1889.—In this year the observations were resumed, but two of the trees, Nos. 6 and 92, had to be given up, having been made ineligible by transplantation. Unfortunately, I was unable to make the observations at the same intervals as in 1888, so that the two sets are not strictly comparable. Nevertheless, a remarkable resemblance comes out. (Table IVB.)

TABLE IVB.—Comparison of Height and Girth-Increase, 1889.

| A. HEIGHT. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mar. 26 to Ap. 15. 21 days. | Ap. 16 to Ap. 29. 14 days. | Ap. 30 to May 13. 14 days. | May 14 to June 3. 21 days. | June 4 to June 29. 26 days. | June 30 to July 15. 16 days. | July 16 to July 31. 16 days. | Aug. 1 to Aug. 31. 31 days. | Sep. 1 to Sep. 30. 30 days. | Total. |
| No. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | |
| 8. Abies Lowiana, | 0 | 0 | 0 | 0 | 5·00 | 6·00 | 3·75 | 1·00 | 0 | 15·75 |
| 91. Abies grandis, | 0 | 0 | 0 | 3·50 | 6·25 | 2·25 | 1·00 | 0·25 | 0 | 13·25 |
| 26. Pinus Pinaster, | 0 | 0 | 0·50 | 2·50 | 9·50 | 4·00 | 0·50 | 0·00 | 0 | 17·00 |
| 64. Araucaria imbricata, | 0 | 0·50 | 1·25 | 1·50 | 3·75 | 2·00 | 0·50 | 2·25 | 0 | 11·75 |
| Total, . . . . . . | 0 | 0·50 | 1·75 | 7·50 | 24·50 | 14·25 | 5·75 | 3·50 | 0 | 57·75 |
| Average rate per day | | ·03 | ·12 | ·36 | ·94 | ·89 | ·36 | | | |
| **B. GIRTH.** | | | | | | | | | | |
| No. | | | | | | | | | | |
| 8. Abies Lowiana, | 0·05 | 0 | 0·10 | 0·35 | 0·35 | 0·10 | 0·15 | 0·50 | 0·30 | 1·90 |
| 91. Abies grandis, | 0·05 | 0·10 | 0·10 | 0·10 | 0·15 | 0·20 | 0·15 | 0·50 | 0·20 | 1·55 |
| 26. Pinus Pinaster, | 0 | 0·05 | 0·05 | 0·20 | 0·20 | 0·05 | 0·05 | 0·15 | 0·00 | 0·75 |
| 64. Araucaria imbricata, | 0 | 0 | 0 | 0·15 | 0·10 | 0·10 | 0 | 0 | 0 | 0·35 |
| Total, . . . . . . | ·10 | ·15 | ·25 | ·80 | ·80 | ·45 | ·35 | 1·15 | 0·50 | 4·55 |
| Average rate per day | ·005 | ·010 | ·017 | ·038 | ·030 | ·028 | ·021 | ·037 | ·016 | |

Here we find the same difference in the duration of the growing period of the girth and the top shoot as in 1888, the former exceeding the latter by about two months.

Dividing the growing season into three periods of two months each, as before, it will be found that the figures for the middle period are almost identical in the two years; and the chief difference is in the incidence of the small proportion (23 per cent.) of top-shoot growth which falls to be divided between the first and third periods, about two-thirds of the amount falling to the third period in 1888 and to the first period in 1889.

| Percentage of Increase. | | | | |
|---|---|---|---|---|
| | April and May. | June and July. | August and September. | April to September. |
| Girth, . . | 29 | 35 | 36 | 100 |
| Top shoot, . | 17 | 77 | 6 | 100 |

Having ascertained these results for the trees taken together, it remains to ascertain whether they hold true in them individually, and on inquiry it turns out that the trees are divisible into two classes, both agreeing in a general way in the relation of girth-increase to top-shoot growth for the first four months of the growing period, but differing materially in the last two months. In the one class (Table V., A.) the girth-increase rallied to perhaps its greatest vigour in the last period, when top-shoot growth became feeble; while in the other (Table V., B.) there was no such rally.

Table V.

| | | Girth-Increase. | | | | Top-shoot Growth. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | April and May. | June and July. | Aug. and Sept. | April to Sept. | April and May. | June and July. | Aug. and Sept. | April to Sept. |
| A. | No. | Inches | Inches | Inches | Inches | Inches | Inches | Inches | Inches |
| | 8. Abies Lowiana (av. of 2 years), | 0·52 | ·52 | ·65 | 1·70 | 0·00 | 13·50 | 1·75 | 15·25 |
| | 92. Abies Lowiana (1 year), | 0·50 | ·65 | ·50 | 1·65 | 0·50 | 11·50 | 6·00 | 18·00 |
| | 91 Abies grandis (av. of 2 years), | 0·35 | ·35 | ·65 | 1·35 | 2·25 | 9·25 | 0·75 | 12·25 |
| | | 1·37 | 1·52 | 1·80 | 4·69 | 2·75 | 34·25 | 8·50 | 45·50 |
| B. | 6. Abies Douglasii | 0·30 | ·30 | ·15 | ·75 | 0·50 | 13·25 | 1·25 | 15·00 |
| | 26. Pinus Pinaster (av. of 2 years), | 0·32 | ·40 | ·12 | ·84 | 2·75 | 15·50 | 1·00 | 19·25 |
| | 64. Araucaria imbricata (av. of 2 years), | 0·20 | ·22 | ·5 | ·47 | 1·75 | 5·25 | 1·25 | 8·25 |
| | | 0·82 | ·92 | ·32 | 2·06 | 5·00 | 34·00 | 3·50 | 42·50 |

Considering that the girth-increase in April was a mere trifle, the relation between girth-increase and top-shoot growth in the six trees was roughly as follows. In May, when the girth-increase was very vigorous, top-shoot growth was only beginning; in June and July, when girth-increase was little more than half as vigorous as in May, top-shoot growth was at its greatest energy, accomplishing four-fifths of its total amount; in August, when top-shoot growth rapidly subsided, a similar rapid subsidence in girth-increase took place in three trees, *Abies Douglasii, Pinus Pinaster,* and *Araucaria imbricata ;* but in three others—two specimens of *Abies Lowiana* and one of *Abies grandis*—it rose to its monthly maximum, and the increase was well marked even in September.

1890.—In this year the relation of girth-increase to the growth of lateral shoots instead of top shoots was observed, a system which, besides other advantages, allowed of deciduous trees being studied as well as the Pinaceæ. Unfortunately I was unable to take the lateral growth observations *pari passu* with the weekly girth-increases. In the beginning of the season the lateral growth was ascertained too seldom, and by rather rude methods; and I had to abandon the observations probably before the growing season was quite over; but the general results are perhaps not materially affected, and I hope to test them by more precise observations in the present year.

I shall first endeavour to ascertain the period when the buds started in the different species; then consider its relation to the start in girth-increase; and finally show the correlation of growth in girth and in lateral shoots throughout the season.

### 1. COMMENCEMENT OF GROWTH IN THE LATERAL SHOOTS.

That trees of different species, and even of the same species, begin to bud at very various dates, is a matter of the commonest observation, but to fix by measurement the precise period when activity begins in the buds is very difficult, if not impossible, from the gradual and almost imperceptible nature of the first movements. Perhaps changes visible to the eye and touch are more reliable in the earliest stages than measurements, and I have trusted mainly to the former accordingly.

A. PINACEÆ.—In the five species under observation the first movement could be tolerably well made out by a softening and enlarging of the bud and the appearance of fresh colour. This was particularly true of the little hard knot-like winter buds of *Abies Lowiana* and *A. grandis*. The order of movement was as follows:—

| | | |
|---|---|---|
| 2. | Pinus excelsa . . . . | 9th April. |
| 26. | Pinus Pinaster . . . | 26th April. |
| 66. | Abies Douglasii . . . | 7th May. |
| 91. | Abies grandis . . . | 7th May. |
| 8. | Abies Lowiana . . . | 25th May. |

The very late period of No. 8, a robust quick grower, is most remarkable: on the 19th May the buds were all as hard, small, and brown as in the depth of winter, and on 1st June fully half of the buds were still in that condition, while those that had begun to shoot were only a quarter of an inch long.

B. Deciduous Trees.—The beginning of movement in these was slow and lingering, and was much more difficult to ascertain with any degree of precision than in the Pinaceæ. My observations began on the 14th March, but slight, perhaps unappreciable, movement must have begun earlier, as the hawthorn buds had already lost their covers, and the buds of all the trees, except the elms, were greenish at the tips. Many catkins were out on the alder, and the elms were coming into flower. After a cold February an unusually mild rainy March seems to have caused early budding. The following list shows the approximate dates of events from the earliest movement in the buds till the full expansion of the leaves, signifying by this not that they have all attained their full size, but that the tree is substantially clothed with large leaves:—

| | Buds beginning to enlarge. | Buds opening. | Young leaves expanding. | Leaves ¼ expanded. | Leaves ½ expanded. | Leaves fully expanded. |
|---|---|---|---|---|---|---|
| Cratægus Oxyacan. | Feb. 28 | March 29 | ? | April 14 | April 26 | |
| Acer pseudo-pl. . | March 22 | April 9 | April 14 | ? | April 26 | May 12 |
| Alnus glutinosa . | ,, 22 | April 1 | April 5 | April 30 | | |
| Æsculus Hippocast. | ,, 22 | April 9 | April 18 | April 30 | | May 19 |
| Prunus Padus . . | ? | April 1 | April 9 | April 30 | | |
| Populus fastig. . . | ? | April 1 | ? | May 19 | | |
| Ulmus campes. . . | April 5 | April 30 | May 3 | | | June 1 |
| Ulmus campes. . . | April 5 | April 30 | May 3 | | | June 1 |

These results are necessarily crude, because they depend on eye observations. It must also be remembered that the development of the buds is not always simultaneous, or nearly so, in the same tree. Thus in *Abies Lowiana*, No. 8, on 26th May only half of the buds were open and green, the other half continuing as hard and brown as in winter till at least June 1st; and in the elms, although many buds were opening on April 30, quite as many were still closed on May 7th.

Generally speaking, the first appreciable movement was much earlier, and much less well defined in the deciduous than in the pinaceous group; and the tender young leaves of the former were exposed to the weather a month earlier than the young needles of the pines. The earliest tree to make a start appreciable to the eye was the hawthorn, about the end of February, and the latest the *Abies Lowiana* on 25th May. The extreme range was therefore about 3 months.

2. CORRELATION OF THE COMMENCEMENT OF GROWTH IN GIRTH AND IN THE BUDS:—

| Pinaceæ. | Girth-increase commenced. | Buds showed activity. | Girth-increase preceded Bud-activity by | Amount of Girth-increase before Bud-activity. |
|---|---|---|---|---|
| No. 8. Abies Lowiana | 9th April | 19th May | 40 days | 0·425 inch |
| ,, 91. ,, grandis | 18 ,, | 7 ,, | 19 ,, | 0·300 ,, |
| ,, 66. ,, Douglasii | 20 ,, | 7 ,, | 17 ,, | 0·175 ,, |
| ,, 26. Pinus Pinaster | 30 ,, | 30 April | 0 ,, | 0 ,, |
| ,, 2. ,, excelsa | 9 ,, | 9 April | 0 ,, | 0 ,, |

| Deciduous Trees. | Girth-increase commenced. | Buds showed activity. | Bud-activity preceded Girth-increase by | Buds began to open. | Bud-activity preceded or followed Girth-increase. |
|---|---|---|---|---|---|
| No. | | | | | |
| 74. Acer pseudo platanus, | 3d May | 14th March | 50 days | 14th April | 19 days before girth-increase |
| 80. Æsculus Hippocastanum, | 17th May | 20th March | 58 days | 9th April | 24 ,, ,, ,, |
| 19. Cratægus Oxyacantha, | 7th May | 1st March | 68 days | 29th March | 39 ,, ,, ,, |
| 22. Prunus Padus, | 15th May | 14th March | 62 days | 1st April | 45 ,, ,, ,, |
| 93. Ulmus campestris, | 20th April | 29th March | 22 days | 30th April | 10 days after girth-increase |
| 94. Do. | Do. | Do. | Do. | Do. | Do. |

The differences shown here are very great. Of the five pines, in the three species of *Abies* the girth-increase preceded movement in the buds by from 17 to 40 days, but in the two species of *Pinus* the start was nearly simultaneous. In all the deciduous trees, on the other hand, the buds showed signs of activity long before measurable girth-increase began, the periods varying from 22 to 68 days. Fortunately the proof is strongest in the most extreme cases. Thus, there can be no question that the hard, brown buds of *Abies Lowiana* showed not the slightest change from their winter state up to 19th May, whereas the girth-increase began 40 days earlier; and there can be equally little doubt that the buds of *Cratægus Oxyacantha* threw off their covers in the end of February, while girth-increase in it did not begin till the 7th May.

But as the very early start of the deciduous buds was followed by a long period of slight movement, let us take the opening of the buds as a more decided era. The correlation of the start in girth-increase with this event is somewhat different. In the four trees first on the list the buds still have a start varying from 19 to 39 days, but in the two elms girth-increase precedes the opening of the buds by 10 days.

## GENERAL CONCLUSIONS.

1. In certain species of Conifers a great retardation or actual stoppage occurs in girth-increase in summer. This was observed in *Pinus sylvestris* and *Abies excelsa* by Karl Mischke in 1888 (Bot. Centralblatt, xliv. 2, 1890) by counting under the microscope, at frequent intervals, the number of cells produced from the cambium, and this "sehr auffälliges factum" he was inclined to attribute to exceptional meteorological conditions,—a conclusion which was natural, as he was dealing with only two trees in a single season, with an abnormal temperature and rainfall. My more extended observations, however, lasting for three years, and including 8 conifers of six species, leave little room for doubt that the phenomenon is constant, at least in some species.

2. Further observations are necessary to ascertain whether the law is applicable to all conifers. My monthly observations on girth-increase do not lead to the belief that it is, as Table VI. shows:—

### TABLE VI.

| Average Monthly Increase in Tenths of an Inch. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Species. | Number of Trees. | Number of Years Observed. | April. | May. | June. | July. | Aug. | Sept. | Total. |
| Sequoia gigantea, | Two | Two | 6 | 28 | 51 | 20 | 8 | 2 | 1·15 |
| Cedrus deodara, | Two | Two | 5 | 13 | 24 | 27 | 24 | 7 | 1·00 |
| ,, africana, | One | Two | 5 | 27 | 37 | 42 | 34 | 0 | 1·45 |
| Pinus excelsa, | Two | Three | 9 | 25 | 27 | 24 | 14 | 11 | 1·10 |
| Abies Douglasii, | Two | Two | 8 | 27 | 14 | 29 | 27 | 15 | 1·20 |
| ,, Lowiana, | One | Four | 8 | 44 | 35 | 24 | 44 | 25 | 1·80 |
| ,, grandis, | One | Four | 11 | 27 | 10 | 30 | 39 | 28 | 1·45 |

Here the species of *Abies* are the only ones that seem to follow the law of retardation, but *monthly* intervals are too long to test the point, and this is proved by the facts that my *weekly* observations brought *Pinus excelsa* under the law, although monthly observations seemed to exclude it.

3. There is some reason to believe that a similar, though much slighter, retardation takes place in deciduous trees, but observations for a single, and exceptionally cold, cloudy, rainy summer are insufficient to establish more than a suspicion, and require confirmation by further experiment.

4. Trees which are abnormally slow in their girth-increase, even when healthy-looking, are unreliable in such investigations. Under such circumstances conifers seem to tend to fall off in their autumn growth only, and deciduous trees to grow by fits and starts throughout the whole season.

5. The retardation in girth-increase in conifers is synchronous with the rapid growth of the new top and lateral shoots, and therefore may be due to incapacity on the part of the trees to carry on the two growths in full measure at the same time.

6. In certain conifers there is a marked increase in girth before the slightest movement in the buds. In others the two processes appear to be synchronous. In most of the deciduous trees observed, the foliage was well developed before girth-increase began, but in elms the two processes appeared to begin at once.

7. Hence it appears that in some conifers *Spring* foliage is not necessary to girth-increase, although the old foliage may be. And in some deciduous trees (elms) girth-increase apparently begins without the aid of foliage at all, although

further observations are desirable on this point. Should the result be confirmed, it would indicate that the use of stored materials and the functions of the roots, and possibly of the bark, may suffice for girth-increase without the leaf being called into play.

## Correlation of Girth-Increase and Meteorological Conditions.

The length to which this paper has already run forbids me from entering fully on the very difficult and complex subject of correlation of girth-increase with the weather in the three years, but the broad fact may be pointed out that a marked retardation occurred alike in the two summers of 1886 and 1890, which were unusually cold and wet, and in the summer of 1889, which was unusually warm and dry. There seems little reason to doubt, therefore, that the phenomenon is a constant one.

In 1890 I endeavoured to ascertain the relation between weekly girth-increase and meteorological conditions, which I was enabled to do by the recent introduction of strictly scientific meteorological observations at the Garden. The results are given in Table VII., but I do not venture to analyse them at present. A study of the kind is eminently difficult and complex, from the number and variety of the points which have to be considered, some of which may be here pointed out. First, as to temperature alone, the effects of low or high average maxima and minima, and of extreme high or low temperatures. Secondly, as to rainfall alone: not only its amount in any week, but whether it falls at the beginning or end of the week, and whether it falls after a course of dry or rainy weather. Thirdly, the effect of sunshine and cloud. Fourthly, the effects of the above in the very various combinations which may occur. Fifthly, whether the effects of the various meteorological conditions are immediate, or are delayed, and if so, for how long. Sixthly, the relation of these complex phenomena to bodies which follow certain as yet undetermined laws of growth, independent of weather, although no doubt modified by it, including the spring rise and autumn decline, but also the intermediate retardation, possibly in all trees, and the actual cessation of girth-increase in some.

With such difficulties to encounter I do little more than supply the facts for a single year, as probably one of the first contributions of the kind, but I may draw attention to one or two salient results.

1. The heavy and steady rainfall of five weeks, beginning June 9th, 1890, amounting to $3\frac{3}{4}$ inches, was synchronous with a great falling off in girth-increase, although the temperature did not fall; but it would be rash to conclude that a heavy rainfall is unfavourable to the growth of wood, for it must be remembered that there was probably a deficiency of sunshine, and that the season previously had been rainy, not to mention that the law of summer retardation may have come into play.

2. From the 13th July onwards the weekly girth-increase appears to rise and fall with the weekly average max. temp., but no such relation can be traced in the earlier part of the season.

3. The remarkably rainy, cool, and cloudy summer had no prejudicial effect on wood-growth. On the contrary, my measurements of the trees concerned, as well as of about 50 other young trees and 50 old trees, show that the increase of 1890 was considerably greater than in any of the previous six years.

TABLE VII.—Weekly Girth-Increase, Temperature, and Rainfall.

| WEEK ENDING | | 6th Apr. | 13th Apr. | 20th Apr. | 27th Apr. | 3d May. | 10th May. | 17th May. | 24th May. | 31st May. | 7th June | 14th June. | 21st June. | 28th June | 5th July. | 12th July. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | Av. Max. | 57·2 | 49·1 | 46·9 | 55·0 | 57·5 | 51·4 | 60·1 | 60·3 | 58·4 | 63·4 | 59·9 | 64·6 | 64·5 | 59·5 | 62·5 |
| | Av. Min. | 35·3 | 34·2 | 36·8 | 38·9 | 40·7 | 44·9 | 43·9 | 48·2 | 41·4 | 47·4 | 49·2 | 50·9 | 47·9 | 48·1 | 46·8 |
| Rainfall . . . | | ·035 | ·076 | ·032 | ·533 | ·060 | ·307 | ·833 | ·053 | ·102 | ·362 | 1·229 | ·575 | ·495 | ·693 | ·755 |
| Girth-inc. | 5 Pines | ·040 | ·050 | ·125 | ·175 | ·260 | ·340 | ·310 | ·440 | ·185 | ·360 | ·365 | ·300 | ·175 | ·225 | ·125 |
| | 5 Decid. | ,, | ,, | ·030 | ·050 | ·085 | ·145 | ·175 | ·360 | ·300 | ·625 | ·635 | ·570 | ·565 | ·385 | ·425 |

| WEEK ENDING | | 19th July. | 26th July. | 3d Aug. | 9th Aug. | 16th Aug. | 23d Aug. | 30th Aug. | 6th Sept. | 13th Sept. | 20th Sept. | 27th Sept. | 4th Oct. | 11th Oct. | 18th Oct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | Av. Max. | 64·5 | 67·2 | 67·4 | 67·2 | 61·9 | 63·3 | 59·7 | 65·5 | 68·5 | 67·8 | 62·9 | 59·2 | 59·1 | 55·8 |
| | Av. Min. | 49·5 | 49·8 | 52·5 | 55·2 | 52·5 | 47·6 | 43·0 | 51·9 | 48·8 | 51·4 | 51·9 | 47·5 | 47·8 | 42·7 |
| Rainfall . . . | | ·291 | ·187 | ·555 | ·070 | 1·718 | ·701 | ·428 | ·395 | ... | ·376 | ·161 | 1·750 | ·015 | ·348 |
| Girth-inc. | 5 Pines | ·225 | ·325 | ·375 | ·450 | ·250 | ·425 | ·125 | ·350 | ·425 | ·300 | ·075 | ·025 | ·150 | .. |
| | 5 Decid. | ·600 | ·450 | ·425 | ·475 | ·325 | ·275 | ·050 | ·075 | ·225 | ·075 | .. | .. | .. | .. |

On Temperature and Vegetation at the Royal Botanic Garden, Edinburgh, during the Month of April. By Robert Lindsay, Curator of the Garden.

The month of April was very cold and dry, with easterly wind predominating. Vegetation generally has been kept in check, and at the close of the month was in a very backward condition. The thermometer was at or below the freezing point on thirteen occasions; the total amount of frost registered was 56°, as against 54° for April 1890. The lowest readings were on the mornings of the 1st, 20°; 14th, 26°; 15th, 27°; 19th, 23°; 21st, 25°; 27th, 26°. The lowest day temperature was 41° on the 6th, and the highest 64° on the 30th. The collective amount of frost registered this season, up to the end of April, is 611°, as against 364° for the same period last year. The following is the distribution for each month:—

October, 19° of frost; November, 80°; December, 121°; January, 126°; February, 79°; March, 130°; April, 56°. The lowest point reached this season was 15° Fahr., or 17° of frost, which occurred on 9th March.

On the Rock-garden 119 species and varieties came into flower during the month, being thirty-one less than for last April.

Among the more interesting were—*Dentaria pentaphylla, Epigæa repens, Erythronium giganteum. Iberis petræa, Narcissus calathinus, N. cystettensis, N. nivalis,* and the varieties of *N. Pseudo-Narcissus, Primula intermedia, P. pedemontana, Trollius acaulis, Trillium erectum, Xanthorrhiza apiifolia.* A good many plants have suffered severely from drought to an extent never before observed so early in the season. Large plants of *Menziesia, Bryanthus, Erica,* and *Genista* have been completely destroyed, while small plants are uninjured. Among the plants injured by the severe frost in March, *Cupressus Lawsoniana erecta viridis* must be added. *Dacrydium Franklinii* has also suffered, but not to the same extent.

Of the forty spring-flowering plants, whose dates of flowering are annually recorded, the following came into flower:—

*Erythronium Dens-canis* on April 6; *Corydalis solida* on April 9; *Hyoscyamus Scopolia* on April 10; *Aubrietia* *grandiflora* on April 13; *Draba aizoides* on April 13; *Narcissus Pseudo-Narcissus* on April 13; *Adonis vernalis* on April 18; *Omphalodes verna* on April 20; *Symphytum caucasicum* on April 20; *Fritillaria imperialis* on May 3.

This completes the list for the fortieth year.

REGISTER OF SPRING-FLOWERING PLANTS, SHOWING DATES OF FLOWERING, AT THE ROYAL BOTANIC GARDEN, EDINBURGH, DURING THE YEARS 1889, 1890, AND 1891.

| No. | Names of Plants. | First Flowers opened. | | |
|---|---|---|---|---|
| | | 1889. | 1890. | 1891. |
| 1 | Adonis vernalis, . . | April 6 | April 2 | April 18 |
| 2 | Arabis albida, . . | March 18 | Feb. 1 | Feb. 17 |
| 3 | Aubrietia grandiflora, . | April 16 | April 9 | April 13 |
| 4 | Bulbocodium vernum, . | Feb. 18 | Jan. 29 | Feb. 25 |
| 5 | Corydalis solida, . | March 23 | March 20 | April 9 |
| 6 | Corylus Avellana, . . | Feb. 22 | Jan. 15 | Feb. 6 |
| 7 | Crocus Susianus, . . | Feb. 14 | Jan. 26 | Feb. 7 |
| 8 | ,, vernus, . . . | Feb. 23 | Jan. 30 | Feb. 18 |
| 9 | Daphne Mezereum, . . | Jan. 26 | Jan. 24 | Feb. 17 |
| 10 | Dondia Epipactis, . . | Jan. 3 | Jan. 6 | Jan. 30 |
| 11 | Draba aizoides, . . | March 22 | March 9 | April 13 |
| 12 | Eranthis hyemalis, . . | Feb. 3 | Jan. 15 | Feb. 11 |
| 13 | Erythronium Dens-canis, . | March 30 | March 10 | April 6 |
| 14 | Fritillaria imperialis, . | April 30 | April 10 | May 3 |
| 15 | Galanthus nivalis . . | Jan. 31 | Jan. 13 | Jan. 31 |
| 16 | ,, plicatus, . . | Jan. 26 | Jan. 17 | Jan. 30 |
| 17 | Hyoscyamus Scopolia, . | March 29 | March 23 | April 10 |
| 18 | Iris reticulata, . . | Feb. 25 | Feb. 16 | March 6 |
| 19 | Leucojum vernum, . . | Jan. 30 | Jan. 16 | Feb. 7 |
| 20 | Mandragora officinalis, . | March 12 | Feb. 18 | March 14 |
| 21 | Narcissus Pseudo-Narcissus, | April 7 | March 15 | April 13 |
| 22 | ,, pumilus, . . | March 25 | March 8 | March 19 |
| 23 | Nordmannia cordifolia, . | March 4 | Feb. 2 | Feb. 19 |
| 24 | Omphalodes verna, . . | March 16 | March 11 | April 20 |
| 25 | Orobus vernus, . . | March 26 | March 9 | March 29 |
| 26 | Rhododendron atrovirens, . | Jan. 17 | Jan. 18 | Jan. 21 |
| 27 | ,, Nobleanum, | Feb. 6 | Jan. 20 | March 1 |
| 28 | Ribes sanguineum, . . | March 30 | March 22 | March 31 |
| 29 | Scilla bifolia, . . | March 6 | Feb. 15 | March 3 |
| 30 | ,, ,, alba, . . | March 12 | Feb. 28 | March 14 |
| 31 | ,, præcox, . . | Feb. 1 | Jan. 6 | Feb. 8 |
| 32 | ,, sibirica, . . | Feb. 3 | Jan. 7 | Feb. 12 |
| 33 | ,, taurica, . . | March 14 | March 5 | March 5 |
| 34 | Sisyrinchium grandiflorum, | Feb. 20 | Jan. 31 | March 23 |
| 35 | ,, album, | Feb. 26 | Feb. 4 | March 28 |
| 36 | Symphytum caucasicum, . | April 16 | Feb. 1 | April 20 |
| 37 | Symplocarpus fœtidus, . | Feb. 22 | Jan. 31 | Feb. 12 |
| 38 | Tussilago alba, . . | Feb. 14 | Jan. 19 | Feb. 10 |
| 39 | ,, fragrans, . . | Jan. 11 | { Dec. 12 1889 } | Jan. 26 |
| 40 | ,, nivea, . . | Feb. 27 | Jan. 30 | Jan. 16 |

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during April 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 20° | 40° | 52° | 16th | 38° | 43° | 56° |
| 2nd | 33 | 36 | 43 | 17th | 28 | 46 | 57 |
| 3rd | 32 | 35 | 45 | 18th | 30 | 49 | 57 |
| 4th | 35 | 40 | 47 | 19th | 23 | 45 | 56 |
| 5th | 37 | 40 | 45 | 20th | 33 | 41 | 52 |
| 6th | 35 | 36 | 41 | 21st | 25 | 44 | 49 |
| 7th | 34 | 36 | 46 | 22nd | 35 | 48 | 50 |
| 8th | 31 | 40 | 49 | 23rd | 38 | 49 | 53 |
| 9th | 35 | 40 | 49 | 24th | 38 | 46 | 52 |
| 10th | 36 | 43 | 56 | 25th | 37 | 42 | 60 |
| 11th | 34 | 45 | 56 | 26th | 31 | 49 | 59 |
| 12th | 31 | 46 | 50 | 27th | 26 | 54 | 61 |
| 13th | 30 | 45 | 49 | 28th | 37 | 47 | 53 |
| 14th | 26 | 41 | 56 | 29th | 34 | 45 | 51 |
| 15th | 27 | 42 | 57 | 30th | 37 | 50 | 64 |

[Table.

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of April 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·838 | 46·8 | 24·7 | 39·2 | 35·7 | E. | Cum. | 2 | S.E. | 0·000 |
| 2 | 29·707 | 46·0 | 35·8 | 39·1 | 36·6 | E. | Cum. | 10 | S.E. | 0·002 |
| 3 | 29·713 | 40·7 | 33·1 | 36·9 | 33·0 | S.E. | Cum. | 10 | S.E. | 0·020 |
| 4 | 29·603 | 43·0 | 36·2 | 43·0 | 40·5 | S.E. | Cum. | 10 | S.E. | 0·005 |
| 5 | 29·581 | 43·9 | 39·3 | 40·2 | 38·7 | S.E. | Cum. | 10 | S.E. | 0·030 |
| 6 | 29·729 | 42·0 | 38·1 | 38·9 | 38·0 | E. | Nim. | 10 | S.E. | 0·002 |
| 7 | 29·923 | 39·1 | 36·1 | 38·1 | 34·0 | E. | Cum. | 10 | E. | 0·000 |
| 8 | 30·048 | 44·9 | 33·0 | 37·8 | 40·9 | N.E. | Cum. | 10 | N.E. | 0·018 |
| 9 | 30·142 | 48·5 | 38·8 | 41·7 | 39·1 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 10 | 30·169 | 43·8 | 39·0 | 43·8 | 40·2 | S.E. | Cum. | 8 | S.E. | 0·000 |
| 11 | 30·163 | 50·8 | 37·0 | 45·6 | 40·8 | S.E. | ... | 0 | ... | 0·000 |
| 12 | 30·192 | 53·6 | 33·0 | 42·1 | 40·2 | E. | Cum. | 10 | E. | 0·000 |
| 13 | 30·022 | 46·3 | 33·9 | 43·7 | 39·0 | S.E. | Cir.<br>Cum. | 4<br>1 | N.W.<br>S.E. | 0·000 |
| 14 | 30·094 | 42·8 | 29·8 | 40·9 | 38·3 | E. | ... | 0 | ... | 0·000 |
| 15 | 30·021 | 51·2 | 30·8 | 43·7 | 41·1 | N.W. | Nim. | 10 | N.W. | 0·012 |
| 16 | 29·836 | 55·0 | 41·1 | 48·0 | 45·1 | N.W. | Cum. | 10 | N.W. | 0·018 |
| 17 | 30·099 | 54·9 | 31·1 | 45·7 | 40·2 | N. | Cum. | 2 | N. | 0·000 |
| 18 | 30·141 | 52·9 | 34·0 | 47·2 | 42·0 | N.E. | Cum. | 1 | N.E | 0·000 |
| 19 | 30·216 | 52·1 | 37·2 | 45·3 | 42·2 | E. | Cum. | 3 | E | 0·000 |
| 20 | 30·331 | 49·8 | 35·8 | 38·7 | 36·7 | S.E. | Cum. | 9 | S.E. | 0·000 |
| 21 | 30·346 | 48·2 | 29·2 | 44·0 | 40·8 | E. | Cum. | 3 | E. | 0·032 |
| 22 | 30·227 | 47·8 | 38·8 | 44·0 | 41·1 | E. | Cum. | 2 | E. | 0·000 |
| 23 | 30·254 | 47·8 | 41·2 | 44·1 | 41·7 | N.E. | Cum. | 8 | N.E. | 0·000 |
| 24 | 30·251 | 49·6 | 41·0 | 44·9 | 40·0 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 25 | 30·131 | 51·8 | 40·0 | 47·2 | 43·5 | N.W. | Cum. | 9 | N.W. | 0·000 |
| 26 | 29·908 | 56·5 | 32·3 | 47·6 | 44·2 | W. | Cum. | 2 | W. | 0·000 |
| 27 | 29·696 | 56·6 | 29·8 | 49·9 | 43·8 | W. | Cir. | 4 | W. | 0·000 |
| 28 | 29·431 | 56·5 | 39·0 | 48·2 | 43·0 | W. | ... | 0 | ... | 0·000 |
| 29 | 29·503 | 53·5 | 36·3 | 44·7 | 40·7 | S.W. | Cum. | 10 | S.W. | 0·030 |
| 30 | 29·391 | 53·1 | 41·0 | 53·1 | 50·3 | W. | Cum. | 2 | W. | 0·058 |

Barometer.—Highest Reading, on the 21st,=30·346. Lowest Reading, on the 30th,=29·391. Difference, or Monthly Range,=0·955. Mean=29·957.

S. R. Thermometers.—Highest Reading, on the 27th,=56°·6. Lowest Reading, on the 1st,=24°·7. Difference, or Monthly Range,=31°·9. Mean of all the Highest =49°·0. Mean of all the Lowest=35°·5. Difference, or Mean Daily Range,=13°·5. Mean Temperature of Month=42°·2.

Hygrometer.—Mean of Dry Bulb=43°·6. Mean of Wet Bulb=40°·4.

Rainfall.—Number of Days on which Rain fell=11. Amount of Fall, in inches, =0·227.

A. D. RICHARDSON, *Observer.*

## On Temperature and Vegetation in the Botanic Garden, Glasgow, during April 1891. By Robert Bullen, Curator of the Garden.

This will long be remembered as a bitterly cold and also as an exceedingly dry month. The mornings were few on which frost was not registered. The lowest temperature recorded here was 28°, or 4° of frost, certainly not a low reading for the month, but the continuity of frosts and scathing north and north-east winds was remarkable; but from whatever point of the compass the wind came, it was so breezy and cold the sun's rays had little effect in forwarding vegetation, which is in a very backward state. We had occasional very light showers, but not sufficient to be of material benefit until the 29th, when we had a light showery day. The lawns were not so green and fresh-looking as in February. The hardy plants in bloom are those mostly recorded for the end of February or early March.

## MEETING OF THE SOCIETY,

Thursday, June 11, 1891.

ROBERT LINDSAY, President, in the Chair.

DAVID PRAIN, M.D., was elected Non-Resident Fellow of the Society.

JAMES MACANDREW and JAMES SHAW were elected Associates of the Society.

Mr G. H. POTTS exhibited a beautiful dwarf seedling saxifrage raised by himself, *Saxifraga hypnoides densa Pottsii.* He considered that the abundance of flower produced by the plant and its compact dwarf habit will make the plant a valuable bedder.

Mr GRIEVE exhibited cut flowers of *Cytisus purpureus albus* and *Cytisus andreanus.*

Mr SANDERSON exhibited a fine bloom of *Cypripedium bellatulum.*

Mr CRAIG exhibited a fasciated scape of *Primula elatior.*

Professor BAYLEY BALFOUR, referring to a plant of *Talinum Caffrum,* from South Africa, which was exhibited, remarked that its tuberous napiform roots had been sent by Prof. T. R. Fraser to the Garden as the source of a deadly poison. The plant is not, however, poisonous. As it flowered in the Garden, it exhibited blooms of an ephemeral character. Opening about four in the afternoon, they closed after expansion of about an hour and a half, and then withering commenced. They were self-pollinated.

The following plants in bloom from the Royal Botanic Garden were exhibited :—*Adonis pyrenaica, Erigeron Roylei, Cytisus purpureus, Gentiana verna, Dianthus alpino-barbatus,*



Issued July 1891.

*Listera ovata, Orchis foliosa, Onosma tauricum, Oxytropis campestris, O. Halleri, Potentilla eriocarpa, Primula sikkimensis, Ramondia pyrenaica, Stylidium gramini-folium, Silene pusilla, Wahlbergella pauciflora, Xanthosia rotundifolia, Saxifraga bronchialis, S. mutata,* and *S. lingulata* seedling.

Presents to the Library, Museum, and Herbarium at the Royal Botanic Gardens were announced.

The following papers were read:—

## THE PILCOMAYO EXPEDITION: PRELIMINARY NOTICE. By J. GRAHAM KERR, Naturalist to the Expedition.

In this preliminary communication I shall confine myself to giving a short sketch of the Expedition itself, along with a summary of the more striking botanical features of the region traversed by it.

A considerable portion of the Southern part of South America is occupied by an immense plain, which stretches from the uplands of Brazil, Entre Rios, and Paraguay on the East, up to the base of the Cordilleras of the Andes on the West; and from Patagonia and the Atlantic on the South, up into the inner provinces of Bolivia upon the North. The Southern part of this plain—that adjacent to Buenos Aires and the Rio de la Plato—is well known to all as the Pampas; while its more Northern portion forms the much less known, and still to a great extent unexplored, region of the Gran Chaco. These two regions are sharply marked off from one another by a striking difference in their vegetation. The Pampas is characterised by the almost absolute absence of trees of any kind; the Gran Chaco is characterised, on the other hand, by the very great development of arborescent forms both of Dicotyledons and Palms which there cover large extents of country.

Traversing the Gran Chaco from West to East are several rivers, of which three are of importance—the Salado, the Bermejo, and the Pilcomayo, all alike taking their origin among the snows of the Andes, and traversing the Chaco in a south-easterly direction to join the Paraguay-Paraná river system, which traverses the Chaco pampean plain from North to South along its eastern margin. Of the three rivers I have mentioned, the largest and most important, from the physiographical standpoint, is the Bermejo. The Pilcomayo has, however, within the last few years been attracting much attention from an economic point of view, owing to its possible utility as an outlet to Bolivia, in the event of its navigability. An important question thus came to be, "Is the Pilcomayo navigable, or is it not?" and with the object of settling this question, a large expedition was fitted out in Buenos Aires in the latter part of 1889. Special steamers were built in this country for the expedition, and everything was placed under the command of an Argentine Officer—Captain John Page; and this expedition I received permission to accompany, in the rôle of naturalist.

Leaving Buenos Aires in the beginning of 1890, several weeks were occupied in steaming up the Rio Parana. Arrived at Resistencia, the military capital of the territory of the "Chaco," some time further was spent in completing preparations; and on February 26th a final start was made for the Pilcomayo. A short run was made up the river Bermejo for the purpose of testing the boats, so it was not until March 12th that the Expedition actually entered the Rio Pilcomayo. The expedition at this time consisted of some 80 men altogether, including an escort of 50 Argentine soldiers; and was embarked upon two steamers—sternwheelers of light draught, specially built. The smaller of these vessels, the "Bolivia," was that destined for the actual work of exploration, the larger boat having to be left behind at a very early stage, owing to her size and unwieldiness.

One of the remarkable features of the part of the world now under consideration is the extraordinary sharpness of the limit between civilisation and utter wilderness: on the one side of the River Paraguay is the country of Paraguay, thickly populated and highly civilised; on the other, scarcely half a mile distant, is the Chaco, peopled only by a few wandering Indians. On entering the Pilcomayo, then, it was with feelings that we were for, at the least, several weeks bidding absolute good-bye to civilisation, and to all contact with the outer world. The river itself impressed one not so much from its wildness as from an all-pervading sense of nature—man and his works being conspicuous by their absence. It formed a small stream only, some 60 yards or so across at its mouth; its clear and dark waters flowed with scarcely perceptible current; and its calm surface reflected as in a mirror the tall steep banks rising on either side. Covered with a rank growth of coarse grasses, these banks were crowned by continuous forest, which varied in character from point to point. Perhaps most frequently this forest consisted for the most part of tall laurel-trees (*Nectandra porphyria*, Gr.), with smooth clear trunks, and dense leafy heads of thick, dark-green leaves, which, uniting with their fellows on each side, formed a continuous canopy, shutting out so completely the rays of the sun as to produce a deep shade and most refreshing coolness even on the hottest day. The interior of these laurel woods was futher rendered agreeable by the absence of noxious insects, while the ground was clear of any undergrowth, covered as a rule with a stratum of decaying leaves only. A very remarkable effect was sometimes to be observed during the night in those woods, when the decaying leaves gave out an intense pale-green diffused phosphorescent light. At other points the forest would be composed almost entirely of small myrtaceous trees of the genus *Eugenia*—such as *E. uniflora* and *E. cisplatensis*; and at others of a more considerable variety of tall forest trees, such as Quebracho, Lapacho, Guayacan, &c., mingled with occasional feather-leaved palm trees.

For the first week or two we continued to make very good progress, steaming rapidly along between the forest-clad banks. A constant interest was derived from the ever-changing forest, and from the numbers of its animal inhabitants which we saw every now and then. Innumerable jacarés were to be seen basking on the water's margin, going in with a heavy splash on our approach; numbers of large otters bobbed up and down in seal-like fashion, watching us as we passed; quiet family parties of staid-looking carpinchoes broke up in confusion; while an occasional jaguar, swimming across the river ahead of us, would cause a little excitement for the time being. Black crow-like cuckoos, snowy white egrets, beautifully-coloured kingfishers, great toucans with immense yellow and scarlet beaks, and flocks of shrill-voiced parrots, added still further variety to the scene. The river was at this time in high flood, and on its surface came innumerable masses of various floating plants, from the inland lagunas—large clumps of the beautiful *Eichornia azurea*, a *Pontederia* with a spike of purply-blue flowers, and immense quantities of a species of *Pistia* were most noteworthy. During this period of rapid progress I naturally got but few opportunities for collecting, this being limited to the hour or so when we stopped to cut fuel each morning.

Soon, however, our progress began to be less rapid. We arrived at a point known as Las Juntas, at which the river divides into two; and the more northern branch, which we followed, we found much smaller than we had the main stream, and our progress was almost from the first greatly obstructed, chiefly by trees, whose trunks, stretching right out across the stream, had to be felled to allow of further progress. Somewhat later another difficulty appeared: the rainy season was now well over, and the level of the water in the river began to fall rapidly, until finally we came to a full stop. The leader of the expedition now resolved to build a dam across the river, and so accumulate enough water to make advance possible. This was done, and by a repetition of the operation some progress was made, although extremely slowly and with immense labour. About the end of May, however, another disagreeable fact began to make itself apparent, and this was the approaching termination of our supplies of provisions. It was finally decided to send down for fresh supplies; a canoe was built, and in it set out Lieutenant Zorilla and a couple of men. Our military escort, I should mention, had departed *en masse* some time before. We were now left but a small party on board the "Bolivia," and this number was destined to be still further reduced. Captain Page's health had been failing for some time, brought on, no doubt, by the constant hardship and worry, and by the middle of July he became so much worse that he decided to try to reach Paraguay in search of proper medical treatment. He left us on the 20th of July; and, as we heard several months later, never reached the Paraguay, but died upon the way. The ten men left on board the "Bolivia" now spent a rather monotonous couple of months, marked by considerable hardship from want of food and water, by the death of the doctor to the expedition, by the open appearance of Indians, and finally concluded by the arrival of a relief expedition bringing us supplies and strong reinforcements. The expedition was now over, but I remained several months longer with the "Bolivia," exploring, collecting, and studying the ways of the Toba Indians, with whom I managed to make friends. I had been accustomed to read accounts of those Indians by Argentine writers, which universally describe them as all that is bad, and I was therefore agreeably surprised to find them immensely less cruel and treacherous than their "Christian" neighbours, and morally far superior to them. I found them absolutely trustworthy, and never detected in them any of those cases of wanton cruelty so characteristic of their white neighbours. That there are innumerable instances of their ill-treating Argentines whom they take captive I do not doubt, but they do this only in retaliation for the frightful atrocities which are daily practised against their own comrades and friends by the Argentine soldiery.

I shall now give a short sketch of the district in which the "Bolivia" remained for the five months succeeding the departure of Lieut. Zorilla. I have before mentioned to you the general aspect of the lower Pilcomayo, with its tall and forest-clad banks. Soon after passing "Las Juntas," the level of the surrounding country becomes much lower, and, as seen from the flood marks upon the trees, liable to occasional inundation to the depth of several feet. The banks are now low and undulating. Instead of the thick forest, we have bordering the river merely a narrow zone of open wood. The trees are of quite different species to those composing the forest further down, the two most characteristic being the Mandu virá and the Timbo blanco. Of these the Mandu virá is especially characteristic of the river margin, and is a fine large tree, with rough bark and gnarled stem and branches, dark-green pinnate leaves, yellow papilionaceous flowers, and somewhat walnut-like drupaceous fruit. The Mandu virá is almost entirely restricted to the edges of the river and of its tributaries, and as a rule stretches its branches more or less horizontally over the water surface. The Timbo blanco, almost equally abundant, is a mimosaceous tree, with tall erect stem and white flower heads—somewhat beech-like in its habit. Accompanying these two trees, although in less numbers, are the beautiful Cina-cina (*Parkinsonia aculeata*, Linn.), with its exquisite, long, delicate, and drooping foliage; and a small laurel-like tree. Accompanying or occupying the place of this band of wood is frequently a broad zone of thick brushwood, consisting for the most part of spiny Espinillo (*Acacia cavenia*), with its sweet-smelling, golden flower-balls, and covered usually with innumerable convolvuli, asclepiads, and passion flowers. Passing beyond this zone of wood and brush which margins the river, one finds oneself in the presence of the most characteristic type of vegetation and scenery in this region, *i.e.*, the "Palmar," or palm forest.

In all directions, as far as the eye can reach, stretches out an immense plain. Covered with thick and dense growth of tall grasses, it is dotted all over, and at varying intervals, with fan-leaved palms averaging about 30 feet in height. These palms are all of one species—that called Carandai in Guarani (*Copernicia cerifera*); and the immense forests which they form, stretching over thousands of square miles in the low-lying districts, make them one of the most striking features in the vegetation of the Chaco. It forms a type of scenery which, on first acquaintance, produces a great impression, due partly to its peculiar weirdness and utter unlikeness to anything one has seen before; but it soon palls upon one, and after travelling through it for days, still more living amongst it for months, it becomes very monotonous. Amongst the tall grass, between the palm trees, is to be found a characteristic herbaceous vegetation, with numerous species of malvaceæ and compositæ, and several brightly-coloured verbenaceæ, while in some places large patches of ground are covered with a beautiful little mimosa, whose habit reminds one of our clovers at home.

Although the greater part of the region I now speak of is occupied by Palmar, yet dicotyledonous forest is not altogether absent. It exists, however, only in small isolated patches—surrounded on all sides by "Palmar"—"isletas," as they are appropriately called by the Spanish. In their character as well as their extent they entirely differ from the forests nearer the Paraguay. They are composed for the most part of small and scrubby trees, 15 or 20 feet in height, several myrtaceous trees being especially abundant and prominent,—above all, *Eugenia uniflora*, Linn., the Arrayan or Ñanga pirü, which has a fruit about half the size of a cherry, of very pleasant flavour, and whose leaves are used occasionally as a substitute for tea. Along with the Arrayan are such trees as the Garabato—*Acacia tucumanensis*, Gr. —with pale yellow flowers and especially characterised by its innumerable recurved spines, which make it a most difficult matter to extricate oneself if one gets entangled among its branches; the Tinticaco—*Prosopis adesmioides*, Gr.; and the Chañar—*Gourliea decorticans*, Gill. These small trees form the mass of the monte, but here and there large trees tower up to a height of 30 to 50 feet above the general level. Such are the Guayacan—*Cæsalpinia melanocarpa* —a tall and stately tree, with thick trunk, covered with smooth green bark and wide spreading head of delicately feathery foliage; the Quebracho colorado—*Loxopterygium Lorentzii*, Gr., with dense, deep-red heart wood, strong and heavy, and forming one of the most valued timbers; and the Wilyik of the Tobas—a tall slender bignoniaceous tree, with large yellow flowers, whose wood the Indians use to rub together to produce fire.

The interior of these montes is, as a rule, very dry; and the closeness together of the small trees, the intertwining lianas and the superabundance of spiny plants, makes them almost absolutely impenetrable. Amongst the spiny plants, the most conspicuous are two species of Bromeliaceæ, known by the Guarani name of Caraguatá. One of these, the Caraguatá ü, is of importance on other grounds—for without it exploration in the Chaco would be well-nigh impossible. Caraguatá ü is literally "water caraguatá," and it gets the name from the fact of its leaves having large, hollow, and sheathing axils, into which trickle the dews and rains, and are there stored up, thus affording a supply of cool, fresh water at all times. Belonging to the same family of Bromeliaceæ is another important Chaco plant—the Üvira or Chaguar, from which the Indians obtain a strong fibre, which they use for manufacturing a coarse kind of cloth, as well as string, rope, bags, &c. Upon the trees in the montes are many epiphytes, especially several species of *Tillandsia*, and also a few Orchids and Ferns; Aroids and Cacti.

Of such a nature, then, were the surroundings of the "Bolivia" for many months. On leaving her, and making my way overland to Asuncion, I came across more variety of vegetation. We skirted along the margins of great swamps, with their luxuriant growth of cannaceous plants and bulrushes, and with their floating carpets of azolla and pistia. Then we traversed stretches of open park-like country—fine green turf, dotted with various kinds of trees — especially numerous being Adenantheræ of the genus *Prosopis*. The small ñandubéy (*Prosopis nandubey*, Lor.) was numerous in places; the Algarrobo and the Vinal (*P. ruscifolia*, Gr.). The latter is one of the largest of the trees here met with, and is very common, generally occurring as isolated specimens in the open. It is characterised by its gigantic thorns. The Algarrobo is more social than the Vinal—resembles it in appearance, but is smaller. It furnishes a long pod, which contains a very large quantity of sugar, providing the Indians with a very nourishing food during the season. Out of it they also make a very refreshing fermented drink, which they call "luktagá."

As we approached nearer to the Rio Paraguay, we got into a much finer country, well drained and watered, and bearing luxuriant vegetation. Patches of thick forest alternated with rich pasture land. The forests themselves were very different from those further inland. They dripped with moisture, decaying tree trunks lay about in all directions, covered with a thick growth of ferns, caragnatas, and pothos plants. The trees were large and varied—tall Timbós, magnificent laurels were mingled with Quebrachos, Lapachos, Guayácanes, &c., with here and there palm trees—either the large feather-leaved Pindóh, or the small fan-leaved dwarf palm. Occasionally, especially about the margins of the woods, we would see one of the extraordinary *Palo borracho*, a huge bombaceous tree, with flask-shaped stem covered with big obtuse spines, and with large white flowers. The riverain region bordering the Paraguay is then, as you will see, very different from that more to the centre of the Chaco—a difference attributable to the higher and better drained nature of its ground, as well as to its very different and much moister climate.

## CRITICISM OF THE VIEWS WITH REGARD TO THE EMBRYO-SAC OF ANGIOSPERMS. By GUSTAV MANN.

The author presented in the first instance a historical sketch of the literature dealing with the structure and the development of the embryo-sac, from Malpighi's description of the ovary of *Amygdalis* up to Westermeyer's paper on the antipodal cells, showing how gradually our knowledge has been acquired. He then opposed the view that the embryo-sac of Angiosperms is a macrospore, and finally called specially the attention of the Society to the fact that in the formation of the secondary or definitive nucleus, the fusion of the two nucleoli is the essential and final step in the act of conjugation of two sexual cells. He said:—

All leading botanists interpret the embryo-sac of Angiosperms as a macrospore, which by germination gives rise to an eight-celled prothallus, in opposition to Warming and Vesque, who regard the same as the equivalent of a special-spore-mother-cell, and the eight nuclei within the embryo-sac as two sets of four macrospores derived from two sporocytes. As these opposing views are fully discussed by Marshall Ward in two very able papers,* and as their author has brought forward a new suggestion, namely, that the eight nuclei correspond to two four-celled prothalli, I have criticised the pro's and contra's given in the quoted papers in the light of new facts discovered in my study of the development of the ovule of *Myosurus minimus*.

Warming, Strassburger and Ward state that only the periclinal walls formed by the division of the embryo-sac-mother-cell show a gelatinous degeneration; but this is decidedly not the case in *Myosurus*, a type which has also been studied by these three authorities, since all the walls of the embryo-sac-mother-cell, after its division into a row of cells, undergo this peculiar change, the only sides excepted being those abutting on the dermatogen and the plerome-elements; the reason of the latter side not undergoing the

* Ward, in Linn. Soc. Journ. Bot., vol. xvii., and in Quart. Journ. Microscop. Sc., January 1880.

gelatinous change being probably to allow of a ready passage of nutritive material into the rapidly developing embryo-sac. Ward explains the diffluent nature of the partitions occurring in the embryo-sac-mother-cell as also partly due to the producing cells, when they approach their limit of division, losing their power to form cellulose-envelopes, a process most accentuated in the formation of the tetrahedral groups of nuclei, when no trace of an envelope appears. This view leads to the following hypothesis:—"It will be remembered that the first divisions across the embryo-sac-mother-cell follow one another in such a way that the two 'cap-cells' were spoken of as being cut off from the mother-cell by diffluent swollen walls; and that, the lower cell having enlarged, destroying the cap-cells, its protoplasm passes to each end, and a vacuole-like clear space forms between. This last division may probably be looked upon as merely a third division across the embryo-sac-mother-cell, and not as the first division of the contents of the macrospore (embryo-sac). In other words, we have here a division-wall still weaker than the two preceding, and the 'vacuole' is its expression. If this be so, it is possible that the embryo-sac-mother-cell is really the mother-cell of four spores, two of which (the cap-cells) yield up their contents to their more vigorous neighbours,—to the other two, which never completely separate, but form an 'embryo-sac' and its contained apparatus. This suggestion does not exclude the view that the eight nuclei derived from that of the embryo-sac-mother-cell are cells of rudimentary prothalli, but explains them as belonging to two prothallial structures instead of one; the one produces a rudimentary archegonium (the egg-cell with its synergidæ may perhaps be an oosphere and two neck canal cells) and one vegetative cell; the lower spore produces four vegetative cells."

In support of the view that the vacuole is a very diffluent cell-wall, the occasional appearance of a septum in the embryo-sac of *Lobelia syphilitica* is mentioned.

To the explanations given by Ward I cannot agree, for the following reasons:—

If the ovule is a macrosporangium, and its aim the formation of one or of several macrospores, we must suppose that it will be subject, for the attainment of this end, to the same changes as take place in all other sporangia. The normal way of spore-formation as found in Vascular Cryptogams starts with the development of several or of only one archesporial cell, by the division of which sporogenous tissue is formed, consisting at one time of sporocytes. These cells have shortly after their formation thin but definite cell-walls; as they grow older the walls commence to swell, and may at this stage be stained deeply with hæmatoxylin. Ultimately each sporocyte is set free, assumes a globular shape, and gives rise to four spores by repeated bipartition. The spores resemble four tetrahedra with arched outer walls, and may become globular on maturation, or may not. Studying now the development of angiospermous ovules, we find in *Myosurus minimus* and *Ranunculus sceleratus* five to six subepidermal initial cells surrounding a central cell, all at first similar in appearance, but soon the central cell outstrips the others in growth and becomes the physiological archesporial cell; in *Rosa livida* and *Fragaria vesca* four subepidermal archesporial cells are formed; in *Lamium maculatum* two occur; while in the great majority of cases only one archesporial cell is found.

This archesporial cell may either always cut off a tapetal cell, as in *Polygonum divaricatum, Rosa livida, Fragaria vesca, Tritonia aurea, Anthericum ramosum;* or may only occasionally do so, as in *Hemerocallis fulva ;* or never do so, as in *Myosurus, Orchis pallens, Monotropa,* &c. After the formation of the tapetal cell, if the latter is formed at all, the archesporium or embryo-sac-mother-cell divides in *Rosa livida* into five or six cells, the uppermost of which, usually, developes into an embryo-sac. In *Senecio vulgaris,* according to Warming and Vesque, the archesporial cell divides occasionally into five cells, although its division into four cells is the rule; in *Lamium maculatum, Salvia pratensis, Tritonia aurea, Sisyrinchium iridifolium, Hemerocallis fulva,* &c., the archesporium divides into four cells, the lowest of which becomes the embryo-sac; in *Myosurus minimus* division into only three cells is the rule, but in a great number of cases my preparations show that the outermost cell, the one just beneath the dermatogen, divides again by an anticlinal wall, so that the archesporium forms four cells; in *Anthericum ramosum, Orchis pallens, Tradescantia virginica, Gymnadenia* *conopsea*, &c., three cells are formed; while in *Allium fistulosum* the archesporium gives rise to only two cells, the lower of which developes into the embryo-sac.

If then the embryo-sac was the equivalent of two spores, and if the archesporium corresponded to a sporocyte, as Ward believes, we would have to consider a sporocyte capable of giving rise to a number of spores, varying from seven in number, as in *Rosa*, down to three in number, as in *Allium;* this does not seem, however, to be in accordance with spore-formation, as it takes place in Cryptogams and in the formation of pollen-grains.

As the initial cell, called the archesporium or embryo-sac-mother-cell, gives rise to a row of cells varying in number from two to seven, it is evident that we cannot regard the cells derived from it as spores, nor it itself a sporocyte, it must be therefore either a special-spore-mother-cell or a true archesporium. In either case tissue derived from it is sporogenous tissue, which will at one time develope into sporocytes, and these into spores.

Let us study how the row of cells is formed in *Myosurus*, and what the fate of each cell is. The archesporium divides into two cells, separated by a very distinct, sharply-defined wall. Each of the two newly-formed cells may repeat the division, although as a rule only the lower cell does so; we see a struggle has commenced, the lower cell is better fed than its sister-cell, as it lies in close contact with the plerome-elements of the ovule. The wall formed across the lower cell is as sharply defined, but narrower than the primary wall running across the archesporium. We have seen how that daughter-cell of the archesporium which lies next the plerome-elements is the more vigorous one, and we shall see that of the two cells derived from it, the one next the plerome-element is again the more vigorous, for the latter will be the future embryo-sac.

At this time the walls of all the cells in the row undergo gelatinisation, with exception of the two walls mentioned above. If the archesporium has divided into three cells, two long lines parallel to the long axis of the ovule, joined by two short crossbars, , deeply stained with Kleinenberg's hæmatoxylin, No. 1, are seen on microscopical examination. As the primary wall formed across the archesporium is thicker than the secondary walls, it is only natural that the thicker one should be the more conspicuous when both undergo the mucilaginous change. This gelatinous appearance of the cells is in every respect identical with that taking place in the walls of sporocytes of other sporangia; and as it takes place before any sign of disorganisation of the sister-cells of the embryo-sac is visible, and as it takes place in the walls of the embryo-sac, Strassburger's and Ward's interpretation as to the mucilaginous change being the initial steps towards a breaking down of the sister-cells of the embryo-sac is not correct.

The lowest cell in the row developes into the embryo-sac thus: it increases considerably in size, not at first at the expense of its sister-cells, *i.e.*, it does not react on the other cells by pressure, but seemingly grows to a larger size, as it has become parasitic on the plerome-elements, for its wall in direct connection with the latter does not show the mucilaginous appearance like the remaining sides. At this time a vacuole is formed in the apical half of the young embryo-sac close to the nucleus, and now growth of the sac takes place rapidly, specially towards the apex of the ovule, the sister-cells of the embryo-sac are compressed and show signs of degeneration. The growth of the embryo-sac is so rapid after the vacuole has appeared, that the latter seems to me to be of the highest physiological importance in helping to dilate the growing cell.

A similar vacuole has been observed by Stassburger in *Senecio vulgaris* below the primary nucleus. It is evident, therefore, that this vacuole appearing before the division of the primary nucleus cannot represent a diffluent cell-wall; but its large size is rather the cause of the non-formation of a cell-wall dividing the embryo-sac into two cells. That occasionally, though rarely, a cell-wall is formed after the division of the primary nucleus is evident from Strassburger's* description and drawings of the young embryo-sac of *Orchis pallens*. Septa running across the embryo-sac are figured by the same author for *Anthericum*, *Allium*, &c., Ward has found and figured a diffluent partition in *Lobelia syphilitica*, and in *Myosurus* a very transient wall of the vacuole appears across the anterior third of the vacuole.

* Strassburger, Zellbildung und Zelltheilung, 1878, pl. ii. figs. 73–75.

We have next to consider the significance of this occasional partition separating the embryo-sac into a micropylar and an antipodal half. Does it correspond to the first wall of a developing prothallus, as generally believed, or to a wall separating two spores, each of which will develop into a prothallus (Ward's view), or are we dealing with a special mother-cell dividing into two sporocytes (Warming-Vesque's view)? I am inclined to hold the latter view, for the division of the embryo-sac makes the impression, as Ward points out distinctly, as being similar in nature to those preceding it; we know further that the walls of spore-mother-cells break down whenever spores are reaching their maturity, that they are, in other words, very transient; in the embryo-sac this process of dissolution of the wall seems to take place even before spore-formation, or rather no definite wall can be laid down, partly due to the vacuole and partly due to the rapid increase in breadth of the embryo-sac taking place at this time. If this wall is really a wall separating two sporocytes, then the sporocytes ought to give rise to four spores each, which they do—namely, the eight structures within the sac.

That we are really dealing with eight structures corresponding to eight modified spores, becomes evident on studying their development. For I find that after division of the primary nucleus into a micropylar and an antipodal one, the latter divides into two nuclei, one of which, the one next the plerome-elements, precedes its sister-cell a short time in division; the two nuclei resulting thus begin to act at once on the surrounding protoplasm, and to shut themselves off from the central part of the embryo-sac by delicate walls. Before the completion of this process, however, the remaining nucleus lying usually to one side of the two nuclei abutting on the plerome-elements, also divides, its antipodal nucleus comes in close contact with the two other antipodal nuclei and the embryo-sac-wall, and now the process of cell-wall formation becomes very evident; three nuclei shut themselves off from the rest of the embryo-sac by highly refractive walls, being fixed by their base to the wall of the embryo-sac, while their free convex ends project into the cavity of the embryo-sac. We find, therefore, if the occasional appearance of a cell-wall separating the embryo-sac into a micropylar and an antipodal half is indicative of the embryo-sac being a two-celled structure, although under now normal conditions, no division of the protoplasm of the young embryo-sac into two masses takes place after the division of the primary nucleus, that we would have to look at the cell-formation in the antipodal half of the embryo-sac as the formation of four cells, three of which are fixed to the wall of the embryo-sac and separated from the remaining fourth cell by definite cellulose-walls. The fourth cell would in this case be a naked or primordial cell containing a nucleus. In the micropylar region of the embryo-sac cell-walls appear first round the synergidal nuclei, and then a very delicate membranous wall is laid down round a third nucleus, which is the nucleus of the egg-cell. Thus three nuclei at the micropylar end of the embryo-sac are separated from the fourth nucleus, which remains free in the protoplasm surrounding the micropylar half of the vacuole. For the reasons given above, this fourth nucleus with its protoplasm must also be regarded as a primordial cell.

If, then, this interpretation of the changes occurring in the embryo-sac is correct, we must look upon the fusion of the two nuclei giving rise to the definitive or secondary nucleus as only the last step of a conjugation of two primordial cells, one from the micropylar, and one from the antipodal region of the embryo-sac, and the secondary nucleus as the nucleus of a newly-formed cell, occupying the centre of the embryo-sac, a cell destined to act as a nurse to the young embryo, to which cell I propose to give the name of endosperm-cell.

The next question to ask ourselves is this:—What induces these two cells in the embryo-sac to conjugate? If we consider the embryo-sac a macrospore, and its contents an eight-celled prothallus, we must believe two central vegetative cells of a prothallus capable of conjugation, with a view of giving rise to tissue which will serve as a storehouse for food-material. No phenomenon analogous to this can I recollect. If we accept the view proposed by Ward and consider the embryo-sac as containing two prothalli, we could suppose very well that the micropylar prothallus gives rise to two sexual cells, one being the ovum, the other the primordial cell lying above the region of the occasional septum in the embryo-sac, while the antipodal prothallus gives rise to one primordial sexual cell; that by the conjugation of two primordial sexual cells a fertilised cell arises, namely, the endosperm-cell, which has the power of further development into a tissue, the endosperm, when by the fertilisation of the remaining sexual cell of the micropylar prothallus, the egg-cell, by an extraneous sexual-cell, the product of the pollen-grain, an impetus has been given to the flow of nutritive material into the ovule. Further, that the embryo resulting from the fertilisation of the egg-cell by a pollen-grain is more vigorous than the embryo resulting from the conjugation of the two sexual cells arising in the embryo-sac, and that in consequence we have the stronger embryo feeding on the weaker one.

Against Ward's view the developmental evidence seems to point, while by a strict comparison with changes which are known to take place in other sporangia, we are driven to consider the embryo-sac as representing a special-mother-cell, giving rise to two sporocytes, each of which, in their turn, give rise to four spores.

The eight spores, however, do not behave as normal spores, nor do they seem to have the same sex; they are neither shed, giving rise to a prothallus and archegonia on germination, as *e.g.*, in *Selaginella*, nor do they germinate within the sporangium, as in Gymnosperms, where the so-called endosperm is in reality a true prothallus forming archegonia. The very fact of eight spores being developed simultaneously in a sac into which nourishment, according to Westermeyer's researches, can only get through the narrow antipodal end, at least in the later stages of its development, and into which, during the earlier stages of development, the nourishment seems, according to my own observations also to pass through the micropylar end,—nourishment derived in one case through the plerome-elements of the ovule, in the other case from the sister-cells of the embryo-sac undergoing disintegration,—is the reason of the spores occupying the position they do, and not forming a prothallus, but becoming reduced to two synergidal cells, which are two "spores" least developed, and the first to disappear;—into three sexual cells, one of which, the egg-cell, is fertilised by the product of a pollen-grain, and gives rise to a true embryo, two of which, derived from different sporocytes, and being brought into close contact by their mode of formation, conjugate, and thus give rise to a fertilised cell, the endosperm-cell, while the three remaining spores form the antipodal cells. These three antipodal cells should then, according to reasons just stated, namely, being nourished better than the remaining five spores, preserve their true spore-character longest, and this really seems to be the case in plants like *Zea mais, Coix lacryma, Panicum crus-galli, Salvia pratensis,* and some scrophularineous plants (Westermeyer), where the antipodal cells proliferate, and form the primordial endosperm, which, if my interpretation be correct, would correspond to prothalli formed by the antipodal spores, when, due to the fertilisation of the egg-cell, more nourishment is brought to the ovule. The objections raised by Ward against the interpretation of the eight structures within the embryo-sac as spores are shortly these: It is stated that one would expect to find in angiospermous ovules the process of reduction of the sexual generation (oophyte) carried on somewhat as in Gymnosperms, but to a further extent; and that ascending from the lower Cryptogams to the Coniferæ the male prothallus is found to suffer a greater reduction than the female prothallus. As further in Coniferæ the pollen-grain contains several prothallus-cells, while the embryo-sac contains a relatively large female prothallus, and as the pollen-grains of Angiosperms contain at least one prothallus-cell, it is evident that the macrospore [*i.e.*, the embryo-sac] of Angiosperms should contain not fewer, and probably more, prothallus-cells than the pollen-grain.

As another objection against the acceptance of the spore-nature of the nuclei, the following is given: "If we regard them (the nuclei) as together representing a prothallial structure, we may look upon the egg-cell as the equivalent of the oosphere of Vascular Cryptogams; but if not, we must imagine a process of reduction carried past the point where one might suppose everything had been removed but the essentials—not only the prothallus reduced to an oosphere, but even beyond. This appears by no means easy to conceive, and taken into consideration along with what has been said above, carries some weight."

I shall take up these objections for discussion in the order in which they have just been stated. Why should we expect to find the reduction of the sexual generation carried on in Angiosperms as in Gymnosperms? We could only do so if we had any proof that Angiosperms were either developed from Gymnosperms, or that both had arisen from the same ancestral Cryptogam, but had become differentiated later on, due to environmental conditions. But evidence goes to show that neither of these two alternatives has taken place; the embryo-sac of Gymnosperms does not correspond to the embryo-sac of Angiosperms, for in the former we are dealing with one macrospore forming a true prothallus (the endosperm) developing archegonia; while if the latter was one macrospore, we would have to consider the division of the primary nucleus as the division of the contents of a macrospore into a sexual and a vegetative part, according to the view generally held, without being able to explain the conjugation of the nuclei. If, on the other hand, we regard the embryo-sac as representing two prothalli, we must hold that reduction of one female prothallus has taken place to allow another female prothallus to develop. Such unselfishness does not occur amongst plants, for if anywhere, then in developing macrosporangia a struggle for existence becomes evident.

That male prothalli are always more reduced than female prothalli amongst Cryptogams and Conifers is well known, but we must be on our guard as to drawing any conclusions with regard to the size of the female prothallus, whenever the male prothallus has become reduced to a single cell; for in *Salvinia*, *Marsilea*, *Pilularia*, *Selaginella*, and others, only one male prothallus-cell is formed, while the female prothalli of these plants attain various degrees of development. It is quite conceivable that in Angiosperms, where the pollen-grain is shed and where it has to form a long pollen-tube, reduction should not have occurred to the same degree as has taken place in the spores of the embryo-sac. The synergidal cells are "reduced even beyond an oosphere" condition, as they are only capable of passing on the male element to their more vigorous companion, the egg-cell or true oosphere; but how our accepting Warming's view as to the spore-nature of the contents of the embryo-sac necessitates that the "egg-cell" is reduced beyond an oosphere, I am unable to see.

I asserted that the eight spores differed in their sex. This statement refers to the conjugation of the two primordial cells, the last stage of which is the mysterious fusion of nuclei. I believe the micropylar half of the embryo-sac to correspond to four female spores or macrospores, and the antipodal half to correspond to four male spores or microspores. The facts which lead me to this belief are the following:—The egg-cell in the micropylar region receives the contents of the pollen-tube and develops into the embryo; it is therefore a true female cell, and its sister-cell I would expect to be also a female cell, and I find that the nucleus of the antipodal cell travels towards the nucleus of the primordial micropylar cell, and that in *Myosurus* the two nuclei meet in the micropylar half of the sac. The same phenomenon holds good for a great number of plants, although according to Strasburger in other cases the two nuclei approach one another mutually. But not only does, in *Myosurus*, the antipodal nucleus travel towards the micropylar one, but also the antipodal nucleolus goes to meet the micropylar one.

Let us shortly study how the conjugation of nuclei is brought about. The two nuclei meet in the anterior half of the embryo-sac and become flattened off against one another, being themselves evidently quite indifferent. Gradually the two nuclear membranes lying in close contact with one another are dissolved from within outwards, and thus a passage is made for the transit of the antipodal nucleolus into the micropylar nucleus. The two nucleoli come in contact with one another in the micropylar half of the secondary, or, as I shall call it, the endosperm-nucleus, and after the formation of a very short bridge-like middle piece the contents of the antipodal nucleolus flow into the micropylar nucleolus. After the fusion is completed, a baglike structure is seen in the antipodal half of the endosperm-nucleus, which I interpret as the nucleolar bag of the antipodal nucleolus. At the time when the two nuclei have just come in contact with one another, two, rarely three, very minute granules surrounded by a pale area and reminding me of polar bodies are found constantly in each nucleus; in some cases these bodies seem even to have the power of division after the formation of the endosperm-nucleus.

I shall briefly state some of the changes I observed in the newly-formed nucleolus of the endosperm-nucleus; but I am not as yet able to give the order in which these phenomena succeed one another. In one endosperm-nucleus the nucleolus shows fifteen minute unstained areas,* or endonucleoli, all of the same size and arranged as the beads of a rosary, forming an irregular coil, while in another nucleolus these areas are of slightly unequal size and arranged in a circle; in still another nucleolus, four kidney-shaped endonucleoli are visible; but perhaps two of the most conspicuous stages are those in which a large central globular endonucleolus is found surrounded by numerous minute ellipsoidal endonucleoli, the large central one either possessing a highly refractive plate-like body or not. It is evident that the nucleolus and not the nucleus is the essential element of the cell during the act of fertilisation; this view, first stated before this Society † and then strengthened by the methods of staining the nucleolus differentially,‡ is proved to be correct by the facts discovered during the conjugation of the sexual cells within the embryo-sac.§ That also during cell-division the nucleolus is the main factor, was first pointed out by Dr Macfarlane. ||

If we have, then, spores of different sex within the embryo-sac, or spores which, if they germinated, would give rise to male and female prothalli, we would have to ask ourselves, Do we know of any sporangium amongst cryptogams giving rise to such spores? We find sporangia in the *Equisetineæ* giving rise to spores of this kind, and not only so, but also means to procure a dissemination ensuring fertilisation, and further, fossil heterosporous *Equisetaceæ* are known. As the histological structure of *Equisetineæ* approaches that of Angiosperms most, may we not reasonably look at the *Equisetineæ* as the ancestors of Angiosperms?

I shall shortly sum up my view of the embryo-sac by stating that I believe it to correspond to two sporocytes; one

* These areas were first observed by Lacaze-Duthiers, and are called by Flemming, in Archive für microscopische Anatomie, x. p. 259, 1874, the "granule of Schrön," or "nucleololus," and interpreted by him, as Hessling had done before, as "vacuoles;" Rudolph Arndt uses the term "nucleolulus," first proposed by Mauther; Macfarlane introduced the term "nucleolo-nucleus" (Trans. Bot. Soc. Edin., 1881, pp. 195, 216), and ultimately substituted, at Professor Rutherford's suggestion, the term "endonucleolus."

† Trans. Bot. Soc. Edin., vol. xviii. (1890), p. 426.

‡ Ibid., vol. xix. (1891), January, p. 46.

§ Ibid., vol. xix. (1891), April, p. 89.

|| Ibid., vol. xiv. (1880–81), p. 192.

of which, the one next the micropyle, is a female sporocyte, while the one next the plerome-elements of the ovule is a male sporocyte; that two of the eight cells resulting by their division undergo conjugation, and thus give rise to the endosperm-cell, which must be looked upon as a true embryo, but which, being weaker than the embryo resulting by cross-fertilisation, has become modified to serve as a storehouse for the stronger embryo.

ON TEMPERATURE AND VEGETATION AT THE ROYAL BOTANIC GARDEN, EDINBURGH, during MAY 1891. By ROBERT LINDSAY, Curator of the Garden.

The past month of May has been one of the most unfavourable experienced for many years. Dull, inclement weather during the day, and frequent frost at nights, has prevented vegetation from making very much progress. A few showers of rain fell, but not of that genial nature wanted at this season of the year. At the close of the month few of the ordinary forest trees were in full leaf, except the Maple, Elm, and Horse Chestnut; the latter is well set with flower buds, which, when fully expanded, will make a grand display. Fruit trees, such as Apple, Pear, and Cherry, are flowering most profusely. Trees and shrubs generally, though later in flowering than I ever remember, promise to be quite up to the average in flowering. Laburnum, Hawthorn, Holly, Lilac, Azalea, and others, are very well set with flower buds, ready to burst forth when more genial weather comes. Vegetation generally is very much in the condition usually found in April; so late a season very rarely occurs. During the month the thermometer was at or below the freezing point on five occasions, indicating a total of 10° of frost. The lowest readings were on the 4th, 30°; 5th, 31°; 17th, 27°; 19th, 30°; 21st, 32°. The lowest day temperature was 48°, on the 8th, and the highest 74°, on the 12th of the month.

On the rock-garden 260 species and varieties of plants came into flower, against 365 for the corresponding month last year. Among the most interesting were:—*Andromeda fastigiata, A. tetragona, Androsace lactea, A. sarmentosa, Arnebia echioides, Aubrietia Hendersoni, A. Leichtlini, Anemone alpina, Cortusa Matthioli, Cytisus decumbens, C.*

*Ardoinii, Erica australis, Daphne cneorum, D. Fioniana, Gentiana verna, Dianthus glacialis, Narcissus triandrus pulchellus, Olearia Gunniana, Petrocallis pyrenaica, Onosma tauricum, Primula grandis, P. integrifolia, P. viscosa, Romanzoffia stitchensis, Stylophorum japonicum, Trichonema rosea, Trillium grandiflorum, Vella pseudo-cytisus,* and others.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during May 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 45° | 48° | 62° | 17th | 27° | 44° | 56° |
| 2nd | 38 | 40 | 54 | 18th | 35 | 55 | 59 |
| 3rd | 35 | 42 | 56 | 19th | 30 | 45 | 58 |
| 4th | 30 | 50 | 58 | 20th | 33 | 50 | 59 |
| 5th | 31 | 54 | 61 | 21st | 32 | 50 | 56 |
| 6th | 42 | 48 | 60 | 22nd | 36 | 50 | 62 |
| 7th | 41 | 44 | 55 | 23rd | 37 | 50 | 63 |
| 8th | 38 | 40 | 48 | 24th | 35 | 44 | 58 |
| 9th | 41 | 48 | 58 | 25th | 36 | 45 | 56 |
| 10th | 35 | 54 | 57 | 26th | 37 | 44 | 54 |
| 11th | 36 | 54 | 62 | 27th | 42 | 44 | 58 |
| 12th | 35 | 55 | 74 | 28th | 41 | 43 | 59 |
| 13th | 43 | 55 | 64 | 29th | 39 | 46 | 61 |
| 14th | 39 | 52 | 60 | 30th | 40 | 57 | 67 |
| 15th | 36 | 49 | 56 | 31st | 37 | 45 | 55 |
| 16th | 32 | 43 | 55 | | | | |

Dr DAVID CHRISTISON, who was unavoidably absent from the meeting, sent the following note:—

"Perhaps, in connection with the Monthly Report on Temperature and Vegetation, it may interest the Society to know that in this extraordinary season there has been a great diminution in the girth-increase of the trees measured by me in the Botanic Garden.

"The aggregate increase of twenty-eight young deciduous trees till the end of May was, . . . 1·80 inches in 1891.
Average of previous four years, . . 3·40 ,,
Aggregate increase of thirty-one young Conifers was, . . . . . . 3·65 ,,
Average of previous four years, . . 6·73 ,,

"Thus the amount was little more than half the average of the previous four years, both in the deciduous and evergreen groups.

"I may add, that while in each of the previous four years there was an appreciable increase in girth in April, amounting in the aggregate to about half an inch in the deciduous trees and one inch and a quarter in the Conifers, there was no increase in either group in April 1891."

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of May 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 a.m.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·140 | 59·6 | 48·8 | 51·7 | 50·2 | W. | Nim. | 10 | W. | 0·150 |
| 2 | 29·391 | 59·7 | 39·0 | 39·1 | 39·1 | N.E. | Nim. | 10 | N.E. | 0·455 |
| 3 | 29·620 | 49·8 | 35·9 | 44·1 | 43·2 | W. | Cum. | 10 | W. | 0·008 |
| 4 | 29·830 | 52·3 | 34·8 | 49·8 | 48·1 | W. | ... | 0 | ... | 0·000 |
| 5 | 30·052 | 53·7 | 34·9 | 50·6 | 49·1 | S.W. | Cum. | 2 | S.W. | 0·000 |
| 6 | 30·031 | 57·8 | 45·8 | 49·5 | 49·1 | S.E. | Cum. | 9 | S.E. | 0·103 |
| 7 | 29·861 | 57·6 | 44·5 | 46·0 | 46·0 | S. | Nim. | 10 | S. | 0·018 |
| 8 | 29·553 | 52·0 | 41·9 | 44·5 | 44·5 | E. | Cum. St. | 10 | E. | 0·174 |
| 9 | 29·948 | 48·8 | 44·0 | 48·8 | 47·2 | E. | Cum. | 7 | E. | 0·005 |
| 10 | 30·054 | 52·9 | 39·2 | 52·3 | 48·0 | E. | ... | 0 | ... | 0·000 |
| 11 | 30·175 | 53·5 | 39·3 | 51·6 | 46·5 | E. | Cum. | 9 | E. | 0·000 |
| 12 | 30·201 | 57·8 | 38·7 | 54·7 | 53·0 | E. | ... | 0 | ... | 0·000 |
| 13 | 30·067 | 68·8 | 50·7 | 55·1 | 53·1 | W. | Cum. | 10 | W. | 0·000 |
| 14 | 29·914 | 61·9 | 40·8 | 52·0 | 47·2 | W. | Cum. | 9 | W. | 0·020 |
| 15 | 29·401 | 57·6 | 38·1 | 48·8 | 44·0 | N.W. | Cum. | 10 | N.W. | 0·027 |
| 16 | 29·734 | 53·6 | 35·3 | 43·4 | 37·1 | N. | Cum. | 5 | N. | 0·002 |
| 17 | 29·498 | 47·6 | 31·0 | 42·9 | 37·8 | N. | Cum. | 3 | N. | 0·002 |
| 18 | 29·380 | 48·7 | 37·2 | 46·7 | 42·8 | N.E. | Cum. | 2 | N.E. | 0·000 |
| 19 | 29·368 | 50·0 | 34·0 | 46·8 | 41·5 | N.W. | Cum. | 10 | N.W. | 0·002 |
| 20 | 29·558 | 53·6 | 37·2 | 49·0 | 44·1 | N.W. | Cir. | 3 | N.W. | 0·000 |
| 21 | 29·567 | 54·6 | 36·1 | 47·6 | 44·5 | E. | Cum. | 5 | E. | 0·000 |
| 22 | 29·573 | 52·7 | 39·6 | 48·8 | 44·1 | N. | Cum. | 10 | N. | 0·000 |
| 23 | 29·588 | 55·9 | 40·1 | 50·3 | 46·0 | N. | ... | 0 | ... | 0·030 |
| 24 | 29·793 | 55·5 | 40·0 | 51·0 | 47·2 | N.E. | Cir.<br>Cum. | 2<br>2 | S.E.<br>N.E. | 0·000 |
| 25 | 29·793 | 53·1 | 39·0 | 47·2 | 43·1 | N. | Cum. | 9 | N. | 0·135 |
| 26 | 29·673 | 51·0 | 40·7 | 45·2 | 44·9 | N.E. | Cum. | 10 | N.E. | 0·182 |
| 27 | 29·467 | 50·0 | 43·2 | 46·5 | 45·9 | N.W. | Nim. | 10 | N.W. | 0·040 |
| 28 | 29·448 | 53·2 | 44·0 | 49·6 | 46·9 | E. | Cum. | 9 | E. | 0·105 |
| 29 | 29·474 | 53·3 | 43·5 | 48·7 | 46·7 | S. | Cum. | 10 | S. | 0·030 |
| 30 | 29·636 | 59·6 | 43·0 | 51·3 | 48·8 | E. | Cum. | 2 | S. | 0·002 |
| 31 | 29·852 | 59·7 | 41·5 | 46·0 | 46·0 | E. | Cum. St. | 10 | E. | 0·000 |

Barometer.—Highest Reading, on the 12th, =30·201. Lowest Reading, on the 1st, =29·140. Difference, or Monthly Range, =1·061. Mean=29·698.

S. R. Thermometers.—Highest Reading, on the 13th, =68°·8. Lowest Reading, on the 17th, =31°·0. Difference, or Monthly Range, =37°·8. Mean of all the Highest =54°·7. Mean of all the Lowest=40°·0. Difference, or Mean Daily Range, =14°·7. Mean Temperature of Month=47°·4.

Hygrometer.—Mean of Dry Bulb=48°·4. Mean of Wet Bulb=45°·7.

Rainfall.—Number of Days on which Rain, or Snow, fell=19. Amount of Fall, in inches, =1·49.

Light showers of snow on 16th and 17th.

A. D. RICHARDSON,
*Observer.*

On Temperature Vegetation, in the Botanic Garden, Glasgow, during May 1891. By Robert Bullen, Curator of the Garden.

This was for the most part a very cold month, and strong easterly winds were frequent. A considerable cyclone passed over this district on the 14th, after which the weather generally was more like March of an ordinary season. Snow was frequently to be seen falling lightly, and the sun shining at the same time, while thunder-showers and hail were frequent. On the 10th, and again on the 12th, the temperature was high. On the latter date, 73° was registered on a shaded thermometer at 3 feet from the ground, which is very unusual at this season. Light morning frosts were frequent here, but in some districts not far removed, as much as 8° were registered, the early bloom of fruit trees being destroyed; while in later districts, and where bloom is also abundant, there is yet hope.

Most out-door plants are in such a backward state, flowers for teaching purposes cannot be had at the usual time.

## MEETING OF THE SOCIETY.

Thursday, July 9, 1891.

ROBERT LINDSAY, President, in the chair.

R. B. WHITE, ESQ. of Ardarroch, was elected Resident Fellow of the Society.

WILLIAM G. SMITH, B.Sc., was admitted Resident Fellow of the Society.

Presents to the Library at the Royal Botanic Garden were announced.

The following contributions to the Illustration Fund were announced:—

Dr Cleghorn, £1.
P. Neill Fraser, £1.

Mr WILLIAM B. BOYD sent for exhibition a large series of cut flowers of alpine and herbaceous plants included in the following list of rare plants flowered in his garden at Faldonside during the summer:—

*Ranunculus anemonoides*, *Anemone thalictroides*, fl. pl., *A Baldensis*, *Aquilegia truncata*, *Helleborus torquatus*, true, *Adonis pyrenaica*, *Jeffersonia diphylla*, *Vancouveria hexandra*, *Corydalis Casseana*, *Iberis petræa*, *Oxalis enneophylla*, *O. lobata*, *Cytisus decumbens*, *Orobus Gibbleri*, *Heuchera sanguinea splendens*, *Saxifraga Rudolphiana*, *S. odontophylla*, *S. flagellaris*, *S. Tombianensis*, *Lonicera pyrenaica*, *Phyteuma comosa*, *Androsace villosa*, *Primula Parryi*, *P. Stuarti*, *P. Reidi*, *Polemonium piliferum album*, *P. confertum*, *Lithospermum Gastoni*, *L. graminifolium*, *L. canescens*, *Pulmonaria dahurica*, *Pentstemon Menziesii*, *P. Lewisi*, *Globularia nana*, *Polygonum sphærocephalum*, *Cypripedium spectabile*, *C. Calceolus*, *Orchis ustulata*, *O. militaris*, *O. latifolia superba*, *Iris fluviatilis*,



Issued October 1891.

*Gladiolus Kotschianus, Fritellaria recurva, F. tristis, F. pallidiflora, Uvularia grandiflora.*

Mr George Potts exhibited a dwarf variety of *Saxifraga Cotyledon* found by him in Norway, also a large leaf of *Rogersia podophylla.*

The Curator of the Royal Botanic Garden exhibited from Mr. Shiels, market gardener, Edinburgh, flowering specimens of the 'Mummy Pea,' which is said to be merely a form of the cultivated pea, *Pisum sativum.*

Dr John H. Wilson, referring to plants of a species of *Geum* exhibited from the Royal Botanic Garden, remarked that they were found by Professor Bayley Balfour during a class-excursion on 13th June in the woods of Blairadam. The plant is *Geum strictum*, Ait., a species with a wide distribution from North America through Japan, Siberia and Songaria to South and Mid Russia. The plant is thoroughly established near the south avenue gate on the banks of the Lochornie Burn, a long way from the garden of Blairadam, but there is a small garden around the gatekeeper's lodge not far off, whence the plant might have strayed.

The following plants in bloom were exhibited from the Royal Botanic Garden:—*Aquilegia pyrenaica, Aceras anthropophora, Campanula G. F. Wilson, Loasa lateritia, Silene quadrifida, Sibthorpia europæa variegata, Veronica diosmæfolia, Saxifraga mutata, Inula Hookerii, Silene maritima*, a hairy variety found by Professor Bayley Balfour during a class-excursion on June 20th in the fields west from North Berwick, and *Chrysanthemum leucanthemum* in the following three varieties:—(*a*) a form found by the late Professor Dickson with tubular white ray flowerets; (*b*) a form found on the Saunton Rocks, Devonshire, by Professor Bayley Balfour, with much-divided leaves and heads showing large convex disks with short and recurved rays; (*c*) a form found by Dr Macfarlane during a class-excursion on May 9th on the banks of the Esk between Musselburgh and Dalkeith, showing stem and leaves densely hirsute.

The following papers were read:—

## The Phanerogamic Flora of St Kilda. By Alexander H. Gibson.

Among the Hebridean Isles there is probably none that surpasses in interest the small Isle of St Kilda. Situated forty miles west of North Uist, within the 100 fathom line, it is, like parts of the Isle of Skye, formed of gabbro and granite. It is hilly, and bounded for the most part by high precipices. Its hills vary in elevation from 700 to 1220 ft. Its soil is turfy on the hill sides, boggy or marshy in the hollows. Abundantly supplied with rain, it has numerous springs, and two small perennial streams, one of which is proudly called by the natives the "avon mohr." Its area is roughly estimated at 3000 acres.

In the neighbourhood of the south-east bay some ground, the best situated in the island, is cultivated and produces barley of fair quality. In this part of the island vegetation is more luxuriant than elsewhere, and the greatest variety of plants occur. All or nearly all the "introduced" plants are confined to this part of the island. A few plants, *e.g.* *Anagallis tenella, Lychnis Flos-cuculi,* find here more genial conditions than are general in St Kilda. Where the vegetation is fully exposed to the strong west winds it is close and compact, of a dark green colour, and composed of *Armeria* and *Plantago.* About the nesting grounds of the puffins it is rank, and consists almost entirely of *Holcus lanatus, Rumex acetosa, Cochlearia, Atriplex,* and *Stellaria media.* Much of the highest hill, Conacher, is covered with heather.

The greater number of the species of plants found in St Kilda are represented by numerous individuals in many parts of the island, *e.g., Calluna, Sedum Rhodiola, Salix repens, Plantago maritima.* A small number of species, however, is limited in numbers and restricted to one or two places, *e.g.* a patch of *Lonicera* 500 or 600 ft. up the side of Conacher; a small colony of *Botrychium Lunaria*; two colonies of *Drosera,* etc.

The species recorded in the subjoined list are very widely distributed in Britain. Only 24 are recorded from *fewer* than 90 of Watson's 112 divisions. Many of these are maritime or North British plants. Outside Britain also the St Kilda species are widely distributed, many of them occurring in Iceland, in Greenland, in Canada, in Alaska, in the Rocky Mountains, north and south of the British boundary, in Kamtchatcha, in Siberia, in Lapland, and several in the Antarctic regions.

Four species, viz., *Ranunculus Ficaria, Agrostis canina, Ophioglossum vulgatum, Botrychium Lunaria*, are not recorded by Watson, 1883, as occurring in the "Hebrides."

The colours of the flowers in the order of their relative abundance are white, yellow, pink, and blue. The St Kilda plants are all low growing, and very frequently dwarfed by the strong winds.

Among the plants of this island many are anemophilous, others are capable of self-fertilisation, and a large number are entomophilous. The Diptera play an important part in the fertilisation of the flowers. There are several species of moths on the island. They probably fertilise such plants as *Primula vulgaris* and *Silene maritima.* Butterflies, bees, wasps, and possibly ants do not occur on the island. It was, therefore, interesting to find in fruit several plants, *e.g., Vaccinium Myrtillus, Pinguicula vulgaris,* which are according to Müller "adapted for bees." Some species, at least, in certain years, are not fertilised at all, *e.g., Vicia Sepium, Trifolium pratense, Lonicera.*

I would take this opportunity of expressing my gratitude to Mr Macleod of Macleod, the proprietor of the island, and to his factor Mr Mackenzie, for the kindness extended to me. I would also state that I am indebted to Dr Wilson, curator of the Herbarium of the Royal Botanic Garden, Edinburgh, for ready reference to books and specimens of plants, and that I have had the advantage of his opinion regarding certain of the species.

*Postscript.*—Since communicating the above to the Society, I have seen, in the Journal of Botany for 1886, "Notes on the Flora of St Kilda," by R. M. Barrington, M.A., F.L.S. The following plants were found by Mr Barrington, but not by me:—*Ranunculus repens, Sagina subulata, Senecio aquaticus, Rumex conglomeratus, Schœnus nigricans, Carex vulgaris, C. glauca, C. panicea, Cystopteris fragilis.* The plants found by me but not by Mr Barrington are indicated in the following list.

The total number of plants recorded for St Kilda by Mr Barrington and by me is about 140, of which at least 20 have been introduced by man. Macgillivray,* in a list of 29 plants, includes 10 not found either by Mr Barrington or by me.

My collection has been deposited in the Herbarium of the Royal Botanic Garden, Edinburgh.

## LIST OF PLANTS FOUND IN ST KILDA, AUGUST 1889.

Explanation. × = 'not indigenous.'
×? = doubtful native.
O = not recorded by Barrington.†

*Ranunculus Flammula*, L.
,, *acris*, L.
,, *Ficaria*, L.
O *Cardamine hirsuta*, L.
*Cochlearia officinalis*, L.
O × *Brassica* sp.
× *Capsella Bursa-pastoris*, Mch.
*Montia fontana*, L.
O *Viola palustris*, L.
,, *canina*, L.
*Polygala vulgaris*, L.
*Silene maritima*, With.
,, *acaulis*, L.
*Lychnis Flos-cuculi*, L.
*Cerastium tetrandrum*, Curt.
,, *triviale*, Link.
*Stellaria media*, Cyr.
*Sagina procumbens*, L.
× *Spergula arvensis*, L.
*Hypericum pulchrum*, L.
O × *Trifolium pratense*, L.
,, *repens*, L.
*Vicia Sepium*, L.
*Potentilla Tormentilla*, Neck.
,, *anserina*, L.
*Saxifraga oppositifolia*, L.
*Sedum Rhodiola*, D.C.
O *Drosera rotundifolia*, L.
*Callitriche verna*, L.
*Epilobium palustre*, L.
*Hydrocotyle vulgaris*, L.
*Angelica sylvestris*, L.
O × *Sambucus nigra*, L.
*Lonicera Periclymenum*, L.
*Galium saxatile*, L.
*Scabiosa succisa*, L.
*Achillea Millefolium*, L.
× *Chrysanthemum segetum*, L.
*Matricaria inodora*, L. var. *maritima*
O *Artemisia vulgaris*, L.
*Senecio Jacobæa*, L.
× *Cnicus lanceolatus*, Hoffm.
*Leontodon autumnalis*, L.
*Taraxacum officinale*, Webb.
× *Sonchus oleraceus*, L.
*Gnaphalium dioicum*, L.
*Vaccinium Myrtillus*, L.
*Erica cinerea*, L.
*Calluna vulgaris*, L.
O *Armeria maritima*, Willd.
*Primula vulgaris*, Huds.

* Edin. Phil. Journ., 1842.
† Jour. of Bot. 1886, p. 213.

*Anagallis tenella*, L.
O *Gentiana campestris.*
O × *Myosotis arvensis*, Hoffm.
*Veronica officinalis*, L.
*Euphrasia officinalis*, L.
*Pedicularis sylvatica*, L.
*Rhinanthus Crista-galli*, L.
*Pinguicula vulgaris*, L.
*Thymus Serpyllum*, Fr.
*Prunella vulgaris*, L.
× *Galeopsis Tetrahit*, L.
O × *Plantago major*, L.
,, *lanceolata*, L.
,, *maritima*, L.
,, *Coronopus*, L.
*Atriplex Babingtonii*, Words.
*Polygonum aviculare*, L.
O × ,, *Persicaria*, L.
*Oxyria digyna*, Hill.
× *Rumex obtusifolius*, L.
× ,, *crispus*, L.
,, *acetosa*, L.
,, *Acetosella*, L.
× *Urtica dioica*, L.
*Salix repens*, L.
,, *herbacea*, L.
*Empetrum nigrum*, L.
*Orchis maculata*, L.
× ? *Iris Pseudacorus*, L.
*Narthecium ossifragum*, Huds.
O *Juncus bufonius*, L.
,, *squarrosus.*
,, *communis*, L.
,, *supinus*, Moench.
O ,, *lamprocarpus*, Ehrh.
*Potamogeton natans*, L.
*Eleocharis palustris*, R. Br.
*Scirpus caespitosus*, L.
*Eriophorum angustifolium*, Rth.
*Carex pulicaris*, L.
,, *stellulata*, Lond.
,, *rigida*, Lond.
*Carex pilulifera*, L.
,, *binervis*, Sm.
,, *flava*, L.
*Anthoxanthum odoratum*, L.
× ? *Alopecurus geniculatus*, L.
O *Agrostis canina*, L.
O ,, *vulgaris*, With.
O ,, ,, var. *pumila.*
*Aira praecox*, L.
*Deschampsia flexuosa*, Trin.
*Holcus lanatus*, L.
O × *Avena elatior*, L.
*Molinia coerulea*, Moench.
*Poa annua*, L.
,, *pratensis*, L. var.
,, *trivialis*, L.
*Festuca ovina*, L.
,, ,, Sub-sp. *duriuscula*, (L. Sp.).
*Festuca ovina*, Sub-sp. *rubra*, (L. Sp.).
O *Festuca ovina*, var. *vivipara.*
O ,, ,, var. *arenaria.*
O × *Lolium perenne*, L.
*Nardus stricta*, L.
O *Triodia decumbens*, Beauv.
× *Triticum repens*, L.
*Hymenophyllum unilaterale*, Bory.
*Pteris aquilina*, L.
*Lomaria Spicant*, Desv.
O *Asplenium Adiantum-nigrum*, L.
,, *marinum.*
O *Athyrium Filix-fœmina*, Roth.
*Lastrea dilatata*, Presl.
*Polypodium vulgare*, L.
*Ophioglossum vulgatum*, L.
*Botrychium Lunaria*, Siv.
*Selaginella selaginoides*, Gray.
*Equisetum arvense*, L.

## THE COTYLEDONARY GLANDS IN SOME SPECIES OF RUBIACEÆ.

By THOMAS BERWICK, St Andrews.

In a previous paper read to this Society,* I noted the presence of two embryonic glands in the axils of the cotyledons of the ungerminated embryos of *Galium Aparine*, L.; *G. cruciata*, Scop.; and *Sherardia arvensis*, L.

Since then I have dissected the ungerminated embryos of numerous other species of the Rubiaceæ, and find two glands in the axils of the following, viz.: — *Asperula arvensis*, L.; *A. setosa*, Jaub. et Spach.; *Borreria capitellata*, Chmss. et Sch.; *Callipeltis Cucullaria*, Stev.; *Galium anglicum*, Huds.; *G. articulatum*, Roem. et Sch.; *G. boreale*, L.; *G. capillipes*, Rchb.; *G. caudatum*, Boiss.; *G. lucidum*, D.C.; *G. macrocarpum*, Boiss.; *G. Mollugo*, L.; *G. nebulosum*, Boiss.; *G. physocarpum*, Boiss.; *G. saccharatum*, All.; *G. spurium*, L.; *G. tenuissimum*, M. B.; *G. tricorne*, Wither.; *Phyllis Nobla*, L.; *Spermacoce tenuior*, L.; *Vaillantia hispida*, L.; *V. incrassata*, Pomel.; *V. muralis*, L.

The form of these glands in the embryonic stage corresponds with that found after germination.† The two embryonic glands in the plants in the above list keep the lead,† in point of size, of all the other cotyledonary glands which appear during the processes of growth. It would seem from the comparatively large size they attain, when more or less fully developed, that, as is the case in *Galium Aparine*, they will outmeasure any gland afterwards developed in the leaf whorls of any of the species named.

In these 26 species of Rubiaceæ every embryo of the very numerous, and in most cases minute seeds, produces its two isolated glands, varying in their outline and dimensions in different species, but fixed in position and identical in form in the same species.

Multiplication † of cotyledonary glands takes place in almost all the above as was the case in *G. Aparine*. There is reason to believe, that a larger embryo contains two larger glands than those found in a smaller embryo, but

* Trans. Bot. Soc. Edin., vol. xviii. p. 436.

† Verified in most species in list.

given two embryos alike of any species, and the two glands are identical.

In *Crucianella angustifolia*, L.; *C. laxiuscula*, Jord.; *C. macrostachya*, Boiss.; *C. patula*, L.; *C. stylosa*, Trin.; there is a deviation from the fixed number of two isolated glands in the ungerminated embryos. In their case there are two contiguous glands in each embryo, and in at least three of the five there is a third isolated gland. The contiguous glands may or may not be equal in size. It may be asked, does the presence of this additional gland indicate greater vitality?

I have failed to notice embryonic cotyledonary glands in *Asperula tinctoria*, L.; *Rubia peregrina*, L.; *R. tinctorum*, L.; *Galium rubioides*, L.; *Coffea arabica*, L.; but this does not prove their absence. In all the five except *R. peregrina* I have seen glands in the axils of the cotyledons after germination. I may here add, that if the cotyledons are sessile, the glands are more readily detected than when they are stalked, as is the case in a marked degree in *R. peregrina* and *R. tinctorum*.

The presence of glands in the ungerminated embryos in thirty-one out of the thirty-six species examined, and probably in the five exceptions as well, seems to point to the universality and heredity of the feature. The effect of hybridization on these glands it would be interesting to know; also the range of plant-life over which the feature extends, as well as the function of the glands.

The adult cotyledonary glands take on a red-brown colour after mounting in glycerine jelly, in *Asperula arvensis*, L., *Crucianella patula*, L., *C. stylosa*, Trin., *Sherardia arvensis*, L., pointing to perhaps the presence of some common chemical element. In the other species mentioned most of the glands have a clear crystalline appearance, but some of them are of a faint brown colour.

In the ungerminated embryo of *Ixora Loureiri*, H. Bn., there are two processes somewhat resembling glands; this embryo has a marked resemblance to that of *Coffea arabica*, but it is rather smaller.

As will be seen in the annexed table, I steeped the seeds, which were all hard and horny, in water, to aid in dissecting out the glands, which may or may not have enlarged from the action of the water. But the possibility of the water having caused growth leading to the presence of the glands is removed, when one considers that on breaking a perfectly dry and hard seed of *Sherardia arvensis*, a gland was readily observed. It was noticeable that the seeds with their testas usually floated on the water for a considerable time, a bubble of air being given off as they sunk. The sinking was usually, if not always immediate if the testa was previously removed.

The seeds for the above investigation were liberally granted for my use to Dr John H. Wilson, late Lecturer on Botany in the University of St Andrews, by M. Maxime Cornu, Professeur-Administrateur au Muséum d'histoire naturelle, Paris.

[Table.

| Name. | Description of Seed. | Hours Immersed. | Ungerminated. | | |
|---|---|---|---|---|---|
| | | | No. of Embryonic Cotyledonary Glands. | Measurement in mm. | |
| | | | | Height. | Across. |
| Asperula arvensis, L., | Comparatively large, round. | 47 | 2 isolated. | ·116 | ·09 |
| ,, setosa, Jaub. et Spach., | Small round. | 47 | do. | ·036 | ·036 |
| ,, tinctoria, L., | do. | ... | ... | ... | ... |
| Borreria capitellata, Chmss. et Sch., | Small elongated. | 24 | 2 isolated. | ·04 | ·04 |
| Coffea arabica, L., | ... | ... | ... | ... | ... |
| Crucianella angustifolia, L., | Small elongated. | 42 | 2 contiguous, 1 isolated. | ... | ... |
| ,, laxiuscula, Jord., | do. | 21 | 2 contiguous. | ·05 | ·03 |
| ,, macrostachya, Boiss., | do. | 42 | 2 contiguous, 1 isolated. | ... | ... |
| ,, patula, L., | do. | 21 | do. | ·04 (solitary gland). | ·033 |
| ,, stylosa, Trin., | do. | 42 | 2 contiguous identical. | ·046 | ·036 |
| Callipeltis Cucullaria, Stev., | Very minute. | 24 | 2 isolated. | ·033 | ·026 |
| Galium anglicum, Huds., | Very minute, round. | 45 | do. | Very minute. | ... |
| ,, Aparine L., | Round. | ... | do. | ·1 | ·093* |
| ,, articulatum, Roem. et Sch., | Small round. | 48 | do. | ·04 | ·04* |
| ,, boreale, L., | do. | 47 | do. | ... | ... |
| ,, capillipes, Rchb., | Very minute. | 47 | do. | ·033 | ·026 |
| ,, caudatum, Boiss., | do. | 45 | do. | ·04 | ·04* |
| ,, cruciata, Scop., | Minute. | ... | do. | ... | ... |
| ,, lucidum, D.C., | Small round. | 21 | do. | ·04 | ·03 |
| ,, macrocarpum, Boiss., | Large seed, round, coat rough. | 24 | do. | ·04 | ·0766 |
| ,, Mollugo, L., | Small round. | 22 | do. | ·03 | ·046 |

| Germinated. | | | Remarks. |
|---|---|---|---|
| Description of Seedling. | Measurement in mm. of largest Cotyledonary Glands—the Embryonic Glands. Height. | Across. | |
| $\frac{1}{4}$ inch above soil + bend (approximate). | ·4 | ·266 | |
| $\frac{1}{2}$ inch above soil. | ·166 | ·186 | |
| ·875 inches. | ·156 | ·086 | Germinated badly. |
| $\frac{1}{5}$ inch fully, testa on. | ·046 | ·1 | |
| ... | ... | ... | Glands in axil of adult persistent cotyledons. |
| ... | ... | ... | |
| $\frac{4}{5}$ inch + bends with root. | ... | ... | Apex of root red brown. |
| ... | ... | ... | One of the contiguous glands is sometimes smaller than the other. |
| $\frac{7}{10}$ inch fully with root. | ·1 | ·1 | Root red when wet. |
| $1\frac{4}{5}$ inches fully with root. | ·15 | ·133 | Root brownish in colour. |
| $\frac{2}{5}$ inch with root. | ·07 | ·066 | |
| $\frac{2}{5}$ inch fully. | ·106 | ·106 | |
| The cotyledons were adult. | ·571 | ·379* | * Corrected measurements of glands, see paper of 13th February 1890. |
| ... | ... | ... | * Probable measurement. Germinated badly. |
| ... | ... | ... | |
| Nearly 1 inch without bend. | ·166 | ·1* | * Probable measurement. |
| $\frac{4}{5}$ inch. | ·166 | ·083 | * Probable measurement. |
| ... | ... | ... | |
| $\frac{1}{3}$ inch above soil. | ·12 | ·08 | |
| $1\frac{1}{4}$ inches above soil. | ·166 | ·166 | First leaves grow on a peduncle; radicle greatly developed. |
| ·375 inches. | | | |

| Name. | Description of Seed. | Hours Immersed. | Ungerminated. | | |
|---|---|---|---|---|---|
| | | | No. of Embryonic Cotyledonary Glands. | Measurement in mm. | |
| | | | | Height. | Across. |
| Galium nebulosum, Boiss., | Very minute. | 96 | 2 isolated. | ·04 | ·03 |
| ,, physocarpum, Boiss., . . | do. round. | 22 | do. | ·036 | ·036 |
| ,, rubioides, L., . | Minute round. | ... | ... | ... | ... |
| ,, saccharatum, All., | Comparatively large seed, round. | 70 | do. | ·036 | ·06 |
| ,, spurium, L., . | Small round. | 21 | do. | ·083 | ·033 |
| ,, tenuissimum, M.B., . . | Very minute. | 22 | do. | ·033 | ·026 |
| ,, tricorne, Wither., | Comparatively large round, varies. | 47 | do. | ·056 | ·05 |
| Ixora Loureiri, H.Bn., . | Fruit, a berry. | Examined 8th day in water. | ... | ... | ... |
| Phyllis Nobla, L., . . | Fruit, small elongated flat. | 24 | do. | ·073 | ·063 |
| Rubia peregrina, L., . | Round. | ... | ... | ... | ... |
| ,, tinctorum, L., . | do. | ... | ... | ... | ... |
| Sherardia arvensis, L., . | Small. | 47 | 2 isolated. | ·036 | ·05 |
| Spermacoce tenuior, L., . | Small elongated. | 24 | do. | ·03 | ·016 |
| Vaillantia hispida, L., . | Very small elongated. | 47 | do. | ·046 | ·046 |
| ,, incrassata, Pomel., . | Very small elongated. | 45 | do. | ... | ... |
| ,, muralis, L., . | do. | 21 | do. | ·033 | ·036 |

* See "Phyto-Observations on Seedlings," by Sir John Lubbock,

| Germinated. | | | Remarks. |
|---|---|---|---|
| Description of Seedling. | Measurement in mm. of largest Cotyledonary Glands—the Embryonic Glands. | | |
| | Height. | Across. | |
| 1 inch fully with root. | ·043 | ·083 | |
| $\frac{1}{2}$ inch above soil. | ·1 | ·09 | |
| ... | ... | ... | Germinated badly; cotyledonary glands present after germination; red in leaves of seedling. |
| $3\frac{1}{2}$ inches fully with root. | ·166 | ·173 | Striking development of root, testa thick and rough.* |
| Bend of hypocotyl above ground, testa on the half green cotyledons. | ·3 | ·106 | |
| $\frac{1}{5}$ inch fully with root. | ·066 | ·05 | |
| $\frac{3}{4}$ to 1 inch above soil. | ·316 | ·103 | |
| ... | ... | ... | 2 Structures resembling glands in embryo. |
| $\frac{1}{4}$ inch above soil. | ·266 | ·176 | |
| ... | ... | ... | Germinated badly. |
| ... | ... | ... | Small glands seen in axil of cotyledon of germinated seedling. Cotyledons with long stalks. |
| $\frac{4}{5}$ inch above soil. | ·333 | ·16 | Raphides in root, &c., as in G. Aparine. |
| $\frac{1}{4}$ inch above soil, testa on. | ·156 | ·2 | |
| $2\frac{1}{10}$ inches with root. | ·166 | ·106 | |
| 2·675 inches with root. | ... | ... | Root very brittle. |
| (approximately) $\frac{7}{10}$ of an inch. | ·086 | ·096 | |

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### NOTE ON THE PROLONGATION OF THE FLOWERING PERIOD OF TRITONIA (MONTBRETIA) WILSONI, BAKER. By JOHN H. WILSON, D.Sc., F.R.S.E.

This *Tritonia* was found near Port-Elizabeth, Cape Colony, by my brother Mr Alexander Wilson. Nothing need be added to Mr Baker's description of it in the Gardeners' Chronicle, vol. xxvi., 1886, p. 38, beyond this, that the flowers have a very pleasant but not powerful odour.

The plant is very accommodating as far as pot-culture goes, and it is not at all difficult to raise from home-saved seed. Pollination of one flower with another of the same series is remarkably successful. The stock being still small, the species has not yet been distributed. It may be stated that persistent efforts were made to effect reciprocal crosses with *Montbretia Pottsii* in September of last year, but without success on either side. Possibly the season was too far advanced.

The inflorescence commonly consists either of a single shoot or of one once branched. In the case now noticed the inflorescence exhibited unusual development. When the first flower opened on 4th September 1890, the inflorescence was composed of an axial shoot bearing eight flowers, and a branch with five flowers, the first of the latter opening on the 13th September. The branch, as usual, arose from between two bract-leaves (spathe-valves), the larger one, on the outside, overlapping the smaller. The flowering-period of this inflorescence extended over many weeks. Before it was finished, there appeared a new shoot three inches below the bifurcation of the former. The new one was subtended by two bracts, one much larger than the other, and forked into two—a main axis without bracts, and a branch with two. The stronger portion reached the same height as the first main shoot (two feet); and bore nine flowers, while the branch bore four. The last flower of this series was open about the 6th December. Although the above-described flower-shoots faded, the vitality of the central axis was not impaired, and on the 5th April of this year the first flower of another series opened. The new shoot arose from a node $4\frac{1}{2}$ inches below that forming the point of origin of the second shoot. Its larger bract was leaf-like, and $2\frac{1}{2}$ inches long. It branched as usual, and reached the height of $21\frac{1}{2}$ inches. The main portion bore seven flowers, the branch (subtended like the former one by two bracts) bore five flowers. The last flower opened on the 22d April. The development of the three successive branched portions of the inflorescence was thus basipetal.

The great extension of the time of flowering was evidently largely due to special conditions of culture. The drying-off system of inducing the plant to come to rest was perhaps not rigorously carried out, and, as no seed was borne, no exhaustion had taken place. Nevertheless, after taking these matters into account, one would not expect an inflorescence to retain its vitality for a period of seven and a half months, and such a record is probably seldom met with.

## ON TEMPERATURE AND VEGETATION AT THE ROYAL BOTANIC GARDEN, EDINBURGH, during JUNE 1891. By ROBERT LINDSAY, Curator of the Garden.

During the month of June, the principal feature of the weather was its excessive dryness, and as the absence of rain followed a long drought lasting throughout the whole of the past spring, the marvel is that its effects have not been more serious on vegetation. A good fall of rain took place on the 26th, after which all danger from drought was at an end. Rain fell on seven days during the month. No frost occurred; the lowest night reading of the thermometer was 37° on the 10th, and the highest 56° on the 18th. The lowest day reading was 54° on the 1st, and the highest 81° on the 29th of the month.

The foliage of all forest and ornamental trees is now complete, except several North American trees, such as Tulip Tree, Liquidambar, Catalpa, and Deciduous Cypress, which are still far behind. Conifers are developing fine clean growths. *Picea* and *Abies* particularly so. The different species of *Pinus* are flowering most profusely this season. The golden-coloured varieties of Yew are very bright and extremely well-coloured.

Herbaceous plants, though late in flowering, are still very fine; the early spring-flowering bulbs, &c., have ripened a fair supply of good seeds.

The rock-garden was most attractive during June, 359 species and varieties of plants came into flower, besides a large proportion of those which commenced to flower in May continued to flower into June. A few of the more interesting plants in flower were:—*Aciphylla squarrosa, Allium M'Leanii, Androsace foliosa, Anthyllis erinacea, Arum palæstinum, Campanula abietina, Cynoglossum nervosum, Cypripedium parviflorum, Dianthus "Michael Foster," Enkianthus himalaicus, Erigeron aurantiacus, Edraianthus pumiliorum, E. serpyllifolius, Geranium anemonæfolium, G. armenum, Haberlea robusta, Heuchera sanguinea, Iris Cengialti Linum acuminatum, Meconopsis aculeata, Mimulus Burnettii, Nardostachys Jatamansi, Olearia furfuracea, O. macrodonta, Orchis foliosa, O. maculata superba, Pentstemon humile, P. Menziesii, Polemonium flavum, Primula reticulata, Ramondia pyrenaica alba, Rhododendron ferrugineum album, Saponaria ocymoides Loderii, Saxifraga Valdensis, Trifolium uniflorum, Verbascum olympicum, Veronica amplexicaulis, V. Bidwillii, V. anomala, V. linifolia,* &c.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during June 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 43° | 45° | 54° | 16th | 48° | 52° | 63° |
| 2nd | 39 | 55 | 63 | 17th | 52 | 60 | 73 |
| 3rd | 47 | 48 | 58 | 18th | 56 | 63 | 74 |
| 4th | 42 | 44 | 53 | 19th | 55 | 65 | 76 |
| 5th | 43 | 48 | 54 | 20th | 47 | 65 | 73 |
| 6th | 42 | 46 | 58 | 21st | 48 | 60 | 64 |
| 7th | 38 | 44 | 60 | 22nd | 44 | 53 | 71 |
| 8th | 42 | 50 | 55 | 23rd | 46 | 65 | 68 |
| 9th | 42 | 55 | 71 | 24th | 51 | 55 | 63 |
| 10th | 43 | 47 | 62 | 25th | 50 | 54 | 68 |
| 11th | 37 | 60 | 76 | 26th | 52 | 54 | 61 |
| 12th | 44 | 55 | 68 | 27th | 51 | 65 | 77 |
| 13th | 38 | 58 | 67 | 28th | 50 | 61 | 71 |
| 14th | 39 | 53 | 68 | 29th | 50 | 69 | 81 |
| 15th | 43 | 50 | 65 | 30th | 52 | 62 | 73 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of June 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·962 | 65·9 | 45·1 | 46·2 | 46·0 | E. | Cum. St. | 10 | E. | 0·000 |
| 2 | 29·874 | 53·6 | 43·0 | 53·1 | 50·7 | E. | { Cir.Cum. Cum. | 2 3 | S.E. E. } | 0·000 |
| 3 | 30·012 | 58·9 | 45·8 | 46·0 | 46·0 | E. | Cum. St. | 10 | E. | 0·000 |
| 4 | 29·948 | 51·7 | 44·2 | 46·1 | 44·2 | E. | Cum. St. | 10 | E. | 0·000 |
| 5 | 30·039 | 49·7 | 45·9 | 49·1 | 48·0 | E. | Cum. | 10 | E. | 0·000 |
| 6 | 30·127 | 49·8 | 45·0 | 46·2 | 42·8 | E. | Cum. | 10 | E. | 0·000 |
| 7 | 30·036 | 50·3 | 42·0 | 47·9 | 45·7 | N.E. | Cum. | 10 | N.E. | 0·070 |
| 8 | 30·101 | 52·0 | 45·1 | 50·3 | 48·3 | E. | Cum. | 10 | E. | 0·000 |
| 9 | 30·039 | 53·6 | 45·0 | 53·2 | 46·8 | N.E. | ... | 0 | ... | 0·000 |
| 10 | 29·957 | 63·8 | 44·0 | 48·5 | 45·7 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 11 | 30·118 | 57·6 | 46·0 | 56·2 | 51·9 | N. | ... | 0 | ... | 0·000 |
| 12 | 30·288 | 73·7 | 47·0 | 55·2 | 49·8 | N. | ... | 0 | ... | 0·000 |
| 13 | 30·138 | 63·8 | 42·0 | 60·3 | 54·0 | W. | Cum. | 3 | W. | 0·000 |
| 14 | 30·018 | 63·9 | 49·7 | 57·8 | 53·9 | W. | Cum. | 7 | W. | 0·085 |
| 15 | 29·782 | 66·5 | 46·0 | 52·0 | 51·1 | W. | Cum. | 10 | W. | 0·032 |
| 16 | 29·949 | 61·9 | 51·5 | 55·1 | 52·7 | W. | Cum. | 9 | W. | 0·002 |
| 17 | 30·017 | 62·0 | 53·9 | 62·0 | 59·4 | W. | Cum. | 10 | W. | 0·000 |
| 18 | 30·072 | 69·0 | 58·5 | 67·4 | 62·3 | W. | Cum. | 3 | W. | 0·000 |
| 19 | 30·236 | 69·0 | 57·2 | 64·6 | 60·9 | W. | Cum. | 10 | W. | 0·000 |
| 20 | 30·294 | 72·3 | 51·2 | 61·1 | 57·8 | E. | ... | 0 | ... | 0·000 |
| 21 | 30·308 | 69·6 | 49·3 | 53·8 | 52·0 | N.E. | Cum. | 6 | N.E. | 0·000 |
| 22 | 30·302 | 59·7 | 47·0 | 55·2 | 52·9 | N.E. | { Cir.Cum. Cum. | 2 1 } | N.E. | 0·000 |
| 23 | 30·241 | 66·2 | 48·9 | 60·2 | 55·3 | N.E. | ... | 0 | ... | 0·000 |
| 24 | 30·057 | 65·6 | 53·1 | 55·5 | 54·1 | N.E. | Cum. | 10 | N.E. | 0·002 |
| 25 | 30·002 | 63·0 | 52·7 | 56·7 | 55·1 | E. | Cum. | 10 | E. | 0·000 |
| 26 | 29·765 | 63·8 | 54·3 | 55·7 | 54·7 | E. | Cum. | 10 | E. | 0·175 |
| 27 | 29·619 | 64·2 | 54·0 | 64·2 | 59·7 | S.W. | Cum. | 10 | S.W. | 0·001 |
| 28 | 29·697 | 68·6 | 53·9 | 64·2 | 58·0 | W. | Cum. | 10 | W. | 0·045 |
| 29 | 29·551 | 65·3 | 54·6 | 65·1 | 58·3 | S. | { Cir.Cum. Cum. | 1 4 } | S. | 0·005 |
| 30 | 29·438 | 70·7 | 56·6 | 62·2 | 57·1 | S. | Cum. | 6 | S. | 0·000 |

Barometer.—Highest Reading, on the 21st, =30·308. Lowest Reading, on the 30th, =29·438. Difference, or Monthly Range, =0·870. Mean=29·999.

S. R. Thermometers.—Highest Reading, on the 12th, =73°·7. Lowest Readings, on the 7th and 13th, =42°·0. Difference, or Monthly Range, =31°·7. Mean of all the Highest=62°·2. Mean of all the Lowest=49°·1. Difference, or Mean Daily Range, =13°·1. Mean Temperature of Month=55°·6.

Hygrometer.—Mean of Dry Bulb=55°·7. Mean of Wet Bulb=52°·5.

Rainfall.—Number of Days on which Rain fell=9. Amount of Fall, in inches =0·417.

A. D. RICHARDSON,
*Observer.*

## Remarks on Temperature and Vegetation in the Botanic Garden, Glasgow, during June 1891. By Robert Bullen, Curator of the Garden.

This was an unusually dry month, and nothing like summer weather was experienced until the 9th, when the temperature began to increase. Although we had a considerable duration of sunshine, the mean temperature for the month was low, owing to the continued breezy north-east winds. June 9th is recorded here as being the first day of summer, but no really hot summer weather was experienced until the 19th. From that date to, and including the 25th, the sun thermometer registered from 93° to 98°, and that in the shade from 70° to 76°.

No rain worthy of mention fell until the 26th, when such plants as had not been forced into premature bloom grew away vigorously. The latter days of the month were cloudy, and mostly cold. Out-door plants are a fortnight behind their usual blooming season.

## First Impressions of the Vegetation of British Guiana. By Rev. David Paul, M.A., Roxburgh.

(Read at the Meeting of the Society on March 12, 1891.)

A record of first impressions made on the mind of a traveller in a foreign country may or may not be of value. Where the subject-matter is of a kind that requires patient observation of facts, and comparison of particulars, and cautious generalisation, as, for instance, in dealing with the character or habits of a people, first impressions acquired during a short visit are obviously worthless. But where, on the other hand, the mere outward features of a strange country are in question, the points in the scenery or vegetation that have especially attracted the eye and the interest of the visitor, and that require no lengthened study for their appreciation, his first impressions may make up in vividness and sharpness for what they lack of full and accurate knowledge. The very fact that what he sees is new to him may lend a freshness to his observations which a more lengthened residence would tend to dull. It is on these considerations that I venture to think it is not presumptuous in one who made a short stay in British Guiana to offer a short account of what struck him most on first acquaintance with the flora of the country, and that only for the benefit of those who have not had the advantage of seeing it with their own eyes. The paper will also serve as an introduction to the lantern slides which I propose to exhibit, and which have been prepared from photographs which were taken by myself.

I went out to British Guiana in October 1889, and lived there for five weeks. I had not an opportunity of seeing almost any part of the colony, except the district of the Pomeroon River. My object being to make some acquaintance with tropical vegetation, and especially to see a tropical forest, perhaps no part of the world could have been chosen which would have suited my purpose better. The Pomeroon is situated between the 7th and 8th degrees of north latitude, and lies immediately to the north of the Essequibo. Throughout its whole course it flows through the dense virgin forest, but towards its mouth there are a few small clearings occupied for the most part by Portuguese. It is not a large river for that part of the world, but from its depth carries a large volume of water. The whole district rises little above the level of the sea, and the tide flows up to a great distance. With the exception of a few Europeans near the mouth, the population is entirely composed of native Indians thinly scattered here and there along the banks. The two great requisites of a luxuriant flora exist there in perfection—heat and moisture. The thermometer varies from about 70° during the night to 85° during the day all the year round, there is a very considerable rainfall, and the dense covering of trees prevents any great evaporation from the surface of the flat and swampy ground. The consequence is a growth of vegetation, rich, varied, and picturesque.

To give anything like an adequate idea even of its superficial features would demand greater space than I can allow myself. I shall only try to give a rough general idea of it, and I shall particularise only those trees or plants which were specially interesting to myself, and of which I have therefore the most distinct recollection.

Approaching from Georgetown one is conveyed by the Essequibo boat to Suddie at the mouth of that river, and thence drives on a good road for some 13 miles to Anna Regina through the fertile belt of ground which runs along the sea-coast of the colony from the mouth of the Corentyn to that of the Pomeroon, and which is devoted to the cultivation of the sugar-cane. It is not necessary to say anything of the vegetation which meets the eye in that part as it consists mainly of cultivated and imported trees and plants, but *Eichhornia speciosa* was in fine flower in the deep trenches by the road side, and the *Victoria regia* lily was growing in luxuriance in a large pond at the house of the manager of the Anna Regina sugar estate. Leaving civilisation at that point, the journey was continued by boat along a water-way connected with the estate, which in two hours communicated with Tapacooma Lake, originally a large wet savannah, now artificially submerged. Quantities of small white water-lilies were growing in it, chiefly *Nymphæa odorata*, and amongst them two beautiful Utricularias, one (*U. oligosperma*) with yellow, and another (*U. purpurea*) with purplish-lilac flowers. At the extremity of the lake the boat was hauled over the embankment which retains its water, and launched into the head of the Arapiacru Creek, through which, after four hours' paddling, the Pomeroon River itself is gained. Here the forest begins. At first the creek is so narrow that the branches of the trees meet overhead, and little can be distinguished in the dim light but the stems. Soon, however, it broadens, and the view opens out, and both banks present themselves to the curious inspection of the stranger. A lovelier water scene I have never gazed upon. The sky was without a cloud, and, as we had spent the night at the head of the Tapacooma Lake, the sun of the early morning, not yet oppressively hot, flooded the air with the purest and brightest light. The creek itself was as calm as a lake, and reflected like a mirror every leaf and bough of the trees on either side which hung out over the water all along. But on a first and general view there were not many features that had a strikingly tropical aspect. I was prepared for something more like the fancy pictures one is accustomed to of tropical scenery. There were palms, no doubt, of several kinds shooting up above the other trees which told one in unmistakable language he was far from home, but they did not grow in masses or continuously, and though they were far from rare, being indeed plentiful, yet they bore but a small proportion to the great mass of other trees, which showed a strong family resemblance to the ashes and elms at home. The bulk of the forest was composed of those familiar-looking trees, and until one had time to take in the details of the picture, one could almost fancy oneself being rowed along some lovely, still, wooded English river. But when notice begins to be directed towards particular points in the vegetation, one no longer thinks of home. Let us begin with the surface of the water and its margin. All along the banks on both sides, standing in the shallow water, runs for miles a fringe, 6 or 12 feet in breadth, of strange-looking plants, with straight, shrubby stems from 4 to 8 feet high, leaves like our familiar greenhouse *Calla*, and somewhat dingy, light yellow arum flowers. They belong to two species of the genus *Montrichardia;* one, *M. arborescens*, Schott, with smooth stem, and the other, *M. aculeata*, Krueger, with stem densely covered with prickles—plants inseparable from the idea of river-side vegetation there. Outside of these and floating in the water here and there in large patches is one of the most beautiful of all small water plants, *Eichhornia natans*, covered with lilac flowers so as to form a mass of colour—a plant which might with great advantage be introduced into our hothouse tanks at home. Floating also up and down in the gentle current caused by the rise and fall of the tide, may be seen many plants of *Eichhornia speciosa*, which does not seem to flower in the moving water as it does in the still water trenches of the sugar plantations. Looking still more closely near the edge, a small dark greyish-green plant catches the eye, resting in quantities on the surface of the water, and belonging to a family of cryptogams unrepresented at home; it is *Salvinia auriculata*.

Rising now from the water to the wooded banks above, the gaze of the stranger is arrested most of all by the palms, a family of plants copiously represented in Guiana—no fewer than 21 genera and about 70 species occurring there. They are everywhere a prime feature in the landscape, and they exhibit great variety both in form and in size, but every one is noteworthy and beautiful of its kind. On first acquaintance the general family resemblance among the several groups renders them difficult to recognise as distinct, and I had to tax the patience of my companion by constantly confounding them, and asking him to set me right; but in a very little time one gets to know them at a glance, and to perceive that each is perfectly distinct in habit and appearance. To see palms growing in perfection had been a long cherished dream, and it was now realised to the full. The first one that caught my eye on that particular creek was, I remember well, the Manicole (*Euterpe edulis*). It is a very slender palm, 40 to 50 feet high, having a perfectly clean, bare stem with hardly any taper in it, its girth in the middle being only 18 inches, surmounted by a crown of pinnate leaves, 7 feet in length. It is a peculiarly graceful tree, the lady among palms, suggesting delicacy and refinement and gentleness, partly by its general appearance, and partly by the fact that from the thinness of its stem in proportion to its height it cannot stand quite erect, but bends over in its upper portion in a slight curve. Its leaflets are of thin substance, and are set in motion by the faintest breath of air, giving to the crown a characteristic shimmering appearance. It is not a grand or stately or majestic tree, but of unsurpassable airiness and lightness and elegance, fit to hold a place in the foremost rank of South American palms.

Presently another palm is caught sight of, and at once claims attention, the Tooroo, as the native tribe of Arawaks call it, *Œnocarpus Batawa*, which is frequent along the same creek, but is not nearly so common as the Manicole. It is a somewhat sturdy, erect tree, 40 feet high, with an elegant crown of pinnate leaves of a dark, almost brownish-green colour, and very easy to recognise at a distance after it is once known. But one has little time to study its special appearance at the moment, for, as one is carried on under the swift strokes of the Indian paddles, his gaze is arrested by what is evidently a different palm from either of the other two, also pinnate-leaved, like almost all the Guiana palms, but with leaflets cut off short at the extremity instead of coming gradually to a point, and with the straight edge deeply serrate. This is the Booba (*Socratea exorrhiza*), of rather short stature, not very frequent in the Pomeroon basin, and therefore too rarely seen to be a marked feature in the landscape like the Manicole and the Tooroo. But a fourth palm is very common there in the most swampy parts of the forest, though from its comparatively low growth it can only now and then be seen from the boat, when it happens to grow near the water's edge,—I mean the Troolie (*Manicaria saccifera*). The stranger recognises in it at once a new palm, and he is never again in danger of mistaking it for any other. Its distinguishing character is its huge, oblong, uncut leaves, 20 to 25 feet long by 5 feet broad when fully developed, and as it is seen in the stillness of a forest swamp, where no wind can touch it to break the leaves, it is a noble sight. Its whole beauty lies in the leaves, for the short trunk is inconspicuous, and is generally encumbered by the old leaf-sheaths. The Indians use these magnificent leaves as thatch in preference to all others.

Let us look, again, along the mass of trees that are visible from the river and we shall presently perceive that, even to a superficial glance, the wealth of this rich country in palms is by no means exhausted. There, contrasting finely with the commoner looking rounded trees beside it, rises a palm with a very conspicuous crown whose pinnate leaves stand strongly up much more erect than any we have yet noticed. This palm differs also from all those others in this, that its stem is banded all the way up with broad rings of very long, strong, sharp-pointed bristles, the intervals between the rings being unarmed. The erect leaves are of large size, as much as 20 feet long by 8 feet broad, and the longest pinnæ may be $4\frac{1}{2}$ feet long, the tree itself being 30 to 40 feet high. The peculiar set of the leaves and the armed trunk render it easy to distinguish. It is *Astrocaryum tacuma*. It may easily be confounded with another palm, *A. tacumoides*, which is very similar, but is smaller in all its parts, and grows, not singly, but with several stems from one root. Both are common, and in both the fruit is very conspicuous, being about the size of a small hen's egg and of a bright orange colour when mature; it is held in high esteem by both Indians and parrots. The same difference in the mode of growth is seen in the case of other two palms of that creek, viz., *Euterpe edulis* (Manicole), which has already been mentioned, and a very similar one of the same genus, *E. stenophylla*, Trail, the latter being solitary, and the former cæspitose. The solitary species did not seem to be common.

I have now to mention two very fine palms, those, namely, which are known there as the Aeta and the Kokerite. The latter is common on the Pomeroon and its tributary creeks, while the former occurs here and there in the same district. But wherever either appears it arrests the attention at once. They are entirely different in every feature, but both are magnificent. The Aeta (*Mauritia flexuosa*) is the only native fan-leaved palm I saw in Guiana. It is a tall, robust tree 50 feet high and 3½ feet in girth, the trunk circled with rings, which are the marks of attachment of the old leaves, and the crown of very long-petioled leaves forming an extremely handsome termination above. The petioles are as much as 9 feet long, and the leaves themselves 6 feet. From the base of the crown three or four old dead brown leaves hang vertically down, the petiole having not yet become detached from the trunk, and form a striking feature in the appearance of the tree. If the prize for beauty were contested by all the palms of which I know anything, the Aeta would certainly be one of two or three among which a judge would have to make his final choice. And it is as useful as it is beautiful. The Indians find it serviceable in many different ways. The outer skin of the young leaves yields an excellent fibre, which they twist into string for the manufacture of hammocks. The leaf-stalks are used for the shafts of fish harpoons, and to form house partitions. The pith of the trunk forms a kind of sago, and the juice which exudes from the trunk when felled supplies a palatable drink. The young leaf, as yet unexpanded, forms an excellent "cabbage," and the fruit is also prized as a food. It is the most valuable of trees to the dwellers in the forest.

The Kokerite (*Maximiliana Martiana*) is no less beautiful, and hardly less useful. It may have a distinct stem of considerable height, or when immature its leaves may spring direct from the ground. From base to apex the leaf may be 35 feet in length, and nothing could surpass its beauty. The pinnæ on this enormous leaf are arranged in a peculiar fashion. They are not all set in the same plane, but you have sets of two or three or four arranged in two different planes with respect to the midrib in regular alternation so as entirely to get rid of the stiffness that would result in the case of so long a leaf, if the ordinary arrangement were followed. These pinnæ are themselves long and narrow, and being of slight substance they cannot stand out stiffly for more than half their length, but hang down beyond that distance with very graceful effect. When the tree is old, and has acquired a tall trunk, the leaves ascend from its top at a high angle, drooping slightly towards its extremity, while at the base of the crown are attached a large number of gigantic flower spathes, new and old, dark or light brown according to age, themselves objects of interest from their great size, and contrasting finely with the dark green leaves above. The majesty of the tree cannot be described, but a good idea of it may be gained from a lantern slide which I shall have presently to exhibit.

These nine complete the number of large native palms which one will be sure to see in the Pomeroon district. But before passing on to other forms of vegetation, it will be well to finish what has still to be said regarding a few other palms, which are either of inconsiderable size or are not certainly indigenous. The latter class contains two in particular, the Paripee and the Cabbage Palm. The Paripee (*Bactris minor* or *Gulielma speciosa*) is found growing beside almost every Indian house in the forest, planted there for the sake of its fruit, which is much valued. It is not a very tall tree, but has a specially graceful and elegant crown of large feathery leaves. The Cabbage Palm (*Oreodoxa oleracea*), on the other hand, is tall and slender, with a crown of short leaves. There is a magnificent avenue of them near the Botanical Gardens at Georgetown, and I saw some fine specimens at Anna Regina. Coco-nuts are cultivated in great numbers in every clearing, and present a distinct feature in the scenery. Then, of the smaller palms, there are many species of *Bactris* and *Geonoma*, which are in places abundant, but I had not time to give much attention to them. Lastly, there are several species of climbing palms (*Desmoncus*), one of which (*D. major*) I noticed in abundance growing in a tangled mass by the side of the Marooka. Its method of climbing was peculiar. The flexible stem along which the leaves were arranged was continued perhaps 3 feet beyond the highest pair of leaves, and tapered gradually to a very thin point. Along this bare continuation of the leaf-stem were set pairs (3 or 4) of strong spines inclined towards the ground, and making with the stem an angle of 30° or 40°. By means of these the palm hooked itself on to plants growing above it, and having gained a step it was able to hold fast until by elongation it could gain another, and was effectually secured against being dragged down again into the tangle below. Obviously, also, it was raised by the growth of the bushes to which it had attached itself.

Such is a sketch of the more noticeable palms which are found in that particular part of the colony, and of which only a few can be observed from our boat as it glides down the Arapiacru Creek. Perhaps the next feature that arrests the attention of a stranger to the Tropics is the Epiphytes and climbing plants. Almost every tree shelters some of these lodgers. Tillandsias are very conspicuous, growing everywhere on the branches, and reminding one of the pine-apple plant. The *Monstera obliqua*, too, is common with its large perforated leaves. Singularly handsome plants are the Clusias of various species, with strong, oval, dark green leaves, and beautiful white flowers. These grow from seed that has found a resting-place in the forks of the branches, and when the plant has become established it flourishes in great luxuriance, almost smothering the parent tree, and sending down aërial roots, often from a great height, of the thickness of whip-cord, which root in the ground and increase to the size of a man's arm, forming a large proportion of the bush-ropes, which make so striking a feature in a tropical forest. I did not find orchids so prominent as I had expected. There are, no doubt, many of them, but in the month of October few were in flower, and any that I happened to see were not very conspicuous. I think the only one that I took special note of was *Zygopetalon rostratum*, growing on a branch which hung out over the water. The creepers are very plentiful, principally Ipomaeas, Allamandas, and Bignonias. These revel in the open sunshine of the river banks and present masses of beautiful colour, as they ascend and hang down from the bushes and trees.

Of the trees, other than palms, it is not necessary to say much, even if I had more knowledge of them than I have. In colour they are for the most part of a uniform dull green, and from the fact that they are clothed with leaves throughout the whole year, and that therefore there is no season when they are in fresh young leaf, or when they are decked in the reds and yellows of an English autumn, they seldom show those exquisite varieties of tint which in May and October we are so familiar with in our woods at home. Add to this that they are all crushed together in closest proximity, so that except here and there on the outskirts of a clearing one is never found sufficiently isolated to present any beauty of form. One does occasionally see a tree completely covered with flower, a "Long John," for example (*Triplaris surinamensis*), laden with cream-coloured bunches, which, as they mature, change gradually to a rusty tinge, and form a very beautiful object in the landscape; but such trees do not occur often enough to light up the sombreness of the forest. I was somewhat disappointed in the *size* of the trees. The truth is, they are all of great size, at least in point of height, and one has therefore no comparative standard to judge by. Nor are there any objects of known height near to measure them by. Besides, a single tree almost never stands out clear of others so as to enable one to form a fair idea of it as a whole. I saw, however, on that first morning a splendid exception in the mission clearing at Cabacaboori on the Pomeroon, as we paddled up the river into which we had issued from the creek. This was a magnificent Ceiba or silk-cotton tree (*Eriodendron anfractuosum*, D.C.), standing 180 feet high, and visible from root to summit, its branches covered with a Bignonia (*B. unguis*, L.), which in its flowering season transfigured it with yellow flowers. It is far and away the finest tree I have ever seen. But such examples are rare.

When one penetrates into the forest in that particular part of the colony, the Mora tree (*M. excelsa*) is found to be the prevailing one. It yields a fine timber, which is not, however, exported from the Pomeroon at present by reason of an obstructive bar at the mouth of the river.* It is a

* The colony abounds in fine timber adapted for almost every purpose. Large shipments of Greenheart have recently been made from the Essequibo for use in the construction of the Manchester Ship Canal, and of the new harbour works at St Lucia. It appears, also, that a wood has been discovered lately in the Guiana forest better suited for the manufacture of lucifer match-boxes than any hitherto known.

remarkable specimen of a buttressed tree. It is supported in its place by flat board-like buttresses standing out at right angles to the trunk, gradually decreasing in breadth upwards till they become merged in the round stem 6 or 8 feet up, and below broadening out so as to project for a considerable distance from the base of the tree, even towards the extremity twisting round at right angles to their former direction so as to secure a firmer grip of the ground. They are there not only as a protection to the tree against wind, but, as I suppose, to keep the tree from falling by its own weight. For the sòil in which they grow is wet and spongy, and ill adapted for taking firm hold of the roots, and without some such special contrivance a tall tree would readily fall. When these buttresses are cut off they make excellent flat boards, and the Indians, who have difficulty in working timber for want of proper tools, find them very convenient for the manufacture of paddles,* and one species of tree in which this sort of buttress is more than usually developed is on that account called the Paddle tree (*Aspidospermum excelsum*).

In addition to the tall trees of different kinds which are able to reach the light above, there grows in the gloomy shade below a miscellaneous scrub, not very dense, so far as my experience goes, consisting of Mora and other seedlings, various small palms, especially *Bactris* and *Geonoma*, beautiful *Maranta* plants, ferns of many sorts, among which I noticed a few tree ferns, and several kinds of filmy ferns, some of the latter on fallen trees being delicately lovely, and in addition to all these many low-growing bushes which I did not know. The ground is strewn with the large, red, bean-shaped seeds of the Mora, and bush ropes hang down everywhere to catch the hat or trip the foot of the unwary.

Walking through such a forest is a novel experience. The atmosphere is extremely close and sultry. Not a breath of air; not a trace of freshness; it is the atmosphere of a washing-house in full swing of work. One could have put up with the heat, but the heat and humidity together were almost overpowering. After the first half-hour one was bathed in perspiration, free flowing and copious. Even the

* This remark does not apply to the buttresses of the Mora itself, the wood of which is too heavy for paddles.

outer garments soon become perfectly wet, the hair gets soaked, moisture trickles down the nose and cheeks, and flows in rivulets over the body. The forest is intensely still; you hear none of those sounds of insect life which are so unceasing in the sunshine, the silence becomes oppressive, the cry of a bird is rare, and if a howling monkey does for a few minutes startle you with its wonderful combination of appalling shrieks and growls, that only emphasizes the stillness when it ceases as suddenly as it began. One pushes onwards with the dogged determination to get to the end of the day's journey, guided not by any indication of path on the ground, but by almost invisible marks of broken twigs and saplings purposely made by some former party of Indians,—onwards, tramping through the bushwood, splashing through the shallow creeks, here tripped up by a creeper, and there caught round the neck by a bush-rope, stopping sometimes to admire a tree, sometimes to pick a fern, or to watch a group of monkeys making great leaps from tree to tree in their hurry to escape, and always with the perspiration oozing, dropping, streaming, —onwards till some Indian house in a clearing is reached, where one may halt for the night. Nature has nowhere any more effective forcing-house than those forests of Demerara.

Issuing from the forest into the clearing, you pass from twilight into bright sunshine, and the change is as welcome as it is sudden. It is delightful to emerge from the dispiriting gloom of the forest into the exhilarating light of heaven, and even in the matter of heat it is pleasant to escape from the close moistness under the trees, though one has to exchange it for the fiercer rays of the sun. Such a clearing is usually two or three acres in extent, and is very roughly made. The trees have in a fashion been cut down and burnt, but the burning has been carried out to so little effect that the whole place is covered with upright portions of stems still rooted in the ground, and littered with fallen trunks and branches. In this rough field or garden the Indian hut occupies the centre, and all around Cassava (*Manihot utilissima*) is thickly planted, from which the natives derive their principal subsistence. Close to the house there are probably a Paripee palm and a Papaw tree (*Carica Papaya*, L.); there is likely, also, to be a picturesque group of plantains, occasionally a few oranges, limes, or coco trees. There are sure to be a plant or two of tobacco, and some bushes of large brilliantly red peppers. Among the weeds that choke the Cassava and trail about unchecked will be found Passion flowers, either the bright scarlet kind, or the somewhat lurid but pretty *Passiflora fœtida*, gourds with strangely-shaped fruit, and other interesting plants. On the edge of the clearing the tall, thin, spindled Trumpet trees (*Cecropia peltata*) are characteristic with their horse-chestnut-like leaves, and most likely you may observe a bright-coloured Toucan or two perched on their branches, their enormous beaks giving them a ludicrous appearance. All the Indian forest clearings which I saw had essentially the same features.

The whole of the Pomeroon district of Demerara is with respect to its vegetation almost completely untouched by civilisation. The primeval forest stands, as it has stood for ages, as yet unpenetrated in all its length and breadth by any kind of road whatever, unless an Indian track, nearly or altogether undiscernible, can be called a road. A very few food plants have been introduced, but nothing more. The face of nature can be seen there as God made it, and it is only in the thinly scattered clearings that you can trace the influence of man. And even in the clearings Nature is only half conquered, so that as soon as an Indian family moves on to occupy another part of the forest, as they are constantly doing, in a very few years she regains her hold of the soil, and sweeps every mark of them away. But there was one clearing on the river that was altogether different from the others and infinitely more interesting and beautiful, and the members of the Botanical Society who are interested in horticulture as well as in botany will not be displeased to have a short account of it. It surrounded the residence of my friend and host, Mr. E. F. im Thurn, now Government Agent for the N.W. District of British Guiana, and well known as a botanist and explorer. On the right bank of the river a few miles above the mouth of the Arapiacru Creek, in a loneliness unbroken save by a passing Indian in his canoe, only one other white man residing within a day's journey, stands a picturesque troolie-thatched cottage, of which I shall be able to show two lantern slides. Round it lie about 25 acres of cleared ground, and the whole is situated somewhat above the ordinary low level of the forest. On part of one side the view is open to the river. Very broad walks kept in perfect order traverse the whole of this large space, so that there, as nowhere else in that densely-wooded country, one can enjoy the luxury of a walk. The palms were spared when the rest of the trees were felled, and these now stand in separate beauty, vying with each other for the admiration of the visitor. Many others have grown from seed around them, and there has been besides a large importation of coco-nut trees, or rather of coco-nuts which are now trees in all their feathered elegance. The greater part of the space occupied by these palms, being much too large to keep as a garden, is covered by native low-growing bush, among which many interesting things may be picked out, and all along the margin of the enclosing forest are countless plants of beauty either for flower or leaf, material for endless botanising. Nothing impressed me more in Guiana than the amazing number of finely-shaped and finely-coloured leaves, a considerable proportion of them being strikingly beautiful. The leaf of the Calladium and that of the Maranta are equally lovely, though they are of totally different types. I used to think that a collection of fifty or a hundred of the finest leaves would not yield in interest, at least in artistic interest, to any other botanical collection, and I regret that I did not make an attempt to form one. Passing from the more remote grounds to the garden proper, its beauty lay in the variety of flowering shrubs and foliage plants. A stranger fresh from Scotland was struck by the absence of small herbaceous plants, which have hardly any native representatives there, and when imported from a temperate climate will not grow. But to make up for the want of these, there was a great profusion of rare and beautiful things arranged so as to show them off to the greatest advantage. Of flowering plants there were *Hibiscus rosa-sinensis* (single and double); *H. magnifica, schizopetalon, liliiflorus, hirsutus* and *tiliaceus; Allamanda cathartica* and *neriifolia; Passiflora coccinea, corifolia* (yielding the succulent and savory Semitoo fruit), and *fœtida; Ixoras; Jasminium sambac,* and two or three other kinds; *Duranta Ellisia,* and the lovely white-flowered *Plumeria acutifolia* (?). Of foliage plants there were some 47 different kinds of Crotons, a great variety of Dracænas, and 5 species of Pandanus, with 25 or 30 species or varieties of Calladium—these last springing up like a weed in any odd corner, even on the hard walks. There were, besides, magnificent specimens of the great Bromeliad, *Brocchinia cordylinoides*, a Roraima plant, holding *Utricularia Humboldtii* in the water gathered in the axils of its leaves; there was *Furcræa gigantea*, worthy of its name, and huge Euphorbias, while Lemon-grass (*Andropogon*) was used as an edging to the beds. Of bulbs there were *Hippeastrum equestre* and the beautiful white *H. solandriflorum; Crinum giganteum, C. erubescens, C. caribbeum*, and *C. Commelyna*, and *Hymenocallis guianensis* —the last two growing wild in profusion at the water-side. Among orchids were grown, either tied to the trees, or hanging in baskets, or rooted in the ground, the pretty, small-flowered *Ionopsis panniculata; Calanthe veratrifolia* (with fine white spike); *Peristeria pendula; Lœlia autumnalis; Epidendron fragrans; Oncidium altissimum* and *O. lanceolatum;* a magnificent tuft of a native *Sobralia*, perhaps *S. liliastrum*, flowering splendidly, and *Epidendron Schomburgkii* from Roraima. Of creepers, *Ipomæa Leerii, Bignonia magnifica, Thunbergia*, and Japanese Honeysuckle rambled gaily on the outskirts of the garden, while here and there stood specimens of the Areca palm, the Sago palm, African Oil palm, and *Latania borbonica*, in addition to a great variety of native palms. I should not omit to mention a curious and interesting specimen of *Puya guianensis*, nor (though it did not form part of the garden) a magnificent clump of bamboos by the river-side. No vegetables were grown, but one portion of the space was allotted to pine-apples. I do not pretend to exhaust the charms of this favoured spot, which it was all the more remarkable to find existing there, as very few white men ever had an opportunity of visiting it. It was not a garden kept for show, but solely for the owner's own delight. A few Red Indians were his only gardeners. I have carried back with me from South America no more delightful memories than of the days I spent in it.

*List of Individual Trees, &c., in addition to General Views, shown by means of Lantern Slides.*

(1) *Euterpe edulis;* (2) *Mauritia flexuosa;* (3) *Oreodoxa oleracea;* (4) *Astrocaryum tacuma;* (5) *A. tacumoides;* (6)

*Maximiliana Martiana*; (7) *Gulielma speciosa*; (8) *Latania borbonica*; (9) Coco-nut palm; (10) African Oil palm; (11) Papaw tree (*Carica Papaya*); (12) Silk-cotton tree (*Eriodendron*); (13) Bread-fruit tree (*Artocarpus*); (14) *Brocchinia cordylinoides*; (15) *Victoria regia*.

NOTE.—In the preparation of this paper I have been indebted to two works by Mr E. F. im Thurn,—his pamphlet, "On the Palms of British Guiana," and his book, "Among the Indians of Guiana." The measurements of palms are all taken from the former.

## THE LEAVES AND STIPULES OF LARREA MEXICANA, Moric. By JOHN H. WILSON. D.Sc., F.R.S.E.

(Read at the Meeting of the Society on March 12, 1891.)

The genus *Larrea* is confined to desert regions of America. Argentina is the home of three species:—*L. nitida*, *L. divaricata*, and *L. cuneifolia*. *L. mexicana* extends over a wide area, comprising Southern California, Nevada, Utah, Arizona, New Mexico, Western Texas, and Mexico. It is particularly abundant in the Mohave (Mojave) desert, where the material I have studied was gathered by Mr A. H. Gibson. As it is evergreen and thrives in arid regions, it is the means of making large tracts verdant which without it would be desolate. The rainfall it requires is stated to be 3 inches per annum. It bears yellow flowers in early summer. Its native names are "Palo ondo," "Tasajo," "Gabernadora," "Hideondo," "Etiontio," and "Guamis." Its English title is Creosote-bush or Creosote-plant. In Northern Mexico its height is 8 feet, in Texas and New Mexico it is only 3 or 4 feet.

There is no mistaking the plant in its native habitat. The foliage is bathed in a very viscid substance having a peculiar, strong, aromatic odour, somewhat resembling that of creosote. The surrounding atmosphere is tainted by it, and animals habitually shun the bush. Its presence is a sure indication of a "sterile worthless soil."* Durand and

* Bigelow, Report of the Botany of Lieut. Whipple's Surveying Expedition in 1853–54, Washington, 1856.

Hilgard* state that "the resin of this shrub collected by the Pimos Indians is formed by them into balls which they kick before them with their feet as they journey from one point to the other of their trail." The dried specimens retain the excretion in quantity, and, if not poisoned, they will preserve the odour for many years.

The wood is extremely hard and tough, showing great induration of the xylem-elements. Prismatic and clustered crystals occur in great numbers, especially in the bast, where they are generally densely packed.† Clustered crystals are present in the leaves and stipules of all the species, and they have been found in the sepals, petals, and pistil of *L. mexicana* and *L. cuneifolia.*

The leaves of *L. mexicana*‡ are composed of one pair of small crescentic pinnæ on a short petiole. A minute apical prominence lies between the pinnæ. They are covered on both surfaces with fine hairs which are unicellular, elongate, tapering gradually to a sharp point, and all directed to the apex of the leaf by a bend near their base. Their roots are placed in a depression of the epidermis. The young branches are also covered with similar hairs. Stomata occur in great numbers on both sides of the leaf. They are slightly elevated on papillæ. Under the action of caustic potash the one or two circles of cells immediately surrounding the stomata are rendered clearer, and the rest appear entirely filled with a brown substance. The hairs remain colourless. Considering the manner in which the excretion is found over the whole leaf surface, and seeing that it is unlikely to be derived either from the hairs or the cells bounding the stomata, it may be concluded that the intervening cells are excretory.

The stipules are objects of very considerable interest. Two pairs occur at each node. At first the pairs are closely approximated. They are small, obliquely cordate, and resemble the leaves in colour and in being clothed, although more sparsely, with similar hairs. Very soon, indeed at the second fully developed node, they assume a reddish colour

* Botanical Report of Explorations for a Railroad Route, Washington, 1855.

† *Vide* Sachs, Physiology of Plants, p. 177. (*Guaicum officinale.*)

‡ Moricand, Pl. nouv. Amer., t. 48, p. 73; A. Gray, Gen. Ill., t. 147.

and more fleshy consistence, the cells having become filled with refractive material. They persist, and enlarge but little. At older nodes they are more deeply coloured, shiny, and resinous, and bear some resemblance to scale-insects. Stomata occur on them in considerable numbers. A transverse section shows that the epidermal cells of the upper (inner) surface form a columnar layer, most distinctly differentiated where it is interrupted by the pedicel of the stipule. The bounding membrane is very delicate, and the cells are commonly filled with homogeneous brown material which here, as in the leaves of dried specimens, resists the action of potash and alcohol. The lower (outer) epidermis is not columnar, and has a well-marked cuticle. To all appearance the inner surface is most actively secretory. The stipules separate laterally in the course of growth of the node. For a time the space between them is green and non-resinous, but ultimately and very commonly the entire node becomes the seat of resinous exudation. The stipules, which at first stand out conspicuously as dark brown scales, are gradually lost sight of in the resin. In branches $\frac{5}{6}$ inch in diameter, the largest available for examination, the nodes were swollen and encased in a thick zone of brittle resin. The area of exudation, however, usually becomes located on the sunny side, leaving a portion of the opposite side bare.

The excretions of the leaves and stipules will serve to protect the growing parts against drought.*

The exuded material has been turned to account commercially. It (and also an excretion of *Acacia Greggii*, Gray, it is said) yields the product known as Arizona shellac or Sonora gum. The following statement is made by American authorities:†—"These lac-yielding plants . . . . . are as plentiful as the so-called sage-bush from Southern Utah to New Mexico, and from the Colorado desert to Western Texas, lac being most abundant round stations on the Mojave and Colorado deserts. The exudations which take place as the result of an insect's sting can be easily collected by boiling the twigs in water, the gum (?) which rises to the top being scummed off, strained and dried on smooth stones, and hand pressed into flakes ready to make sealing-wax or

* Pringle, in Garden and Forest, vol. i. p. 524.

† Stillmann and Redding, *vide* Pharm. Jour., 3rd ser., vol. x. p. 962.

varnish." It is mentioned that Sonora gum is used in the manufacture of porter by brewers in California.

An account of some of its chemical reactions is given by Grazer.* Stillmann† has noted that the lac of *Larrea* contains more dye (Farbstoff) than that of the *Acacia*, and considers it very probable that the Arizona shellac has the same chemical constitution as the Indian product. His analysis of Arizona shellac is as follows:—

| | | |
|---|---|---|
| Resin and other bodies soluble in alcohol, . | 61·7 | per cent. |
| Colour substance dissolved out with water, | 1·4 | ,, |
| Lac soluble in caustic potash, . . . | 26·3 | ,, |
| Insoluble residue, . . . . . . | 6·0 | ,, |
| Loss, and colour substance dissolved out in caustic potash, . . . . . | 4·6 | ,, |

A description of *Acacia Greggii*, Gray, the Cat's-claw Mesquit, is given by Rothrock,‡ but no mention is made of its having exudation at any point. The peculiarities of *L. mexicana*,§ however, are thus noticed by him:—"Creosote-bush. Common form from Western Texas to Kern County, California, and southward into Mexico. Dr Loew's examination proves that 'the reddish-brown exudate on the branches' will yield a red colouring-matter showing all the reactions of cochineal. 'The alcoholic extract of the leaves on evaporation yields a greenish-brown residue of a specific and somewhat disagreeable odour, more strongly perceptible on boiling the extract with water. This residue is only to a small extent soluble in water, and the solution has an acid reaction. It yields a light yellow precipitate with acetate of lead. The part of the alcoholic extract that is insoluble in water is easily soluble in alkalies. It also dissolves in nitric acid at a moderate heat, whereby oxidation takes place. On addition of water, a yellow brittle mass is precipitated.' The Mexicans are said to use an infusion of the leaves for bathing in, in rheumatic affections."

* Pharm. Journ., 3rd ser., vol. xvi. p. 128.

† *Vide* Botanischer Jahresbericht, viii. i. p. 434.

‡ Wheeler's Report, U.S. Geograph. Surveys West of the 100 Meridian, vol. vi. p. 108.

§ Ibid., pp. 41, 80.

Engler* mentions that the natives smear (fix ?) their arrow-heads with the excretion of the leaves.

Brandegge,† in an enumeration of plants from Baja California, says:—"*Larrea* and *Euphorbia* are held in high repute for their curative properties, and it is difficult to find any common, ill-smelling plant that, for some ailment or other, is not 'buena par medecina.'"

Opportunity has not been afforded of knowing whether the excretions of *Acacia Greggii* occur in the same quantity and possess the same qualities as those of *Larrea.* This seems highly improbable. On the other hand, it is evident that the *Larrea* by itself can yield the shellac and the dye. The author quoted attributes the secretion to the puncture of insects. With *Larrea* such stimulation is not necessary, the exudation being spontaneous and singularly general and copious. No insects were found on the specimens.

*L. cuneifolia,* Cav.,‡ occurs in salt deserts of Cordoba, Argentina. The cuneate leaves consist of a pair of closely-coherent pinnæ clothed with hairs. An apical seta is present. As in *L. mexicana,* only the cells immediately surrounding the stomata have clear contents. Cavanilles describes the stipules as "breves crassæ rubentes." They are acute, and bear numerous hairs on the exposed (lower) surface, and stomata are present. The columnar character of the inner (upper) epidermis is very well marked.

*L. divaricata,* Cav.,§ covers, almost exclusively, whole tracts of sand steppes in Argentina. The leaves resemble those of *L. mexicana* in form, but are different in texture. The epidermis of both surfaces is easily separable, a condition not found in any other species. The hairs are fewer, longer, and softer, and the epidermal cells are almost entirely devoid of brown material. The stipules are broader, flatter, and more villous than those of the others, and the stomata are fairly numerous. Their cell-contents are brown, but not so deep a tinge as in the other species. The deep-celled layer of the upper surface is differentiated from the hypodermal cells with extreme distinctness.

* Pflanzenfamilien, iii. Teil, 4 Abt., p. 86.

† Proceedings of the California Academy of Sciences, 2nd ser., vol. ii. p. 125.

‡ Cavanilles, Icones Plantarum, vol. vi., Tab. 560.

§ Ibid., Tab. 560.

*L. nitida*, Cav.,* is found along with *L. cuneifolia*. It is distinguished from all the others in having leaves with 5 to 7 pinnæ. Hairs are numerous along the margins of the pinnæ, and few on the two surfaces. Almost all the epidermal cells, including those encircling the stomata, have brown contents. The stipules bear a considerable number of hairs on the outer surface, and stomata, probably soon functionless, are present, mostly near the apex.

Volkens † studied this species under cultivation. He lays great stress on the excretory power of the stipules, and questions whether the leaves excrete at all. It is evident, however, from the specimens examined for this communication that the leaves themselves, especially in the young state, take an active part in covering their surfaces with the excretion found on them.

In transverse section the inner (upper) epidermis was seen to have deeper cells than the outer surface, but the difference in depth is by no means so great as in the other three species.

Volkens ‡ has found a distinct cuticle on the outer surface, and none on the inner, a condition agreeing with that seen in all the stipules of the other species.

* Cavanilles, Op. cit., Tab. 559.

† Berichte deutsch bot. Gesell., Bd. viii., p. 126.

‡ Ibid., Taf. viii., figs. 10*a*. 10*b*.

# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH.

VOLUME XIX.

PART III.

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MDCCCXCIII.

# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH.

## SESSION LVI.

### MEETING OF THE SOCIETY,

Thursday, November 12, 1891.

ROBERT LINDSAY, Esq., President, in the Chair.

The following Officers of the Society were elected for the Session 1891–92:—

**PRESIDENT.**

DAVID CHRISTISON, M.D., F.S.A. Scot.

**VICE-PRESIDENTS.**

Professor F. O. BOWER, D.Sc., F.R.SS. L. & E., F.L.S.
ROBERT LINDSAY, Royal Botanic Garden.
HUGH F. C. CLEGHORN, M.D., LL.D., F.R.S.E., F.L.S.
GEORGE BIRD.

**COUNCILLORS.**

WILLIAM CRAIG, M.D., F.R.S.E., F.R.C.S.E.
J. E. T. AITCHISON, M.D., LL.D., C.I.E., F.R.S.
ANDREW TAYLOR, F.R.P.S.
WILLIAM MURRAY.
WILLIAM B. BOYD of Faldonside.
WILLIAM SOMERVILLE, Dr Œc., B.Sc., F.R.S.E.
JOHN M. MACFARLANE, D.Sc., F.R.S.E.
THOMAS A. G. BALFOUR, M.D., F.R.S.E., F.R.C.P.E.
MALCOLM DUNN.
WILLIAM SANDERSON.



Issued December 1891.

*Honorary Secretary*—Professor Sir DOUGLAS MACLAGAN, M.D., LL.D., P.R.S.E.

*Honorary Curator*—The PROFESSOR OF BOTANY.

*Foreign Secretary*—ANDREW P. AITKEN, M.A., D.Sc., F.R.S.E.

*Treasurer*—PATRICK NEILL FRASER.

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*Artist*—DAVID CHRISTISON, M.D., F.S.A. Scot.

*Auditor*—THOMAS BOND SPRAGUE, M.A., F.R.S.E.

## LOCAL SECRETARIES.

*Aberdeen*—A. STEPHEN WILSON of North Kinmundy.
  „ Professor J. W. H. TRAIL, M.A., M.D., F.L.S.

*Beckenham, Kent*—A. D. WEBSTER.

*Berwick*—PHILIP W. MACLAGAN, M.D.
  „ FRANCIS M. NORMAN, R.N.

*Birmingham*—GEORGE A. PANTON, F.R.S.E., 73 Westfield Road.

*Bridge of Allan*—ALEXANDER PATERSON, M.D.

*Calcutta*—GEORGE KING, M.D., F.R.S., Botanic Garden.
  „ DAVID PRAIN, M.D., F.R.S.E., F.L.S., Botanic Garden.

*Cambridge*—CHARLES C. BABINGTON, M.A., F.R.S., Professor of Botany.
  „ ARTHUR EVANS, M.A.

*Chirnside*—CHARLES STUART, M.D.

*Croydon*—A. BENNETT, F.L.S.

*Glasgow*—Professor F. O. BOWER, D.Sc., F.R.S., F.L.S.

*Kelso*—Rev. DAVID PAUL, M.A., Roxburgh Manse.

*Kilbarchan*—Rev. G. ALISON.

*Leicester*—JOHN ARCHIBALD, M.D., F.R.S.E.

*Lincoln*—GEORGE MAY LOWE, M.D.

*London*—WILLIAM CARRUTHERS, F.R.S., F.L.S., British Museum.
  „ E. M. HOLMES, F.L.S., F.R.H.S.

*Manchester*—BENJAMIN CARRINGTON, M.D., Eccles.

*Melbourne, Australia*—Baron FERDINAND VON MUELLER, M.D., K.C.M.G., F.R.S.

*Nova Scotia*—Professor GEORGE LAWSON, LL.D., Dalhousie.

*Ottawa, Ontario*—W. R. RIDDELL, B.Sc., B.A., Prov. Normal School.

*Perth*—F. BUCHANAN WHITE, M.D., F.L.S.

*Saharunpore, India*—J. F. DUTHIE, B.A., F.L.S.

*Silloth*—JOHN LEITCH, M.B., C.M.

*St Andrews*—Professor M'INTOSH, M.D., LL.D., F.R.SS. Lond. and Edin.

*Wellington, New Zealand*—Sir JAMES HECTOR, M.D., K.C.M.G., F.R.SS. Lond. and Edin.

*Wolverhampton*—JOHN FRASER, M.A., M.D.

Mr Thomas Jamieson was admitted a non-Resident Fellow of the Society.

The Transactions and Proceedings of the Society during the Session 1890–91, which had been issued to Members in parts in course of the Session, were laid on the table.

Presents to the Library, Museum, and Herbarium at the Royal Botanic Garden were announced.

The Curator exhibited from the Royal Botanic Garden a spadix of *Ptychosperma elegans*, with ripe fruit, from a tree over 50 feet high in the Palm House; a large plant of *Saxifraga longifolia vera*, and a collection of New Zealand species of *Veronica*.

Mr John Campbell exhibited blooms of *Escallonia macrantha*, *Veronica speciosa* var., and *Passiflora* "Constance Elliot," from plants growing in the open air in his garden at Ledaig, Argyleshire.

The retiring President, Mr Robert Lindsay, delivered the following Address:—

Gentlemen,—It is now my duty to demit the high office to which you did me the honour of electing me, and I have to acknowledge the uniform kindness and sympathy which I have received at your hands, and to return you my most cordial thanks for the support thus accorded me.

We are now entering on the fifty-sixth session of the Botanical Society, and I venture to affirm that, from the success which has uniformly attended it during that long period, we may confidently anticipate greater results in the future.

Last Session has been a prosperous one, and many valuable and interesting communications have been made. The success which has attended the printing and issuing of the Transactions, at short intervals, is so decided as to render a return to the old method well-nigh impossible. Authors have now the satisfaction of knowing that their papers will be printed and issued immediately after they have been read before the Society, instead of being held back until the close of a Session, and even until far into a new one, to be published in one volume or part. The rapid interchange of thought characteristic of the present time, and the importance of priority of publication, have rendered the new departure absolutely necessary. That it will have a good effect on the future prosperity of our Society is certain. I need not refer to the papers themselves, as they are, or at least may be, now well known to you all. There is one original feature, however, to which I ought to allude, viz., the series of Commentaries on British Plants, by Professor Bayley Balfour and Dr Muirhead Macfarlane, in which were described the structure of the wood of indigenous trees and shrubs, illustrated by means of the micro-lantern. I am sure that every one who had the privilege of seeing those lantern-projections will join with me in expressing a hope that exhibitions of a similar character may form a prominent part of our proceedings in future. Nothing can possibly be better adapted for teaching purposes.

I am glad to be able to congratulate the Society upon the fact that its membership has been fully maintained during the past session. While, on the one hand, I have to record the following losses by death:—

Foreign Honorary Fellow—1.
 Dr Carl von Nägeli, Professor of Botany and Director of the Botanic Garden, Munich.
Corresponding Fellow—1.
 Dr R. Schomburgk, Director of the Government Botanic Garden, Adelaide.
Ordinary Fellows—4.
 Thomas J. Call, M.D., Ilkley.
 John Gair, Falkirk.
 Henry Cadogan Rothery, M.A., F.L.S. London.
 William Thomson, F.R.C.S.E.
Associate—1.
 Andrew Brotherston, Kelso.

I have, on the other hand, to note the following additions to the list of members:—

British Honorary Fellow—1.
 Hugh Francis C. Cleghorn, M.D.
Foreign Honorary Fellows—4.
 Dr Max Cornu, Director of the Jardin des Plantes, Paris.
 Dr Adolph Engler, Professor of Botany and Director of the Imperial Botanic Garden, Berlin.

Dr Robert Hartig, Professor of Forestry, Munich.
Dr Edouard de Regel, Director of the Imperial Botanic Garden, St Petersburg.

Ordinary Fellows—14.

Thomas Berwick.
Richard Brown, C.A.
Alexander Edington, M.B.
George Hunter, M.D., F.R.C.S.E.
Thomas Jamieson, F.I.C.
J. Melvin Lowson, B.Sc.
David Prain, M.D.
Robert A. Robertson, M.A., B.Sc.
William G. Smith.
J. Pentland Smith, B.Sc.
W. Maxwell Tress.
R. B. White of Ardarroch.
John Wilson, D.Sc.
J. C. Wright, F.R.S.E.

Corresponding Fellow—1.
Augustine Henry, M.D.

Associates—3.
James Macandrew. James Shaw. Charles Taylor.

And the numerical strength of the Society is now the following:—

Honorary Fellows, 31.
Ordinary Fellows, 313.
Corresponding Members, 63.
Lady Associates, 9.
Associates, 31.

Giving a total Membership of 447.

I have had some difficulty in selecting a topic on which to make a few remarks before demitting the office to which you called me; but I have chosen a subject to which I have given some attention for a few years past, viz., New Zealand Veronicas, and which I now beg to submit to your notice.

The genus *Veronica* is by far the largest of flowering plants in New Zealand: nowhere else is the genus so abundantly represented, and in no other country do so many large shrubby forms exist.

A great number of these have now been introduced into this country, and have been found to be admirably adapted for many garden purposes. Perhaps nowhere in this country are to be found so many different species of these New Zealand Veronicas, thriving so well, as in the Edinburgh Botanic Garden; and a few remarks regarding their value, chiefly from a horticultural point of view, may not be altogether out of place here.

There are about sixty species indigenous to New Zealand; and, with one exception, they are not found in any other country. The solitary exception is *Veronica elliptica,* which occurs also at Cape Horn and on the Falkland Islands. They form a most conspicuous feature of the vegetation of New Zealand by the beauty and ubiquity of the various species of large bushes so many of them form, and also by the remarkable forms many of them present. The species are difficult of discrimination. Numerous intermediate forms exist between many apparently distinct ones. They vary extremely in all their organs, and appear to hybridise freely in a natural state; consequently very great confusion exists as to their correct nomenclature. Nearly every genus of any magnitude in the colony shows variability to a remarkable degree, but in none is there so extreme variability to be found as in these Veronicas. Although many handsome shrubs have been introduced from New Zealand into our gardens of recent years which are decided acquisitions, such as the various species of *Olearia*, *Senecio*, &c., and there are many other species and genera yet to be introduced, of great beauty and hardiness, from high elevations on the New Zealand mountains, yet none will be found more valuable for garden purposes generally than the various species of *Veronica*. Many of them are indeed most beautiful plants: from the tiny *V. Bidwilli*, a little trailing species, to the dense and compact *V. Traversii*, 6 feet in height, there is not one but is worthy of the most careful cultivation and attention.

One of the earliest to be introduced was the very handsome but tender *V. speciosa*, R. Cunn. This has large, leathery, entire, and shining leaves, with dense racemes of dark purple flowers. It is a native of the northern island, and is found near the sea-coast. All the species that inhabit these districts in New Zealand are too tender for out-door culture in this country during winter, except in a few mild districts near the sea, where they flourish in great luxuriance for long periods without being injured by frost. *V. salicifolia*, Forst., *V. elliptica*, Forst., *V. Lavaudiana*, Raoul, *V. parviflora*, Vahl, *V. diosmæfolia*, R. Cunn., all found near the sea-coast, are among the tenderest kinds we have in cultivation, and were very early introduced into this country. Some beautiful hybrids of *V. salicifolia* crossed with *V. speciosa*, also hybrids between *V. elliptica* and *V. speciosa*, have been raised in this country, but chiefly in France. One of the first hybrids obtained was *V. Andersoni.*

This, the result of a cross between *V. salicifolia* and *V. speciosa*, was raised by the late Isaac Anderson Henry over forty years ago. It is still one of the best. All the above require protection during winter. As greenhouse plants, either planted out or grown in pots, they are most effective, and lend a pleasant variety at all times with their bright-shining foliage, and compact bush-like habit. They are free-flowering plants, particularly the hybrid varieties, which produce handsome racemes of flowers of various shades of blue, red, or white. A very handsome variegated-leaved form of *V. Andersoni*, which originated as a sport from it, was at one time in general use as a summer bedding plant, and is still one of the finest variegated plants in existence.

It is in the out-door garden, however, that the value of New Zealand veronicas will be most appreciated, and there are fortunately a large number of species well fitted to bear all the vicissitudes of our fickle climate; and it is those species that I wish particularly to bring under your notice to-night. The hardiest of all the species are those described by Sir Joseph D. Hooker in the Handbook of the New Zealand Flora, and which form section 4 of his arrangement of the genus. These consist of some six species found at altitudes of from 3000 to 8000 feet on the ice-clad slopes of the New Zealand mountains. Thoroughly alpine in character, they have a very curious appearance, closely resembling some conifers, and, except when in flower, might readily be mistaken for such, rather than for veronicas of the ordinary type. *V. cupressoides*, Hook. f., forms a dense, erect-growing bush, reaching a height of about 4 feet. In cultivation, it flowers very sparingly at the tips of the branches. The flowers are white, tinged with violet. It is, however, for the fine upright habit and evergreen branches and foliage that the plant is valued. It is of easy growth in ordinary soil, is very suitable for planting in beds alone or along with other plants in borders, and is a choice plant for the alpine garden.

A beautiful golden variegated sport has been observed on this species; and no doubt, when this plant is more widely distributed throughout the country, these sports will become more numerous, and we shall probably have variegations similar to those that obtain at present among conifers, to which they bear so striking a likeness.

*V. cupressoides*, var. *variabilis*, N.E.Br., is one of the most useful and ornamental of this group. It differs from the type very much in being dwarfer, more spreading in habit, and in having light green foliage, almost golden-coloured at times. It grows from 8 to 10 inches only in height, but spreads from 3 to 4 feet wide when old. It is unsurpassed among dwarf shrubs for the rockery, where it forms dense cushions of shapely growth, having all the appearance of a dwarf *Retinospora*. It is of the easiest culture, and will thrive in any soil or position except in very dry places; drought is the only thing that seems to affect it. The flowers, which are sparingly produced, are white with pink anthers. This fine plant was introduced into this country in 1876 by the late Mr Anderson Henry, under the name of *V. salicornioides*, under which name it is known in gardens both in this country and in New Zealand.

*V. Hectori*, Hook. f., is one of the most remarkable plants of the genus. It is an upright-growing species, 1 to 2 feet high, with rounded branches; the leaves are closely imbricated and reduced to mere scales; the whole plant is greyish-green in colour. An exceedingly hardy species, coming as it does from an altitude of from 7000 to 7500 feet on the Southern Alps, no frost we ever have in this country can at all affect it. The first living plant of *V. Hectori* was introduced into this country in 1888 by Mr Dunn of Dalkeith Gardens, and it now forms one of the chief attractions in the rock garden at the Royal Botanic Garden. It has not yet flowered in cultivation, but grows freely; unlike most of the species, it does not root readily from cuttings.

*V. lycopodioides*, Hook. f., resembles the latter, but differs chiefly in having square stems, which are not so thick; the leaves are sharp-pointed, and the colour of the plant is dark green; the habit is not so erect, but more spreading than in *V. Hectori*. In appearance it resembles *Andromeda tetragona* very closely.

*V. Armstrongi*, Kirk, is a compact, graceful shrub, about a foot high; the leaves and branches are light green in colour, and the stems have a miniature tree-like appearance, somewhat resembling a dwarf juniper. Belonging to this section of *Veronica* are *V. tetragona*, Hook., *V. tetrasticha*, Hook. f., and the true *V. salicornioides*, Hook. f., which have not yet been introduced. The manner in which these veronicas shed their leaves is remarkable. The smaller branches are articulated with the stem and fall off bodily, leaving a well-defined scar, similar to what is found in some conifers. They also exhibit a peculiar heterophyllous condition, which in a former communication to the Society * I pointed out, stating that this was probably due to a reversion to the juvenile condition of the plants. Since then seedlings have been raised of *V. cupressoides*, var. *variabilis*, which entirely bears out the conjecture then indicated.

There is a large number of species of a totally different character from the preceding, in having larger foliage and handsomer flowers. These come from altitudes of 2500 to 5000 feet, and are also quite hardy in this country. They number about twenty species, all differing from each other in some respects, and yet linked so closely together that one is forced to the conclusion that many of them are but varieties of each other. They may be roughly divided into those having the leaves more or less glaucous, and those with more or less glabrous leaves.

*V. pinguifolia*, Hook. f., represents the former. In cultivation it forms a compact shrub, about 18 inches in height, having thick, very glaucous foliage, and stout erect branches, which spread when old about a yard across. Throughout the summer it becomes covered with small spikes of white flowers, giving the plant the appearance at a distance of being sprinkled with snow. *V. carnosula*, Hook. f., *V. Godefroyana*, Decne, and *V. amplexicaulis*, Arm., are of the same type, differing chiefly in size of foliage and flower. *V. pimelioides*, Hook. f., and *V. glauco-cœrulea*, Arm., have also glaucous foliage; but the leaves are much smaller and narrower, and the habit more spreading. Of a quite different type is *V. Colensoi*, Hook. f., *glauca*, which is a larger and much more erect shrub than any of the preceding. All those kinds having glaucous foliage are among the hardiest, besides being among the most ornamental of the genus.

The well-known *V. Traversii*, Hook. f., may be taken as representing those having glabrous foliage. It is an erect-growing shrub, attaining a height of from 6 to 7 feet, and naturally forms beautiful shapely bushes, and, when covered

* Trans. Bot. Soc., vol. xvii.

with its longish racemes of lilac-white flowers, is an exceedingly handsome object. Others of this type, though differing in size and other respects, are *V. rakaiensis, V. monticola*, Arm., *V. lævis*, Benth., *V. buxifolia*, Benth., and *V. anomala.* Of a different type is *V. linifolia*, Hook. f., a small alpine herb about 6 inches high, a very distinct hardy species, having entire glabrous leaves about an inch long and very narrow. The flowers are axillary, large, white streaked with rosy purple; a most useful rockwork plant, quite distinct from any other.

A number of very beautiful species, which are found at altitudes below 2500 feet, are too tender to withstand our severe winters, but pass through our ordinary winters in safety; they can only be termed half-hardy, and include the handsome *V. Hulkeana*, F. Muell., which forms a lax-growing bush 2 to 3 feet high; the leaves are about an inch long, serrate, and leathery in texture. The flowers appear in May and June; they are arranged on a spike about 1 foot long, and are of a delicate mauve colour. *V. Fairfieldi* resembles the latter somewhat, but is not so high, scarcely 1 foot in height; the leaves are serrate, having a brownish tinge at the edges. The flowers are larger, not so lilac as in *V. Hulkeana*, and the spikes are shorter and more racemose. It is of recent introduction, having been raised from seed by Mr Martin of the Fairfield Nurseries, Dunedin, and is probably a hybrid of *V. Hulkeana. V. Lyallii*, Hook. f., a neat dwarf shrub, with deeply-toothed leaves and racemes of violet-coloured flowers, is one of the hardiest of this set. *V. cataractæ*, Forst., seems to be a large-leaved form of *V. Lyallii*, while the beautiful trailing *V. Bidwillii*, Hook., seems to be a small-leaved form.

Other half-hardy species which we have in cultivation are *V. ligustrifolia*, A. Cunn., *V. Lewisii*, Arm., *V. chathamica*, Buch., *V. Kirkii*, Arm., *V. epacridea* (?), and *V. vernicosa* (?).

Although the above species cannot be depended upon in all seasons, yet they are sufficiently hardy to withstand our ordinary winters; not one of those mentioned was injured during last winter at Edinburgh; and as they include some of the finest flowering species, they are worthy of being extensively planted, particularly near the sea-coast, where all the New Zealand veronicas flourish most freely. In very cold districts a few cuttings may be put in during August, and placed in a cold frame they will root readily, and be well fitted in spring to be planted out in room of any that may have been too much injured. Several fine species have still to be introduced from New Zealand, particularly *V. macrantha*, Hook. f., and *V. Benthami*, Hook. f.; the former, at least, should be quite hardy in this country, as it is found at from 3000 to 6000 feet altitude. It has the largest flowers of any of the species; they are pure white, and about 1 inch across. *V. Benthami* is also a most desirable species, and has bright blue flowers. All attempts to introduce these fine species alive into this country have hitherto failed, the long journey having proved fatal to them. The difficulty will be overcome by sending seeds home, when they are procurable.

New Zealand veronicas are easily raised from seed, and self-sown seedlings of many of the species spring up spontaneously near where old plants are growing; and while much may be done by selecting varieties better suited in one respect or another for garden purposes, it is to the hybridist that we shall have mainly to look for improved varieties. Some good results have already been obtained by crossing the tender kinds only. Nothing has as yet been done in the way of hybridising the hardy species; but there is little reason to doubt that, by crossing these with the tender and more showy kinds, we might succeed in raising an improved race of veronicas, perfectly capable of standing through our worst winters. The numerous species, as they now exist, are very suggestive of their having originated at some distant date, from one or two types, as natural hybrids; and this is probably the cause of the great variation now found in the genus. Be that as it may, the artificial crossing of several of the species offers a tempting means of throwing additional light upon, if not of solving, the problem of their origin.

Nearly all the species naturally form compact shapely bushes, and do not require much in the way of pruning or trimming into shape. Their varied evergreen foliage and different-coloured flowers render them very attractive at all seasons. They are not particular as to soil, and they may be increased rapidly and without much trouble from cuttings. Few plants are so useful for various purposes as those New Zealand speedwells. They are very effective when planted in groups on lawns, or singly in borders along with other shrubs. Many of them are peculiarly well adapted for the rock-garden, their unique appearance, compact habit of growth, combined with their extreme hardiness, all tending to make them invaluable for that style of gardening. They may also be used advantageously for winter bedding plants, or for edgings to beds in summer. For window-boxes in towns the dwarf kinds are extremely useful, as they resist the injurious effects of smoke better than most plants; and, possessing as they do so many advantages for decorative purposes, they ought to become more widely known than they are at the present time.

Species of Veronica from New Zealand, cultivated in the Royal Botanic Garden, Edinburgh, in 1891.

*Hardy Species.*

Veronica Hectori, Hook. f., 7-7500 ft. altitude.
,, lycopodioides, Hook. f., 4-5000 ft. altitude.
,, cupressoides, Hook. f., 4000 ft. altitude.
,, ,, var. variabilis, N.E.Br.
,, Armstrongi, Kirk.
,, carnosula, Hook. f., 5000 ft. altitude.
,, pinguifolia, Hook. f., 5000 ft. altitude.
,, amplexicaulis, Arm., 5000 ft. altitude.
,, buxifolia, Benth., 5000 ft. altitude.
,, lævis, Benth., 2-6000 ft. altitude.
,, Godefroyana, Decne.
,, monticola, Arm., 3-4500 ft. altitude.
,, Colensoi, Hook. f., 3-5000 ft. altitude.
,, ,, var. glauca.
,, Traversii, Hook. f., 4000 ft. altitude.
,, rakaiensis, Arm., 2-4000 ft. altitude.
,, glauco-cœrulea, Arm., 2-5000 ft. altitude.
,, pimelioides, Hook. f., 2-4000 ft. altitude.
Veronica linifolia, Hook. f., 2500-4000 ft. altitude.
,, anomala, Arm.

*Half-hardy Species.*

,, Lyallii, Hook. f., 2-4000 ft. altitude.
,, Bidwillii, Hook., 2-3000 ft. altitude.
,, cataractæ, Forst.
,, Kirkii, Arm.
,, epacridea? 5-6000 ft. altitude.
,, vernicosa, Hook. f., 1500-3000 ft. altitude.
,, Lewisii, Arm.
,, ligustrifolia, A. Cunn.
,, chathamica, Buch.
,, Hulkeana, F. Muell., 1500-2000 ft. altitude.
,, Fairfieldi, Hort.

*Tender Species.*

,, diosmæfolia, R. Cunn., sea-coast.
,, elliptica, Forst., sea-coast.
,, parviflora, Vahl, sea-coast.
,, salicifolia, Forst.
,, Lavaudiana, Raoul.
,, Andersoni, hybrid.
,, speciosa, R. Cunn., sea-coast.
,, elegans.

On the motion of Dr CLEGHORN, the thanks of the Society were given to Mr Lindsay for his address.

The following Papers were read:—

ON ROOT-HAIRS. By THOMAS JAMIESON, F.I.C., Fordyce Lecturer on Agriculture, University of Aberdeen.

On Temperature and Vegetation in the Royal Botanic Garden, during July, August, September, and October 1891. By Robert Lindsay, Curator of the Garden.

JULY.

The month of July was for the greater part changeable and inclement; there was a marked absence of real summer warmth. The lowest night temperature was 42°, which occurred on the 10th of the month, and the highest 54°, on the 17th. The lowest day temperature was 63°, on the 16th, and the highest 79°, on the 17th. Roses were unusually fine, although late in commencing to flower. Herbaceous plants generally were also good. On the rock-garden 252 species and well-marked varieties came into flower as against 204 for the corresponding month last year. A few of the more interesting were:—*Aquilegia pyrenaica, Anomatheca cruenta, Astragalus alopecuroides, Calamintha patavina, Campanula Waldsteiniana, Dianthus neglectus, D. cinnabarinus, Cyananthus lobatus, Epilobium obcordatum, Eriogonum aureum, Gentiana septemfida, G. tibetica, Hypericum reptans, Galium rubrum, Linaria origanifolia, Mimulus roseus, Palava flexuosa, Pentstemon speciosum, Potentilla lanuginosa, Saxifraga diversifolia, Senecio laxiflora, Swertia multicaulis, Veronica elliptica,* and *V. rakaiensis,* &c.

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during July 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 53° | 70° | 75° | 17th | 54° | 59° | 79° |
| 2nd | 49 | 61 | 75 | 18th | 50 | 70 | 76 |
| 3rd | 47 | 56 | 68 | 19th | 48 | 64 | 72 |
| 4th | 46 | 58 | 72 | 20th | 52 | 56 | 74 |
| 5th | 44 | 55 | 71 | 21st | 53 | 59 | 69 |
| 6th | 53 | 66 | 70 | 22nd | 47 | 59 | 69 |
| 7th | 44 | 62 | 68 | 23rd | 53 | 60 | 75 |
| 8th | 45 | 61 | 68 | 24th | 49 | 64 | 69 |
| 9th | 49 | 54 | 69 | 25th | 48 | 57 | 72 |
| 10th | 42 | 64 | 76 | 26th | 49 | 50 | 71 |
| 11th | 48 | 57 | 67 | 27th | 52 | 59 | 67 |
| 12th | 52 | 58 | 72 | 28th | 43 | 56 | 64 |
| 13th | 50 | 65 | 74 | 29th | 42 | 60 | 68 |
| 14th | 51 | 64 | 70 | 30th | 50 | 58 | 71 |
| 15th | 50 | 64 | 73 | 31st | 51 | 53 | 64 |
| 16th | 49 | 54 | 63 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of July 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·587 | 67·1 | 55·6 | 63·9 | 52·5 | S.W. | { Cir. St. / Cum. } | 1 / 5 | S.W. | 0·125 |
| 2 | 29·609 | 70·4 | 52·9 | 61·7 | 57·0 | S. | Cum. | 5 | S. | 0·033 |
| 3 | 29·571 | 68·5 | 51·0 | 57·1 | 54·8 | W. | Cum. | 9 | W. | 0·210 |
| 4 | 29·812 | 63·9 | 48·9 | 59·9 | 55·1 | W. | Cum. | 5 | W. | 0·002 |
| 5 | 29·803 | 66·8 | 47·7 | 58·1 | 53·2 | E. | Cum. | 10 | S. | 0·365 |
| 6 | 29·483 | 64·2 | 55·2 | 61·9 | 57·3 | S.W. | Cum. | 1 | S.W. | 0·157 |
| 7 | 29·342 | 67·0 | 48·0 | 59·9 | 55·2 | W. | ... | 0 | ... | 0·002 |
| 8 | 29·649 | 66·8 | 50·1 | 60·2 | 56·1 | N. | Cum. | 8 | N. | 0·162 |
| 9 | 30·020 | 66·4 | 51·9 | 55·1 | 51·3 | N. | Cum. | 10 | N. | 0·005 |
| 10 | 29·979 | 62·6 | 46·1 | 62·0 | 56·8 | S.W. | ... | 0 | ... | 0·000 |
| 11 | 29·902 | 71·6 | 51·1 | 57·4 | 53·6 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 12 | 29·900 | 62·9 | 53·9 | 59·7 | 55·9 | S.W. | Cum. | 10 | S.W. | 0·012 |
| 13 | 30·101 | 65·6 | 53·2 | 64·7 | 59·9 | S.W. | Cum. | 4 | S.W. | 0·025 |
| 14 | 30·324 | 69·6 | 55·1 | 62·3 | 58·8 | N.E. | Cum. | 2 | N.E. | 0·000 |
| 15 | 30·167 | 66·1 | 52·7 | 59·9 | 54·8 | E. | { Cir. St. / Cum. } | 5 / 1 | S. / E. | 0·343 |
| 16 | 29·768 | 66·0 | 52·9 | 56·3 | 56·1 | S.W. | Nim. | 10 | S.W. | 0·035 |
| 17 | 29·660 | 60·7 | 56·1 | 60·7 | 60·0 | S.W. | Cum. | 10 | S.W. | 0·004 |
| 18 | 29·753 | 74·1 | 53·9 | 68·8 | 62·1 | S.E. | Cum. | 2 | S.E. | 0·000 |
| 19 | 29·775 | 70·8 | 51·5 | 60·9 | 56·3 | N.E. | Cum. | 10 | S. | 0·002 |
| 20 | 29·780 | 66·6 | 55·1 | 59·4 | 57·2 | S.W. | Cum. | 10 | S.W. | 0·040 |
| 21 | 29·774 | 68·0 | 56·9 | 61·1 | 58·8 | S.W. | Cum. | 9 | S.W. | 0·335 |
| 22 | 29·676 | 64·0 | 50·5 | 60·2 | 57·1 | W. | Cum. | 9 | W. | 0·540 |
| 23 | 29·854 | 65·0 | 55·1 | 60·8 | 57·2 | N. | Cum. | 10 | N. | 0·005 |
| 24 | 29·823 | 67·6 | 51·8 | 62·0 | 55·8 | W. | Cum. | 2 | W. | 0·000 |
| 25 | 29·942 | 65·9 | 50·9 | 59·1 | 53·8 | W. | Cum. | 6 | W. | 0·000 |
| 26 | 29·920 | 69·8 | 51·9 | 65·3 | 59·9 | W. | { Cir. Cum. / Cum. } | 3 / 2 | W. | 0·000 |
| 27 | 29·592 | 67·7 | 54·7 | 57·2 | 52·2 | N.W. | Cum. | 2 | N.W. | 0·005 |
| 28 | 29·604 | 61·9 | 46·5 | 57·7 | 51·0 | N.W. | { Cir. St. / Cum. } | 5 / 2 | N.W. | 0·065 |
| 29 | 29·412 | 63·8 | 46·0 | 58·3 | 53·2 | W. | Cum. | 4 | N. | 0·070 |
| 30 | 29·694 | 64·5 | 53·0 | 57·2 | 53·0 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 31 | 29·897 | 65·2 | 51·3 | 58·1 | 55·6 | E. | Cum. | 10 | E. | 0·000 |

Barometer.—Highest Reading, on the 14th, =30·324. Lowest Reading, on the 7th, =29·342. Difference, or Monthly Range, =0·982. Mean=29·781.

S. R. Thermometers.—Highest Reading, on the 18th, =74°·1. Lowest Reading, on the 29th, =46°·0. Difference, or Monthly Range, =28°·1. Mean of all the Highest =66°·6. Mean of all the Lowest=52°·0. Difference, or Mean Daily Range, =14°·6. Mean Temperature of Month=59°·3.

Hygrometer.—Mean of Dry Bulb=60°·2. Mean of Wet Bulb=55°·8.

Rainfall.—Number of Days on which Rain fell=22. Amount of Fall, in inches, =2·542.

A. D. RICHARDSON,
*Observer.*

## AUGUST.

August was an exceedingly cold and wet month. No really warm days occurred, and altogether the month was a most unfavourable one. The lowest night temperature was 34°, which occurred on the 30th, and the highest 55°, on the 18th. The lowest day temperature was 59°, on the 23rd, and the highest 77°, on the 19th. On the rock-garden 84 species came into flower as against 81 during last August. Amongst the most conspicuous were :—*Cheiranthus Allionii, Carlina subcaulescens, Cyclamen hederæfolium, Dalibarda repens, Dianthus Atkinsoni, D. monspessulanus, Delphinium velutinum, Epilobium Fleisherii, Gentiana arvernensis, Helleborus niger angustifolius, Lilium dalmaticum, L. auratum, Lobelia cardinalis, Mimulus cardinalis, Spiræa gigantea, Stobæa purpurea, Tricyrtis australis.*

Readings of exposed Thermometer at the Rock Garden of the Royal Botanic Garden, Edinburgh, during August 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 43° | 64° | 72° | 17th | 44° | 52° | 66° |
| 2nd | 42 | 65 | 69 | 18th | 55 | 62 | 76 |
| 3rd | 45 | 55 | 66 | 19th | 47 | 68 | 77 |
| 4th | 46 | 54 | 62 | 20th | 47 | 56 | 67 |
| 5th | 50 | 62 | 66 | 21st | 49 | 54 | 67 |
| 6th | 45 | 58 | 72 | 22nd | 48 | 55 | 66 |
| 7th | 49 | 54 | 69 | 23rd | 52 | 55 | 59 |
| 8th | 54 | 57 | 67 | 24th | 47 | 56 | 66 |
| 9th | 53 | 60 | 66 | 25th | 52 | 60 | 67 |
| 10th | 45 | 57 | 70 | 26th | 48 | 53 | 66 |
| 11th | 45 | 50 | 68 | 27th | 47 | 57 | 68 |
| 12th | 51 | 56 | 65 | 28th | 44 | 58 | 64 |
| 13th | 48 | 54 | 69 | 29th | 36 | 54 | 66 |
| 14th | 48 | 52 | 68 | 30th | 34 | 56 | 76 |
| 15th | 49 | 62 | 69 | 31st | 43 | 57 | 63 |
| 16th | 50 | 60 | 68 | | | | |

[TABLE.

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of August 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·799 | 65·8 | 45·8 | 63·1 | 56·2 | W. | Cir.<br>Cum. | 3<br>6 | W. | 0·000 |
| 2 | 29·604 | 67·1 | 48·9 | 60·0 | 55·2 | S.W. | Cum. | 9 | S.W. | 0·155 |
| 3 | 29·440 | 66·8 | 47·9 | 57·1 | 54·3 | N.N.E. | Cum. | 10 | N.N.E. | 0·545 |
| 4 | 29·528 | 62·3 | 51·9 | 54·8 | 53·9 | E.N.E. | Cum. | 10 | E.N.E. | 0·220 |
| 5 | 29·783 | 60·7 | 52·9 | 60·1 | 55·8 | N.N.E. | Cum. | 9 | N.N.E. | 0·015 |
| 6 | 29·902 | 61·7 | 49·4 | 57·6 | 54·3 | W.N.W. | Cum. | 7 | N.W. | 0·045 |
| 7 | 29·845 | 68·3 | 51·2 | 56·1 | 54·2 | W.S.W. | Cum. | 10 | W.S.W. | 0·075 |
| 8 | 29·818 | 65·8 | 55·8 | 59·9 | 58·2 | W.S.W. | Nim. | 10 | W.S.W. | 0·085 |
| 9 | 29·498 | 64·7 | 55·2 | 60·8 | 60·1 | W.S.W. | Cum. | 10 | W.S.W. | 0·660 |
| 10 | 29·714 | 63·7 | 50·5 | 59·0 | 57·6 | N. | Cir. Cum. | 6 | N. | 0·028 |
| 11 | 29·736 | 64·8 | 48·6 | 53·9 | 52·9 | S.W. | Nim. | 10 | S.W. | 0·002 |
| 12 | 29·430 | 62·7 | 50·9 | 56·8 | 53·8 | S.W. | Nim. | 10 | S.W. | 0·095 |
| 13 | 29·723 | 61·9 | 50·9 | 60·7 | 55·8 | W. | Cir. | 1 | N.W. | 0·095 |
| 14 | 29·738 | 66·8 | 52·9 | 55·3 | 55·1 | E.N.E. | Nim. | 10 | E.N.E. | 0·032 |
| 15 | 29·642 | 65·8 | 52·2 | 60·1 | 55·6 | W. | Cir.<br>Cum. | 4<br>1 | S.W.<br>W. | 0·000 |
| 16 | 29·849 | 65·1 | 52·9 | 58·5 | 53·3 | S.E. | Cum. | 8 | N.W. | 0·000 |
| 17 | 29·768 | 63·5 | 47·7 | 55·6 | 52·5 | S.E. | Cum. | 10 | S.E. | 0·162 |
| 18 | 29·496 | 63·2 | 55·0 | 62·7 | 58·9 | S.E. | Cir.Cum.<br>Cum. | 3<br>5 | S.E. | 0·010 |
| 19 | 29·423 | 69·9 | 51·8 | 64·0 | 57·2 | S.E. | ... | 0 | ... | 0·000 |
| 20 | 29·520 | 69·9 | 52·1 | 56·2 | 54·8 | E. | Cum. | 10 | N.E. | 0·025 |
| 21 | 29·432 | 60·8 | 53·7 | 55·1 | 54·2 | N.N.E. | Cum. | 10 | N.E. | 0·850 |
| 22 | 29·602 | 60·8 | 52·2 | 56·8 | 54·2 | N.N.E. | Cum. | 10 | N.E. | 0·002 |
| 23 | 29·712 | 63·7 | 52·3 | 55·8 | 51·3 | N. | Cum. | 5 | N. | 0·000 |
| 24 | 29·625 | 61·8 | 46·3 | 57·0 | 53·5 | W. | Cum. | 8 | W. | 0·140 |
| 25 | 29·215 | 61·8 | 55·7 | 60·5 | 55·9 | W.S.W. | Cum. | 10 | W.S.W. | 0·270 |
| 26 | 28·898 | 64·6 | 52·9 | 55·1 | 52·3 | W.S.W. | Cir.Cum.<br>Cum. | 4<br>2 | W. | 0·005 |
| 27 | 29·267 | 63·0 | 55·9 | 58·0 | 54·7 | S.S.W. | Cum. | 9 | S.S.W. | 0·150 |
| 28 | 29·312 | 62·3 | 46·7 | 54·6 | 51·8 | W.S.W. | Nim. | 10 | W.S.W. | 0·002 |
| 29 | 29·721 | 62·3 | 40·1 | 56·8 | 52·1 | W.N.W. | ... | 0 | ... | 0·030 |
| 30 | 29·911 | 63·6 | 40·7 | 55·6 | 51·3 | Calm. | Cum. | 2 | S.W. | 0·020 |
| 31 | 29·354 | 62·9 | 49·2 | 55·8 | 53·1 | S. | Cum. | 9 | S.W. | 0·150 |

Barometer. Highest Reading, on the 30th, =29·911. Lowest Reading, on the 26th, =28·898. Difference, or Monthly Range, =1·013. Mean=29·590.

S. R. Thermometers.—Highest Readings, on the 19th and 20th, =69°·9. Lowest Reading, on the 29th, =40°·1. Difference, or Monthly Range, =29°·8. Mean of all the Highest=64°·1. Mean of all the Lowest=50°·6. Difference, or Mean Daily Range, =13°·5. Mean Temperature of Month=57°·3.

Hygrometer.—Mean of Dry Bulb=57°·8. Mean of Wet Bulb=54°·6.

Rainfall.—Number of Days on which Rain fell=26. Amount of Fall, in inches, =3·873.

A. D. RICHARDSON,
*Observer.*

SEPTEMBER.

The month of September was very changeable and unsettled, with frequent storms of wind and rain, yet in some respects it was the best month of the season. More really fine and warm days occurred than in any of the three months previous. The severe storm of wind and rain which took place on the 21st, and which caused so much destruction throughout the country, passed over without doing any serious damage in the garden. No frost occurred, and there was a fair amount of bright sunshine. Late-flowering herbaceous plants and annuals now reached their best. Those which flowered earlier mostly produced good seed, a large supply of which has been obtained for distribution. The lowest night temperature was 38°, which occurred on the 21st of the month, and the highest 54°, on the 14th. The lowest day temperature was 49°, on the 21st, and the highest 85°, on the 12th. On the rock-garden 41 species and varieties came into flower as against 47 for the corresponding month last year, amongst which were the following:—*Coreopsis verticillata, Gentiana alba, G. ornata, Gladiolus Saundersii, Crocus annulatus, C. imperati, C. pulchellus, C. speciosus, Colchicum maximum, Kniphofia Uvaria, K. nobilis, Potentilla formosa, Senecio pulcher, Veronica Lindleyana, V. longifolia subsessilis, Lilium auratum macranthum*, &c.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during September 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 51° | 61° | 64° | 16th | 50° | 55° | 60° |
| 2nd | 42 | 60 | 66 | 17th | 54 | 59 | 64 |
| 3rd | 44 | 65 | 71 | 18th | 54 | 57 | 63 |
| 4th | 42 | 55 | 69 | 19th | 49 | 60 | 64 |
| 5th | 42 | 54 | 65 | 20th | 45 | 50 | 54 |
| 6th | 41 | 46 | 64 | 21st | 38 | 44 | 49 |
| 7th | 45 | 59 | 67 | 22nd | 44 | 49 | 54 |
| 8th | 37 | 47 | 60 | 23rd | 40 | 50 | 62 |
| 9th | 50 | 60 | 72 | 24th | 42 | 50 | 68 |
| 10th | 43 | 63 | 81 | 25th | 43 | 52 | 68 |
| 11th | 47 | 68 | 76 | 26th | 45 | 58 | 61 |
| 12th | 47 | 70 | 85 | 27th | 43 | 51 | 57 |
| 13th | 46 | 63 | 73 | 28th | 41 | 53 | 64 |
| 14th | 54 | 56 | 60 | 29th | 49 | 54 | 66 |
| 15th | 44 | 51 | 63 | 30th | 43 | 55 | 65 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of September 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 28·800 | 64·4 | 53·9 | 61·0 | 56·0 | S.W. | Cir.Cum. / Cum. | 2 / 4 | S.W. | 0·260 |
| 2 | 29·269 | 62·3 | 51·8 | 58·3 | 54·0 | S.W. | Cum. | 5 | S.W. | 0·002 |
| 3 | 29·815 | 62·8 | 45·1 | 58·3 | 52·3 | W.S.W. | ... | 0 | ... | 0·105 |
| 4 | 29·860 | 65·2 | 47·2 | 53·8 | 52·7 | S.E. | Cum. | 2 | S.W. | 0·015 |
| 5 | 29·856 | 61·8 | 46·2 | 55·0 | 51·9 | S.W. | Cum. | 10 | S.W. | 0·175 |
| 6 | 29·523 | 62·6 | 48·9 | 57·3 | 52·8 | W.S.W. | Cum. | 10 | W.S.W. | 0·032 |
| 7 | 29·783 | 62·3 | 47·0 | 56·7 | 51·9 | W. | Cir. / Cum. | 1 / 1 | N.W. / W. | 0·115 |
| 8 | 29·933 | 64·0 | 41·6 | 55·1 | 54·2 | Calm | Nim. | 10 | Calm | 0·192 |
| 9 | 29·869 | 63·7 | 49·8 | 63·0 | 60·9 | S.W. | Cum. | 6 | S.W. | 0·007 |
| 10 | 29·905 | 68·0 | 49·9 | 61·4 | 58·5 | N.E. | ... | 0 | ... | 0·000 |
| 11 | 29·922 | 74·1 | 52·2 | 65·7 | 62·6 | W.N.W. | Cir. / Cum. | 2 / 2 | N.W. | 0·000 |
| 12 | 29·867 | 72·1 | 50·1 | 65·4 | 61·7 | Calm | ... | 0 | ... | 0·000 |
| 13 | 29·748 | 79·7 | 49·4 | 59·8 | 52·9 | S.E. | Cir. | 2 | S.W. | 0·023 |
| 14 | 29·599 | 69·4 | 57·0 | 59·4 | 59·2 | W.S.W. | Nim. | 10 | W.S.W. | 0·115 |
| 15 | 29·927 | 60·6 | 47·0 | 55·6 | 51·7 | W.N.W. | Cum. | 4 | N.W. | 0·011 |
| 16 | 29·881 | 61·1 | 52·8 | 56·4 | 54·2 | W. | Nim. | 10 | W. | 0·002 |
| 17 | 29·660 | 60·7 | 55·7 | 59·9 | 52·3 | S.W. | Cum. | 5 | S.W. | 0·017 |
| 18 | 29·492 | 61·9 | 55·3 | 58·0 | 55·6 | W. | Cir. / Cum. | 3 / 2 | W. | 0·000 |
| 19 | 29·664 | 62·9 | 51·2 | 58·3 | 54·5 | W. | Cir. / Cum. | 1 / 4 | W. | 0·048 |
| 20 | 29·618 | 60·9 | 48·0 | 52·0 | 52·0 | N.N.E. | Nim. | 10 | N.N.E. | 1·482 |
| 21 | 29·474 | 53·4 | 45·2 | 47·2 | 45·6 | N.N.E. | Nim. | 10 | N.N E. | 0·376 |
| 22 | 29·837 | 50·1 | 46·2 | 49·2 | 45·9 | N.N.E. | Cum. St. | 10 | N.N.E. | 0·000 |
| 23 | 29·966 | 52·6 | 42·8 | 50·0 | 47·6 | E. | Cum. | 8 | S.W. | 0·075 |
| 24 | 29·809 | 57·7 | 45·4 | 52·6 | 51·4 | E. | Nim. | 10 | S.W. | 0·087 |
| 25 | 29·877 | 61·6 | 44·9 | 53·8 | 51·0 | S.W. | Cum. | 8 | S.W. | 0·265 |
| 26 | 29·231 | 62·9 | 48·4 | 57·0 | 52·6 | S.W. | Cum. | 4 | S.W. | 0·100 |
| 27 | 29·506 | 60·6 | 48·5 | 53·0 | 44·6 | W. | Cum. | 2 | W. | 0·045 |
| 28 | 29·667 | 57·0 | 50·7 | 55·4 | 53·9 | W.S.W. | Cum. | 10 | W.S.W. | 0·270 |
| 29 | 29·560 | 62·4 | 52·5 | 55·4 | 51·7 | S.W. | Cum. | 4 | S.W. | 0·045 |
| 30 | 29·461 | 61·7 | 46·1 | 55·4 | 51·1 | S. | Cum. | 5 | S.W. | 0·080 |

Barometer.—Highest Reading, on the 23rd, =29·966. Lowest Reading, on the 1st, =28·800. Difference, or Monthly Range, =1·166. Mean=29·679.

S. R. Thermometers.—Highest Reading, on the 13th, =79°·7. Lowest Reading, on the 8th, =41°·6. Difference, or Monthly Range, =38°·1. Mean of all the Highest =62°·7. Mean of all the Lowest=49°·0. Difference, or Mean Daily Range, =13°·7. Mean Temperature of Month=55°·8.

Hygrometer.—Mean of Dry Bulb=56°·6. Mean of Wet Bulb=53°·2.

Rainfall.—Number of Days on which Rain fell=25. Amount of Fall, in inches, =3·914.

A. D. RICHARDSON, } *Observers.*
A. ANDERSON,

## OCTOBER.

The month of October was on the whole favourable. The first frost this season took place on the 18th of the month, when the glass registered 32°. The thermometer was at or below the freezing point on eight occasions, indicating collectively 20° of frost for the month. The lowest readings were on the 18th, 32°; 23rd, 32°; 25th, 27°; 29th, 26°; 30th, 29°; and 31st, 26°.

The lowest day reading was 45°, on the 29th, and the highest 71°, on the 5th. Dahlias and other tender plants were destroyed by frost on the 23rd. Deciduous trees and shrubs were late in shedding their leaves. Autumn tints were most conspicuous on Scarlet and Hungarian Oaks, Tulip-tree, Beech; *Pavia flava, Amelanchier vulgaris, Azalea pontica,* and *Ampelopsis tricuspidata.* Amongst fruit-bearing trees or shrubs the best set are Hollies, Cotoneasters, and Gaultherias. Hardy Rhododendrons and Azaleas are fairly well set with flower-buds.

On the rock-garden 13 species came into flower during October, as against 23 from October 1890. Amongst those which flowered were:—*Crocus asturicus, C. Salzmannii, Erica ciliaris, Gentiana Kurroo, Gynerium argenteum, Helleborus altifolius, Kniphofia Saundersii, Oxalis lobata, Saxifraga Fortunei.* The total number which have flowered since January 1st is 1210; during the same period last year 1154 had flowered.

Register of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during October 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 44° | 48° | 65° | 17th | 39° | 45° | 57° |
| 2nd | 39 | 47 | 64 | 18th | 32 | 35 | 67 |
| 3rd | 40 | 52 | 64 | 19th | 43 | 46 | 54 |
| 4th | 50 | 58 | 65 | 20th | 34 | 45 | 61 |
| 5th | 46 | 50 | 71 | 21st | 41 | 47 | 60 |
| 6th | 43 | 52 | 61 | 22nd | 38 | 44 | 54 |
| 7th | 42 | 53 | 61 | 23rd | 32 | 33 | 53 |
| 8th | 41 | 50 | 64 | 24th | 37 | 45 | 57 |
| 9th | 45 | 61 | 61 | 25th | 27 | 38 | 54 |
| 10th | 39 | 42 | 65 | 26th | 39 | 45 | 53 |
| 11th | 40 | 46 | 60 | 27th | 44 | 46 | 52 |
| 12th | 40 | 50 | 62 | 28th | 35 | 44 | 54 |
| 13th | 38 | 47 | 53 | 29th | 26 | 30 | 45 |
| 14th | 40 | 42 | 56 | 30th | 29 | 35 | 47 |
| 15th | 37 | 42 | 52 | 31st | 26 | 30 | 47 |
| 16th | 36 | 47 | 53 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of October 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·370 | 61·0 | 47·0 | 50·0 | 48·5 | S.S.W. | Cum. | 10 | S.S.W. | 0·044 |
| 2 | 29·584 | 55·8 | 41·7 | 49·0 | 47·3 | N. | Cum. | 10 | N. | 0·005 |
| 3 | 29·860 | 55·8 | 44·3 | 54·0 | 52·0 | S.W. | Cum. | 10 | S.W. | 0·002 |
| 4 | 29·934 | 61·6 | 52·4 | 58·2 | 53·6 | S.W. | Cir. | 6 | S.W. | 0·002 |
| 5 | 29·743 | 61·8 | 49·9 | 52·3 | 48·5 | S. | Cum. | 6 | S.W. | 0·020 |
| 6 | 28·953 | 57·6 | 51·9 | 55·3 | 52·9 | S.E. | Cum. | 10 | S.E. | 0·115 |
| 7 | 29·200 | 58·8 | 46·2 | 53·1 | 49·1 | S. | Cir.<br>Cum. | 2<br>2 | S. | 0·020 |
| 8 | 29·533 | 57·8 | 43·5 | 51·6 | 48·2 | S. | Cir. | 3 | W. | 0·305 |
| 9 | 29·269 | 59·9 | 49·1 | 53·1 | 49·1 | S.W. | Cum. | 10 | S.W. | 0·022 |
| 10 | 29·626 | 59·8 | 43·0 | 49·9 | 46·6 | S.S.W. | ... | 0 | ... | 0·000 |
| 11 | 29·261 | 57·8 | 43·0 | 50·1 | 47·7 | S.E. | Cum. | 10 | S. | 0·017 |
| 12 | 29·125 | 56·8 | 42·0 | 49·2 | 46·0 | S.W. | ... | 0 | ... | 0·045 |
| 13 | 29·188 | 55·4 | 42·2 | 47·0 | 44·6 | S.S.E. | Cum. | 2 | S.S.E. | 0·348 |
| 14 | 28·753 | 52·8 | 43·7 | 49·1 | 44·1 | S.S.W. | ... | 0 | ... | 0·240 |
| 15 | 29·163 | 53·5 | 44·0 | 44·0 | 43·6 | S. | Nim. | 10 | S. | 0·224 |
| 16 | 29·089 | 50·2 | 38·0 | 49·3 | 47·9 | S.E. | Cum. | 10 | S. | 0·070 |
| 17 | 29·365 | 54·8 | 43·4 | 48·1 | 45·4 | W. | Cum. | 8 | W. | 0·000 |
| 18 | 29·770 | 54·8 | 35·0 | 44·0 | 43·1 | W. | ... | 0 | .. | 0·085 |
| 19 | 29·131 | 55·0 | 43·0 | 47·8 | 46·0 | W.S.W. | Cum. | 9 | W.S.W. | 0·000 |
| 20 | 29·237 | 51·7 | 35·4 | 44·2 | 42·7 | S. | ... | 0 | ... | 0·000 |
| 21 | 28·951 | 53·5 | 43·8 | 47·9 | 45·8 | E. | Cum. | 10 | S.E. | 0·000 |
| 22 | 28·971 | 53·5 | 42·4 | 46·6 | 44·8 | S. | Cum. | 10 | S. | 0·000 |
| 23 | 29·226 | 50·8 | 34·5 | 35·0 | 34·9 | S.W. | Cir. | 3 | S.W. | 0·000 |
| 24 | 29·601 | 49·3 | 34·1 | 42·8 | 42·7 | W. | Cir. | 1 | W. | 0·000 |
| 25 | 29·851 | 49·6 | 29·9 | 33·0 | 32·2 | W. | ... | 0 | ... | 0·010 |
| 26 | 30·088 | 47·8 | 32·0 | 47·0 | 46·0 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 27 | 30·210 | 51·2 | 46·8 | 48·2 | 44·2 | E.N.E. | Cum. | 10 | E.N.E. | 0·000 |
| 28 | 30·272 | 49·8 | 38·0 | 45·6 | 43·1 | S.E. | Cum. | 10 | S.E. | 0·000 |
| 29 | 30·392 | 50·9 | 29·0 | 32·6 | 32·0 | S. | ... | 0 | ... | 0·000 |
| 30 | 30·563 | 43·9 | 31·5 | 37·2 | 37·1 | S. | Cum. St. | 10 | S. | 0·000 |
| 31 | 30·651 | 44·1 | 30·3 | 32·9 | 32·9 | W. | ... | 0 | ... | 0·020 |

Barometer.—Highest Reading, on the 31st, = 30·651. Lowest Reading, on the 14th, = 28·753. Difference, or Monthly Range, = 1·898. Mean = 29·546.

S. R. Thermometers.—Highest Reading, on the 5th, = 61°·8. Lowest Reading, on the 29th, = 29°·0. Difference, or Monthly Range, = 32°·8. Mean of all the Highest = 54°·1. Mean of all the Lowest = 41°·0. Difference, or Mean Daily Range, = 13°·1. Mean Temperature of Month = 47°·5.

Hygrometer.—Mean of Dry Bulb = 46°·4. Mean of Wet Bulb = 44°·6.

Rainfall.—Number of Days on which Rain fell = 18. Amount of Fall, in inches, = 1·594.

A. D. RICHARDSON,
*Observer.*

On Temperature and Vegetation in the Royal Botanic Garden, Glasgow, during July, August, September, and October. By Robert Bullen, Curator of the Garden.

JULY.

This was the driest summer month experienced here since July 1885, but the temperature was much higher this month. The readings on the shaded thermometer varied during the month from 63° to 76°, and on that in the sun from 75° to 101°. The lowest night temperature was 44° and the highest 56°. Dull mornings were frequent, but generally followed by bright days; altogether, a bright sunny month. Trees, shrubs, and various crops suffered much by lack of moisture; numerous pansies, &c., died out in the open borders, but the various Californian annuals and the usual assortment of bedding-out plants were very effective, the bright weeks having brought out the natural brilliancy of their flowers. The leaves had a parched appearance.

AUGUST.

In striking contrast to last month, this was mostly cloudy and wet, the latter part unusually so, and the rains were often so heavy as to greatly discount the previous harvest prospects. At this time the prospect was further darkened by the rapid development of the potato-blight in many districts of the country, the meteorological conditions being highly favourable. Occasional bright days were recorded, and bright sunshine, but generally of short duration.

The highest reading of the sun thermometer was 90° on the 18th, but frequently the reading was below 80°. The temperature in the shade was also low for the month. Half-hardy plants made good growth and bloomed well until the stormy night of the 25th, which gave them a very tattered appearance.

SEPTEMBER.

This was a rainy, stormy month; probably one of the viest known in meteorological history. The storms and floods were most injurious to garden and farm crops of all descriptions, and over a large part of the country. In a few districts the harvest was fairly well gathered, but mostly the reverse was the case, and the potato crop a comparative failure.

Owing to the continued wet weather and immunity from frost, many hardy shrubs, both deciduous and evergreen, were still growing at the end of the month.

*Rhododendron ponticum* and its progeny mostly made a second growth. All the tender and some of the so-called hardy annuals died an early death from cold and damp.

## OCTOBER.

A chilly, wet, and comparatively sunless month. The fine days recorded as such from beginning to end only count one week, the remainder being very coarse. Floods and storms were frequent and severely felt; farm and garden land suffered much from the immense access of water, apart from the crops that were either in or on the ground; it will make winter tillage in heavy land difficult. The only vegetation which has derived benefit by the deluge are those trees whose roots run deep. Grass continued to grow at the end of the month, and the fall of the leaf is this season much later than is usual here. A storm of great severity was experienced on the night of the 13th, leaving behind it much disaster. The day temperature was nearly normal, but the night temperature fell rapidly after the 22nd; the lowest reading was 6°, on the night of the 24th. Total frost 17°, and thrice at freezing point.

## MEETING OF THE SOCIETY,

Thursday, December 10, 1891.

Dr Cleghorn, Vice-President, in the Chair.

Andrew Semple, M.D., F.R.C.S.E., was elected and admitted Resident Fellow of the Society.

The death of Dom Pedro II., Ex-Emperor of Brazil, and Honorary Fellow of the Society, was announced.

The death of Dr Hermann Hoffman, Professor of Botany in the University and Director of the Botanic Garden, Giessen, a Corresponding Member of the Society, was announced.

The Treasurer submitted the following Statement of Accounts for Session 1890–91:—

Receipts.

| | | | |
|---|---|---|---|
| Annual Subscriptions, 1890–91, 76 at 15s., | £57 | 0 | 0 |
| Do. do., 1889–90, 1 do. | 0 | 15 | 0 |
| Compositions for Life Membership, | 39 | 18 | 0 |
| Transactions sold, | 14 | 4 | 9 |
| Interest received, | 0 | 14 | 10 |
| Subscriptions to Illustration Fund, | 2 | 0 | 0 |
| Receipts, | £114 | 12 | 7 |

Payments.

| | | | |
|---|---|---|---|
| Printing Transactions, Billets, &c., | £68 | 13 | 6 |
| Lithographing Plate i., and Engraving Woodcuts, | 4 | 1 | 3 |
| Assistant Secretary's Salary, | 15 | 0 | 0 |
| Rooms for Meetings, and Tea, | 6 | 2 | 0 |
| Commission paid to Collector, | 1 | 15 | 2 |
| Postages, Carriages, &c., | 12 | 6 | 11 |
| Sundries, | 0 | 13 | 0 |
| Payments, | £108 | 11 | 10 |
| Balance of Receipts, | 6 | 0 | 9 |
| | £114 | 12 | 7 |

Issued December 1891.

STATE OF FUNDS.

| | | |
|---|---|---|
| Amount of Funds at close of Session 1889–90, | £63 13 5 | |
| Increase during Session 1890–91, . . . | 6 0 9 | |
| | | £69 14 2 |
| Being :—Sum on Deposit Receipt with Union Bank of Scotland, . . . | £60 0 0 | |
| Sum on Current Account with do. . | 9 14 2 | |
| | | 69 14 2 |

I have compared the above with the Accounts and Vouchers, and find it correct.

T. B. SPRAGUE.

4th Dec. 1891.

The following contribution to the Illustration Fund was announced :—

William Sanderson, £1 : 1 : 0.

Presents to the Library, Museum, and Herbarium at the Royal Botanic Garden were announced.

The CURATOR exhibited a flowering branch of *Posoqueria multiflora* from the Royal Botanic Garden.

The following Papers were read :—

EXCURSION OF THE SCOTTISH ALPINE BOTANICAL CLUB TO TYNDRUM IN 1891. By WILLIAM CRAIG, M.D., F.R.S.E., F.R.C.S. Ed., Secretary of the Club.

On Monday, 27th July 1891, the following members of the Scottish Alpine Botanical Club—viz., William B. Boyd, Rev. George Alison, Rev. David Paul, Dr A. P. Aitken, Mr G. H. Potts, and Dr William Craig assembled in Stewart's Royal Hotel, Tyndrum, Perthshire, for a few days' botanising. They were most comfortably entertained in the hotel, and the charges were very moderate.

Tuesday, 28th July.—This morning, after an early breakfast, the party drove in a waggonette about 8 miles down the valley of the Lochy on the way towards Dalmally, to a point near the foot of Beinn Laoigh. We ascended this mountain from its west side, and were soon at the rocks. The day was fine, and during our drive down the valley of the Lochy we saw two golden eagles.

We did not go to the top of the mountain, but confined our examination to the rocks on the west and north of the mountain. These rocks are very rich in alpine plants. We observed most of the common alpine plants, and amongst others, gathered *Dryas octopetala*, L.; *Saxifraga aizoides*, L.; *S. hypnoides*, L.; *S. nivalis*, L.; *S. oppositifolia*, L.; *S. stellaris*, L.; *Saussurea alpina*, DC.; *Bartsia alpina*, L.; in great abundance. *Juncus castaneus*, L.; *J. trifidus*, L.; *J. triglumis*, L.; *Carex atrata*, L.; *C. capillaris*, L.; *C. pauciflora*, Lightf.; *C. pulicaris*, L.; *C. pulla*, Good.; *C. rariflora*, Sm.; *C. rigida*, Good.; *Cystopteris montana*, Link., was seen in several ravines in great profusion.

In the evening we met our conveyance and returned to the hotel in good time for dinner, having enjoyed much our first day's excursion.

Wednesday, 29th July.—To-day we resolved to visit the eastern portion of Beinn Laoigh. We walked all the way from Tyndrum, going by Coninish, and reached the rocks immediately to the west of the Great Corrie. On the way up to the rocks we picked *Kobresia caricina*, Willd.; we did not go into the Great Corrie, but examined the rocks to the west of it. We saw most of the plants seen on the previous day, and again saw the *Cystopteris montana* in great profusion and beauty. To-day Mr Boyd gathered some good varieties of *Asplenium viride*, three of which he proposes to name:—1. *A. viride*, var. *bifidum*. This plant has all the fronds bifid. 2. *A. viride*, var. *truncatum*, and 3. *A. viride*, var. *convolutum*. Mr Boyd in a letter says, "If they keep as they are at present, they will be very distinct."

Rain came on in the afternoon, which somewhat spoiled our excursion and prevented us from going to the summit of the mountain. We returned to the hotel by way of Coninish. It rained the most of the way home, but this was the only rain we experienced during this excursion.

Thursday, 30th July.—We resolved to-day to examine some of the places near Tyndrum. Accordingly we first examined the rocks in Crom Allt, a small burn which comes down from Beinn Odhar. The burn forms a beautiful ravine, in which were many sub-alpine plants and some good mosses, but none deserving any special notice.

We afterwards visited Lochan Bhe, a small loch to the north-west of Tyndrum, and from which the Lochy takes its rise. It is situated in Argyleshire, and is 822 feet above sea-level. In this loch we saw some good aquatic plants, such as *Lobelia Dortmanna*, L.; *Sparganium natans*, L.; and *Isoetes lacustris*, L. We gathered in considerable quantity a grass-like plant, growing entirely under water, and at a considerable distance from the edge of the loch, which we were unable to identify. Living specimens were obtained, and the plant is now being cultivated in the Royal Botanic Garden. The plant has been submitted to various authorities, including Mr Bennett of Croydon, and there appears to be a general consensus of opinion that the plant is *Scirpus fluitans*, L. I asked Dr John H. Wilson to examine the plant microscopically, and he writes to me saying "further microscopic examination has convinced me that your Tyndrum plant is *Scirpus fluitans*." There was neither flower nor fruit on any of the specimens gathered. The leaves were long, linear, and grass-like, and the plant presented somewhat the appearance of having become viviparous, producing new plants instead of flowers. I sincerely hope the plant will produce flowers in the Royal Botanic Garden, and thus establish beyond the possibility of a doubt the identity of the species. We could see no vestige of *Scirpus fluitans* growing around the edge of the loch, and certainly if it be *S. fluitans* it is a very remarkable variety. Hooker gives the length of the leaves of *S. fluitans* as 1 to 2 inches, and Bentham as ½ to 2 inches. The leaves on our plants were very much longer. *Scirpus fluitans* is not a common plant, and our plant was abundant in the loch. Babington, in his Manual, mentions under *Scirpus fluitans* "stem rooting from the lower joinings and spreading to a great extent in a zigzag manner." This may to a certain extent explain one of the peculiarities of our plant. I hope that a further search will be made in Lochan Bhe for this plant. In many respects this was not only, the find of the day, but was the best plant gathered during this excursion.

Friday, 31st July.—To-day we resolved to visit the Corrie in Cruach Ardran, a mountain 3428 feet high, and situated south-west of Ben More. We took the train from Tyndrum to Crianlarich, from which the mountain is easily ascended. The day was fine, and we had a pleasant excursion. The best rocks in the Corrie are on the right hand as we ascend the burn. On these rocks we saw many of the common alpine plants, including *Draba incana*, L.; and *Hymenophyllum unilaterale*, Willd. We ascended to the summit by the south ridge, and on the ridge saw *Potentilla Sibbaldi*, Hall. f.; *Silene acaulis*, L.; *Gnaphalium supinum*, L.; &c. From the summit we obtained a splendid view: we saw Loch Voil and Loch Lomond, and had a good view of the surrounding mountains. On the rocks at the summit we gathered many good plants, including *Saxifraga nivalis*, L.

By far the best botanising ground on this mountain is among the debris in the ravine leading from the summit north-east towards Am Binnein. On this portion of the mountain we found such plants as *Cerastium alpinum*, L.; *Cochlearia alpina*, Wats.; *Armeria vulgaris*, Willd.; *Epilobium alpinum*, L.; *Silene acaulis*, L.; *Saxifraga nivalis*, L.; and other species.

On returning to Crianlarich we learned that the train was nearly two hours late. We therefore drove to Tyndrum in a waggonette, and reached the hotel in good time for dinner, after a very pleasant though not a very productive excursion, but an excursion to a mountain which was new ground to the Club, and one about which we previously knew nothing.

This may be said to have ended our excursion, for on Saturday the meetings of the Club were brought to a close, and all the members returned home except Mr Potts, who remained behind for a few days' fishing.

Appended is a list of the principal plants collected during our four days' excursion to Tyndrum:—

Thalictrum alpinum, L.; Ranunculaceæ.
Trollius europæus, L.; ,,
Arabis petræa, Lamk.; Cruciferæ.
Draba incana, L.; ,,
Cochlearia alpina, Wats.; ,,
Silene acaulis, L.; Caryophylleæ.
Cerastium alpinum, L.; ,,
Arenaria Cherleri, Benth.; ,,
Rubus Chamæmorus, L.; Rosaceæ.
,, saxatilis, L.; ,,
Dryas octopetala, L.; ,,
Potentilla Sibbaldi, Hall. f.; ,,
Alchemilla alpina, L.; ,,
Saxifraga oppositifolia, L.; Saxifrageæ.
,, nivalis, L.; ,,
,, stellaris, L.; ,,
,, aizoides, L.; ,,
,, hypnoides. L.; ,,
Drosera anglica, Huds.; Droseraceæ.
Epilobium alpinum, L.; Onagrarieæ.
Adoxa Moschatellina, L.; Caprifoliaceæ.
Galium boreale, L.; Rubiaceæ.
Gnaphalium supinum, L.; Compositæ.
Saussurea alpina, DC.; ,,
Cnicus heterophyllus, Willd.; ,,
Lobelia Dortmanna, L.; Campanulaceæ.
Vaccinium uliginosum, L.; Ericaceæ.
,, Vittis-Idæa, L.; ,,
Pyrola rotundifolia, L.; ,,
Armeria vulgaris, Willd.; Plumbagineæ.
Lysimachia Nummularia, L.; Primulaceæ.
Bartsia alpina, L.; Scrophularineæ.
Oxyria digyna, Hill.; Polygonaceæ.
Salix herbacea, L.; Salicineæ.
Habenaria viridis, Br.; Orchideæ.
Tofieldia palustris, Huds.; Liliaceæ.
Juncus triglumis, L.; Junceæ.

Juncus castaneus, L.; Junceæ.
,, trifidus, L.; ,,
Luzula spicata, DC.; ,,
Sparganium natans, L.; Typhaceæ.
Kobresia caricina, Willd.; Cyperaceæ.
Carex pauciflora, Lightf.; ,,
,, pulicaris, L.; ,,
,, atrata, L.; ,,
,, rigida, Good.; ,,
,, rariflora, Sm.; ,,
,, capillaris, L.; ,,
,, pulla, Good.; ,,
Poa glauca, Sm.; Gramineæ.
Hymenophyllum unilaterale, Willd.; Filices.
Asplenium Ruta-muraria, L.; Filices.
Asplenium Trichomanes, L.; Filices.
,, viride, Huds.; ,,
,, Adiantum-nigrum, L.; ,,
Cystopteris montana, Link.; ,,
Aspidium Lonchitis, Sw.; ,,
,, aculeatum, Sw.; ,,
Nephrodium Oreopteris, Desv.; ,,
Polypodium alpestre, Hoppe; ,,
Lycopodium alpinum, L.; Lycopodiaceæ.
Lycopodium Selago, L.; Lycopodiaceæ.
Isoetes lacustris, L.; Selaginellaceæ.

To this list I may add

Scirpus fluitans, L., var.

The Scottish Alpine Botanical Club was founded in 1870, twenty-one years ago, so we have now reached our majority—and during these twenty-one years we have made annual excursions, and with three exceptions, these excursions have been to the Highlands of Scotland. The three exceptions being—to Teesdale and Kirkby Lonsdale in England in 1884; to the Hardanger District of Norway in 1887; and to Connemara in Ireland in 1890.

These annual excursions have afforded much happiness and pleasant intercourse to the members of the Club, and in addition, have contributed not a little to our knowledge of the flora of Scotland. Among the most notable discoveries made by the Club during these excursions may be mentioned the discovery of *Gentiana nivalis*, L., in Chamacreag, by Professor Bayley Balfour on 3d October 1872; the discovery of *Carex frigida* (Allioni), a plant new to the British Isles, in Corrie Ceann-mor, and of *Salix Sadleri* (Syme), a plant new to science, both plants being discovered in the same Corrie by the late Mr John Sadler on 7th August 1874. On 31st July 1880. the Club discovered a new station for *Thlaspi alpestre*, L., in Glen Taitneach, near Spittal of Glen Shee. It is probable that it was during the excursion of the Club to Braemar in 1883 that Mr Boyd gathered that remarkable *Sagina* which bears his name. On 4th August 1885 I gathered on Ben Laoigh three plants of *Aspidium Lonchitis* with every frond crested. During our excursion to Glen Spean in 1886 Mr Boyd discovered a new station for that rarest of Scottish plants *Saxifraga cæspitosa*, L., and which I believe to be the only known station for this plant in this country. During the same excursion we discovered two new stations for *Saxifraga rivularis*, L., and one for

*Luzula arcuata*, Swartz. And during our excursion to Connemara, Dr Stuart discovered the heath which bears his name, a variety never previously described in so far as known to the members of the Club. All these were original discoveries, and deserve a permanent place in the records of Botanical Science.

In conclusion, I think it right to mention that at the business meeting of the Club reference was made to the great loss the Club had sustained since its previous meeting by the death of Mr Archibald Gibson, one of the original members of the Club. Mr Gibson had on several occasions granted privileges to the Club, which in his official capacity as Secretary to the Caledonian Railway he was enabled to do. He was, moreover, a man of a most genial disposition, and was universally beloved by all who knew him. His death is a great loss to the Club, and has left a blank which it will be difficult to fill.

The roots of Grasses in relation to their upper growth. By Andrew P. Aitken, D.Sc., F.R.S.E., Professor of Chemistry, Royal (Dick) Veterinary College, Edinburgh.

(With Plates II. and III.)

During recent years, when the agriculture of this country has been passing through a period of great depression, the minds of farmers have been much exercised in endeavouring to discover how they can best utilise the resources of their soil, so as to contend successfully against the greatly increased foreign competition to which they are now subjected. One of the chief directions in which it has been found possible to make a great and safe advance is in the improvement of grass land. As the result of many experiments and observations, it was found that many of the grasses grown on meadow land were of very inferior quality, that much that farmers included under the term grass was simply weeds, and that while many of these were nature-planted, not a few were imported in the seeds sown upon the farm. Farmers are now becoming educated in these matters, and they are now demanding and they are also able to obtain grass seeds fairly pure and true to name. A good deal has been done by way of determining by means of analysis what are the species of grass that are most nutritious, and experiments are now in progress to discover what are the best proportions in which various seeds should be sown so as most completely to occupy the ground and leave least room for weeds taking possession of the soil. The management and manurial treatment of grass so as to favour the best species and discourage others is also receiving attention; and inasmuch as the answers to these questions will vary according to the nature of the soil and climate, the purpose for which the grass is grown, the number of years it is to be allowed to lie, and many other considerations, it is evident that the subject of grass cultivation is a very wide one, and only to a very limited extent appropriate for discussion in this Society.

It seemed to me an important thing, from an agricultural point of view, to study the rooting of grasses more carefully than has been the custom hitherto, and I began an experiment the summer before last with a simple object in view, viz., to discover what proportion the underground structure bore to the overground structure of the more important grasses, to see what was the special characters of their roots, and, further, to see what part of the soil the various species utilised in their search for nourishment.

These questions have an important bearing upon agricultural practice, for grasses are grown not only for the sake of the food contained in their leaves and stems, but also for the sake of the manurial value of their roots. In some cases it is mainly for the sake of the amelioration of the soil that land is laid down in grass, to "rest" as it is called. After it has so rested for some years it is once more put under the plough, and the accumulation of organic matter due to the growth of grass roots provides suitable soil and nourishment for the cereal crops which follow. Accordingly it is of importance to know what are the grasses which make the greatest amount of root growth in proportion to their amount of leafage. On the other hand, where a soil is thin and a hay crop is wanted, it is of service to know what are the species of grass which yield the largest crop of hay with the smallest demand for soil space.

Another important object to be attained by a more thorough knowledge of the rooting of grasses is the more complete utilisation of all the available area of the soil. It is not unusual to find land lying in grass where only the upper layer of the soil is charged with roots to any notable extent, while the lower layers are lying idle for want of the presence of those grasses which send their roots down into the lower soil and subsoil. The farmer will probably be heard complaining that his land is too dear, and yet he may be found utilising only the upper half of it. By the selection in due proportion of grass seeds of different rooting tendencies, it is natural to suppose that the capabilities of grass land might be greatly increased. It was such considerations that led me to make the experiment I have to bring before your notice.

There are some difficulties in the way of making such an experiment, but the chief one is that of collecting the grass roots in such a way as to lose nothing—not even the smallest hairs. To get over that difficulty, I had a number of pots made of zinc, like the one I now exhibit. It is 2 feet deep, with a superficial soil area of 6 inches square. One side of the box is made movable, so that it can be taken off and put on at pleasure. The pots or rather boxes were filled almost to the top with good farm soil made thoroughly homogeneous and well shaken down, and between the movable side and the soil there was placed a sheet of glass to enable me to take off the side without disturbing the soil, and this I did in the hope that I might be able to see the roots and watch their progress. The mass of roots which one sees sometimes when repotting plants led me to expect that the grass roots might be in part visible, but in this I was entirely disappointed—there was scarcely a trace of a root to be seen at any time during the period of growth. The zinc boxes were all sunk in sawdust in a large square wooden box which was turned every morning one quarter round, so as to expose all the pots equally to the light, &c., and give them all an equal chance.

The seeds were sown in June 1889, and the crop was cut and the roots were taken out in end of June 1890, so that the quantities of vegetable matter produced represent only the first year's growth.

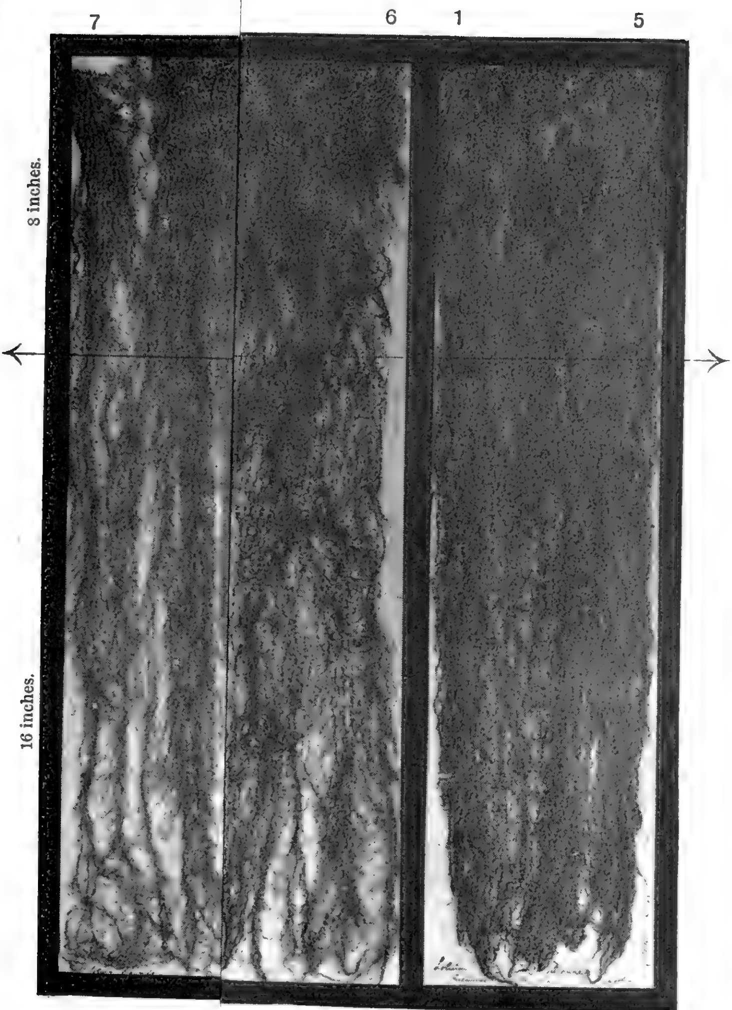
In taking the plants out of the earth each box was laid on its back, the movable side and the glass below it taken away, and the whole was immersed in water in a large sink and placed on a wire grating, which was supported some inches above the bottom of the sink.

On this grating the block of earth was carefully placed by canting the box slowly over on its face, and the particles of earth gradually fell away from the roots, and passed through the grating, leaving the roots almost *in situ* and quite uninjured. The roots were removed to another sink full of clean water to get rid of their last traces of soil, and then floated out upon zinc plates 6 inches broad, in the same way as sea-weeds are managed, and there they were allowed to dry. I have since transferred them to white paper, where they are better seen, and as you see I have gummed them down. Before doing so I cut the roots away from the stubbles, which were weighed separately, and the roots also were cut at a depth of 8 inches from the stubbles, and the two portions of root, namely the upper 8 inches and the lower 16 inches, were separately weighed. All these portions, the grass, the stubble, and the two sections of roots, were weighed in an air-dry condition some months after their removal from the boxes, and the actual weighings of the produce from a block of soil 6 inches square and 2 feet deep, viz. half a cubic foot in content, are given in the adjoining table.

TABLE I.—Weight of Produce of Grasses in Grammes.

| | Upper Growth. | | Root. | | Total. | |
|---|---|---|---|---|---|---|
| | Hay. | Stubble. | Upper Third 8 inches. | Lower Two-Thirds 16 inches. | Upper Growth. | Roots. |
| 1. Lolium perenne, L. (28 lb. per bushel), (Perennial Rye Grass), . . . | 24·15 | 4·70 | 3·96 | 4·26 | 28·85 | 8·22 |
| 2. Festuca elatior, Auct. (Tall Fescue), . | 20·85 | 6·92 | 4·60 | 2·60 | 27·77 | 7·20 |
| 3. Avena flavescens, L. (Golden Oat Grass), . | 15·50 | 3·40 | 4·95 | 1·67 | 18·90 | 6·62 |
| 4. Dactylis glomerata, L. (Cock's Foot), . | 13·75 | 16·71 | 4·65 | 1·45 | 30·46 | 6·10 |
| 5. Alopecurus pratensis, L. (Meadow Fox Tail), | 11·75 | 2·54 | 3·87 | 1·62 | 14·29 | 5·49 |
| 6. Festuca pratensis, Huds. (Meadow Fescue), | 10·85 | 4·68 | 3·07 | 2·05 | 15·53 | 5·12 |
| 7. Lolium perenne, L. (22 lb. per bushel), . | 10·75 | 6·99 | 2·60 | 1·40 | 12·72 | 4·00 |
| 8. Cynosurus cristatus, L. (Dog's Tail), . | 12·00 | 6·18 | 3·20 | 0·71 | 18·18 | 3·91 |
| 9. Phleum pratense, L. (Timothy), . . | 11·70 | 4·70 | 1·90 | 0·82 | 16·40 | 2·72 |
| 10. Poa pratensis, L. (Smooth Meadow Grass), | 14·45 | 5·20 | 1·84 | 0·79 | 19·65 | 2·63 |
| 11. Poa trivialis, L. (Rough ,, ,, ), | 19·50 | 4·96 | 2·30 | 0·31 | 24·46 | 2·61 |
| 12. Poa nemoralis, L. (Wood. ,, ,, ), | 13·25 | 2·50 | 1·80 | 0·27 | 15·75 | 2·07 |
| 13. Anthoxanthum odoratum, L. (Sweet Vernal Grass), . . . . . . . | 12·90 | 1·47 | 0·92 | 0·19 | 14·37 | 1·11 |
| 14. Festuca ovina, L. (Sheep's Fescue), . . | 3·65 | 1·10 | 0·70 | 0·05 | 4·75 | 0·75 |

The grasses are here arranged in order according to the weight of root material they produced.



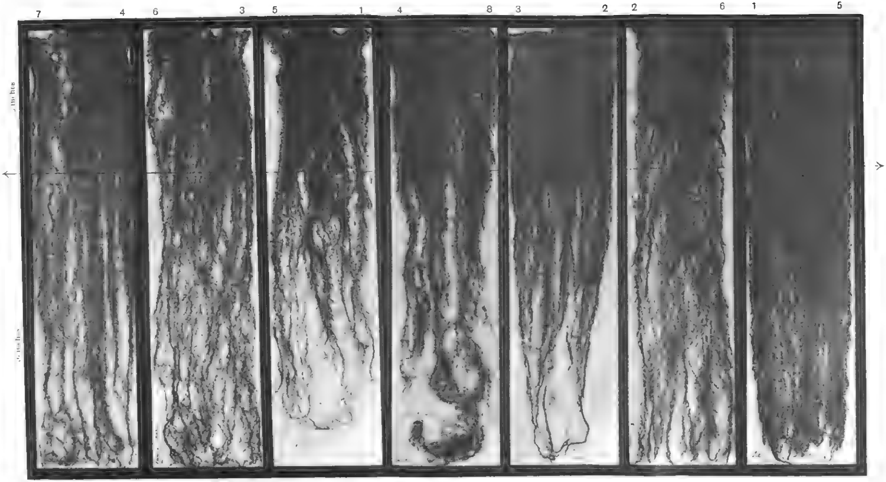

Lolium perenn
(22 lb. per bushe

estuca elatior.

Lolium perenne
(28 lb. per bushel).

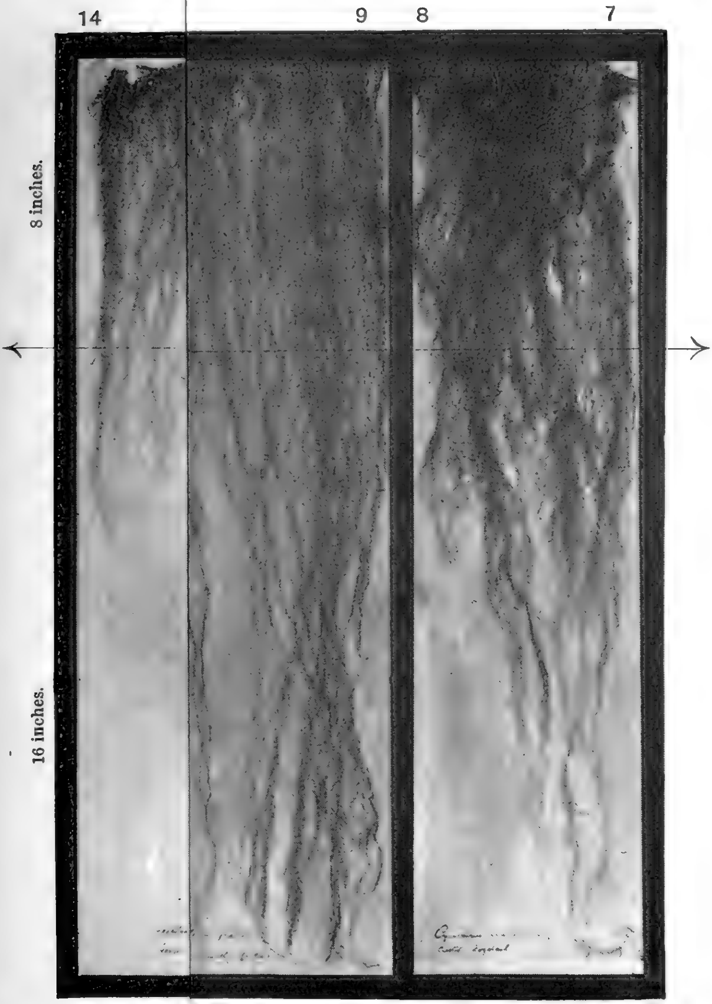
eft with Table I.

ROOTS OF GRASSES—ONE YEAR'S GROWTH.




Lolium perenne (22 lb per bushel) — Festuca pratensis. — Alopecurus pratensis. — Dactylis glomerata. — Avena flavescens. — Festuca elatior — Lolium perenne (28 lb per bushel).

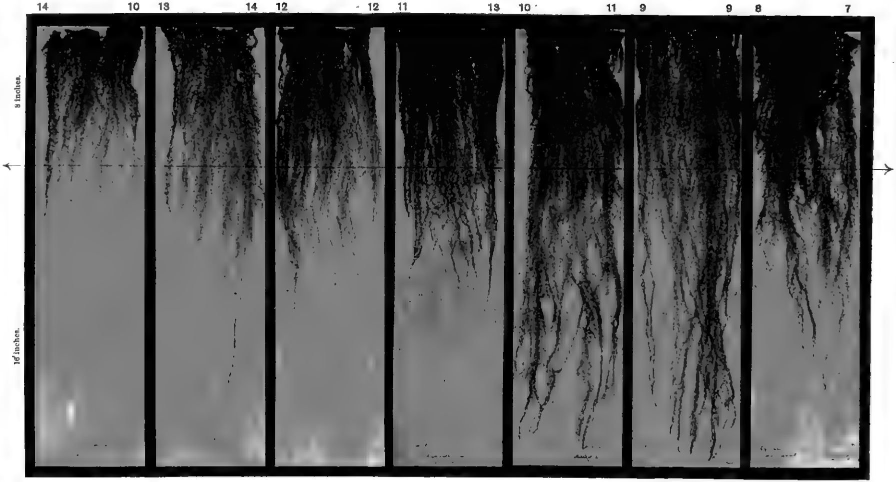
The numbers at the top of each specimen correspond with those on the Tables—those on the right with Table II, those on the left with Table I




Festuca Phleum pratense. Cynosurus cristatus

e left with Table I.

ROOTS OF GRASSES—ONE YEAR'S GROWTH.




Festuca ovina. Anthoxanthum odoratum. Poa nemoralis. Poa trivialis. Poa pratensis. Phleum pratense. Cynosurus cristatus

The numbers at the top of each specimen correspond with those on the Tables—those on the right with Table II, those on the left with Table I

It is not to be supposed that these figures represent accurately the relative weights of produce which the respective grasses may be expected always to yield, for, as experience abundantly shows, the vigour of a species of grass depends in the first place on the goodness of the seed, for weak parents produce weak offspring, and also on the nature of the soil and climate and other circumstances. These grasses were grown in a greenhouse attached to my laboratory, in light loamy soil, and the seed was the best procurable that year, while the quantity sown was such as to sufficiently occupy the surface area of 36 square inches.

Upon the whole, I am of opinion that the quantities of product are fairly representative of what the respective grasses may, under favourable circumstances, be expected to grow in one year.

As might be expected, the perennial rye-grass of the best quality, 28 lb. per bushel, tops the list in quantity both of leaf and root, but there is another specimen of root from rye-grass of 22 lb. per bushel, and it is instructive to notice how great is the difference between this fine sample of rye-grass whose seed weighed 28 lb. per bushel, and the inferior sample whose seed weighed only 22 lb. per bushel, accentuating the great importance of selecting the best seed, of the false economy of endeavouring to make a saving by purchasing seed of inferior quality. Next comes the tall fescue, which approaches it very nearly. It is a grass which is not very well known to farmers, but it is evidently one which they ought to value very highly.

The golden oat-grass has produced the most unexpected result, for it is usually regarded as one of the feeble grasses, although known to be a good pasture grass. It is evident from this experiment that it deserves a higher place in the esteem of farmers than has been hitherto accorded to it, and that it may well take a place among the seeds of grass that is intended to lie even for one year.

Cocksfoot, foxtail, and timothy, which are the great bulky natural grasses of the farm, take a subordinate place in the table, the last named more especially in regard to the quantity of roots produced; but it is necessary to remember that these grasses do not make much growth during the first year, but go on steadily improving for several years.

The poas are seen to be poor rooting grasses. But it is to the proportion between the upper and under growth that I wish chiefly to direct your attention.

TABLE II.—Proportion of Grass and Roots per cent.

| | Upper Growth. | | Root. | | Total. | |
|---|---|---|---|---|---|---|
| | Hay. | Stubble. | Upper Third. | Lower Two-Thirds. | Grass. | Root. |
| 1. Alopecurus pratensis, | 59·4 | 12·8 | 19·6 | 8·2 | 72·2 | 27·8 |
| 2. Avena flavescens, | 60·8 | 13·3 | 19·4 | 6·5 | 74·1 | 25·9 |
| 3. Festuca pratensis, | 52·5 | 22·7 | 14·8 | 10·0 | 75·2 | 24·8 |
| 4. Lolium perenne (22 lb. per bushel), | 64·3 | 11·8 | 15·6 | 8·3 | 76·1 | 23·9 |
| 5. Lolium perenne (28 lb. per bushel), | 65·1 | 12·7 | 10·7 | 11·5 | 77·8 | 22·2 |
| 6. Festuca elatior, | 59·7 | 19·8 | 13·2 | 7·3 | 79·5 | 20·5 |
| 7. Cynosurus cristatus, | 54·3 | 28·0 | 14·5 | 3·2 | 82·3 | 17·7 |
| 8. Dactylis glomerata, | 37·6 | 45·7 | 12·7 | 4·0 | 83·3 | 16·7 |
| 9. Phleum pratense, | 61·2 | 24·6 | 9·9 | 4·3 | 85·8 | 14·2 |
| 10. Festuca ovina, | 66·4 | 20·0 | 12·7 | 0·9 | 86·4 | 13·6 |
| 11. Poa pratensis, | 64·9 | 23·3 | 8·2 | 3·6 | 88·2 | 11·8 |
| 12. Poa nemoralis, | 74·4 | 14·0 | 10·1 | 1·5 | 88·4 | 11·6 |
| 13. Poa trivialis, | 72·1 | 18·3 | 8·5 | 1·1 | 90·4 | 9·6 |
| 14. Anthoxanthum odoratum, | 83·4 | 9·5 | 5·9 | 1·2 | 92·9 | 7·1 |

That is a character less under the influence of external or accidental circumstances. The bulk of the crop of grass may be large or small, according to circumstances; but it may be presumed that the relative proportion of that which is above and below ground will be pretty constant, inasmuch as that is a circumstance depending chiefly on the nature and habit of the plant.

If I am right in that assumption, then the results of this experiment (as shown in Table II.) convey information of considerable value to agriculturists, for it shows that the foxtail (*Alopecurus pratensis*), the golden oat-grass (*Avena flavescens*), and the common meadow fescue (*Festuca pratensis*), are even better than rye-grass in respect of the proportion of root matter which they contribute to the soil after one year's growth. Of these three grasses the first is a much prized early grass, the second is apt to be overlooked, and the third is regarded with disfavour by some on account of the hardness of its leaf.

The poas, which are a much esteemed class of grasses, are seen to be among the least valuable of the grasses in so far as rooting power is concerned. As to the sweet vernal grass (*Anthoxanthum odoratum*), it is seen to be the feeblest rooter among the grasses.

The depth to which the roots penetrate in search of food is fairly well shown by the two columns indicating the amounts of root matter above and below the 8-inch limit.

Pre-eminent among deep-rooting grasses is rye-grass, which has more than half of its roots below the 8-inch layer. This is one of the most valuable characteristics of that grass. In the short period of one year its roots are able to penetrate to the subsoil, and bring up to the surface the stores of plant food contained there, some of which would otherwise be lost to the soil.

That this is the habit of the species is seen by the fact that the two samples of rye-grass resemble each other in that respect, although differing so widely in quality.

Next in value in this respect is the meadow fescue, nearly the half of whose roots dip below 8 inches, and then the tall fescue, fully one-third of whose roots are in the lower soil and subsoil. Even the common meadow-grass (*Poa pratensis*) has more than one-fourth of its roots in the lower soil, and in that respect it is a serviceable grass, but the other poas have a very feeble hold upon the subsoil, and belong to that class of grasses which are easily injured by extremes of heat and cold.

As to the sweet vernal grass (*Anthoxanthum odoratum*), it is seen to be a merely surface grass, finding with difficulty its nourishment in that part of the soil where it is subjected to the greatest competition from its stronger rivals. Fortunately it is not a grass that it is desirable to have in a pasture except to a very limited extent—more as a flavouring ingredient than as any considerable component of the grass or hay.

The specimens of the actual roots that are before you tell their story more eloquently than the diagrams, but not so accurately, as the eye cannot do more than examine their surface. The roots are gummed on to strips of paper exactly the width of the box in which they were grown. You will see that they are there in their entirety, and as nearly *in situ* as it is possible for that which is grown in three dimensional space to be when it is flattened down into a space of two dimensions.

In conclusion, I would again remind you that these observations are made upon grass of one year old. A set of two-year-old roots would doubtless present a very different picture, and I trust I may be able to exhibit such a one by and by to the Society.

## NOTES ON THE FLORA OF THE MOFFAT DISTRICT FOR 1891.
By JOHN THORBURN JOHNSTONE, Moffat.

I. New records for the County of Dumfries gathered in this district:—

*Fumaria confusa*, Jord., July 11. Waste ground, Beattock station.

*Fumaria densiflora*, DC., Aug. 1890. Edgemoor, in Parish of Johnstone, but was named by Mr A. Bennett in 1891.

*Stellaria umbrosa*, Opiz., Aug. 22. Linn at Cleughfoot (foliage only).

*Hypericum perforatum*, var. *angustifolium*, Gaud., Aug. 12. Wamphray Glen.

*Hypericum perforatum*, var. *lineolatum*, Jord., Aug. 15. Barnhill Road.

*Medicago lupulina*, Linn., July 11. Waste ground, Beattock station, gathered by Mr James M'Andrew.

*Epilobium montanum*, Linn., var. *minus*. Black's Hope. This plant was also gathered here two seasons ago by Mr E. F. Linton.

*Hieracium gothicum*, Fr., July 26. Well Burn.

*Vaccinium uliginosum*, Linn., Aug. 29. Moffat Hills, elevation from 1800 to 2000 feet, growing on the mossy soil covering damp rocks.

*Veronica serpyllifolia*, Linn., var. *humifusa*, Dicks., July 19. Whitecoomb, elevation 2000 feet.

*Euphrasia gracilis*, Fr. Beattock Hill.

*Polygonum lapathifolium*, Linn., var. *incana*, July 4. Waste ground, Beattock station.

*Polygonum Persicaria*, Linn., sub sp. *nodosum*, Pers., var. *glandulosum*, August 5. Cornfield at Riddings Holm; name of plant determined by Mr A. Bennett, Croydon. And it is, as far as I am aware, a new record for Scotland.

*Salix triandra*, Linn., var. *Hoffmanniana* (Sm.). Annan Water.

*Salix fragilis*, Linn., var. *decipiens*, Hoffm. Barnhill Bridge.

*Salix stipularis*, Sm. Annan Water, at Oakridge side.

*Salix Smithiana*, Willd. Evan Water, at Holms Bridge.

*Salix aurita* × *phylicifolia*, Kerr.

*Salix herbacea*, Linn., var. *fruticosa*. Whitecoomb.

*Luzula multiflora*, Lej. Railway cuttings.

*Carex glauca*, Murr., var. *stictocarpa* (Sm.). Black's Hope.

*Festuca loliacea*, Huds. Waste ground at Gas Works, gathered by Mr James M'Andrew.

II. Plants which have been previously recorded for Dumfriesshire, but having hitherto no recorded habitat from this district :—

*Papaver Rhœas*, Linn. Waste ground, Beattock station.

*Sisymbrium officinale*, Scop. Waste ground near Industrial School.

*Viola arvensis*, Murr. Sandbeds and cultivated fields.

*Hypericum hirsutum*, Linn. Wamphray Glen.

*Hippuris vulgaris*, Linn. Earshaig Lakes.

*Conium maculatum*, Linn. Cornal Tower.

*Apium nodiflorum*, Reichb. Earshaig Burn.

*Polygonum amphibium*, Linn., var. *terrestre*, Leers. Waste ground, Beattock station.

*Urtica urens*, Linn. Nethermill.

*Sparganium simplex*, Huds. Earshaig Lakes.

*Sparganium minimum*, Fr. Earshaig Lakes.

*Scirpus sylvaticus*, Linn. Annan Water at Nether Murthat.

*Scirpus multicaulis*, Sm. Damp stony places on the hills.

*Scirpus setaceus*, Linn. Damp roadsides, &c.

*Carex dioica*, Linn. Frenchland Burn.

*Carex ovalis*, Good. Gallowhill, Frenchland Burn.

*Carex Oederi*, Ehrh. Hill ditches and damp places.

*Phalaris arundinacea*, Linn. Riversides.

*Alopecurus geniculatus*, Linn. Common.

*Alopecurus pratensis*, Linn. Common.

*Holcus lanatus*, Linn. Common.

*Avena pratensis*, Linn. Common.

*Avena pratensis*, Linn., var *alpina* (Sm.). Black's Hope and Hartfell.

*Cynosurus cristatus*, Linn. Common.

*Dactylis glomerata*, Linn. Common.

*Poa pratensis*, Linn. Common.

*Glyceria fluitans*, Linn. Common.

The following carices and grasses come under the above head, and were gathered by Mr M'Andrew, New Galloway, when staying at Moffat this summer:—

*Carex hirta*, Linn.; *C. paludosa*, Good.; *C. vesicaria*, Linn.; *Agrostis alba*, Linn.; *Aira caryophyllea*, Linn.; *Poa annua*, Linn.; *Festuca Myurus*, Linn.; *F. elatior*, Linn.; *Bromus giganteus*, Linn.; *B. mollis*, Linn.; *Agropyron caninum*, Beauv.

III. Plants not now found at their previous recorded stations, but which have been reconfirmed for the district:—

*Cardamine impatiens*, Linn., Aug. 22, near Kirkpatrick-Juxta Manse, where it rather curiously occurs as a wayside plant. Its former stations were at Garpel and Beld Craig Linn, but I have never come across it at these places. I also gathered this plant on the Mouse Water, near Cleghorn, on Aug. 23, 1890.

*Vicia Orobus*, DC., June 21, Beef Tub and Corehead; the previous station was the Grey Mare's Tail.

*Arctostaphylos Uva-ursi*, Spreng., Moffat Hills, Aug. 29 (foliage only). This, as far as Watson's Topographical Botany is concerned, is also a new record for Dumfriesshire, but it is given for the Moffat Hills in the Stat. Acct. Scot. for 1843.

*Salix Lapponum*, Linn., var. *arenaria* (Linn. ex p.), Whitecoomb.

IV. The following plants are already given for this district, but I have to report their occurrence in Lanarkshire (upper part of Crawford Parish), and all growing within two miles or so of the Dumfriesshire and Lanarkshire Boundary Line:—

*Helianthemum Chamæcistus*, Mill. Railway embankment past viaduct.

*Silene Cucubalus*, Willd. Railway embankment at viaduct.

*Epilobium angustifolium*, Linn. Rowan tree Grani Linn.

*Conium maculatum*, Linn. Around ruins of Crawford Castle.

*Cnicus heterophyllus*, Willd. Railway embankment Hampden's Bridge; meadows at Medlock; meadows at Watermeetings.

*Hieracium gothicum*, Fr. Small rivulet, not named on Ord. Map.

*Hieracium auratum*, Fr. Railway cutting near summit.

*Hieracium strictum*, Fr. Rowan tree Grani Linn.

*Gentiana campestris.* River embankments Medlock and Camps Water.

I have to express my indebtedness to Rev. E. F. Linton, Bournemouth, for naming the willows given in the foregoing list, and some of the other plants, and also to Mr A. Bennett, Croydon, for naming and examining the plants submitted to him.

## ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, EDINBURGH, during NOVEMBER 1891. By ROBERT LINDSAY, Curator of the Garden.

The past month of November, although somewhat changeable and unsettled, has been mild for the season. Storms of wind and rain were less frequent than usual, and no snow fell. The thermometer was at or below the freezing point on 12 mornings, indicating collectively 41° of frost for the month. The lowest readings were on the 18th, 28°; 23rd, 24°; 24th, 26°; 27th, 24°; 28th, 25°. The lowest day temperature was 38° on the 27th, and the highest 55° on the 2nd. Outdoor vegetation is, as nearly as possible, in a resting condition. Not a single plant came into flower on the Rock Garden during the month.

Readings of exposed Thermometers at the Rock Garden of the Royal Botanic Garden, Edinburgh, during November 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 34° | 44° | 48° | 16th | 30° | 31° | 46° |
| 2nd | 44 | 45 | 55 | 17th | 33 | 37 | 45 |
| 3rd | 32 | 39 | 49 | 18th | 28 | 35 | 52 |
| 4th | 42 | 45 | 49 | 19th | 34 | 44 | 47 |
| 5th | 38 | 40 | 50 | 20th | 43 | 45 | 50 |
| 6th | 40 | 43 | 49 | 21st | 32 | 37 | 46 |
| 7th | 41 | 43 | 53 | 22nd | 32 | 38 | 44 |
| 8th | 37 | 39 | 47 | 23rd | 24 | 25 | 43 |
| 9th | 35 | 40 | 50 | 24th | 26 | 35 | 43 |
| 10th | 34 | 37 | 46 | 25th | 29 | 38 | 42 |
| 11th | 35 | 42 | 48 | 26th | 32 | 38 | 42 |
| 12th | 34 | 36 | 39 | 27th | 24 | 26 | 38 |
| 13th | 35 | 46 | 50 | 28th | 25 | 35 | 45 |
| 14th | 33 | 40 | 48 | 29th | 37 | 40 | 44 |
| 15th | 35 | 45 | 48 | 30th | 29 | 35 | 47 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of November 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 30·608 | 47·0 | 32·1 | 47·0 | 47·0 | N.E. | Nim. | 10 | N.E. | 0·025 |
| 2 | 30·564 | 48·6 | 46·5 | 47·4 | 45·9 | E.N.E. | Cum. | 10 | E. | 0·000 |
| 3 | 30·475 | 51·8 | 35·3 | 40·0 | 39·8 | S.E. | Cum. | 10 | S.E. | 0·000 |
| 4 | 30·469 | 47·3 | 39·1 | 47·3 | 44·8 | S.E. | Cum. | 10 | S.E. | 0·025 |
| 5 | 30·610 | 48·0 | 40·6 | 47·2 | 46·0 | E. | Cum. | 10 | E. | 0·020 |
| 6 | 30·408 | 46·0 | 41·6 | 42·9 | 42·1 | W. | Cum. | 6 | N.W. | 0·000 |
| 7 | 30·262 | 47·4 | 42·2 | 45·0 | 41·1 | S.W. | Cum. | 4 | S.W. | 0·005 |
| 8 | 29·844 | 50·0 | 37·9 | 45·0 | 41·6 | S. | Cum. | 6 | S. | 0·030 |
| 9 | 29·246 | 46·9 | 39·0 | 42·1 | 40·3 | S.W. | Cir. | 2 | W. | 0·010 |
| 10 | 29·231 | 46·9 | 36·0 | 38·7 | 37·8 | S.W. | ... | 0 | ... | 0·190 |
| 11 | 28·569 | 44·9 | 37·1 | 44·9 | 44·0 | E. | Nim. | 10 | E. | 0·280 |
| 12 | 29·064 | 47·8 | 36·8 | 37·8 | 35·7 | S.W. | ... | 0 | ... | 0·005 |
| 13 | 29·038 | 48·4 | 37·0 | 48·3 | 46·1 | E. | Nim. | 10 | S.E. | 0·225 |
| 14 | 29·127 | 48·6 | 35·8 | 41·8 | 41·1 | S. | Cum. | 5 | S. | 0·010 |
| 15 | 29·354 | 45·9 | 39·0 | 45·5 | 44·8 | E. | Cum. | 8 | .E | 0·085 |
| 16 | 29·521 | 47·8 | 32·5 | 32·8 | 32·8 | E. | ... | 0 | ... | 0·075 |
| 17 | 29·533 | 45·1 | 32·3 | 41·2 | 40·9 | S. | Nim. | 10 | S. | 0·045 |
| 18 | 29·718 | 44·1 | 30·8 | 37·5 | 37·1 | E. | Cum. | 10 | E. | 0·324 |
| 19 | 29·528 | 52·9 | 36·8 | 46·3 | 43·9 | S.W. | ... | 0 | ... | 0·135 |
| 20 | 29·625 | 48·2 | 43·6 | 44·8 | 43·2 | W. | Cum. | 5 | W. | 0·005 |
| 21 | 29·779 | 46·9 | 35·1 | 38·1 | 37·8 | Calm. | Cum. | 9 | N.E. | 0·000 |
| 22 | 29·805 | 42·7 | 34·7 | 38·8 | 37·1 | N.W. | Cum. | 10 | N.E. | 0·000 |
| 23 | 29·753 | 41·9 | 26·0 | 27·1 | 27·0 | Calm. | Fog. | 10 | ... | 0·000 |
| 24 | 29·778 | 35·5 | 26·1 | 35·5 | 35·5 | N.W. | Cum. | 10 | W. | 0·005 |
| 25 | 29·500 | 38·9 | 31·0 | 38·9 | 37·0 | S.S.E. | Cum. | 10 | S. | 0·000 |
| 26 | 29·430 | 40·9 | 30·2 | 33·4 | 33·0 | S.W. | Cum. | 4 | S.W. | 0·000 |
| 27 | 29·699 | 38·9 | 26·0 | 27·7 | 27·2 | W. | ... | 0 | ... | 0·000 |
| 28 | 29·514 | 36·0 | 26·1 | 36·0 | 34·7 | S.E. | Cum. | 10 | S.S.E. | 0·000 |
| 29 | 29·413 | 45·1 | 35·4 | 40·0 | 38·1 | S.W. | ... | 0 | ... | 0·010 |
| 30 | 29·559 | 42·7 | 31·6 | 35·2 | 34·8 | S. | Cum. | 10 | S.W. | 0·000 |

Barometer.—Highest Reading, on the 5th, =30·610. Lowest Reading, on the 11th, =28·569. Difference, or Monthly Range, =2·041. Mean=29·701.

S. R. Thermometers.—Highest Reading, on the 19th, =52°·9. Lowest Readings, on the 23rd and 27th, =26°·0. Difference, or Monthly Range, =26°·9. Mean of all the Highest=45°·4. Mean of all the Lowest=35°·1. Difference, or Mean Daily Range, =10°·3. Mean Temperature of Month=40°·2.

Hygrometer.—Mean of Dry Bulb=40°·5. Mean of Wet Bulb=39°·4.

Rainfall.—Number of Days on which Rain fell=19. Amount of Fall, in inches, =1·504.

A. D. RICHARDSON,
*Observer.*

## On Temperature and Vegetation in the Botanic Garden, Glasgow, during November 1891. By Robert Bullen, Curator of the Garden.

This was another wet, variable, unseasonable month; much dark and foggy weather prevailed.

The maximum and minimum readings of the thermometer were both high for the season. No frost was registered until the night of the 21st, but after that, light night frosts were frequent. The lowest reading was 7° during the night of the 25th, and the total only 26°. Owing to the wet state of the ground, out-door work had to be abandoned.

## MEETING OF THE SOCIETY,

Thursday, January 14, 1892.

DR DAVID CHRISTISON, President, in the Chair.

The PRESIDENT referred in fitting terms to the death on this day of H.R.H. PRINCE ALBERT VICTOR, DUKE OF CLARENCE AND AVONDALE, and suggested that it would be an appropriate mark of respect on the part of the Society were the business of the Meeting postponed to a future date. Dr WILLIAM CRAIG formally moved that the suggestion of the President be adopted, and that the meeting of the Society be adjourned to Thursday, January 28. Mr GUSTAV MANN seconded the motion. The Society adjourned.

## ADJOURNED MEETING OF THE SOCIETY,

Thursday, January 28, 1892.

DR CLEGHORN, Vice-President, in the Chair.

The death of the Rev. WILLIAM MURRAY M'DONALD, Non-resident Fellow of the Society, and of THOMAS WALKER and CHARLES TAYLOR, Associates of the Society, were announced.

The following contribution to the Illustration Fund was announced:—

Dr David Christison, £2 0 0

Presents to the Library, Museum, and Herbarium at the Royal Botanic Garden were announced.

Mr MALCOLM DUNN, Dalkeith, exhibited specimens of the cones of cedar of Lebanon, and remarked that they



Issued April 1892

were the produce of the oldest cedars now extant in the ancient forest of Lebanon, and a sample of a quantity gathered last season, and brought to this country with the view of raising young plants from the seeds. It was found, however, on examining them after their arrival that they contained no fertile seeds, and we cannot look forward to seeing, as the result of this direct importation, any cedars which could be pointed to as the immediate descendants of those venerable and interesting trees. The sterility of the seeds in these cones may have arisen from various causes, but it is to be hoped that the ancient trees are still producing fertile seeds. The cones are very durable, and if collected before they are over-ripe, they will keep for many years in a perfect state, as is shown by a cone on the table, which I gathered at Sprotborough Hall, in South Yorkshire, in 1858, and it is still quite sound and perfect. Ever since the days of the building of the Temple at Jerusalem by King Solomon, the cedars of Lebanon have been among the most famous trees in history. In more recent times their numbers have become comparatively few in the forest of Lebanon, and there is some danger of their disappearing altogether from their native habitat at an early period if they are not more carefully protected and means devised by which they may reproduce themselves.

Since the middle of the sixteenth century many travellers have visited Mount Lebanon, and left on record the number of the cedars they met with, and the condition in which they found them. The earlier travellers state that upwards of two dozen of the ancient cedars existed about 1550, but Maundrell, who visited the forest in 1696, found only sixteen trees, which he described as being "very old and of a prodigious bulk," while he said that "others younger, and of a smaller size, are very numerous." When Sir Joseph D. Hooker visited Lebanon in 1860, he found the cedars confined to a small and comparatively level area at the head of the Kadisha Valley, at an altitude of 6000 feet, about four miles south of the summit of Mount Lebanon, and fifteen miles eastward, as the crow flies, from the Levant. Sir Joseph on his return gave a very interesting and minute account of the cedars, which appeared in the public prints, in which he said about four hundred trees, young and old, then existed. They all grew in nine irregular clumps, on a space about a quarter of a mile in diameter. The largest of the trees was over 40 feet in girth, and none of the smaller ones girthed less than 18 inches. Only seventeen trees exceeded 12 feet in girth, and of these the fifteen largest, all over 15 feet in girth, were growing in two of the clumps. No young cedars of a less size, not even two-years' seedlings, were seen. In the autumn of 1878 the cedars were visited by Captain S. P. Oliver of the Royal Artillery, who gave a very interesting account of them in the "Gardeners' Chronicle" in the following year. He was told by the guardian of the cedars that there were exactly 385 trees, large and small, the smallest of which was at least fifty years old, and no younger trees were springing up. He saw abundance of germinating seeds beneath the trees and over a considerable space beyond them where they had been scattered by the wind, but they were so severely trodden upon by thoughtless tourists, or, worse still —if that be possible!—by the all-devouring goats, that no young tree had been able to rear its head aloft within the previous half century.

Although the cedar of Lebanon is a perfectly hardy tree in these islands, there is no record of it growing in Britain till the latter half of the seventeenth century. Evelyn's "Silva," which was written in 1664, contains no mention of it, and the actual date of its introduction, or by whom it was introduced, have not been determined, and probably never will be now. A very fine old cedar, which is still in vigorous health, grows at Bretby Park, the seat of the Earl of Carnarvon, near Burton-on-Trent, in Derbyshire. It is known to have been planted in 1676, and is the oldest in Britain of which there is any authentic record, if it is not absolutely the oldest cedar in England. It is now 82 feet in height, 16 feet 2 inches in girth at 5 feet up, and has a spread of branches 85 feet in diameter. It grows on sloping ground at an altitude of about 360 feet, on a deep loamy soil, resting on an open gravelly subsoil. The stem is clean and straight, with no perceptible taper, to a height of 11 feet, where it swells out and divides into a central leader and two heavy side limbs, all rising nearly perpendicular, and with their branches forming a fine healthy, wide-spreading head. From that time onwards the cedar of Lebanon has been a favourite with planters of ornamental trees, and there are but few country-seats in England where one or more grand old specimens cannot be seen in the gardens or parks around them. In Goodwood Park, Sussex, there is perhaps the greatest number of fine old cedars in one place in England, and they form an important feature in the grounds at Syon House, Gunnersbury, and Chiswick House, in Middlesex; at Woburn Abbey, in Bedfordshire; at Blenheim, in Oxfordshire; at Warwick Castle, and at many other places of more or less renown.

So far as the history of the cedar in Scotland has been traced, the famed cedar of Lebanon, at Biel, in East Lothian, known as the "Union Cedar," is probably the oldest north of the Tweed. It is on record that it was planted in 1707 by the Lord Belhaven of that day, to commemorate the union of England and Scotland. It is a splendid specimen, with a short stem about 18 feet in girth at the smallest part, and branching at about 4 feet from the ground into a fine healthy umbrageous head. The well-known cedars at Hopetoun, in West Lothian, are stated to have been planted in 1748, and the largest now girths about 23 feet at 5 feet from the ground, with a height of upwards of 80 feet. Good specimens of healthy cedars are met with in the grounds attached to most country-seats, as far north as Ross-shire, when situated on a good soil and at a moderate altitude. A considerable number of young and old cedars are growing in the Park at Dalkeith. The oldest probably grow at Smeaton, in the lower part of the Park, and are mostly short-stemmed trees, with large branching heads. The handsomest trees with the finest stems grow in the grounds at the Conservatory, in a well-sheltered spot near the South Esk River. They have fine clean stems, from 11 to 13 feet in girth at 5 feet up, and 15 to 20 feet in length, carrying full-shaped heads, rising to a height of about 70 feet. They are about 120 years old, in vigorous health and growing fast, and occasionally bear a few cones, which have not produced fertile seed, so far as it has been tried. Younger cedars of all the varieties—*Cedrus atlantica*, *C. Deodara*, and *C. libani*,—planted about forty years ago, are thriving well, and have attained a height of about 40 feet, with stems girthing 4 feet 6 inches to 5 feet at 5 feet up, with fine healthy, well-furnished heads.

Dr AITCHISON referred to cedar trees he had seen in India, and confirmed the view that the Lebanon, Deodar, and Atlas cedar are varieties of one species.

Dr PATERSON sent for exhibition blooms of *Vanda Gowerii.*

Mr RUTHERFORD HILL exhibited a pod of the *Poinciana regia* of Madagascar, the Indian "Forest Flame" or "Gold Mohur," so called on account of its rich yellow or orange blossoms; also a herbarium specimen of *Andrographis paniculata,* an acanthaceous plant of some interest as the reputed source of "Kreat Halviva," an Indian remedy for influenza, about which there has been extensive correspondence recently in the public press. For the specimen he was indebted to Mr Thomas Stevenson, F.C.S., of Messrs Kemp & Co., Bombay, and from him he had also obtained the specimen exhibited of the dried herb as sold in the bazaars in India. The name Kreat had also been applied to *Ophelia chirata,* and there was much confusion as to the plants even in India. When Mr Stevenson sent a messenger to the bazaar for "Kreat," he in the first instance brought back *Ophelia chirata.* The plant is common in India, and possesses bitter, tonic, and mild aperient properties. A compound infusion and a compound tincture are official in the Indian Pharmacopœia, and the expressed juice of the leaves is used by the natives in bowel complaints of children.

The following Papers were read:—

## NOTES ON FERTILISATION; CHIEFLY OF BRITISH CRUCIFERÆ. By G. F. SCOTT ELLIOT, M.A., B.Sc., F.L.S.

During the summer just passed I have been occupied in forming lists of insect-visitors to plants belonging to some of the earlier orders of British plants. The names of the insects observed will be found in my "Flora of Dumfriesshire," part i., but there are certain conclusions derived from my observations which may, perhaps, be worth giving here.

There has been during recent years a tendency to minimise the importance of insects as agents in effecting fertilisation. Meehan* and also Schulz,† for instance, have tried to show that self-fertilisation is, in all cases, the regular method, and that insect-fertilisation is only of occasional assistance. Henslow‡ has, to a certain extent, supported similar views, though not, I think, accepting them in the extreme just stated.

Of course, the only way of proving or disproving dogmatic assertions of this kind is by an appeal to observation. Can any series of plants be found in which insect-visits are so rare that the above statement is strictly within the facts? If such a series can be discovered, it must surely be amongst the plants of the early "weedy" orders of Thalamifloræ. The plants studied by me this summer were almost all of this nature, and were, in fact, as many of the British species up to the end of Cruciferæ as were common in the district about Dumfries.

The flowers of the majority of these plants are small and inconspicuous; most are white or yellow in colour; and they are therefore all, as "weeds," more likely to be dependent on self-fertilisation. The modifications in their structure for insect-visits are, in almost every case, very slight and unimportant. They are, moreover, in chiefly Dipterous flowers, and it is amongst these that one is most likely to find self-fertilisation. Flies are particularly sensitive to bad weather, and are sometimes prevented by wind or rain for several days from visiting flowers. Hence the advantage of possible self-fertilisation seems obvious enough. In fact, there could not be *primâ facie* a set of plants more likely to uphold the theory of Meehan and Schulz that insect-visits are only of occasional assistance, than those in the following Table. Yet what is the result? I found insect-visits universal.

* Meehan, in American Naturalist, vols. xii., xiii., &c.

† Schulz, in Bibliotheca Botanica, Heft x. and xvii.

‡ Henslow, in Trans. Linn. Soc., 1869.

Every single species I studied, except one, was visited by insects, and, in the vast majority, the visits were numerous enough to fertilise every pod. The single exception was that of *Senebiera Coronopus*, which I could only watch for about three hours on a hopelessly wet and windy day.

The following Table shows the state of the evidence at a glance. Insect-visits are, however, very much more numerous than one would suppose from it. I could not give an exhaustive list of any single species; such a list, to be thoroughly complete, would take about six weeks of careful work on every single form. Moreover, I could not get names for a very large number of insects which I did not catch, and which are therefore not noticed.

The first and second columns in the Table give the number of species of insects observed by myself * and Müller † respectively; the third column is the sum of the first and second. The fourth column is an attempt to estimate the frequency of insect-visits. In calculating this, I tried to take into account the average life of each flower or number of days during which it is open to insect-visits, and then, by calculating the number of individual insect-visits, seen by me in a specified time, and making allowance for bad weather, to estimate how many individual insect-visits occur within a flowering period. The result is, of course, in a measure, guesswork, or a matter of opinion; but I tried to give every possible doubt to the self-fertilising side, and I think I have very much understated the probability of insect-visits. In further explanation of the Table, I understand that the number "4" means that every individual flower is visited more than once by insects during its blossoming period; the number "3" means that every individual flower is probably visited at least once; the number "2" means that half the flowers of the species are visited once by insects; the number "1" means that not half the flowers are so visited; and the number "0" would mean that no insects were noted on the plant, but, as will be seen, it does not occur in the Table at all.

* The three species on *Teesdalia* were caught by Miss Ethel Taylor, from whom I received them.

† Müller, Fertilisation of Flowers.

| Names of Plants. | Number of Species caught | | | Frequency of Visits. |
|---|---|---|---|---|
| | By me. | By Müller. | Total. | |
| Thalictrum minus, . . | 1 | 0 | 1 | ... |
| Anemone nemorosa, . . | 7 | 8 | 15 | 4 |
| Ranunculus aquatilis, . | 6 | 9 | 15 | 3 |
| ,, Flammula, . | 7 | 8 | 15 | 4 |
| ,, Ficaria, . . | 9 | 14 | 23 | 4 |
| ,, sceleratus, . | 3 | ... | 3 | 2 |
| ,, auricomus, . | 4 | 9 | 13 | 3 |
| ,, acris, / ,, repens, / ,, bulbosus, } . | 8 | 61 | 69 | 4 |
| Caltha palustris, . . | 6 | 12 | 18 | 3 |
| Trollius europaeus, . . | 5 | ... | 5 | 3 |
| Nuphar luteum, . . | 1 | 2 | 3 | 1 |
| Nymphaea alba, . . | 4 | 2 | 6 | 3 |
| Papaver dubium, . . | 5 | ... | 5 | 3 |
| Glaucium luteum, . . | 4 | ... | 4 | 2 |
| Fumaria officinalis, . . | 1 | 1 | 2 | 1 |
| Corydalis claviculata, . | 4 | ... | 4 | 3 |
| ,, lutea, . . | 1 | 1 | 2 | 2 |
| Barbarea vulgaris . . | 8 | ... | 8 | 2 |
| Nasturtium officinale, . | 21 | ... | 21 | 4 |
| ,, palustre, . | 2 | ... | 2 | 3 |
| Arabis hirsuta, . . | 5 | 6 | 11 | 3 |
| ,, Thaliana, . . | 1 | ... | 1 | 2 |
| Cardamine pratensis, . | 7 | 22 | 29 | 4 |
| ,, amara, . . | 11 | ... | 11 | 4 |
| ,, flexuosa, . . | 5 | ... | 5 | 3 |
| Sisymbrium officinale, . | 2 | 3 | 5 | 3 |
| ,, Alliaria, . | 6 | 7 | 13 | 4 |
| Brassica monensis, . . | 5 | ... | 5 | 3 |
| ,, Sinapis, . . | 12 | 9 | 21 | 4 |
| Cochlearia officinalis, . | 4 | 4 | 8 | 4 |
| Draba verna, . . . | 3 | 3 | 6 | 1 |
| Subularia aquatica, . . | 1 | 0 | 1 | 1 |
| Teesdalia nudicaulis, . . | 3 | 10 | 13 | 2 |
| Capsella Bursa-pastoris, . | 6 | 8 | 14 | 3 |
| Lepidium Smithii, . . | 5 | 0 | 5 | 2 |
| Cakile maritima, . . | 2 | 0 | 2 | 2 |
| Crambe maritima, . . | 4 | 0 | 4 | 3 |
| Raphanus maritimus, . | 4 | 0 | 4 | 3 |

Thus, excluding the anemophilous *Thalictrum*, every individual flower is visited in my opinion more than once by insects in ten cases, every flower is visited at least once in eighteen cases, half the flowers are visited in eight cases, and less than half the flowers are visited in only four cases! This is certainly sufficient to show that in these species, at any rate, the facts do not in the least support the theory of Meehan and Schulz. Henslow seems to me to have been a little hasty in taking *Nasturtium officinale* (*loc. cit.*, p. 350), *Capsella Bursa-pastoris* and *Sisymbrium Alliaria* (I have not studied *Lepidium campestre*) as typical self-fertilising Cruciferæ. *Nasturtium officinale* is more visited by insects than any other cruciferous plant known to me, and by many different species. *Sisymbrium alliaria* is much frequented by Syrphidæ, though of few distinct kinds, and insect-visits are very fairly common in the case of *Capsella Bursa-pastoris* which secretes plenty of honey. One might, indeed, ask why there are so many and such varied modifications adapted to insect-fertilisation, and why cleistogamy should not be universal if self-fertilised flowers are perfectly fertile.

In fact, the conclusion seems to me inevitable that insect-visits are chiefly relied upon in every case, and that self-fertilisation is only of occasional and additional assistance.

There are certain slight modifications even in the Cruciferæ only explicable by the advantage of insect-visits.

1. The Flowers are Collected into Corymbs or Corymb-like Heads.—This is the case in *Iberis amara*, *Teesdalia nudicaulis*, *Nasturtium officinale*, and some varieties of *Brassica campestris*. *Nasturtium officinale* is very abundantly visited probably for this reason; so also is *Teesdalia nudicaulis* (*cf.* Müller, *loc. cit.*, p. 106), in spite of its extremely small flowers; *Iberis amara* has never, so far as I know, been studied in this respect. Both in *Iberis amara* and *Teesdalia nudicaulis*, the outer petals of the most external flowers of the corymb are much longer and broader than the inner, just as one finds very commonly in Umbelliferæ.

2. Nectaries.—The nectaries seem to have been originally six in number. One is found outside each pair of long stamens, and a pair of nectaries occurs inside the insertion of each short stamen. It seems almost certain that Müller is right in considering these to be the remains of the lost stamens of the flower. Whether, however, there were originally twelve stamens, or four stamens, each with a pair of stipular appendages at the base, does not seem to me very clear. The nectaries are in some forms of almost equal importance, *e.g.*, *Cakile maritima* and *Cardamine amara;* the tendency, however, is for those at the base of the short stamen to become more developed, while those of the long stamens either disappear (*Nasturtium officinale*, *N. palustre*), or

cease to secrete honey (*Alliaria*, *Crambe*). The pollen of the short stamen is wholly devoted to cross-fertilisation by insects seeking honey, while that of the long stamens seems in part used by pollen-eating flies and in part employed in self-fertilisation, hence the minor importance of the nectaries of the long stamens is obvious enough. The nectaries of the short stamens sometimes consist of two separate peg-like processes, in other cases they are confluent with one another behind the filament, and form a single pulley-like or kidney-shaped mass (*Barbarea*, *Nasturtium officinale*, *Cardamine flexuosa*, *Lepidium Smithii*, *Cakile*, *Crambe*). In *Arabis Thaliana* and *Alliaria*, however, the whole of the tissue about the insertion of the short stamen has become nectareal, and the filament is seated on a sort of cushion of honey tissue.

3. SEPALS.—The sepals are in many Cruciferæ saccate at the base, so as to form a sort of pouch to hold the honey. The degree of this pouching seems to depend upon the development of the corresponding nectary, as has been already pointed out by Müller. Thus in *Raphanus maritimus*, *Brassica monensis*, *Cardamine flexuosa*, *C. pratensis*, and *Arabis Thaliana*, the sepals opposite the short stamens (*i.e.*, the largest, most important nectary), possess distinct pouches, while the other sepals do not. Where the nectaries are nearly equal in size, the sepals are either not pouched at all or are equally saccate (*Nasturtium palustre*, *Cardamine amara*, *Brassica Sinapis*).

In *Cakile*, *Crambe*, *Lepidium*, and other Siliculosæ, the honey is contained within the filament, and the same sort of pouching does not, so far as I know, occur.

Of course, the mere fact of the existence of a prominent swelling at the base of a long and narrow pod, must tend to produce a corresponding hollow at the base of the sepal which covers it in the bud; in fact, it seems to me that this is quite sufficient to account for the presence of the pouch, and for its usually accompanying a well-developed nectary. In the Siliculosæ, the pod being broader upwards, prevents a similar formation (as the sepaline midrib usually runs in a straight line from the broadest part of the pod to the base), but even in these forms a well-developed nectary sometimes produces a corresponding excavation in the sepal covering it. Once formed, the pouch is found of advantage as a honey-receptacle, and is retained for that purpose.

4. DEHISCENCE.—In many Cruciferæ the anthers of the longer stamens do not dehisce directly inwards, but are severally twisted through 45° each towards the nearest short stamen, so that the entrance to the more important nectary within the base of the latter is surrounded by three dehiscing anthers. This is well seen in *Nasturtium officinale*, *Alliaria*, *Brassica Sinapis*, *Lepidium Smithii*, and *Crambe maritima*. In the last-mentioned species, *Crambe maritima*, the filaments of the longer stamens are broadened and flattened out with a groove along the middle line; the filament ends at the top in two horns, of which one bears the anther, while the other is pressed against the ovary. The groove above mentioned guides an insect's proboscis to the honey. No other Crucifer except *Teesdalia nudicaulis*, which is quite abnormal (see Müller, *loc. cit.*), has so complicated an arrangement as has this species.*

5. THE LONGER AND SHORTER STAMENS DEHISCE AT DIFFERENT PERIODS IN SOME CRUCIFERÆ.—This is the case in *Cardamine pratensis*, *C. flexuosa*, *Alliaria*, and *Brassica monensis*, where the long stamens shed their pollen some time before the short stamens are ripe.

6. RELATIVE POSITION OF ANTHERS AND STIGMA.—In all the forms known to me, except *Cardamine amara* and *Subularia aquatica*, the stigma when mature is above the level of the anthers of the short stamens; these latter are therefore unable to effect self-fertilisation. On the other hand, pollen from the anthers of the long stamens may produce self-fertilisation in most Cruciferæ though it is only in *Arabis hirsuta* and *A. Thaliana* that it seemed to me inevitable.

## THE EMBRYO-SAC IN MYOSURUS MINIMUS, LINN. By GUSTAV MANN.

* Kunth in Bot. Centralblatt, 1891.

## On Temperature and Vegetation in the Royal Botanic Garden, Edinburgh, during December 1891. By Robert Lindsay, Curator of the Garden.

The month of December was, for the most part, mild and open, with a very heavy rainfall. The thermometer was at or below the freezing point on eighteen mornings, the total amount of frost registered being 83°, as against 121° for the corresponding month of 1890. The lowest readings occurred on the 15th, 24°; 16th, 26°; 17th, 23°; 18th, 24°; 22nd, 23°. The lowest day temperature was 34°, on the 11th, and the highest 57°, on the 2nd.

On the rock-garden the following plants came into flower during the month, viz., *Helleborus niger major*, *H. purpurascens*, var., and *Primula inflata*. The total number of alpine and dwarf-growing herbaceous plants which have flowered on the rock-garden during the year 1891 amounts to 1216, being 137 less than during 1890. The deficiency occurred chiefly during the month of May. The number of species which came into flower each month was as follows:—

January, 6; February, 39; March, 40; April, 119; May, 260; June, 359; July, 252; August, 84; September, 41; October, 13; November, 0; December, 3; Total, 1216.

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during December 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 35° | 47° | 51° | 17th | 23° | 34° | 36° |
| 2nd | 29 | 31 | 57 | 18th | 24 | 35 | 46 |
| 3rd | 30 | 50 | 57 | 19th | 37 | 42 | 44 |
| 4th | 42 | 45 | 50 | 20th | 35 | 42 | 44 |
| 5th | 39 | 44 | 49 | 21st | 36 | 40 | 43 |
| 6th | 37 | 40 | 50 | 22nd | 23 | 27 | 36 |
| 7th | 34 | 38 | 44 | 23rd | 26 | 33 | 38 |
| 8th | 29 | 41 | 47 | 24th | 28 | 34 | 38 |
| 9th | 40 | 42 | 50 | 25th | 28 | 29 | 37 |
| 10th | 33 | 38 | 43 | 26th | 27 | 39 | 47 |
| 11th | 29 | 31 | 34 | 27th | 33 | 36 | 49 |
| 12th | 27 | 32 | 38 | 28th | 30 | 33 | 39 |
| 13th | 28 | 33 | 39 | 29th | 34 | 37 | 50 |
| 14th | 30 | 34 | 38 | 30th | 33 | 36 | 41 |
| 15th | 24 | 26 | 45 | 31st | 32 | 35 | 42 |
| 16th | 26 | 41 | 45 | | | | |

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of December 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| 1 | 29·408 | 48°·8 | 34°·8 | 48°·8 | 46°·1 | S.E. | Cum. | 10 | S.S.W. | 0·160 |
| 2 | 29·249 | 50·4 | 31·9 | 32·3 | 32·3 | Calm. | Cir. | 2 | S. | 0·090 |
| 3 | 29·043 | 52·2 | 31·2 | 52·2 | 49·6 | S. | Cir.Cum.<br>Cum. | 4<br>1 | W.<br>S. | 0·095 |
| 4 | 29·586 | 56·0 | 43·2 | 45·2 | 42·7 | W.S.W. | Cir. | 2 | W.S.W. | 0·470 |
| 5 | 29·621 | 49·6 | 44·8 | 48·6 | 47·3 | W.S.W. | Nim. | 10 | W.S.W. | 0·155 |
| 6 | 29·655 | 48·8 | 40·0 | 41·5 | 39·7 | W.S.W. | Cum. | 1 | W. | 0·050 |
| 7 | 29·504 | 43·7 | 35·1 | 40·1 | 40·0 | E. | Nim. | 10 | E. | 0·180 |
| 8 | 29·615 | 43·6 | 30·0 | 43·6 | 42·1 | W.S.W. | Cir.<br>Cum. | 2<br>2 | N.W.<br>W. | 0·022 |
| 9 | 29·105 | 47·7 | 41·5 | 41·6 | 40·1 | W.S.W. | ... | 0 | ... | 0·810 |
| 10 | 28·563 | 50·9 | 41·0 | 41·9 | 40·0 | W.S.W. | Cum. | 10 | W.S.W. | 0·642 |
| 11 | 29·182 | 42·9 | 32·0 | 32·8 | 31·7 | W.S.W. | Cum. | 1 | W. | 0·000 |
| 12 | 29·825 | 35·9 | 30·6 | 34·1 | 33·0 | S.W. | Cir. | 4 | W. | 0·315 |
| 13 | 28·950 | 37·6 | 33·1 | 34·2 | 34·2 | Calm. | Cum. St. | 10 | Calm | 0·285 |
| 14 | 29·584 | 38·0 | 32·6 | 33·8 | 33·4 | W. | ... | 0 | ... | 0·000 |
| 15 | 29·805 | 38·6 | 27·0 | 28·9 | 28·9 | Calm. | Fog | 10 | Calm | 0·640 |
| 16 | 29·593 | 44·7 | 28·0 | 42·7 | 40·8 | N. | Cum. | 10 | N.N.E. | 0·000 |
| 17 | 30·325 | 43·2 | 26·0 | 26·9 | 26·9 | W. | ... | 0 | ... | 0·005 |
| 18 | 30·342 | 35·8 | 26·1 | 35·8 | 35·2 | N.E. | Cum. | 10 | W.S.W. | 0·000 |
| 19 | 30·340 | 44·7 | 35·0 | 43·3 | 41·7 | S.S.W. | Cir.<br>Cum. | 3<br>1 | W.<br>S.W. | 0·000 |
| 20 | 30·391 | 44·1 | 37·1 | 38·5 | 36·8 | W.S.W. | Cir. | 1 | Calm | 0·000 |
| 21 | 30·494 | 41·7 | 34·0 | 34·8 | 34·1 | W.S.W. | Cum. | 1 | W.S.W. | 0·000 |
| 22 | 30·483 | 38·6 | 26·0 | 27·3 | 26·0 | S.W. | ... | 0 | ... | 0·000 |
| 23 | 30·304 | 37·4 | 26·8 | 34·9 | 33·6 | S.W. | ... | 0 | ... | 0·000 |
| 24 | 30·108 | 36·7 | 29·1 | 34·5 | 34·0 | W. | Cum. St. | 10 | W. | 0·000 |
| 25 | 29·871 | 36·7 | 30·2 | 31·3 | 31·0 | S.W. | ... | 0 | ... | 0·000 |
| 26 | 29·475 | 43·7 | 29·6 | 43·2 | 41·0 | S.S.W. | Cum. | 10 | S.S.W. | 0·060 |
| 27 | 29·504 | 48·8 | 35·3 | 36·6 | 34·6 | W.S.W. | ... | 0 | ... | 0·055 |
| 28 | 29·542 | 43·1 | 33·0 | 34·2 | 33·5 | W.S.W. | ... | 0 | ... | 0·230 |
| 29 | 29·188 | 49·5 | 33·3 | 38·1 | 37·2 | W.S.W. | ... | 10 | W.S.W. | 0·430 |
| 30 | 29·328 | 38·9 | 34·2 | 38·9 | 38·0 | W.S.W. | Cum. | 10 | W.S.W. | 0·055 |
| 31 | 29·146 | 41·9 | 35·1 | 36·1 | 34·9 | W.S.W. | ... | 0 | ... | 0·002 |

Barometer.—Highest Reading, on the 21st, =30·494. Lowest Reading, on the 10th, =28·563. Difference, or Monthly Range, =1·931. Mean=29·649.

S. R. Thermometers.—Highest Reading, on the 4th, =56°·0. Lowest Readings, on the 17th and 22nd, =26°·0. Difference, or Monthly Range, =30°·0. Mean of all the Highest =43°·8. Mean of all the Lowest=33°·1. Difference, or Mean Daily Range, =10°·7. Mean Temperature of Month=38°·4.

Hygrometer.—Mean of Dry Bulb=37°·9. Mean of Wet Bulb=36°·8.

Rainfall.—Number of Days on which Rain, or Snow, fell=20. Amount of Fall, in inches, =4·751. First fall of Snow for Season on night of 10th.

A. D. RICHARDSON, *Observer*.

## Abstract of Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during 1891.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Months. | Barometer, corrected and reduced to 32°. (Inches.) | | | | | | Thermometers, protected, 4 feet above grass. Self-Registering Thermometers. | | | | | | | | | | Hygrometer. | | Rain, &c. (Inches.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Mean. | Highest. | | Lowest. | | Range | Mean of all the Highest. | Mean of all the Lowest. | Mean Daily Range. | Mean Temperature. | Mean of Dry Bulb. | Mean of Wet Bulb. | No. of Days on which Rain, &c. fell. | Amount. | Greatest Fall in 24 Hours. | |
| | Date. | Reading. | Date. | Reading. | | | Date. | Reading. | Date. | Reading. | | | | | | | | | | Date. | Amount. |
| January, | 14 | 30·635 | 23 | 29·078 | 1·557 | 29·908 | 29 | 51·3 | 8 | 21·0 | 30·3 | 40·9* | 32·0 | 8·9 | 36·4 | 36·8 | 35·1 | 15 | 0·561 | 3 | 0·122 |
| February, | 4 | 30·576 | 11 | 29·803 | 0·773 | 30·266 | 26 | 53·7 | 27 | 23·1 | 30·6 | 47·5 | 34·1 | 13·4 | 40·8 | 38·9 | 37·8 | 7 | 0·153 | 3 | 0·075 |
| March, | 18 | 30·039 | 26 | 29·201 | 0·838 | 29·683 | 2 | 54·8 | 9 | 17·8 | 32·7 | 44·2 | 31·8 | 12·4 | 38·0 | 38·0 | 35·1 | 16 | 2·801 | 16 | 1·555 |
| April, | 21 | 30·346 | 30 | 29·391 | 0·955 | 29·957 | 27 | 56·6 | 1 | 24·7 | 31·9 | 49·0 | 35·5 | 13·5 | 42·2 | 43·6 | 40·4 | 11 | 0·277 | 30 | 0·058 |
| May, | 12 | 30·201 | 1 | 29·140 | 1·061 | 29·698 | 13 | 68·8 | 17 | 31·0 | 37·8 | 54·7 | 40·0 | 14·7 | 47·4 | 48·4 | 45·7 | 19 | 1·490 | 2 | 0·455 |
| June, | 21 | 30·308 | 30 | 29·438 | 0·870 | 29·999 | 12 | 73·7 | 7, 13 | 42·0 | 31·7 | 62·2 | 49·1 | 13·1 | 55·6 | 55·7 | 52·5 | 9 | 0·417 | 26 | 0·175 |
| July, | 14 | 30·324 | 7 | 29·342 | 0·982 | 29·781 | 18 | 74·1 | 29 | 46·0 | 28·1 | 66·6 | 52·0 | 14·6 | 59·3 | 60·2 | 55·8 | 22 | 2·542 | 22 | 0·540 |
| August, | 30 | 29·911 | 26 | 28·898 | 1·013 | 29·590 | 19, 20 | 69·9 | 29 | 40·1 | 29·8 | 64·1 | 50·6 | 13·5 | 57·3 | 57·8 | 54·6 | 26 | 3·873 | 21 | 0·850 |
| September, | 23 | 29·966 | 1 | 28·800 | 1·166 | 29·679 | 13 | 79·7 | 8 | 41·6 | 38·1 | 62·7 | 49·0 | 13·7 | 55·8 | 56·6 | 53·2 | 25 | 3·944 | 20 | 1·482 |
| October, | 31 | 30·651 | 14 | 28·753 | 1·898 | 29·546 | 5 | 61·8 | 9 | 29·0 | 32·8 | 54·1 | 41·0 | 13·1 | 47·5 | 46·4 | 44·6 | 18 | 1·594 | 13 | 0·348 |
| November, | 5 | 30·610 | 11 | 28·569 | 2·041 | 29·701 | 19 | 52·9 | 23, 27 | 26·0 | 26·9 | 45·4 | 35·1 | 10·3 | 40·2 | 40·5 | 39·4 | 19 | 1·504 | 18 | 0·324 |
| December, | 21 | 30·494 | 10 | 28·563 | 1·931 | 29·649 | 4 | 56·0 | 17, 22 | 26·0 | 30·0 | 43·8 | 33·1 | 10·7 | 38·4 | 37·9 | 36·8 | 20 | 4·751 | 9 | 0·810 |
| For Year, | Oct. 31 | 30·651 | Dec. 10 | 28·563 | 2·088 | 29·788 | Sept. 13 | 79·7 | Mar. 9 | 17·8 | 61·9 | 52·9 | 40·3 | 12·5 | 46·6 | 46·7 | 44·2 | 207 | 23·857 | Mar. 16 | 1·555 |

* Printed 41°·0 in Report for January in error.

A. D. RICHARDSON, } Observers.
A. ANDERSON,

On Temperature and Vegetation in the Botanic Garden, Glasgow, during December 1891. By Robert Bullen, Curator of the Garden.

The weather throughout was exceedingly mild, but mostly very wet and stormy.

The highest day reading on a shaded thermometer at 3 feet from the ground was 53°, on the 3rd; the lowest 34°, on the 13th, when a light fall of snow was experienced. The night readings were correspondingly high for the month; the lowest reading was 25°, or 7° of frost; and the total readings for the nine nights on which frost was registered was only 31°. But on five or six other nights the mercury was either at or very near the freezing-point. Within a mile from the city the temperature was from 3° to 6° lower.

The sudden change of wind and weather—frequent rains, and thick fogs—were a great impediment to outdoor work.

## MEETING OF THE SOCIETY,

Thursday, February 11, 1892.

DR DAVID CHRISTISON, President, in the Chair.

A. N. M'ALPINE, B.Sc. (Lond.), was elected Resident Fellow of the Society.

The following contributions to the Illustration Fund were announced:—

| | | | | |
|---|---|---|---|---|
| Dr Aitken, . . | £2 | 0 | 0 | |
| Dr Cleghorn, . . | 2 | 0 | 0 | (additional) |
| P. Neill Fraser, . . | 2 | 0 | 0 | (additional) |

Presents to the Library, Museum, and Herbarium at the Royal Botanic Garden were announced.

Mr MALCOLM DUNN, Dalkeith, exhibited flowering twigs of *Chimonanthus fragrans*, *Garrya elliptica*, *Jasminum nudiflorum*, *Helleborus* sp., and other spring flowering plants.

The CURATOR exhibited, from the Royal Botanic Garden, flowering twigs of *Hamamelis japonica* and of *Acokanthera veneneta*, the Bushman's poison-bush from South Africa, the active principle of which is now being investigated in Edinburgh.

Dr CLEGHORN read an

OBITUARY NOTICE OF DOM PEDRO II., LATE EMPEROR OF BRAZIL. By His Excellency Dr R. HALLIDAY GUNNING.

The late Emperor of Brazil, Dom Pedro II., who died in Paris on the 5th of December last, being an Honorary Fellow, deserves some notice from the Botanical Society of Edinburgh. In character, as a man, a patriot, and a philanthropist, Dom Pedro stood very high, and in learning and knowledge of Science and Art he had no equal among modern Sovereigns. This was the opinion of the late



Issued April 1892.

Professor Agassiz, who knew him well and was a good judge of his acquirements. When a mere boy-Emperor, and engrossed by the cares of a new and gigantic empire, he found time to work at Physics and Chemistry in his own laboratory, and to master several languages, besides keeping up with the Politics and Scientific progress of Europe. He could converse and write fluently in French, Italian, Spanish, German, and English, in addition to his native Portuguese. In ancient languages, besides Latin and Greek, he was well versed in Sanscrit, Arabic, and Hebrew; and, when in exile, he busied himself translating the "Arabian Nights" into Portuguese, and latterly in translating from the Hebrew Jewish poetry and ritual songs as sung by the Jews of all countries. Among his favourite authors were Sir Walter Scott, Victor Hugo, and Longfellow, from whose writings he made several poetical translations into Portuguese.

His Majesty was fond of Scotland, and, after his visit to Europe in 1871, often enquired after those whom he had met in Edinburgh and Glasgow. Botany was a favourite study, and he ranked the Botanic Garden of Edinburgh as the best he had seen in his travels after those of Kew. His delight was to be among celebrities in Science and Literature, and he much regretted that the state of affairs in Brazil did not allow him to be present at the tercentenary commemoration of the Edinburgh University in 1884, to be associated with Virchow, Pasteur, Lowell, &c. It gratified him much to receive the degree of LL.D. from that university, in recognition of which he conferred high decorations on the Chancellor, the Principal, and the Secretary. It was also his desire and intention to visit the Forth Bridge, in the construction of which he had taken great interest, but his physicians and family were averse to his risking the cold and fatigue of the journey.

In London His Majesty was enthusiastic in seeing all that was interesting. He especially enjoyed the British Museum and Kew Gardens, to both of which he made studious visits. Out of London, what most interested him were the arsenals and dockyards, and the officers who showed him over the works at Woolwich were much struck with his great scientific knowledge of guns and gunnery, and the construction of ironclads. In fact, his endowments were extraordinary, being abreast of all that was going on in Physics, Mechanics, Electricity, and Astronomy, as well as in the Fine Arts, and all that was new in Politics and Literature. He was elected one of the four Royal Honorary Fellows of the Royal Society of London, 23rd November 1871.

In Brazil the Emperor was the soul of all that was done for Education, Science, the Fine Arts, and Industry. At his instance the Faculties of Medicine and Law, and the Polytechnic, were endowed by the State, as were also the Primary and High Schools throughout the empire. In Rio de Janeiro he seldom failed to be at the periodical examinations in these institutions, and, with the Imperial family, was always present at the Academical Fêtes of conferring degrees and awarding prizes. He took particular interest in a night "Lyceum of Arts and Trades," where about sixty qualified gentlemen-volunteers in turn took charge of, on an average, 400 boys and 300 girls, instructing them in French, English, Music (vocal and instrumental), Drawing and Modelling, Mathematics, Chemistry, Physics, &c., as selected; the object being to enable them to rise to better positions in their respective callings. Besides this general interest in popular education, the Emperor was ever ready to help young men of marked ability, and frequently sent them to Europe to complete their studies at his own expense. He especially encouraged the study of Botany, in establishing and endowing two public gardens—appointing to the one a distinguished Belgian botanist, and to the other a German; and, at the same time, he initiated the publication of the great national work the "Flora Braziliensis," which is not yet completed. It must not be omitted that, besides the national observatory in Rio, which he frequently visited, he had one of his own at his country palace, and that he regularly sent his observations to Paris, having been elected a Corresponding Member of the Academy of Sciences in 1875.

The Emperor was not only the chief promoter of Education and Science, but was the leading spirit in every social and material improvement. The abolition of slavery, in spite of strong and persevering constitutional opposition, would alone make his reign memorable. The material improvements he introduced were numerous. Till 1854 there was scarcely a mile of road of any kind in the country. Now there is a network of communication by railroads and telegraphs over the whole empire.

Sanitary improvements have been introduced into most of the leading cities, as well as gas and electric light. Regular lines of steamers ply along the sea-coast and up the large rivers, and commerce and trade have been greatly increased. All these lines of steamers and railroads are managed by native engineers, of whom there is now a large school.

These remarks may be concluded by a short notice of the eventful careers of the Emperor and his family. Dom Pedro's grandfather, John VI. of Portugal, withdrew from Lisbon to Rio de Janeiro on the invasion of the French under Napoleon in 1807, and did not return to Portugal till 1821, when he founded there the present constitutional monarchy. The Emperor's father, Dom Pedro I., elder son of John VI., was left by him as Prince Regent of Brazil, but the following year he asserted the independence of that country, and was proclaimed Emperor on 7th September 1822. His reign was a checkered one, and, disgusted with the opposition he met with from the different political parties, he in 1831 abdicated in favour of his son, Dom Pedro II., and returned to Portugal to save that kingdom from the usurpation of his brother Dom Miguel. Dom Pedro II. was only in his sixth year when he became Emperor. He was declared of age when 15, in 1840, and crowned the following year. In 1843, he married Donna Theresa Christina Maria, daughter of the late Francis I., King of the Two Sicilies. By her he had two sons, who died as infants, and two daughters, the elder of whom, Donna Isabel, the Princess Imperial (who is now the successor to the rights of the Emperor), married in 1864 Prince Louis of Orleans, Comte d'Eu, and has three sons.

The Emperor was cordially supported in all his projects for the good of his people by the Empress and Princess, who, like him, were universally beloved;—notwithstanding which, he was, without complaint or warning, on 15th November 1889, seized, dethroned, and, with his family, sent into exile, to ensure the success of a military revolt, and the establishment of a Republic. This *coup d'état* in two years all but ruined the country; and now, when too late, Brazil sees that the usurpation was not only a crime, but a blunder.

The following papers were read:—

SUPPLEMENTARY NOTES ON THE MARINE ALGÆ OF THE ORKNEY ISLANDS. By GEORGE WILLIAM TRAILL.

NOTES ON THE RECORDS OF SCOTTISH PLANTS FOR 1891. By ARTHUR BENNETT.

As year by year these records are made up from correspondents, the fact of the large number they amount to cannot but be noticed by anyone who follows their publication.

No doubt to some extent they are expanded (outside the names of "Topographical Botany," 2nd ed.) by the numerous segregates of some of the critical genera; yet still with this in view, it seems that the commoner species are very far from yet being fully recorded; rarieties are sure to be named—not so the common species.

The second edition of "Topographical Botany" bears the date of 1883. By 1893 we may be able to say and show what counties in Scotland the British types of Watson are absent from with some degree of safety—(though in this, as in local floras, finality is impossible)—and if not by counties, at least by sub-provinces. It will then be an easy matter for any botanist in any one county to jot down these wanted species, and keep a "look out" for them in his walks.

Though these records have, here and there, scattered among them, altitudes of species above those hitherto known, still they are by no means so numerous as I could wish. Equally so is it desirable to ascertain the lower limits of many of the boreal species, and put them on record.

I would suggest to Scottish botanists the need of careful searching of the two groups of islands, the Outer and Inner

Hebrides; already the latter produce a species (*Arabis alpina*, L.) unknown elsewhere in Scotland, and that their floras are nothing like complete I confidently assert, from studying the ranges of species northwards and eastwards of them. Anyone in the Outer Hebrides may fully expect to gather 40 to 50 species hitherto not on record, and a still larger number in the Inner Hebrides.

Passing to the records, Dumfries has ten—*Vaccinium uliginosum* and *Arctostaphylos Uva-ursi* among them. To Kirkcudbright, Mr M'Andrew has added a large number—*Thalictrum alpinum*, *Vicia Orobus*, *Cicuta*, *Mertensia*, *Carex pauciflorus*, and *Asplenium viride* being among them. Wigtown, Renfrew, and Lanark have each one only. Stirling, by the labours of Col. Stirling and Mr R. Kidston, numbers 52. Many, however, are not native. *Elatine hexandra*, *Callitriche autumnalis*, *Hieracium lingulatum*, *Rumex domesticus*, *Carex aquatilis*, var., and *Sclerochloa loliacea* are some of the interesting species. West Perth one. Mid Perth has a very interesting addition, gathered by the Messrs Groves, *i.e.*, *Carex alpina*. Mr Holt of Manchester has sent me a fragment of *Eriophorum alpinum*, "gathered by Mr Henry Stansfield some twenty years ago on Craig Challiach, Perthshire." I need hardly say that endeavours should be made to thoroughly search this mountain to try and verify this rare plant.

Mr Somerville, among a very large series of specimens, kindly transmitted to me from Easterness (East Inverness), seven new records.

For Westerness (West Inverness), my friend, Mr Druce, records over 50 additions, and Mr Macvicar several for its Argyle side. Nine are recorded by Mr Ewing for Argyle; and for Dumbarton Mr L. Watt has sent 17, among them *Raphanus maritimus* and *Carex aquatilis*, var.

Mr Ewing also records for North Ebudes several, as also for West Ross.

To East Ross, my good friend the Rev. E. Marshall, about 40 species—*Oxytropis uralensis*, in a new station, *Galium erectum*, *Potamogeton prælongus* among them.

East and West Sutherland produce each two species. To the Outer Hebrides, Mr W. S. Duncan contributes 23 new records, verifying several of Macgillivray's made many years ago, as *Orobanche rubra* and *Subularia aquatica;* others are *Carduus heterophyllus, Carex pauciflora, C. pilulifera,* and *Listera cordata.*

To the Orkneys, Mr T. Irvine Fortescue adds *Potamogeton lucens,* f., a station far to the north of any certain one known hitherto.

In the Shetlands, Mr W. H. Beeby has found several, the most interesting being several *Hieracia,* one (*H. zetlandicum,* Beeby) an endemic form, and two others (*H. protractum,* Lindeb. and *H. truncatum,* Lindeb.) not known elsewhere in Scotland.

Summary.

| No. | | | No. | | |
|---|---|---|---|---|---|
| | | | | Brought forward, | 188 |
| 72. | Dumfries, | 16 | 98. | Argyle, | 10 |
| 73. | Kirkcudbright, | 46 | 99. | Dumbarton, | 17 |
| 74. | Wigtown, | 1 | 104. | N. Ebudes, | 11 |
| 75. | Ayr, | 1 | 105. | W. Ross, | 11 |
| 76. | Renfrew, | 1 | 106. | E. ,, | 45 |
| 77. | Lanark, | 1 | 107. | E. Sutherland, | 2 |
| 86. | Stirling, | 52 | 108. | W. ,, | 2 |
| 87. | W. Perth, | 1 | 110. | Outer Hebrides, | 23 |
| 88. | M. ,, | 2 | 111. | Orkney, | 1 |
| 96. | Easterness, | 8 | 112. | Shetland, | 10 |
| 97. | Westerness, | 59 | | | |
| | | | | Total, | 320 |
| | Carry forward, | 188 | | | |

The Life-History of the Mistletoe. By Professor Bayley Balfour.

Some Notes on Economic Orchids. By W. Etherington Dixon.

On Temperature and Vegetation in the Royal Botanic Garden, Edinburgh, during January 1892. By Robert Lindsay, Curator of the Garden.

During the past month of January the weather was exceedingly cold and frosty, with much snow during the early part of the month. Frost was registered every night in succession, but one, from the 1st till the 25th, after which the temperature rose rapidly till the end of the month. Such a long continuance of frosty nights is unusual, but at no single time was it very severe. The lowest readings were on the 8th, 22°; 10th, 22°; 13th, 21°; 16th, 22°; and 17th, 22°. Although the lowest reading was thus only 11° of frost, the collective amount for the month was 136° as against 126° for the corresponding month last year. The lowest day reading was 33° on the 11th, and the highest 55° on the 29th of the month.

Very few plants came into flower in January. Of the 40 selected plants whose dates of flowering are annually recorded to the Society, only one came into flower, viz., *Galanthus plicatus* on the 26th. At the same date last year five were in flower, and in January 1890 as many as 18 of the 40 had flowered.

On the rock-garden the following came into flower, viz., *Galanthus plicatus*, *Polygala Chamæbuxus* and *P. purpurea*, *Geum miniatum*, *Hepatica angulosa*, *Helleborus purpurascens*, and *Primula variabilis*.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during January 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 32° | 33° | 44° | 17th | 22° | 33° | 38° |
| 2nd | 29 | 36 | 47 | 18th | 31 | 36 | 42 |
| 3rd | 25 | 33 | 44 | 19th | 34 | 35 | 38 |
| 4th | 25 | 33 | 36 | 20th | 32 | 33 | 37 |
| 5th | 26 | 40 | 46 | 21st | 25 | 32 | 42 |
| 6th | 25 | 29 | 41 | 22nd | 30 | 35 | 42 |
| 7th | 26 | 27 | 34 | 23rd | 27 | 28 | 44 |
| 8th | 22 | 24 | 36 | 24th | 32 | 34 | 43 |
| 9th | 25 | 29 | 33 | 25th | 32 | 35 | 42 |
| 10th | 22 | 37 | 40 | 26th | 35 | 41 | 49 |
| 11th | 23 | 27 | 33 | 27th | 44 | 47 | 51 |
| 12th | 28 | 35 | 37 | 28th | 33 | 37 | 52 |
| 13th | 21 | 25 | 37 | 29th | 45 | 50 | 55 |
| 14th | 26 | 29 | 39 | 30th | 42 | 44 | 45 |
| 15th | 24 | 26 | 35 | 31st | 35 | 39 | 40 |
| 16th | 22 | 28 | 37 | | | | |

[TABLE.

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of January 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| 1 | 29·699 | 40°·1 | 34°·0 | 34°·9 | 33°·1 | W. | ... | 0 | ... | 0·000 |
| 2 | 29·819 | 41·2 | 32·0 | 41·2 | 39·3 | W.S.W. | Cir. | 3 | N.W. | 0·000 |
| 3 | 29·773 | 44·0 | 31·0 | 33·6 | 30·4 | W. | ... | 0 | ... | 0·000 |
| 4 | 30·013 | 36·6 | 28·1 | 31·3 | 30·4 | N.W. | ... | 0 | ... | 0·000 |
| 5 | 29·348 | 42·2 | 26·2 | 42·2 | 40·9 | W. | { Cir. / Cum. | 4 / 4 | N.W. / W. } | 0·000 |
| 6 | 29·056 | 43·9 | 28·9 | 32·0 | 30·6 | W. | Cir. | 2 | N.N.W. | 0·000 |
| 7 | 29·218 | 35·7 | 27·3 | 30·1 | 27·5 | W.N.W. | ... | 0 | ... | 0·070 |
| 8 | 29·204 | 34·7 | 23·0 | 25·4 | 24·8 | W.S.W. | Cir. | 1 | N.N.W. | 0·010 |
| 9 | 29·488 | 34·9 | 24·8 | 30·0 | 27·2 | W.N.W. | Cum. | 10 | N. | 0·015 |
| 10 | 29·659 | 36·4 | 24·7 | 36·4 | 33·9 | E.N.E. | { Cir. / Cum. | 4 / 2 | E. / E.N.E. } | 0·060 |
| 11 | 29·983 | 39·1 | 24·9 | 25·9 | 25·4 | W. | Cir. | 3 | N.W. | 0·050 |
| 12 | 29·792 | 37·1 | 25·8 | 36·6 | 35·1 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 13 | 29·668 | 36·5 | 24·0 | 25·5 | 25·0 | W. | Cum. | 9 | W.S.W. | 0·000 |
| 14 | 29·298 | 36·7 | 25·0 | 31·8 | 30·1 | S.W. | Cir. | 1 | S.W. | 0·015 |
| 15 | 29·401 | 35·7 | 26·2 | 27·2 | 26·9 | Calm. | Cum. | 9 | S.E. | 0·000 |
| 16 | 29·361 | 33·1 | 26·1 | 30·0 | 29·6 | S.E. | ... | 0 | ... | 0·000 |
| 17 | 29·629 | 36·8 | 29·2 | 36·8 | 34·3 | E. | Cum. | 10 | E. | 0·010 |
| 18 | 29·681 | 38·5 | 35·1 | 38·5 | 37·0 | E. | Cum. | 10 | S.E. | 0·225 |
| 19 | 29·795 | 40·5 | 36·0 | 36·1 | 36·0 | W. | Nim. | 10 | W. | 0·135 |
| 20 | 29·788 | 37·6 | 33·5 | 34·6 | 34·0 | S.E. | Cum. | 10 | S.E. | 0·000 |
| 21 | 29·751 | 36·0 | 28·5 | 32·7 | 31·1 | S. | ... | 0 | ... | 0·000 |
| 22 | 29·592 | 40·4 | 31·8 | 36·0 | 34·8 | S.W. | Cum. | 10 | S.W. | 0·005 |
| 23 | 29·749 | 39·9 | 30·3 | 32·5 | 32·1 | Calm. | Cir. | 2 | W. | 0·010 |
| 24 | 29·794 | 45·9 | 31·0 | 38·4 | 37·0 | W.S.W. | ... | 0 | ... | 0·005 |
| 25 | 30·218 | 41·8 | 35·5 | 37·2 | 36·0 | S.W. | ... | 0 | ... | 0·002 |
| 26 | 30·067 | 42·4 | 36·0 | 42·4 | 41·0 | S.W. | { Cir. / Cum. | 5 / 2 | N.W. / W. } | 0·050 |
| 27 | 29·550 | 49·9 | 42·0 | 48·8 | 47·2 | S.W. | Nim. | 10 | S.W. | 0·050 |
| 28 | 29·811 | 49·4 | 35·8 | 39·2 | 37·7 | W. | Cum. | 10 | W. | 0·070 |
| 29 | 29·543 | 51·9 | 38·8 | 51·1 | 49·2 | W. | Cum. | 10 | W. | 0·005 |
| 30 | 29·707 | 54·5 | 43·6 | 44·1 | 40·7 | W. | Cum. | 6 | W. | 0·040 |
| 31 | 29·869 | 46·3 | 36·9 | 38·2 | 36·5 | W. | ... | 0 | ... | 0·110 |

Barometer.—Highest Reading, on the 25th, =30·218. Lowest Reading, on the 6th, =29·056. Difference, or Monthly Range, =1·162. Mean=29·656.

S. R. Thermometers.—Highest Reading, on the 30th, =54°·5. Lowest Reading, on the 8th, =23°·0. Difference, or Monthly Range, =31°·5. Mean of all the Highest =40°·6. Mean of all the Lowest=30°·8. Difference, or Mean Daily Range, =9°·8. Mean Temperature of Month=35°·7.

Hygrometer.—Mean of Dry Bulb=35°·5. Mean of Wet Bulb=34°·0.

Rainfall.—Number of Days on which Rain, or Snow, fell=19. Amount of Fall, in inches, =0·937.

A. D. RICHARDSON,
*Observer.*

## ON TEMPERATURE AND VEGETATION IN THE BOTANIC GARDEN, GLASGOW, during JANUARY 1892. By ROBERT BULLEN, Curator of the Garden.

The temperature was at or below the freezing-point on seventeen nights during the first three weeks. The last week was unusually mild, with frequent light rain, and at times stormy.

Ten degrees of frost was registered during the nights of the 9th and 15th respectively. The total night frost was only 84° and four times at the freezing-point. Owing to the unusually high temperature of the last week, the mean for the month is comparatively high. Snow fell during the night of the 6th, and owing to the continuous frosts the ground presented a very wintry appearance until the 17th, when the temperature gradually became higher, as the month came to a close. The readings for the last eight days varied from 40° to 51°, and at night from 40° to 47°.

## MEETING OF THE SOCIETY.

Thursday, March 10, 1892.

DR DAVID CHRISTISON, President, in the Chair.

A. N. M'ALPINE, B.Sc. (Lond.), was admitted Resident Fellow of the Society.

The death of J. T. WILSON, Resident Fellow of the Society, was announced.

The following contribution to the Illustration Fund was announced:—

Symington Grieve, £1 : 0 : 0.

Presents to the Library, Museum, and Herbarium at the Royal Botanic Garden were announced.

Mr MALCOLM DUNN, Dalkeith, exhibited *Tillandsia stricta*, var., in flower.

The CURATOR exhibited, from the Royal Botanic Garden, *Saxifraga luteo-purpurea*, a natural hybrid between *S. media* and *S. arctioides*, *Saxifraga Burseriana* and its variety *multiflora*, and a tuber of *Amorphophallus campanulatus* recently received from Mr J. H. Storey, Superintendent, Sajjan Niwas Gardens, Oodeypore, Rajpootana. The tuber weighed 26 lbs., and produced last year a leaf with a petiole 18 inches in circumference and 6 feet high, the spread of the lamina being 7 feet. The tuber was grown under the shade of a tree of *Ficus religiosa* without protection from sun or rain.

Dr PATERSON, Bridge of Allan, sent for exhibition cut blooms of *Cœlogyne cristata alba*, *Odontoglossum* several species, and *Crinum Macowanum*.

Professor BAYLEY BALFOUR exhibited a series of Museum specimens—seedlings, dissections of fruits, &c., mounted on



Issued May 1892.

mica and glass by means of a transparent medium and preserved in alcohol. The substance used was photoxylin, obtained from Grübler of Leipzig, from whom alone it can be obtained. The advantage attaching to its use is twofold, (1) rapidity of mounting, (2) transparency. Hitherto objects mounted for the museum on mica or glass plates have been either tied to the plate by thread or fixed to it by such a medium as glue or this mixed with plaster of Paris, or similar opaque substance. The objection to the tying process has been that it takes a considerable time to prepare the object, and that in handling delicate specimens hardened in alcohol the thread often cuts through or breaks the specimen. On the other hand, the opaque cements, whilst enabling the mounting to be more rapidly accomplished, have the drawback of obscuring a portion of the object mounted. Dr Jost, Assistant to the Professor of Botany in the University of Strassburg, has recently discovered the value of the substance photoxylin—a special preparation of Grübler's—and the process of mounting with it was communicated to the exhibitor during a visit to Strassburg in the autumn of last year. The procedure is as follows :—The specimen to be mounted is taken from the alcohol in which it has been hardened, and the surface alcohol having been removed, it is placed on the plate of mica or glass on which it is to be mounted. A few drops of photoxylin are dropped on it at the points at which it is to be fixed, and the mica or glass plate with the specimen is then carefully laid in an open bath of 80 per cent. alcohol and left there for about a minute. The photoxylin immediately sets as a transparent jelly, and the specimen is thereby fixed to the mica or glass plate, and may then be transferred to the jar in which it is to be permanently kept, when the object will be seen held in position upon the mica or glass plate, but the medium by which it is so held is invisible. Of the durability of the mount the exhibitor could not speak, but there are specimens so mounted in the Strassburg Botanical Museum of about a year old, and still in perfect condition. The process is a most convenient one, easily accomplished, and giving most admirable results, and should be a great boon to those who have the care of museums in which delicate objects are mounted and preserved in alcohol.

The following Papers were read:—

## OBSERVATIONS ON THE INCREASE IN GIRTH OF YOUNG TREES IN THE ROYAL BOTANIC GARDEN, EDINBURGH, FOR FIVE YEARS ENDING 1891. By DAVID CHRISTISON, M.D., President.

CONTENTS OF THE PAPER.

## INTRODUCTORY.

In March 1883 I communicated to the Royal Society of Edinburgh observations on the Girth-Increase of Trees, begun in 1878 by Sir Robert Christison and completed by myself in 1882; and in 1887 and 1888 these observations were supplemented by five additional years' results in Papers read by me to this Society. It was then stated that the majority of the selected trees proved to be too old, or too prematurely old, or to have been too seriously affected by the extraordinary low temperatures of the winters 1879–80–81, to yield altogether satisfactory results, and that I intended to institute a fresh series of experiments on a younger set of trees, partly of the same but mainly of different species. The results are now given for the five years 1887–1891.

Experience taught me that to ascertain the laws which govern girth-increase it was necessary to select vigorous trees in a good soil, because, under less favourable conditions, growth is apt to be irregular, and to fall mainly sometimes on the early, sometimes on the late, part of the season. Unfortunately the soil of the Botanic Garden and Arboretum, although varying in quality, is for the most part poor and sandy, and notwithstanding the care exercised in selecting my specimens, the results in a considerable number proved disappointing. About half of the thirty-five selected deciduous trees grow in the south shelter belt of the Arboretum, where the soil is little better than a sand-bed; and although they looked well at first, in the result they contrasted unfavourably both as to appearance and amount of increase with the others, the majority of which were in the well-sheltered and richer hollow of the east belt. The few trees selected in the Botanic Garden were also favourably situated. But the soil is unfortunately still less suited to the Coniferæ. Some species grow luxuriantly while quite young, but they are apt to fall off very much long before reaching their prime. A few, nevertheless, have thriven to a respectable size, such as the handsome yew, No. 41 in my list, now above six feet in girth, and the Scots fir, No. 11, nearly eight feet in girth; but it only serves to illustrate the occasional superiority and general inferiority of the soil within the narrow limits of the Arboretum, that a number of other Scots firs scattered about the ground are all wrecks, although the biggest of them is not much more than half the size of No. 11. The number of the selected Coniferæ was 32, but not more than half of them proved satisfactory, and of these several were temporarily disabled by being transplanted.

To guard against loss of results through abnormality, accident, or disease in single specimens, at least two of each species were generally put under observation, a precaution which proved of great service. But what with slow growth in some, sickliness in others, and the transplantation of not a few, the task of appreciating the facts and attempting to deduce general laws has been no easy one.

The Point of Measurement in the old set of trees was almost invariably five feet from the ground, but many of the new set were too young to be measured so high up, neither was it necessary at their early period of life; therefore a point between two and a half and five feet up was selected according to the varying conditions of girth, branching, &c.

The Measuring Instruments used were the well-known steel tapes of Chesterman, graduated to tenths or twentieths of an inch, certain methods being used which are explained in former papers. Accuracy with this instrument can be depended on to the tenth of an inch in all trees which are not very rough or apt to scale in the bark, and to the twentieth of an inch in young trees with smooth symmetrical stems; nay, I am persuaded that, with practice, measurements even to the fiftieth of an inch are reliable on carefully selected stems.

The figures in the tables and in the text, when referring to measurements, represent inches and decimal parts of an inch, unless otherwise stated. Percentages are calculated only to a single decimal.

The subject naturally falls under the two heads of Annual and Monthly Results, and each of these I have subdivided into the history of the species separately, and the collective results.

When it seems desirable the results for the older set of trees observed previous to 1887 are given for comparison. The majority of these trees are in the Botanic Garden, but a considerable number grow at Craigiehall, 5 miles west of Edinburgh. The latter are distinguished by an asterisk.

## I. ANNUAL RESULTS.

### A. History of the Species.

### (1) DECIDUOUS TREES.

#### BETULA ALBA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 78 | 9·30 | 0·95 | 0·80 | 1·35 | 1·10 | 0·95 | 14·45 | 5·15 | 1·05 |
| 82 | 20·80 | ·90 | ·70 | ·90 | 1·10 | ·80 | 25·20 | 4·40 | 0·88 |

Well sheltered in the Arboretum. No. 78 at the east end of the south shelter belt; No. 82 on the grass in the hollow under the lee of the east belt.

The annual rate of the younger tree, 1·05, is rather better than that of the older one, 0·88, although the latter is in the better situation and looks healthy and vigorous, seemingly indicating that already, at a girth of twenty inches, the rate of the species was falling off. But the rate of the much older Craigiehall Birch, No. 5*, five feet in girth in 1890, a healthy tree, was only 0·46 for six years; and that of the once graceful weeping Birch, No. 1, in the Botanic Garden, while still in fine condition, and measuring but four and a half feet in girth, was only 0·37 for four years previous to the great frosts of 1879–80–81, since when it has been reduced to 0·07.

Both the young trees shared in a depression of girth-increase which affected the Deciduous trees in 1888, and thus their annual range was increased, but still it is not excessive, amounting to from 0·80 to 1·35 in No. 78, and 0·70 to 1·10 in No. 82. The rise and fall of the two in different years corresponded pretty closely.

No. 8. ALNUS GLUTINOSA. No. 96. SALIX sp.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 8 | 9·50 | 0·80 | 0·85 | 1·20 | 0·55 | 0·70 | 13·60 | 4·10 | 0·82 |
| | March 1888 | | | | | | | | |
| 96 | 1·15 | ... | ·90 | 1·80 | 1·65 | 1·65 | 7·50 | *6·00 | 1·50 |

* This amount appears to be too small, because the point of measurement was shifted from near the ground to 5 feet up, as the infant stem grew.

*Alnus glutinosa.* Sheltered by other trees in the south belt of the Arboretum.

Its annual rate, 0·82, has been lowered by some special cause in 1890, when the increase, 0·55, was less than half that of the previous year, 1·20, and it did not quite recover in 1891. In both years the foliage looked diminutive and shabby. The rate for the previous three years was 0·95.

*Salix* sp. In the Osier bed near the pond in the Botanic Garden.

Its annual rate, 1·50, will probably in future be excelled, as when first measured it was in its infancy, one of many shoots from a common stock, which in 1890 were all pruned away except itself and another. Excluding the first year of infancy, the rate rises to 1·70.

NOS. 76, 87. POPULUS FASTIGIATA. No. 83. POPULUS ALBA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 76 | 8·25 | 1·25 | 0·75 | 1·75 | 1·35 | 0·75 | 14·10 | 5·85 | 1·17 |
| 87 | 6·65 | 1·60 | ·80 | 1·35 | 1·00 | ·45 | 11·85 | 5·20 | 1·04 |
| 83 | 7·25 | ·65 | ·45 | ·75 | ·85 | ·50 | 10·45 | 3·20 | 0·64 |

*P. fastigiata.* Both near the outer side of the south belt of the Arboretum. Their annual rate, little above an inch in either, seems low for a fast-growing species, and has apparently been reduced by their participating largely in the depressions of 1888 and 1891. In the latter years the whole of the Deciduous trees suffered a severe fall in girth-increase in the first half of the season, but the great majority rebounded much above their average in the second half. In these two Poplars, however, the depression was prolonged through the whole season, and their foliage had a very pinched look. Excluding the two bad years, their rate rises to 1·45 and 1·32.

*P. alba.* In the west belt of the Arboretum. Has a crooked stem, and does not appear to be thriving.

Like the other Poplars, its rate was reduced in 1888 and 1891, but even deducting these bad years the rate rises only from 0·64 to 0·78.

CARPINUS BETULUS.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 81 | 7·30 | 0·55 | 0·80 | 1·00 | 0·60 | 0·55 | 10·75 | 3·45 | 0·69 |
| 86 | 5·90 | ·40 | ·40 | ·70 | ·60 | ·70 | 8·65 | 2·75 | 0·55 |

No. 81 in the well-sheltered east belt of the Arboretum; No. 86 somewhat more exposed, and in the thinner soil of the south belt.

The annual rate, 0·69 and 0·55, seems low, and it may be questioned if the trees are thriving, as the foliage is rather shabby, and their growth has been very irregular and not at all corresponding in the two in the annual rise and fall. The rate of a handsome symmetrical Hornbeam, No. 33, standing free in the Botanic Garden, and 4 feet in girth, was only 0·41 for ten years.

FAGUS SYLVATICA.

| No. in List. | Girth. | Annual Increments. | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|
| | March 1888 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 97 | 10·30 | 1·15 | 1·30 | 1·50 | 1·30 | 15·55 | 5·25 | 1·31 |
| 98 | 8·10 | 1·00 | 1·10 | 1·45 | 1·35 | 12·95 | 4·85 | 1·21 |

Both in the well-sheltered east belt of the Arboretum.

The annual rates, 1·31 and 1·21, are higher than in any of the ten much older Beeches, some in the Botanic Garden, others at Craigiehall, girthing respectively 60, 66, 70, 78, 80, 81, 100, 121, 138, and 143 inches in 1887, under observation for from seven to ten years previously, the average rate of the whole having been 0·62, and that of the best, nearly 7 feet in girth, 1·03.

QUERCUS ROBUR.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 70 | 7·10 | 0·80 | 0·50 | 0·75 | 0·95 | 1·05 | 11·15 | 4·05 | 0·81 |
| 72 | 5·90 | ·50 | ·20 | ·40 | ·80 | 0·55 | 8·35 | 2·45 | ·49 |
| | March 1888 | | | | | | | | |
| 1 | 5·50 | ... | ·40 | ·40 | ·65 | ·75 | 7·70 | 2·20 | ·55 |
| 2 | 8·00 | ... | ·20 | ·30 | ·65 | ·80 | 9·95 | 1·95 | ·49 |

All four in the south belt of the Arboretum, well sheltered from the south, but slightly exposed to the north.

Nos. 70 and 72 were selected originally, but as the latter showed signs of failure, Nos. 1 and 2 were added next year to secure a better average. Nevertheless none of the others show anything like so good an annual rate as No. 70, which yields 0·81, compared with their 0·55, ·49, and ·49. This was probably due to the almost entire destruction of the leaves in June 1888 from an insect plague which affected Oaks in many parts of Scotland and England. I noted that No. 70 recovered its full foliage next year, while the others continued to look shabby both then and in 1890. A corresponding variation in girth-increase appears from the aggregate increments of the four trees, that of 1888 (1·30) being not half those of 1890 (3·05) and 1891 (3·15).

The immediate effect of the disaster was shown by the fact that there was absolutely no increase in June in Nos. 70, 74, and only an increase of 0·05 in each of the others. The annual loss would probably have been still greater but for an abundant second crop of leaves in late summer. From what has been said it is evident that the annual range must have been great; in No. 70 it was from 0·50 to 1·05; in 72 and 2 from 0·20 to 0·80; and in 1, from 0·40 to 0·75. A much older tree, No. 12*, about 6 feet in girth, at Craigiehall, grew for ten years at the slow rate of 0·37, but like almost all the numerous Oaks at Craigiehall, it had a shabby stag-horned look. One of the largest in the Park, however, had a fine head of spreading foliage, and although 11 feet in girth, grew at the rate of no less than 0·69 for ten years. This is a rate not exceeded by any forest tree of similar size and of whatever species that I have measured, a proof that the Oak when of considerable size is not invariably a slow grower.

No. 61. QUERCUS RUBRA. No. 63. Q. CERRIS. No. 16. Q. ILEX.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 61 | 5·40 | 0·10 | 0·00 | 0·30 | 0·90 | 1·00 | 7·70 | 2·30 | 0·46 |
| 63 | 60·25 | ·60 | ·70 | ·45 | ·65 | ·50 | 63·15 | 2·85* | ·57 |
| 16 | 4·20 | ·45 | ·55 | ·80 | ·85 | ·60 | 7·35 | 3·15 | ·63 |

*Q. rubra.* Transplanted in spring 1887 to the grassy, free, but sheltered space behind the great Yew in the Botanic Garden.

In consequence of transplantation, the foliage was miserably poor in 1887, and the increase was only a tenth of an inch. In 1888 the whole of the shoots of the previous year died. The tree was almost leafless, and there was no girth-increase. Apparently it was in a hopeless state. Nevertheless it recovered perfectly, although slowly. In 1889 the leaves were scanty, but large and healthy, and the increase was 0·30. Next year it was 0·90; and in 1891, although a year of general depression, it rose to 1·00, and the tree was handsomely clothed. Hence the normal rate is probably about an inch.

*Q. Cerris.* Although much older than the other trees, it was selected as the only available specimen of its species. It is a fine tree, with a straight, tall, cylindrical stem and a fair head of foliage, well situated south of the central open space in the Botanic Garden.

Its annual rate was 0·57, exactly the same as in No. 43 of the former set, also a Botanic Garden tree, which as to

* In this instance and several others the sum of the increase does not quite correspond with the difference between the girth-measurements at the beginning and end of the period. These discrepancies arise from unimportant causes, are trifling in amount, and are of no moment as regards the results.

appearance might be described in the same terms as No. 63. But both were quite eclipsed by the much larger Craigiehall Turkish Oak, No. 10*, 6½ feet in girth in 1890, which in the previous eleven years averaged 0·88. This tree has a shorter stem, of about 8 or 10 feet, but a more spreading ramification than the others.

*Q. Ilex* stands free on grass in the grove of young Oaks in the north-west corner of the Arboretum. Although evergreen, it is given here for comparison with the other Oaks.

The annual rate, 0·63, is probably too low, as the tree was an infant when measurement, which had to be taken low down, began. The rate was steadily increasing till checked in the very late season of 1891, having been 0·40, ·55, ·80, ·85, ·50.

As far as can be judged from the exceptional character of their careers, these three species do not seem to have shared in the misfortunes of *Q. Robur* in 1888, but *Q. Cerris* had a very small increase in 1889.

TILIA EUROPÆA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 69 | 7·20 | 0·65 | 0·60 | 0·85 | 0·75 | 0·55 | 10·60 | 3·40 | 0·68 |
| 85 | 7·65 | ·40 | ·50 | ·60 | ·65 | ·45 | 10·25 | 2·60 | ·52 |

In the south shelter belt of the Arboretum, somewhat exposed to the north.

Although these trees are quite healthy-looking, their rates, 0·68 and 0·52, are low compared with most forest species; but that of the older No. 18, at the north end of the belt between the Botanic Garden and Arboretum, was only 0·34 for fourteen years, although it is only 4 feet in girth, stands tolerably free, and is quite healthy-looking; that of the still older No. 2, in the centre of the Garden, a handsome symmetrical tree, 6½ feet in girth, with a spreading head of dense foliage, but showing signs of failure in some twigs, has been only 0·30 for fourteen years; and the rate for the same period of the still larger Craigiehall No. 21*, about $8\frac{1}{2}$ feet in girth, a perfectly healthy spreading tree, was only 0·15. Thus, as far as my limited experience goes, the rate of the Lime at all ages in the Edinburgh district is slow.

ÆSCULUS HIPPOCASTANUM.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 73 | 6·80 | 0·70 | 0·70 | 1·10 | 0·90 | 0·80 | 11·00 | 4·20 | 0·84 |
| 80 | 7·35 | 1·00 | 1·05 | 1·35 | 1·30 | 1·15 | 13·25 | 5·85 | 1·17 |

No. 73 is in the south, No. 80 in the east belt of the Arboretum. Better shelter and richer soil no doubt account for the quicker rate, as well as for the denser foliage and more spreading ramification, of No. 80, compared with the slower, scanty foliage and short branches of No. 73.

The annual range, 0·70 to 1·10 and 1·00 to 1·35, is small, and the two trees agree pretty well in their annual rise and fall of increase.

ACER PSEUDO-PLATANUS.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 67 | 6·75 | 0·10 | 0·20 | 0·30 | 0·50 | 0·40 | 8·30 | 1·50 | 0·30 |
| 71 | 8·45 | ·95 | ·85 | 1·05 | 1·40 | 1·20 | 13·90 | 5·45 | 1·09 |
| 74 | 9·15 | ·85 | ·70 | 1·10 | 1·55 | 1·40 | 14·75 | 5·60 | 1·12 |

Nos. 71 and 74 are thriving specimens in the south belt of the Arboretum. No. 67 is now a handsome young tree in an open but well-sheltered spot in the Botanic Garden, a little north-west of the pond, but its foliage was very scanty for a time, and its rate was much checked by transplantation in spring 1887.

The successive rates of No. 67 were 0·10, ·20, ·30, ·50, ·40, showing a gradual improvement after transplantation, till checked by the late season of 1891. This corresponded with the condition of the foliage, which, although always healthy, was extremely scanty in 1887, but improved every year, and in 1891 was quite abundant. The individual leaves all along were remarkably large.

The annual rates of Nos. 71 and 74 were nearly alike, 1·09 and 1·12, and they followed each other steadily in the rise and fall of the yearly amounts. A Botanic Garden Sycamore of the older set No. 28, upwards of 5 feet in girth in 1891, increased at the rate of only 0·31 in fourteen years, although rather fine-looking, with a fair head of healthy foliage, and well sheltered in the west border of the Garden. No. 13, the largest Sycamore in the Arboretum, a still handsome though failing tree, above 11 feet in girth, did not much worse than this, its rate having been 0·26 for thirteen years; but No. 7*, nearly 11 feet in girth, in the Park at Craigiehall, had the better rate of 0·43 for twelve years.

The annual range, particularly of No. 74, 0·70 to 1·55, was high.

No. 21. CYTISUS LABURNUM. No. 19. CRATÆGUS OXYACANTHA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 21 | 6·05 | 0·60 | 0·75 | 1·00 | 0·85 | 0·90 | 10·20 | 4·10 | 0·82 |
| 19 | 9·65 | ·70 | 1·05 | 1·65 | ·90 | 1·00 | 15·00 | 5·30 | 1·06 |

*Cytisus Laburnum.* In the south belt of the Arboretum. It seemed to be healthy, and its rate was apparently unaffected by profuse flowering in two seasons. The rate, 0·82, may be normal for a sandy soil, as the range was not excessive.

*Cratægus Oxyacantha.* In the south belt of the Arboretum, sheltered but not pressed by other trees. Its annual rate was 1·06; that of the handsome weeping Thorn, No. 16, in the Botanic Garden, a much older tree, nearly 4 feet in girth, was 0·56 for fourteen years; and as this rate was maintained in the last four years, its vigour does not seem to diminish. The range of No. 19 was great, 0·70 to 1·65, and the latter amount in a single year indicates that the Hawthorn *may* grow very rapidly even in a thin sandy soil.

## PRUNUS PADUS.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 18 | 4·55 | 0·90 | 0·65 | 0·90 | 0·80 | 0·70 | 8·50 | 3·95 | 0·79 |
| 22 | 6·55 | 1·15 | 1·20 | 1·45 | 1·25 | 1·35 | 13·05 | 6·40 | 1·28 |

No. 18 in the south belt of the Arboretum, No. 22 in the hollow of the east border.

The inferiority of the annual rate in No. 18, 0·79, to that of No. 22, 1·28, may be explained by the superior situation and soil of the latter. No. 18 is of a straggling habit, No. 22 thickly branched. The latter flowered abundantly in 1890 and 1891 without appreciable effect on the girth-increase. The annual range, 0·65 to 0·90 in the one, and 1·15 to 1·45 in the other, is unusually small.

## PYRUS AUCUPARIA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 77 | 6·65 | 0·30 | 0·80 | 0·40 | 0·70 | 0·55 | 9·45 | 2·75 | 0·55 |
| 79 | 10·80 | ·90 | ·75 | 1·05 | 1·10 | ·90 | 15·55 | 4·70 | ·94 |

No. 77 well sheltered at the east end of the south belt of the Arboretum, No. 79 under the lee of the east belt.

Superior soil probably accounts for No. 79 having grown at nearly double the rate, 0·94 to 0·55, of No. 77. The deficiency in the latter was almost entirely due to failure in the second half-seasons.

## ULMUS CAMPESTRIS.

| No. in List. | Girth. | Annual Increments. | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 93 | 12·75 | 1·75 | 1·80 | 1·75 | 1·50 | 19·55 | 6·80 | 1·70 |
| 94 | 10·65 | 1·15 | 1·75 | 1·45 | 1·30 | 16·35 | 5·65 | 1·41 |

These two Elms are in the hollow of the east belt of the Arboretum, perhaps the best situation and with the best soil in the place. If planted at the same age as the other trees in the same belt, the Elms have visibly surpassed them all in rapidity of growth, and this is confirmed by their large rate of 1·70 and 1·41. Their range, 1·50 to 1·80, and 1·15 to 1·75, was small. The rate of No. 60, an older but quite young Elm, not 3 feet in girth, at the west end of the grove on the high ground at the north-east corner of the Arboretum, was only 0·32 for five years, probably from poverty of soil.

FRAXINUS EXCELSIOR.

| No. in List. | Girth. | Annual Increment. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 23 | 5·75 | 0·85 | 0·85 | 1·15 | 0·90 | 0·80 | 10·30 | 4·55 | 0·91 |
| 75 | 4·90 | ·50 | ·45 | ·60 | ·45 | ·60 | 7·55 | 2·65 | 0·53 |

No. 23 in the rich hollow of the east shelter belt of the Arboretum, No. 75 in the more exposed and sandy south belt. This difference of position and soil may account for the slow rate, 0·53, of No. 75, compared with 0·91 of No. 23. The old Craigiehall Ash, No. 6*, 12 feet in girth, increased 0·70 in 1878, but after the disastrous winters of 1879–80–81, its rate for thirteen years fell to 0·38, and this rate is still maintained, although the tree shows many dead branches and has a shabby look.

(2) CONIFERÆ.

ABIES DOUGLASII.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 6 | 4·35 | 0·95 | 0·80 | 0·40 | 0·55 | 0·65 | 7·80 | 3·35 | 0·67 |
| 66 | 6·50 | ·95 | ·45 | 1·20 | 1·25 | 1·10 | 11·55 | 4·95 | ·99 |
| | March 1889 | | | | | | | | |
| 99 | 7·80 | | | 1·20 | 1·20 | 1·05 | 11·30 | 3·45 | 1·15 |

Nos. 6 and 99 are in the *Abies* collection, No. 66 on "the Triangle," all in good, sheltered situations.

No. 6 was quite healthy till moved a short distance in spring 1889. Since then the annual shoots have been late and short, and, although improving, the tree is far from having recovered its pristine vigour. This history is reflected in the girth-increase, which fell from 0·80 in 1888 to 0·40 in 1889, and rose to only 0·65 in 1891.

No. 66 also suffered from transplantation in autumn 1887. It looked very shabby in 1888, gradually improved thereafter, and has now, in 1891, nearly recovered a thoroughly vigorous look. The girth-increase, falling from 0·95 in 1887 to 0·45 in 1888, sprang up at once in 1889 to 1·20, notwithstanding the continuing shabby look of the tree.

No. 99 does not appear from the measurement to be much older than the others, but probably is so, the girth having been taken higher up, and the tree being altogether much larger. Its rate, 1·15, is more reliable, as this tree has not been recently disturbed, but the progenitor of them all, which formerly stood on "the Triangle," must have had a rate of 1·56 for its first thirty-seven years of life; in the next four years, 1875–78, when about $5\frac{1}{2}$ feet in girth, Sir R. Christison found it still increasing at the fair rate of 0·77; but, perhaps from the effects of the following severe winters, it gradually became a wreck, the rate for nine years fell to 0·22, and it was cut down.

Another *Abies Douglasii*, No. 68, has never rallied from transplantation in spring 1887, and is apparently dying.

ABIES LOWIANA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 8 | 4·65 | 1·95 | 1·50 | 1·85 | 1·90 | 1·65 | 13·55 | 8·90 | 1·78 |
| 92 | 3·95 | 1·95 | 1·65 | 0·30 | 1·00 | 1·00 | 9·90 | 5·90 | 1·18 |

Both in the collection of *Abies*, Botanic Garden.

No. 8 has always been healthy, and clothed with dense foliage to the ground, and has grown at the great rate of 1·78, with the low range of 1·50 to 1·95. This was at 2 feet from the ground, but I was surprised to find from three years' measurements that at 5 feet above ground the rate was even greater, amounting to 1·90, and in 1890 it grew 2·25, the largest year's growth I have ever recorded in any tree.

No. 92, an equally fine specimen in 1887 and 1888, promised to do quite as well, but being moved, its rate fell from an average of 1·80 in these two years to 0·30 in 1889, and although there was a rally to 1·00 the next two years, it has not yet recovered its pristine look of vigour. An older tree, No. 31, began to fall off in appearance when under 2 feet in girth, and, when a little above it, became very thin in the branches and unsightly, and was cut down in 1887. Notwithstanding its shabby look, its rate for the last five years was 1·02.

No. 91. Abies grandis. No. 24. Abies Hookeriana.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 91 | 3·00 | 1·25 | 1·15 | 1·65 | 1·80 | 1·60 | 10·55 | 7·45 | 1·49 |
| 24 | 9·00 | 0·60 | 0·60 | 0·70 | 0·55 | 0·50 | 11·95 | 2·95 | 0·59 |

*Ab. grandis.* In the *Abies* collection, very healthy, densely clothed to the ground. The annual rate has been 1½ inch, and the range, 1·15 to 1·80, is moderate. Numerous vesicles appeared on the stem in 1891, but there has been no exudation of turpentine.

*Ab. Hookeriana.* A bushy, well-clothed tree, with an upright habit, on the west side of the *Abies* collection, with a rate of 0·59 and the moderate range of from 0·50 to 0·70.

Pinus excelsa.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 2 | 2·60 | 0·90 | 0·90 | 1·20 | 1·10 | 1·10 | 8·15 | 5·40 | 1·08 |
| 3 | 3·45 | ·60 | ·60 | 0·65 | 0·55 | 0·45 | 6·25 | 2·85 | 0·57 |
| 11 | 3·70 | ·30 | ·50 | 1·00 | 1·30 | 1·00 | 7·90 | 4·10 | 0·82 |

Nos. 2 and 3 are in the collection of *Pinus*, and No. 11 on "the Triangle."

No. 2 is three-quarters closely surrounded and overshadowed, but not touched by other trees. It seems quite healthy, but is short-branched; its rate, 1·08, is probably fair for so young a tree, and the range, 0·90 to 1·20, is small.

No. 3, near the last and similarly situated, but more overshadowed and pressed by neighbours, has still shorter branches and is more straggling though symmetrical. Its rate, 0·57, little more than half that of No. 2, must be exceptionally low.

No. 11 is a larger tree, the girth given, although much the same as in the others, being taken higher up. It was transplanted to "the Triangle" in spring 1887, hence its rate, 0·82, is unduly low. For the last three years it has risen to 1·10, and the tree is now thoroughly healthy and well clothed to the ground.

Two older specimens, Nos. 24 and 26, on the Terrace, one a little under, the other a little above 3 feet in girth, are stunted, although the foliage is healthy. For thirteen years the rate of No. 24 has been only 0·22, and of No. 26, 0·49; but the latter seems to be rallying somewhat, as its rate for the first six years was only 0·34, and for the last seven rose to 0·62.

No. 26. PINUS PINASTER. No. 25. P. MURRAYANA.
No. 28. P. AUSTRIACA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | March 1891 | | |
| 26 | 3·30 | 0·95 | 0·95 | 0·80 | 0·60 | 0·60 | 7·25 | 3·90 | 0·78 |
| 25 | 12·50 | ·75 | ·70 | ·75 | ·70 | ·55 | 16·05 | 3·50 | 0·70 |
| 28 | 4·10 | ·80 | ·85 | ·70 | ·45 | ·35 | 7·25 | 3·15 | 0·63 |

All in the Pine collection and but poor specimens.

*P. Pinaster.* A lanky tree, but throwing out long shoots; a good deal overshadowed by neighbours. It seems to be falling off both in appearance and increase, the latter having averaged 0·90 the first three years and only 0·60 the last two.

*P. Murrayana.* A spreading and rather scraggy tree, somewhat pressed by neighbours. Its rate was very steadily about 0·70 for the first four years, but fell to 0·55 in the late season of 1891.

*P. austriaca.* A fairly good specimen at first, but has been getting more and more lanky yearly, and the girth-increase gradually fell from 0·85 in 1888 to 0·35 in 1891. It contrasts unfavourably with a handsome somewhat older specimen in the south border of the Arboretum, which increased 1·25 in 1891, the only year of measurement; and still more so with No. 2* of the old set, outside the garden wall at Craigiehall, in rich soil, and now 3 feet in girth, whose rate for twelve years has been 1·53.

CUPRESSUS LAWSONIANA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 9 | 24·50 | 0·40 | 0·45 | 0·45 | 0·60 | 0·50 | 26·90 | 2·40 | 0·48 |
| 10 | 22·20 | ·40 | ·20 | ·50 | ·70 | ·55 | 24·60 | 2·35 | ·47 |

At opposite ends of the strip of grass south of the central space of the Botanic Garden.

They are healthy and symmetrical, but the branches are short in proportion to the thickness of the stem. The two are very much alike in aspect and situation, and their girth-increase corresponds closely in amount and in the yearly rise and fall, except for a marked failure in No. 10 in 1888. Their rate, barely half an inch, is inferior to the 0·82 for twelve years of No. 1*, outside the garden wall at Craigiehall, a tree of nearly the same girth. 0·70 is the largest increase in one year in either No. 9 or 10, but No. 1* twice attained 1·05.

NO. 12. THUJA GIGANTEA. NO. 14. RETINOSPORA OBTUSA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 12 | 20·80 | 0·50 | 0·70 | 1·15 | 1·05 | 0·60 | 24·90 | 4·10 | 0·82 |
| 14 | 4·30 | ·45 | ·25 | 0·60 | 0·50 | ·40 | 6·60 | 2·20 | 0·44 |

*Thuja gigantea.* On the grass west of the large Yew, in a sheltered position. A thriving tree, though rather bare to the east. Its rate, 0·82, though it does not seem large, is double that of a younger neighbour, which looks quite as well. Two apparently healthy, well-grown specimens of *Thuja Craigieana*, east of the *Abies* collection, were also under observation, but one grew at the rate of only 0·24 and the other at the still lower rate of 0·18, so that there is no use in recording the details.

*Retinospora obtusa.* A healthy shrub at the north-west angle of the grass behind the large Yew. The annual rate, 0·44, is somewhat lowered by a depression to 0·20 in 1888, and as 0·60 was made in the following year, the range is large. Another younger specimen, No. 90, although it did not in the least suffer in appearance from transplantation in spring 1888, has only averaged 0·15 since, while it increased 0·45 the year before.

ARAUCARIA IMBRICATA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 64 | 7·25 | 0·65 | 0·60 | 0·35 | 0·60 | 0·55 | 9·95 | 2·70 | 0·54 |
| 65 | 14·45 | ·60 | ·60 | ·55 | ·70 | ·65 | 17·50 | 3·05 | 0·61 |

These trees stand together at the south-west angle of the Araucaria grove. No. 64 has short internodes, No. 65 long ones, and both look well.

The rate of No. 64, the younger tree, was 0·54; that of No. 65 was 0·61. Two Araucarias of the older set, much damaged by frost in 1860, were rather unsightly ever afterwards. One of them, No. 34, nevertheless grew 0·60 in 1878, but never recovered further damage from frost in 1879–80–81, and its rate was only 0·31 till cut down in 1887. The other, No. 35, escaped injury in the latter frosts, and attained a rate of 0·69, till cut down on account of its shabby look in 1887. Its girth, like that of No. 34, was then only about 2 feet, and another healthy young tree, No. 4* at Craigiehall, but which has lost its lower branches, increased at the better rate of 0·72 for thirteen years. But the species is able to grow in Scotland at a much greater rate than any of these. A very handsome specimen at Stravithie near St Andrews, a locality by no means noted for fine trees, must have grown at the annual rate of fully an inch for 26 years, as this is well ascertained to be its age, and it girths 24 inches at 5 feet from the ground. Allowing six years for it to grow to the height of 5 feet, the rate would be 1·20 for 20 years. It is about 27 feet high, so that its upward growth for 26 years has been at the rate of about a foot a year.

LARIX EUROPÆA.

| No. in List. | Girth. | Annual Increments. | | | | | Girth. | Total Incr. | Annual Average. |
|---|---|---|---|---|---|---|---|---|---|
| | March 1887 | 1887 | 1888 | 1889 | 1890 | 1891 | Oct. 1891 | | |
| 20 | 3·90 | 0·75 | 1·25 | 1·75 | 1·40 | 0·95 | 10·10 | 6·10 | 1·22 |
| 89 | 4·00 | ·90 | 1·05 | 1·10 | 1·15 | ·55 | 8·85 | 4·70 | 0·94 |

No. 20 is in the south belt and No. 89 in the north belt of the Arboretum. Both throve well till 1891, when they were thickly sprinkled with small bluish-white spots, looked sickly, and had their girth-increase considerably lowered. No. 20 seems to have been the quicker grower of the two, its rate being 1·22, while that of No. 89 is only 0·94, but this may be because the latter was measured higher up. In their best years No. 20 attained 1·75 and No. 89, 1·15.

## *B.* Collective Results.

### (1) Deciduous Trees.

#### *a.* Comparative Annual Rate of the Species.

In considering this question I have taken only the quickest grower of each species, because two or three specimens are not sufficient to establish a fair average of growing power when one or two of them are in comparatively poor soil, or have shown signs of unhealthiness, as happened with several of my selected trees. It must also be remembered that even if the trees were in equally favourable conditions of soil, situation, and health, their rates might not be strictly comparable, because, although all young, they are not actually of the same age; and even if they were, a further source of error arises from the different periods of life at which the species may be in the habit of passing from the slow rate of infancy to the rapid rate of youth. Therefore the figures in the first column of Table I. must be accepted not so much as comparative of the growing power of the different species as indicative of their rate in tolerably good soil, or in poor soil, as the case may be.

[Table I.

TABLE I. ANNUAL RATE AND RANGE OF GIRTH-INCREASE IN DECIDUOUS SPECIES DERIVED FROM ONE SPECIMEN OF EACH.

| Species. | Girth, Oct. 1891. | Annual Rate. | Range. | |
|---|---|---|---|---|
| | | | Least Incr. in one year. | Greatest Incr. in one year. |
| 94. Ulmus campestris, | 19·55 | 1·70 | 1·50 | 1·80 |
| 96. Salix, | 6·05 | 1·50 | ·90 | 1·80 |
| 97. Fagus sylvatica, | 15·55 | 1·31 | 1·15 | 1·50 |
| 22. Prunus Padus, | 13·05 | 1·28 | 1·15 | 1·45 |
| 80. Æsculus Hippocastanum | 13·25 | 1·17 | 1·00 | 1·35 |
| 76. Populus fastigiata,* | 14·15 | 1·17 | ·75 | 1·75 |
| 74. Acer Pseudo-platanus,* | 14·75 | 1·12 | ·70 | 1·55 |
| 19. Cratægus Oxyacantha,* | 15·00 | 1·06 | ·70 | 1·65 |
| 78. Betula alba,* | 14·45 | 1·05 | ·80 | 1·35 |
| 61. Quercus rubra, | 7·70 | 0·95 | ·90 | 1·00 |
| 79. Pyrus Aucuparia, | 15·55 | 0·94 | ·75 | 1·10 |
| 23. Fraxinus excelsior, | 10·30 | 0·91 | ·80 | 1·15 |
| 88. Alnus glutinosa,* | 13·65 | 0·82 | ·55 | 1·20 |
| 21. Cytisus Laburnum,* | 10·20 | ·82 | ·60 | 1·00 |
| 70. Quercus Robur,* | 11·15 | ·81 | ·50 | 1·05 |
| 81. Carpinus betulus, | 10·85 | ·69 | ·55 | 1·00 |
| 69. Tilia europæa,* | 10·60 | ·68 | ·55 | ·85 |
| 16. Quercus Ilex,† | 7·35 | ·63 | ·45 | ·80 |

No. 94. *Ulmus campestris* stands well at the head of the list with an annual rate of 1·70. Its girth is from a fourth to a third greater than that of the other quicker growers, but that probably implies that it has outstripped them in the race rather than that it is of greater age. A neighbouring Elm, No. 93, has apparently also been outstripped by 94, but not by so much, as it would take third place in the Table with a rate of 1·41.

No. 96. *Salix.* Its rate, 1·50, will probably soon be exceeded, as it is only emerging from infancy, the girth having been only 1·20 when the measurements began.

No. 97. *Fagus sylvatica.* The rate, 1·31, is probably representative, as it is a fine healthy tree, in good soil, and a neighbouring Beech, No. 98, is not far behind with 1·21.

No. 22. *Prunus Padus*, with 1·28, and No. 80, *Æsculus Hippocastanum*, with 1·17, are also very healthy, vigorous-looking, and apparently reliable trees, in a favourable situation.

No. 76. *Populus fastigiata.* The rate, 1·17, is no doubt low from an apparent failure and unhealthiness in two of

* These eight in poor sandy soil, the others more favourably placed.

† Although evergreen, introduced for comparison with its relatives.

the five years. The amount in its best year, 1·75, shows what it is capable of doing even in a very poor soil.

No. 74. *Acer Pseudo-platanus,* 1·12; No. 19, *Cratægus Oxyacantha,* 1·06; No. 78, *Betula alba,* 1·05. These results are probably reliable, as the trees are fine specimens; nevertheless, the great range in 74 (0·70 to 1·55), and in 19 (70 to 1·65), suggest that, possibly from temporary depressions, or from the thin sandy nature of the soil, the averages may be abnormally low.

A second *Acer,* No. 71, is close up to 74, with 1·09; but a second *Betula,* with 0·88, falls behind No. 78, notwithstanding a better situation, perhaps from greater age, its girth being above 2 feet.

No. 61. *Quercus rubra.* A very young tree, just recovering from transplantation. Probably its rate will soon exceed the 0·95, which is that of the last two years.

No. 79. *Pyrus Aucuparia,* 0·94, probably a reliable result, as the tree is in good soil, is vigorous and healthy-looking, and the range is not great.

No. 23. *Fraxinus excelsior,* 0·91, is rather low compared with the rate of some forest species, but the specimen is favourably situated, seems quite healthy, and the range is small.

No. 88. *Alnus glutinosa,* 0·82; apparently reduced by failure of health in the last two seasons. In poor sandy soil.

No. 21. *Cytisus Laburnum,* 0·82, reliable as far as the healthy appearance of the tree goes, but it is in thin sandy soil.

No. 70. *Quercus Robur,* 0·81, seems good for an Oak, in a district where that species does not greatly flourish. It is nearly twice as high as the average of three other specimens, near No. 70, but they are obviously inferior in development, and suffered more than it from an insect plague in 1888. All these Oaks are in the almost pure sand of the south border of the Arboretum.

No. 81. *Carpinus Betulus,* 0·69, seems a low rate, but it exceeds that of a neighbour, No. 86, which is only 0·55. In both the foliage latterly was rather small and shabby.

No. 69. *Tilia europæa.* 0·68 in this, and 0·52 in a neighbour, No. 85, are low rates compared with other forest trees, but both have every season been well-clothed and healthy, and the range is not remarkably high. The low rates are probably due to the poor soil.

No. 16. *Quercus Ilex*, although an evergreen, has been added, as it is a *Quercus*. 0·63 may be too low, as the tree is little more than an infant, its girth where measured, near the ground, being only 7·35.

### *b.* Range of Girth-increase in the five years.

(See Table I.)

The variations in the increase of a tree in different years may be due to meteorological causes, to variations in health, to passage from the infantile to adult life, or to causes of which we have as yet no knowledge. The range proved always considerable, as the Table shows, but it is comparatively small in *Ulmus*, 1·50 to 1·80; *Fagus*, 1·15 to 1·50; and *Prunus*, 1·15 to 1·45; and it is comparatively large in *Populus*, 0·75 to 1·75; *Acer*, 0·70 to 1·55; and *Cratægus*, 0·70 to 1·65.

### *c.* Maximum Annual Growth in the Species.

The last column in Table I. shows that of the seventeen deciduous trees, all of different species, *Tilia europæa* alone failed to reach an inch of growth in one or other of the five years. None of them attained 2 inches, but *Ulmus* and *Salix* were not very far off, with 1·80 each. The only deciduous tree I have ever measured which grew 2 inches in a year is *Quercus conferta*, No. 54, a young tree, but belonging to the older set, which twice in eleven years reached 2·05.

### *d.* Annual Variation in the aggregate Girth-increase.

As probably very few of the trees have attained their maximum rate of growth, it might be expected that the annual results would show a gradual increase, but this is far from being the case, as the following Table shows.

| | | Total Increase. | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1887 | 1888 | 1889 | 1890 | 1891 | Average. |
| 28 Trees | 16 Species | 20·05 | 18·40 | 25·75 | 24·75 | 21·65 | 22·10 |
| 35 Trees* | 17 Species | ... | 25·45 | 34·45 | 33·85 | 30·30 | 31·00 |

Taking the 28 trees under observation for five years, their best season was 1889, with an increase of 25·75, but 1890, with 24·75, was little inferior to it. 1888 was the worst year, with 18·40, being 1·65 below the previous year, 6·35 below the subsequent year, and 3·70 below the general average. Taking in the additional seven trees for the last four years, the results are confirmed,—1888, the worst year, with 25·45, being 9·00 below 1889, the best, with 34·45, or 5·55 below the general average.

In the season 1891, when the depression was comparatively slight, 23 of the 37 trees shared in it, but in 1888, when the maximum depression occurred, 31 of the 35 trees showed a smaller increase than in 1889.

## (2) CONIFERÆ.

The introductory remarks regarding the Deciduous group are applicable to this group also.

### *a.* Comparative Annual Rate of the Species.

Thirty trees of 17 species of Coniferæ were under observation for five years, and another for three years only. Unfortunately, as already remarked, the soil of the Botanic Garden is not favourable to the growth of Coniferæ. A few species thrive very well in infancy and early youth, but they are apt to fall off in vigour before or soon after reaching middle life, and other species grow poorly from the beginning, although they thrive well in other Scottish localities. As the results in the latter are of comparatively little value, I have separated them in the Tables from the more vigorous trees. In both Tables I give, as in the Deciduous Class, only the best grower of the two or three of each species under observation.

* The above 28, with 7 added in 1888.

TABLE II. ANNUAL RATE AND RANGE OF CONIFERÆ, DERIVED FROM ONE TREE ON EACH SPECIES (vigorous group).

| | Girth, Oct. 1891. | Annual Rate. | Range. | |
|---|---|---|---|---|
| | | | Least Incr. in one year. | Greatest Incr. in one year. |
| 8. Abies Lowiana, | 13·55 | 1·78 | 1·50 | 1·95 |
| 91. Abies grandis, | 10·55 | 1·49 | 1·15 | 1·65 |
| 20. Larix europæa, | 10·10 | 1·22 | ·70 | 1·75 |
| 66. Abies Douglasii, 3 years, | 11·55 | 1·18 | 1·10 | 1·25 |
| 2. Pinus excelsa, | 8·15 | 1·08 | ·90 | 1·20 |
| 12. Thuja gigantea, | 24·90 | 1·02 | ·50 | 1·15 |
| 65. Araucaria imbricata, | 17·50 | ·61 | ·55 | ·65 |
| 24. Abies Hookeriana, | 11·95 | ·59 | ·50 | ·70 |
| 9. Cupressus Lawsoniana, | 24·60 | ·48 | ·40 | ·60 |
| 14. Retinospora obtusa, | 6·60 | ·44 | ·25 | ·60 |

No. 8. *Abies Lowiana* stands decidedly in the first place, with 1·78. This was at 3 feet up, but the rate for 1890 at 5 feet up was no less than 2·25. The rate is confirmed by that of a neighbour, 1·80, but this was for two years only, transplantation having greatly retarded its growth for the three subsequent years.

No. 91. *Abies grandis,* 1·49, is probably representative, as no tree could be healthier or more vigorous-looking. Although the rate is not equal to that of *A. Lowiana,* it is probably owing to the tree being rather younger.

No. 20. *Larix europæa,* 1·22, is probably too low for a Larch, as the growth was very irregular, and one year reached 1·75. It is the only one of my Coniferæ that has the disadvantage of growing in the south belt of the Arboretum.

No. 66. *Abies Douglasii,* 1·18, probably too low, as the tree may still be suffering from transplantation, which in 1888 reduced the rate to 0·45. The rate given is deduced from the three subsequent years. It is true the rate (1·15) of another tree, No. 99, some few years older, is much the same, but an ancestor of them both, that stood on the same spot as No. 66, had a rate of 1·56 for thirty-seven of its early years.

No. 2. *Pinus excelsa.* 1·08 may be a natural rate for so young a tree.

No. 12. *Thuja gigantea,* 1·02, probably reliable, as the tree is a fine one.

No. 65. *Araucaria imbricata.* 0·61 is a fair rate compared with that of other specimens in the Botanic Garden.

No. 24. *Abies Hookeriana*, 0·59; No. 9, *Cupressus Lawsoniana*, 0·48; No. 14, *Retinospora obtusa*, 0·44. Compared with the others in the Table, these rates are low, and the specimens, although healthy enough, are not very luxuriant. The rate of an older Cypress at Craigiehall was 0·82.

*b.* Range of Girth-increase in the five years.

This was comparatively small in *Abies Lowiana*, 1·50 to 1·95; in *Abies grandis*, 1·15 to 1·65; and especially in *Abies Douglasii* (3 years only), 1·10 to 1·25; and in *Araucaria imbricata*, 0·55 to 0·65. It was specially large in *Thuja gigantea*, 0·50 to 1·15; in *Larix europæa*, 0·70 to 1·75; and in *Retinospora obtusa*, 0·25 to 0·60.

*c.* Maximum Annual Growth in the Species.

Although none of the 30 Pinaceæ under observation attained an increase of 2 inches in a single year at the regularly measured point, two examples of *Abies Lowiana*, Nos. 8 and 92, each came very near it with 1·95, and in 1890 No. 8 went beyond it to 2·25, at a higher point.

The maximum years of *Larix*, 1·75, and *Abies grandis*, 1·65, were also high. On the other hand, none of the last four in the Table came near an inch in their best year, *Abies Hookeriana* attaining 0·70, *Araucaria imbricata* 0·65, *Cupressus Lawsoniana* and *Retinospora obtusa* 0·60 each.

TABLE III. ANNUAL RATE AND RANGE OF CONIFERÆ. INFERIOR GROUP.

| | Girth, Oct. 1891 | Annual Rate. | Range. | |
|---|---|---|---|---|
| | | | Worst Year. | Best Year. |
| 26. Pinus Pinaster, | 7·25 | ·78 | ·60 | ·95 |
| 25. Pinus Murrayana, | 20·05 | ·70 | ·55 | ·75 |
| 28. Pinus austriaca, | 7·25 | ·63 | ·35 | ·85 |
| 30. Pinus Lambertiana, | 12·10 | ·33 | ·20 | ·55 |
| 4. Pinus Cembra, | 5·10 | ·33 | ·30 | ·35 |
| *7. Thuja Craigieana, | 14·95 | ·24 | ·10 | ·30 |

It is unnecessary to say much of these. *Pinus Pinaster* for the first two years had a rate of 0·95, probably good enough for so young a tree, but in the next three years it fell

* Perhaps not a true species, but a variety either of *Thuja gigantea* or *occidentalis*.

off greatly, and the tree is straggling and weak-looking. The same is true of the others, except *Thuja Craigieana*, which gives the worst results of all and yet looks well. *Pinus austriaca* looked and did well the first two years, but has fallen off since. In 1891, when its increase was only 0·35, that of a vigorous-looking specimen, somewhat older, in the Arboretum was 1·25.

*d.* Annual Variation in the Aggregate Girth-increase.

| | | Total Increase. | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1887 | 1888 | 1889 | 1890 | 1891 | Average. |
| 30 Trees | 13 Species | 20·40 | 19·00 | 20·85 | 20·90 | 17·25 | 19·70 |

The average for the five years being 19·70 inches, the worst year was 1891, with a deficit in round numbers of 2½ inches, and 1888 follows next with a deficit of only ¾ inch. 1890, the best year, exceeded the average by 1¼ inch.

In the depression of 1891, 21 of the Pinaceæ suffered a diminution of girth-increase, 4 showed a slight increase, and 5 were unaffected, in comparison with the previous year.

Comparison of the Annual Variation in Girth-Increase of the Deciduous and Evergreen Classes.

| | | | Total Increase. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1887 | 1888 | 1889 | 1890 | 1891 | Average. |
| Deciduous | 28 Trees | 16 Species | 20·05 | 18·40 | 25·75 | 24·75 | 21·75 | 22·10 |
| Coniferæ | 30 Trees | 13 Species | 20·40 | 19·00 | 20·85 | 20·90 | 17·25 | 19·70 |

The differences between the two classes are considerable.

In the first place, the annual variation is much more marked in the Deciduous than in the Evergreen group. The average yearly amount in the two being not far apart,—viz., in round numbers, 22 inches in the former and 20 in the latter,—there is a difference of 7 inches between the highest and lowest years in the Deciduous trees, and only of 3½ in the Coniferæ. Or, while the worst year of the former is 4½ inches below average, the worst of the latter is only 2½ below average.

Secondly, the two classes were by no means equally affected in the same years. In 1888, when the Deciduous class fell 4½ inches below average, the Coniferæ were only ¾ inch down. On the other hand, in 1891 when the latter fell 2½ inches the Deciduous group all but maintained their average.

With the view of defining within narrower limits the period when these depressions occurred, let us take the girth-increases in half-seasonal periods instead of in years.

| Year. | Deciduous Trees. | | Coniferæ. | |
|---|---|---|---|---|
| | First Half Season. | Second Half Season. | First Half Season. | Second Half Season. |
| 1887 | 11·30 | 8·75 | 13·20 | 7·65 |
| 1888 | 8·25 | 10·15 | 12·00 | 7·65 |
| 1889 | 12·10 | 13·65 | 11·60 | 10·15 |
| 1890 | 11·35 | 13·40 | 11·15 | 10·60 |
| 1891 | 7·15 | 14·50 | 8·70 | 9·05 |
| Average | 10·03 | 12·09 | 11·33 | 9·02 |

In the year 1888 the Deciduous class fell 4½ inches and the Coniferæ only ¾ inch below average. Taking now the incidence upon the half-seasons in the same year, it appears that in the first half the Deciduous group fell 1¾ inch *below* its average of 10 inches, while the Coniferæ was ¾ inch *above* their average of 11. In the second half, on the other hand, both groups were affected, falling 2 inches and 1¾ below their respective averages of 12 and 9 inches.

In 1891 the Coniferæ fell 2½ inches below their yearly average; the Deciduous trees, on the other hand, maintained theirs. But on going into the matter, it comes out that in the first half-season both groups suffered, falling 2½ and 3 inches respectively *below* average, and that while in the second half-season the Coniferæ only regained their average, the Deciduous group actually rose 3 inches *above* theirs.

The differences here seem far too marked to be accidental, and unless they are due to inferior reliability in the Pinaceæ, owing to transplantation in some and to lack of vigour in others, they indicate that the two classes may be influenced in different degrees and ways by the same causes of variation, and this is confirmed by my previous observations (*Proc.*, 1888–89, p. 397).

## II. MONTHLY RESULTS.

### A. History of the Species.

### (1) DECIDUOUS TREES.

#### BETULA ALBA.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 78 | 0·05 | ·95 | 1·50 | 1·35 | 1·00 | ·30 | 2·50 | 2·65 |
| 82 | ·10 | ·50 | 1·60 | 1·25 | ·80 | ·15 | 2·20 | 2·25 |
| Total | ·15 | 1·45 | 3·10 | 2·60 | 1·80 | ·45 | 4·70 | 4·85 |
| No. | Percentage. | | | | | | | |
| 78 | ·1 | 18·5 | 29 | 26 | 19·5 | 6 | 48·5 | 51·5 |
| 82 | ·2 | 11·5 | 36·5 | 28·5 | 18 | 3·5 | 50 | 50 |
| Av. | 1·5 | 15 | 32·5 | 27·5 | 19 | 4·5 | 49 | 51 |
| No. | Older Birch at Craigiehall, 5 feet in girth, six years. | | | | | | | |
| 6* | ... | ... | ·75 | 1·40 | ·60 | ... | 0·75 | 2·00 |
| | Percentage. | | | | | | | |
| 6* | ... | ... | 27 | 51 | 22 | ... | 27 | 73 |

The p.c. of girth-increase in the half-seasons in the two young trees was almost identical, the amount in each half in both trees being all but equal. Very different was it with the old Birch, in which the proportion was as 27 to 73.

In the young trees the increase was distributed over the months in the average proportion for Deciduous species, but the old one showed no increase at all in April, May, or September, during six years' observation. The best month in the young trees was June, with an average annual amount of 0·30 and 0·32; but July was best in No. 6* with 0·23.

If these contrasts are due simply to difference in age, they illustrate how extreme the differences may be between young and old trees of the same species. No. 6* was quite healthy, and for six years grew at the probably fair rate for so old a tree of nearly half an inch.

No. 88. ALNUS GLUTINOSA. No. 96. SALIX sp.

| Total Increase, No. 88 five, No. 96 four years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 88 | 0·05 | ·45 | 1·55 | 1·35 | ·65 | ·05 | 2·05 | 2·05 |
| 96 | ·05 | ·80 | 1·35 | 1·60 | 1·60 | ·60 | 2·20 | 3·80 |
| Percentage. | | | | | | | | |
| 88 | 1 | 11 | 38 | 33 | 16 | 1 | 50 | 50 |
| 96 | 1 | 13·5 | 22·5 | 26·5 | 26·5 | 10 | 37 | 63 |

*Alnus.* The half-season increases were exactly equal. June was the best month, with an annual average amount of 0·31 and p.c. of 38, but July followed closely, with 0·27 and 33. The growth in April and September was hardly appreciable.

*Salix.* In its first year, when an infant, the first half-season slightly surpassed the second, but in the other three the second greatly predominated, the general average being as 37 to 63.

July and August were equal for the best place, the annual average amount in each being 0·40 and the p.c. 26·5. The amount, 0·15, and p.c., 10, for September are remarkably high.

Nos. 76, 87. POPULUS FASTIGIATA. No. 83. POPULUS ALBA.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 76 | ·10 | ·40 | ·95 | 2·00 | 2·20 | ·20 | 1·45 | 4·40 |
| 87 | ... | ·50 | 1·30 | 1·80 | 1·45 | ·15 | 1·80 | 3·40 |
| Total | ·10 | ·90 | 2·25 | 3·80 | 3·65 | ·35 | 3·25 | 7·80 |
| No. | Percentage. | | | | | | | |
| 76 | 1·5 | 6·5 | 16 | 34·5 | 38 | 3·5 | 24 | 76 |
| 87 | ... | 10 | 25 | 34 | 28 | 3 | 35 | 65 |
| Av. | 1 | 8 | 20·5 | 34·5 | 33 | 3 | 29·5 | 70·5 |
| No. | Total Increase, five years. | | | | | | | |
| 83 | 10 | ... | 1·25 | 1·05 | ·65 | ·15 | 1·35 | 1·85 |
| Percentage. | | | | | | | | |
| 83 | 3 | ... | 40 | 33 | 20 | 4 | 43 | 57 |

*P. fastigiata.* The second half-season greatly predominated in both, particularly No. 76, in which the proportions were as 24 to 76. In 1891 the two grew only 9 p.c. in the first half, showing a great falling off from the average 29 p.c.; but in 1888 they grew no less than 45 p.c. in the first half, and as the annual amount was below average there must have been a failure in the second half.

August was the best month in No. 76, with an average annual amount of 0·44 and p.c. of 38, July being close up with 0·40 and 34·5. But July was decidedly the best in No. 87, with 0·36 of amount and 34 p.c. The April growth was inappreciable, and that of May and September insignificant.

*P. alba.* The preponderance of the second half-season was not so marked as in *P. fastigiata.* June was the best month, with 40 p.c., a remarkable amount, as there was no increase in May in any year of the five. But the results are probably abnormal, as the tree is not very thriving.

CARPINUS BETULUS.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 81 | 0·15 | ·25 | 1·15 | ·95 | ·80 | ·15 | 1·55 | 1·90 |
| 86 | ... | ·25 | ·70 | ·75 | ·80 | ·25 | ·95 | 1·80 |
| Total | ·15 | ·50 | 1·85 | 1·70 | 1·60 | ·40 | 2·50 | 3·70 |
| No. | Percentage. | | | | | | | |
| 81 | 4·5 | 7 | 33 | 28 | 23 | 4·5 | 44·5 | 55·5 |
| 86 | ... | 9 | 25·5 | 27·5 | 29 | 9 | 36·5 | 65·5 |
| Av. | 2 | 8 | 29·5 | 27·5 | 26 | 7 | 39·5 | 60·5 |
| No. | Older Hornbeam, No. 33, 4 feet in girth, for four years. | | | | | | | |
| 33 | ·30 | ·30 | ·30 | ·65 | ·20 | ... | ·90 | ·85 |
| | Percentage. | | | | | | | |
| 33 | 17 | 17 | 17 | 37 | 12 | ... | 51 | 49 |

The half-season increase in both the young trees was greatest in the second period, although not by much in No. 86, and in the older tree the periods were almost equal.

June, with an annual average amount of 0·23 and p.c. of

33, was the best month in No. 81; August, with 0·16 of amount and 29 p.c., in No. 86; but June and July were not much behind it. In the older No. 33 July is best, with 0·16 of amount and 37 p.c.; and, quite exceptionally, April, May, and June came out equal, with 17 p.c. each, but the annual rate was only 0·44, and these results are probably quite abnormal.

Fagus sylvatica.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| Total Increase, four years. | | | | | | | | |
| 97 | ... | 0·40 | 1·55 | 1·85 | 1·25 | ·20 | 1·95 | 3·30 |
| 98 | ·05 | ·40 | 1·65 | 1·60 | 1·10 | ·05 | 2·10 | 2·75 |
| | ·05 | ·80 | 3·20 | 3·45 | 2·35 | ·25 | 4·05 | 6·05 |
| Percentage. | | | | | | | | |
| 97 | ... | 7·5 | 30 | 35 | 23·5 | 4 | 37·5 | 62·5 |
| 98 | 1 | 8 | 34 | 33 | 23 | 1 | 43 | 57 |
| | ·05 | 8 | 32 | 34 | 23 | 2·5 | 40·5 | 59·5 |
| Percentage of nine old Beeches (eight years). | | | | | | | | |
| ... | 4 | 9 | 25 | 36 | 21 | 5 | 38 | 62 |

The half-season increase was greatest in both young trees in the second period, and the average for that period of the two, 59·5, comes very near 62 p.c., that of the nine older Beeches.

July was the best month, with 0·46 of annual average amount, and 35 p.c. in No. 97, and June and July were almost equal in No. 98, with 0·41 and 0·40 of amount, and 34 and 33 p.c. In the conjoined nine old Beeches July was decidedly at the head, with 36 p.c., and the proportions for the first and last months were larger in them than in the young trees.

## QUERCUS ROBUR.

Total Increase, Nos. 70, 72 five years. Nos. 1, 2 four years.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 70 | 0·10 | ·50 | ·65 | 1·55 | 1·05 | ·20 | 1·25 | 2·80 |
| 72 | ·05 | ·50 | ·55 | ·95 | ·25 | ·15 | 1·10 | 1·35 |
| 1 | ... | ·25 | ·40 | ·95 | ·50 | ·10 | ·65 | 1·55 |
| 2 | ... | ·40 | ·25 | ·85 | ·40 | ·05 | ·65 | 1·30 |
| Total | ·15 | 1·65 | 1·85 | 4·30 | 2·20 | ·50 | 3·65 | 7·00 |
| | | | | Percentage. | | | | |
| 70 | 2·5 | 12·5 | 16 | 39 | 24 | 6 | 31 | 69 |
| 72 | 2 | 20·5 | 22·5 | 39 | 10 | 6 | 45 | 55 |
| 1 | ... | 11 | 18 | 42 | 22 | 7 | 29 | 71 |
| 2 | ... | 20·5 | 13 | 43·5 | 20·5 | 2·5 | 33·5 | 66·5 |
| Av. | 1·5 | 15·5 | 17·5 | 40 | 21 | 4·5 | 34·5 | 65·5 |
| No. | | | An old Oak at Craigiehall for four years. | | | | | |
| 12 | ·10 | ·35 | ·10 | ·60 | ·20 | ·10 | ·55 | ·90 |
| | | | | Percentage. | | | | |
| 12 | 7 | 24 | 7 | 41 | 14 | 7 | 38 | 62 |
| | *Quercus Cerris*, of the present set, but considerably older than the rest. | | | | | | | |
| 63 | ·05 | ·80 | ·50 | ·90 | ·40 | ·25 | 1·35 | 1·50 |
| | | | | Percentage. | | | | |
| 63 | 2 | 28 | 17 | 31 | 14 | 8 | 47 | 53 |
| | No. 43 same size as No. 63, No. 10* considerably larger (former set). | | | | | | | |
| 43 | ·05 | ·45 | ·25 | ·85 | ·60 | ·10 | ·75 | 1·55 |
| 10* | ·10 | ·80 | ·25 | 1·25 | 1·10 | ·10 | 1·15 | 2·45 |
| Total | ·15 | 1·25 | ·50 | 2·10 | 1·70 | ·20 | 1·90 | 4·00 |
| No. | | | | Percentage. | | | | |
| 43 | 2 | 20 | 11 | 37 | 26 | 4 | 33 | 67 |
| 10* | 3 | 22 | 6·5 | 35 | 30·5 | 3 | 31·5 | 68·5 |
| Av. | 2·5 | 21 | 8·5 | 36 | 28·5 | 3·5 | 32 | 68 |
| No. | | | | *Quercus rubra.* | | | | |
| 61 | ·05 | ·35 | ·45 | ·90 | ·45 | ·10 | ·85 | 1·45 |
| | | | | Percentage. | | | | |
| 61 | 2 | 15 | 20 | 39 | 20 | 4 | 37 | 63 |
| | | | | *Quercus Ilex.* | | | | |
| 16 | ... | ·25 | ·55 | 1·00 | ·75 | ·60 | ·80 | 2·35 |
| | | | | Percentage. | | | | |
| 16 | ... | 7·5 | 17·5 | 32 | 24 | 19 | 25 | 75 |

*Q. Robur.* The four young Oaks differ considerably in their amounts and p.c., due probably to their being affected in different degrees by an insect plague, yet they agree in some important respects, as in the superiority of the second half-season, the average of the four, 65·5 p.c., agreeing closely with 62 p.c., that of the older Craigiehall tree.

They also agree in July being very decidedly their best month, the p.c. varying between 39 and 43·5. That of the old tree, 41 p.c., is in close agreement.

*Q. Cerris.* In No. 63 the second half-season increase very little exceeded the first, but in the two Turkish Oaks of the former set the proportions for the second half were 67 p.c. in No. 43, and 68·5 p.c. in No. 10*, thus closely agreeing with *Q. Robur.*

All three agree with the five British Oaks in July being the best month, although it does not predominate so decidedly in the former as in the latter, the p.c. varying from 31 to 37 instead of from 39 to 43·5.

The three Turkish Oaks are remarkable in this respect, that their June increase is very much below that of May.

*Q. rubra.* Transplantation greatly reduced its increase, but in the p.c. it agrees closely with the other Oaks. The half-season proportions are 39 and 63, and July is much the best month, with 39 p.c.

*Q. Ilex,* in the half-season proportions followed the rule of the Oaks but to an excessive degree, the p.c. for the second period being 75. July again was the best month, although only with 32 p.c., and the p.c. of September was very remarkable, being no less than 19.

QUERCUS CONFERTA (*former set*).

| Total Increase, four years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 40 | 0·50 | ·40 | 1·20 | 2·15 | 1·50 | ·35 | 2·10 | 4·00 |
| 54 | ·65 | ·65 | 1·40 | 2·45 | 1·75 | ·30 | 2·70 | 4·50 |
| 55 | ·60 | ·85 | 1·45 | 2·20 | 1·30 | ·10 | 2·90 | 3·60 |
| Total | 1·75 | 1·90 | 4·05 | 6·80 | 4·55 | ·75 | 7·70 | 12·10 |
| No. | Percentage. | | | | | | | |
| 40 | 8 | 6·5 | 20 | 35·5 | 24·5 | 5·5 | 34·5 | 65·5 |
| 54 | 9 | 9 | 29·5 | 34 | 24·5 | 4 | 37·5 | 62·5 |
| 55 | 9 | 13 | 22·5 | 34 | 20 | 1·5 | 44·5 | 55·5 |
| | 9 | 9·5 | 20·5 | 34·5 | 23 | 3·5 | 39 | 61 |

Although belonging to the former set, these Hungary Oaks are taken for comparison with the other species. They are young, and are by far the quickest growers of the Deciduous trees of their set, their annual rate for from twelve to fourteen years having been 1·53, 1·68, and 1·53 respectively.

On the whole, the three agree remarkably well with each other, and with the chief characteristics of the other oaks. The first half-season predominates with 61 p.c. July is the best month in all three, with the large annual averages in amount of 0·52, 0·61, and 0·55, and in p.c. of 34 to 35·5. Remarkable points in this species are the high proportion, 9 p.c., of the April increase, and its almost equality with that of May, 9·5 p.c.

### TILIA EUROPÆA.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 69 | ... | 0·35 | 1·80 | ·90 | ·30 | ·05 | 2·15 | 1·25 |
| 85 | ... | ·45 | 1·40 | ·55 | ·05 | ·15 | 1·85 | ·75 |
| Total | ... | ·80 | 3·20 | 1·45 | ·35 | ·20 | 4·00 | 2·00 |
| | | | | Percentage. | | | | |
| 69 | ... | 10 | 53 | 26·5 | 9 | 1·5 | 63 | 37 |
| 85 | ... | 17 | 54 | 21 | 2 | 6 | 71 | 29 |
| Av. | ... | 13·5 | 53·5 | 24 | 5·5 | 3·5 | 67 | 33 |
| No. | | | An older Lime, for four years. | | | | | |
| 18 | ... | ·05 | ·50 | ·85 | ·10 | ·05 | ·55 | 1·00 |
| | | | | Percentage. | | | | |
| 18 | ... | 3 | 32·5 | 55 | 6·5 | 3 | 35·5 | 64·5 |

The second half-season increase in the two young trees was double that of the first, but it was almost precisely the reverse with the older No. 18. All three were remarkable for the large proportion of increase in their best month, 53, 54, and 55 respectively, but while June was the favoured month with Nos. 69 and 85, it was July with the older No. 18, a healthy but slow-growing tree.

ÆSCULUS HIPPOCASTANUM.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 73 | ... | 0·45 | 1·25 | 1·50 | 85 | ·15 | 1·70 | 2·50 |
| 80 | ... | ·45 | 1·85 | 1·95 | 1·40 | ·20 | 2·30 | 3·55 |
| Total | ... | ·90 | 3·10 | 3·45 | 2·25 | ·35 | 4·00 | 6·05 |
| No. | | | | Percentage. | | | | |
| 73 | ... | 10·5 | 30 | 35·5 | 20·5 | 3·5 | 40·5 | 59·5 |
| 80 | ... | 7·5 | 32 | 33 | 24 | 3·5 | 39·5 | 60·5 |
| Av. | ... | 9 | 31 | 34·5 | 22 | 3·5 | 40 | 60 |

The half-season and monthly *proportions* in these trees agree remarkably, although the *amount* was much greater in No. 80 than in No. 73. The second half-season predominated, with 60 p.c. July was the best month, with 0·30 and 0·39 of annual average amount and 35·5 and 33 p.c., June being not far behind, with 30 and 33 p.c. There was no April growth in either.

ACER PSEUDO-PLATANUS.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 71 | ... | 0·65 | 2·20 | 1·55 | ·90 | ·15 | 2·85 | 2·60 |
| 74 | ·05 | ·95 | 2·15 | 1·55 | ·80 | ·10 | 3·15 | 2·45 |
| 67 | ... | ·15 | ·70 | ·50 | ·15 | ... | ·85 | ·65 |
| Total | ·05 | 1·75 | 5·05 | 3·60 | 1·85 | ·25 | 6·85 | 5·70 |
| | | | | Percentage. | | | | |
| 71 | ... | 12 | 40·5 | 28·5 | 16·5 | 2·5 | 52·5 | 47·5 |
| 74 | 1 | 17 | 39·5 | 28 | 13·5 | 1 | 57·5 | 42·5 |
| 67 | ... | 10 | 47 | 33 | 10 | ... | 57 | 43 |
| Av. | ·05 | 13 | 42·5 | 30 | 13 | 1 | 56 | 44 |
| No. | | | An older Sycamore, for six years. | | | | | |
| 28 | 0·10 | ·15 | 1·05 | ·85 | ·20 | ... | 1·30 | 1·05 |
| | | | | Percentage. | | | | |
| 28 | 4 | 6·5 | 45 | 36 | 8·5 | ... | 55·5 | 45·5 |

The two young Sycamores, Nos. 71 and 74, much alike in size and situation, agree closely in all their amounts and proportions. The still younger No. 67, although greatly inferior in its *amounts* owing to transplantion, nevertheless resembles the other two in the main *proportions*, and so does the older No. 28. The p.c. of the first half-season predominates slightly over the second in all four, and its variation is only from 52·5 to 57·5 p.c. June is the best month in all, the *proportion* varying from 39·5 to 45 p.c., although the *amount* varies from 0·14 in the transplanted No. 67 to 0·44 in No. 71.

No. 21. CYTISUS LABURNUM. No. 19. CRATÆGUS OXYACANTHA.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 21 | 0·30 | ·60 | 1·00 | 1·05 | ·30 | ·35 | 1·90 | 2·20 |
| 19 | ·25 | ·50 | 1·50 | 1·15 | 1·30 | ·60 | 2·25 | 3·05 |
| Percentage. | | | | | | | | |
| 21 | 7 | 14·5 | 24·5 | 25·5 | 20 | 8·5 | 46 | 54 |
| 19 | 4·5 | 9·5 | 28 | 22 | 24·5 | 11·5 | 42 | 58 |

*Cytisus Laburnum.* The second half-season exceeds the first, but only slightly. July is the best month, with 0·21 of *annual average amount*, and 25·5 p.c., but the increase is unusually well distributed over the six months, and the proportions for June and August are but little inferior to that of July. The proportions of April, 7 p.c., and Sept., 8·5 p.c., are high.

*Cratægus Oxyacantha.* The second half-season predominates, with 58 p.c. June is the best month, with 0·30 of annual average *amount*, and 28 p.c.

The proportion for Sept., 11·5, is unusually high, and the tree is further remarkable because the proportion for August, 24·5, exceeds that for July, 22 p.c.

NOS. 18, 22. PRUNUS PADUS. NOS. 77, 79. PYRUS AUCUPARIA.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 18 | 0·05 | ·10 | 1·20 | 1·50 | ·90 | ·20 | 1·35 | 2·60 |
| 22 | ·15 | ·50 | 2·30 | 2·05 | 1·15 | ·25 | 2·95 | 3·45 |
| 77 | ·05 | ·15 | 1·00 | ·95 | ·40 | ·20 | 1·55 | 2·75 |
| 79 | ·05 | ·25 | 1·05 | 1·85 | 1·20 | ·30 | 3·35 | 4·70 |
| Percentage. | | | | | | | | |
| 18 | 1 | 2·5 | 30·5 | 38 | 23 | 5 | 34 | 66 |
| 22 | 2 | 8 | 36 | 32 | 18 | 4 | 46 | 54 |
| 77 | 2 | 6 | 36 | 34·5 | 14·5 | 7 | 44 | 56 |
| 79 | 1 | 5 | 22·5 | 39·5 | 25·5 | 6·5 | 28·5 | 71·5 |

*Prunus Padus.* The results in the two trees have so little resemblance that it is safer to take the quick-growing and vigorous-looking No. 22 as truly representative of the average of the species. It shows a slight inferiority in the second half-season, and June is the best month, with 0·46 of annual average amount and 36 p.c.

*Pyrus Aucuparia.* Much the same general remarks apply here; but if we accept No. 79, much the quickest grower and most vigorous-looking of the two Rowans as representative of the species, we get an extreme disproportion in the half-yearly p.c., 28·5 and 71·5. July is decidedly the best month, with 0·37 of annual average amount, and 39·5 p.c.

ULMUS CAMPESTRIS.

| Total Increase, four years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 93 | 0·10 | 1·05 | 2·00 | 1·80 | 1·50 | ·35 | 3·15 | 3·65 |
| 94 | ·15 | ·85 | 2·05 | 1·35 | ·95 | ·30 | 3·05 | 2·60 |
| | ·25 | 1·95 | 4·05 | 3·15 | 2·45 | ·65 | 6·20 | 6·25 |
| Percentage. | | | | | | | | |
| 93 | 1·5 | 15 | 30 | 26·5 | 22 | 5 | 46·5 | 53·5 |
| 94 | 2·5 | 15 | 36·5 | 24 | 17 | 5 | 54 | 46 |
| | 2 | 15 | 32·5 | 25·5 | 20 | 5 | 49·5 | 50·5 |

The average of the two Elms gives a nearly equal p.c. for the half-seasons, and the increase was much alike through the first half-season; but as No. 93 decidedly outgrew No. 94 in the second, the half-season results are somewhat in favour of the second period in the former, and of the first in the latter. June is the best month, with an annual average amount of 0·50 in both, and a proportion of 30 p.c. in No. 93 and of 36·5 p.c. in No. 94. July in No. 94 comes close up, with 0·45 of amount and 26·5 p.c. The growth is well distributed over the season, the amount in April and September being quite appreciable.

FRAXINUS EXCELSIOR.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 23 | ·10 | ·95 | 1·55 | 1·25 | ·60 | ·10 | 2·60 | 1·95 |
| 75 | ·05 | ·70 | 1·40 | ·40 | ·10 | ... | 2·15 | ·50 |
| | ·15 | 1·65 | 2·95 | 1·65 | ·70 | ·10 | 4·75 | 2·45 |
| Percentage. | | | | | | | | |
| 23 | 2 | 21 | 34 | 27·5 | 13·5 | 2 | 57 | 43 |
| 75 | 2 | 26·5 | 53 | 15 | 3·5 | ... | 81·5 | 18·5 |
| | 2 | 24 | 43·5 | 26 | 8·5 | 1 | 69·5 | 30·5 |

The discrepancies here are so great that it is better to accept No. 23, much the quicker and steadier grower of the two, as representative of the species. No. 75 grew pretty much on a par with it in the first half-season, but failed almost entirely in the second. The half-season proportions of No. 23 (57 and 43 p.c.) agree pretty well with those for the old Craigiehall Ash No. 6* (62·5 and 37·5 p.c.). June was the best month in both the young trees, the amounts averaging nearly alike, 0·31 and 0·28, but the proportions, from the failure of No. 75 in the second half-season, being very different, 34 and 53 p.c.

## (2) Coniferæ.

### Abies Douglasii.

Total Increase, five years. (No. 99, three only.)

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 6 | 0·20 | ·95 | ·75 | ·70 | ·70 | ·05 | 1·90 | 3·35 |
| 66 | ·35 | 1·25 | 1·00 | 1·10 | ·85 | ·40 | 2·60 | 4·95 |
| 99 | ·15 | ·75 | ·40 | ·85 | ·90 | ·40 | 1·30 | 2·15 |
| | | | | Percentage. | | | | |
| 6 | 6 | 28 | 22·5 | 21 | 21 | 1·5 | 56·5 | 43·5 |
| 66 | 7 | 25·5 | 20 | 22·5 | 17 | 8 | 52·5 | 47·5 |
| 99 | 4·5 | 22 | 11·5 | 24·5 | 26 | 11·5 | 38 | 62 |

### Abies Lowiana.

Total Increase, five years. (No. 99, three only.)

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 8 | ·35 | 2·10 | 2·00 | 1·20 | 2·00 | 1·25 | 4·45 | 4·45 |
| 92 | ·10 | ·95 | 1·50 | 1·10 | 1·45 | ·80 | 2·55 | 3·35 |
| | | | | Percentage. | | | | |
| 8 | 4 | 23·5 | 22·5 | 13·5 | 22·5 | 14 | 50 | 50 |
| 92 | 2 | 16 | 25·5 | 18·5 | 24·5 | 13·5 | 43·5 | 56·5 |

### Abies grandis.

Total Increase, five years. (No. 99, three only.)

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 91 | ·45 | 1·45 | ·55 | 1·50 | 2·00 | 1·50 | 2·45 | 5·00 |
| | | | | Percentage. | | | | |
| 91 | 6 | 19·5 | 7·5 | 20 | 27 | 20 | 33 | 67 |

### Abies Hookeriana.

Total Increase, five years. (No. 99, three only.)

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 24 | ... | ·25 | 1·25 | ·80 | ·50 | ·15 | 1·45 | 2·95 |
| | | | | Percentage. | | | | |
| 24 | ... | 8·5 | 42·5 | 27 | 17 | 5 | 51 | 49 |

*Abies Douglasii.* The half-season proportions, 38 and 62 p.c. for No. 99, the only one of the three not interfered with by transplantation, differs very greatly from those of Nos. 6 and 66, which are nearly alike, and average 54·5 and 45·5. I cannot account for this, as transplantation does not seem to have affected Nos. 6 and 66 in such a way as to explain it. In the monthly proportions there was also a great contrast, May having the largest, with 28 and 25·5 p.c. in No. 6 and 66; and August, with 26 p.c., in No. 99. There is a remarkable depression in June below May and July in Nos. 66 and 99.

*Abies Lowiana.* The half-season proportions were exactly equal in No. 8, but in No. 92, which was interfered with by transplantation, the second had a considerable excess over the first (43·5, 56·5). May had slightly the advantage of June in No. 8, but June was very much above May in No. 92. Both showed a great depression in July below June and August.

*Abies grandis.* The second half-season greatly exceeded the first (33 and 67 p.c.). The proportion for August, 27 p.c., was highest, and it is singular that the p.c. for May, July, and September, 19·5, 20, and 20 p.c., should be almost equal. The average amounts also were large, 0·40 for August, 0·29 for May, and 0·30 for July and September. But June showed a great depression, having a p.c. of only 7·5, or little more than a third of the p.c. of May on the one side, and July on the other. This depression took place every year.

*A. Hookeriana.* The half-season increases were nearly equal. June was by far the best month, with 42·5 p.c. There was no increase in April, and that of May, 8·5 p.c., was very low for an evergreen.

PINUS EXCELSA.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 2 | 0·45 | 1·15 | 1·40 | 1·15 | ·75 | ·50 | 3·00 | 2·40 |
| 11 | ·35 | ·70 | 1·10 | ·70 | ·70 | ·55 | 2·15 | 1·95 |
| Aver. | ·80 | 1·85 | 2·50 | 1·85 | 1·45 | 1·05 | 5·15 | 4·35 |
| Percentage. | | | | | | | | |
| 2 | 8 | 21·5 | 26 | 21 | 14 | 9·5 | 55·5 | 44·5 |
| 11 | 8·5 | 17 | 27 | 17 | 17 | 13·5 | 52·5 | 47·5 |
| Aver. | 8 | 19·5 | 26·5 | 19·5 | 15·5 | 11 | 54 | 46 |
| No. 26. P. PINASTER. No. 25. P. MURRAYANA. No. 28. P. AUSTRIACA. | | | | | | | | |
| Total increase, five years. | | | | | | | | |
| 26 | ·20 | 1·10 | 1·15 | ·75 | ·55 | ·15 | 2·45 | 1·45 |
| 25 | ·10 | 1·00 | ·80 | ·70 | ·65 | ·25 | 1·90 | 1·60 |
| 28 | ·10 | 1·15 | 1·00 | ·55 | ·35 | ... | 2·25 | ·90 |
| Percentage. | | | | | | | | |
| 26 | 5 | 28 | 29·5 | 19·5 | 14·5 | 4 | 62·5 | 37·5 |
| 25 | 3 | 28·5 | 23 | 20 | 18·5 | 7 | 54·5 | 45·5 |
| 28 | 3 | 36·5 | 32 | 17·5 | 11 | ... | 71·5 | 28·5 |
| An older P. AUSTRIACA, for five years also. | | | | | | | | |
| 2* | 1·40 | 2·05 | 1·75 | 1·40 | 1·00 | ·40 | 5·20 | 2·80 |
| Percentage. | | | | | | | | |
| 2 | 17·5 | 25·5 | 22 | 17·5 | 12·5 | 5 | 65 | 35 |

*Pinus excelsa.* The *proportions* in the two trees, although No. 11 suffered loss in *amount* from transplantation, do not materially differ. The averages of the two give 54 and 46 for the half-season p.c.; June is the best month, with 0·29 of average annual amount and 26 p.c. in No. 2; 0·22 and 27 p.c. in No. 11. The growth was well diffused over the season, the p.c. for April and September being 8 and 11 p.c.

*P. Pinaster, Murrayana, austriaca.* As these Pines proved defective in appearance and rate of increase, the results are not reliable, and it is unnecessary to remark upon them. No. 2*, a healthy, quick-growing *P. austriaca* at Craigiehall, however, is probably reliable, and agrees with the inferior Botanic Garden specimen in the large excess of the first

CUPRESSUS LAWSONIANA.

Total Increase.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 9 | 6·15 | ·70 | ·80 | ·55 | ·15 | ·05 | 1·65 | ·75 |
| 10 | ·15 | ·95 | ·70 | ·40 | ·10 | ·05 | 1·80 | ·55 |
| Aver. | ·30 | 1·65 | 1·50 | ·95 | ·25 | ·10 | 3·45 | 1·30 |

Percentage.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 9 | 6 | 29·5 | 33·5 | 23 | 6 | 2 | 69 | 31 |
| 10 | 6·5 | 40·5 | 30 | 17 | 4 | 2 | 77 | 23 |
| Aver. | 6 | 35 | 32 | 20 | 5 | 2 | 73 | 27 |

THUJA GIGANTEA.

Total Increase.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 12 | ·45 | 1·20 | 1·10 | ·45 | ·60 | ·30 | 2·75 | 1·35 |

Percentage.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 12 | 11 | 29·5 | 27 | 11 | 14·5 | 7 | 67·5 | 32·5 |

An older CUPRESSUS LAWSONIANA.

Total Increase.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 1* | ·35 | 1·00 | 1·10 | 1·25 | 30 | ... | 2·45 | 1·55 |

Percentage.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 1* | 9 | 25 | 27·5 | 31 | 7·5 | ... | 61·5 | 38·5 |

RETINOSPORA OBTUSA.

Total Increase.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 14 | ·25 | ·80 | ·50 | ·35 | ·20 | ·10 | 1·35 | 0·65 |

Percentage.

| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
|---|---|---|---|---|---|---|---|---|
| 14 | 11 | 36·5 | 23 | 16 | 9 | 4·5 | 70·5 | 29·5 |

half-season increase, the proportions being 65 to 35 p.c. in No. 2* and 71·5 to 28·5 in No. 28. They also agree in June being the best month, with a p.c. of 25·5 and 36·5 respectively. But No. 2* is distinguished above No. 28 and all my measured trees by its large April growth, the average annual amount having been 0·28 and the p.c. 17·5.

*Cupressus Lawsoniana.* The three Cypresses agree in the large proportion of the first half-season growth, although the degree varies from 61·5 to 77 p.c. The best month is May in No. 10, June in No. 9, and July in No. 1*, but the predominance is not great in any of them.

*Thuja gigantea.* The first half-season takes a strong lead, with 67·5 p.c. May is the best month, but is not much ahead of June, and July is considerably depressed below August.

*Retinospora obtusa.* The first half-season proportion is 70·5 p.c.; and May is the best month, with 36·5 p.c.

Araucaria imbricata.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 64 | ... | 0·90 | 1·00 | ·45 | ·20 | ·15 | 1·90 | ·80 |
| 65 | ·10 | 1·35 | ·95 | ·35 | ·15 | ·15 | 2·40 | ·65 |
| Total | ·10 | 2·25 | 1·95 | ·80 | ·35 | ·30 | 4·30 | 1·45 |
| Percentage. | | | | | | | | |
| 64 | ... | 33·5 | 37 | 16·5 | 7·5 | 5·5 | 70·5 | 29·5 |
| 65 | 3 | 44·5 | 31·5 | 11 | 5 | 5 | 79 | 21 |
| Aver. | 1·5 | 39 | 34·5 | 14 | 6 | 5 | 75 | 25 |
| Three older Araucarias. Total Increase, five years. | | | | | | | | |
| 34 | ·20 | ·45 | ·55 | ·35 | ... | ... | 1·20 | ·35 |
| 35 | ·80 | ·80 | 1·00 | ·30 | ·55 | ... | 2·60 | ·85 |
| 4* | ·35 | ·90 | 1·25 | ·90 | ·25 | ... | 2·50 | 1·15 |
| Total | 1·35 | 2·15 | 2·80 | 1·55 | ·80 | ... | 6·30 | 2·35 |
| Percentage. | | | | | | | | |
| 34 | 13 | 29 | 35·5 | 22·5 | ... | ... | 77·5 | 22·5 |
| 35 | 23 | 23 | 29 | 9 | 16 | ... | 75 | 25 |
| 4* | 9·5 | 24·5 | 34·5 | 24·5 | 7 | ... | 68·5 | 31·5 |
| Aver. | 15 | 25 | 33 | 19 | 8 | ... | 73·5 | 26·5 |

Although the two younger and three older Araucarias agree in the great proportion of the first half-season increase, which varies between 68·5 and 79 p.c., they differ materially in the monthly incidence. In the younger trees the increase of April is barely appreciable, but in the others it is distinct enough, particularly in No. 35, its annual average amount being 0·16. On the other hand, increase seems to linger later in the season in the younger trees, but as from roughness of the stem they were more difficult to measure than the older trees, this may be an error of observation. June was the best month in all but No. 65, in which it was decidedly May.

LARIX EUROPÆA.

| Total Increase, five years. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No. | April. | May. | June. | July. | Aug. | Sept. | 1st Half. | 2nd Half. |
| 20 | 0·10 | ·90 | 2·05 | 1·30 | 1·25 | ·50 | 3·05 | 3·05 |
| 89 | ·10 | 1·10 | 1·45 | 1·25 | ·65 | ·15 | 2·65 | 2·05 |
| Total | ·20 | 2·00 | 3·50 | 2·55 | 1·90 | ·65 | 5·70 | 5·10 |
| Percentage. | | | | | | | | |
| 20 | 1·5 | 15 | 33·5 | 21·5 | 20·5 | 8 | 50 | 50 |
| 89 | 2 | 23·5 | 31 | 26·5 | 14 | 3 | 56·5 | 43·5 |
| Aver. | 2 | 18·5 | 32·5 | 24 | 17 | 6 | 53 | 47 |

The half-season proportions were exactly equal in No. 20, but in No. 89 the first, with 56·5 p.c., predominated. June was the best month in both, with an average annual amount of 0·41 and p.c. of 33·5 in No. 20, and of 0·29 and 31 p.c. in No. 89.

*B.* Collective Results.

The general monthly results are considered under the following heads in the Deciduous and Coniferous groups respectively:—

(1) Monthly *amount* of Girth-increase in the trees individually and collectively.

(2) Monthly *proportions* of Girth-increase in the trees collectively.

(3) Monthly *proportion* of Girth-increase in the trees individually.

(4) Distribution of Girth-increase over the growing season.

(5) Proportion of Girth-increase in the first and second halves of the growing season.

The number of trees upon which the results are based varies under the different heads, for reasons given in the text; and sometimes the new set is used alone, sometimes the old is taken in, either separately, or in conjunction with the new.

### (1) DECIDUOUS TREES.

#### (*a*) Monthly Amount of Girth-increase in thirty young Deciduous Trees, individually and collectively.

The complete set of monthly increases in these young trees for the five years 1887 to 1891 are given in Table IV., followed by some of the general results, individual and collective, to be derived from it.

TABLE IV. MONTHLY GIRTH-INCREASE OF THIRTY DECIDUOUS TREES IN HUNDREDTHS OF AN INCH.

| | | 1887. | | | | | | 1888. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | April. | May. | June. | July. | Aug. | Sept. | April. | May. | June. | July. | Aug. | Sept. |
| 69 | Tilia europæa . | ... | 10 | 40 | 10 | 5 | ... | ... | 10 | 20 | 25 | 5 | ... |
| 85 | ,, | ... | 5 | 30 | ... | ... | 5 | ... | 10 | 15 | 20 | ... | 5 |
| 71 | Acer Pseudo-ps. | ... | 5 | 50 | 30 | 10 | ... | ... | 20 | 30 | 25 | 5 | 5 |
| 74 | ,, | ... | 20 | 40 | 15 | 5 | 5 | ... | 20 | 25 | 20 | 5 | ... |
| 73 | ÆsculusHippocm. | ... | 10 | 25 | 25 | 10 | ... | ... | 15 | 10 | 30 | 15 | ... |
| 80 | ,, | ... | ... | 45 | 35 | 20 | ... | ... | 10 | 25 | 35 | 30 | 5 |
| 77 | Pyrus Aucuparia | ... | 5 | 15 | 5 | ... | 5 | ... | 5 | 20 | 35 | 15 | 5 |
| 79 | ,, | ... | 5 | 35 | 30 | 15 | 5 | 5 | 5 | ... | 35 | 30 | ... |
| 70 | Quercus Robur . | 5 | ... | 20 | 35 | 15 | 5 | 5 | 25 | ... | 15 | 5 | ... |
| 72 | ,, | ... | 10 | 10 | 15 | 10 | 5 | 5 | 10 | ... | 5 | ... | ... |
| 81 | Carpinus Betulus | 5 | 5 | 30 | 5 | 10 | ... | ... | 5 | 25 | 30 | 20 | ... |
| 86 | ,, | ... | 10 | 20 | ... | 10 | ... | ... | 5 | 10 | 10 | 5 | 10 |
| 78 | Betula alba . . | ... | 25 | 35 | 25 | 5 | 5 | ... | 20 | 15 | 20 | 20 | 5 |
| 82 | ,, | ... | 10 | 40 | 20 | 15 | 5 | ... | 10 | 25 | 25 | 10 | ... |
| 18 | Prunus Padus . | ... | 5 | 35 | 25 | 25 | ... | 5 | 5 | 10 | 25 | 5 | 15 |
| 22 | ,, | ... | 10 | 55 | 35 | 5 | 10 | ... | 15 | 40 | 35 | 30 | ... |
| 93 | Ulmus campestris | 5 | 25 | 50 | 40 | 25 | ... | 5 | 30 | 40 | 40 | 50 | 10 |
| 94 | ,, | ... | 20 | 50 | 35 | 25 | 10 | 5 | 25 | 35 | 25 | 20 | 5 |
| 97 | Fagus sylvatica . | ... | 10 | 40 | 45 | 30 | 5 | ... | 20 | 30 | 45 | 20 | ... |
| 98 | ,, | ... | 10 | 40 | 40 | 25 | ... | ... | 20 | 35 | 35 | 10 | ... |
| 23 | Fraxinus excelr. | ... | 15 | 40 | 25 | 5 | ... | ... | 20 | 20 | 30 | 15 | ... |
| 75 | ,, | ... | 20 | 25 | 5 | ... | ... | ... | 20 | 25 | 10 | ... | ... |
| 76 | Populus fastig. . | 5 | 5 | 35 | 35 | 40 | 5 | 5 | 15 | 15 | 20 | 20 | 5 |
| 87 | ,, | ... | 10 | 55 | 50 | 40 | 5 | ... | 20 | 20 | 20 | 15 | 5 |
| 83 | Populus alba . | ... | ... | 30 | 20 | 15 | ... | 5 | ... | 20 | 10 | 5 | 5 |
| 88 | Alnus glutinosa | ... | 10 | 45 | 15 | 5 | 5 | ... | 5 | 30 | 30 | 20 | ... |
| 63 | Quercus Cerris . | ... | 20 | 5 | 25 | 10 | ... | 5 | 20 | 20 | 5 | 5 | 15 |
| 21 | Cytisus Labm. . | 5 | 15 | 25 | 10 | ... | 5 | 10 | 15 | 5 | 20 | 15 | 10 |
| 19 | Cratægus Oxya. | 5 | 15 | 35 | 5 | ... | 10 | 5 | ... | 20 | 35 | 45 | ... |
| 96 | Salix, sp. . . . | ... | 15 | 20 | 15 | 15 | 5 | 5 | 20 | 25 | 5 | 35 | ... |
| | Total . . . | ·30 | 3·25 | 10·20 | 6·75 | 3·95 | 1·00 | ·60 | 4·20 | 6·00 | 7·20 | 4·75 | 1·05 |
| | Percentage . | 1 | 13 | 40 | 26·5 | 15·5 | 4 | 2·5 | 18·0 | 25 | 30 | 20 | 4·5 |

TABLE IV. MONTHLY GIRTH-INCREASE OF THIRTY DECIDUOUS TREES—*continued.*

| | | 1889. | | | | | | 1890. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | April. | May. | June. | July. | Aug. | Sept. | April. | May. | June. | July. | Aug. | Sept. |
| 69 | Tilia europæa . | ... | 5 | 45 | 20 | 10 | 5 | ... | 10 | 45 | 15 | 5 | ... |
| 85 | ,, | ... | 10 | 35 | 10 | 5 | ... | ... | 20 | 35 | 5 | ... | 5 |
| 71 | Acer Pseudo-pts. | ... | ... | 40 | 30 | 35 | ... | ... | 30 | 60 | 30 | 15 | 5 |
| 74 | ,, | 5 | 15 | 50 | 25 | 15 | ... | ... | 30 | 55 | 50 | 20 | ... |
| 73 | ÆsculusHippocm. | ... | 10 | 40 | 30 | 25 | 5 | ... | 10 | 30 | 30 | 15 | 5 |
| 80 | ,, | ... | 15 | 50 | 40 | 30 | ... | ... | 10 | 40 | 45 | 25 | 10 |
| 77 | Pyrus Aucuparia | 5 | ... | 20 | 15 | ... | ... | ... | 5 | 30 | 20 | 10 | 5 |
| 79 | ,, | ... | 5 | 30 | 35 | 30 | 5 | ... | 5 | 25 | 45 | 25 | 10 |
| 70 | Quercus Robur . | ... | 5 | 10 | 30 | 20 | 10 | ... | 10 | 25 | 35 | 15 | 10 |
| 72 | ,, | ... | 10 | 10 | 10 | 5 | 5 | ... | 15 | 25 | 35 | ... | 5 |
| 81 | Carpinus Betulus | 5 | 5 | 25 | 30 | 25 | 10 | 5 | 5 | 20 | 15 | 10 | 5 |
| 86 | ,, | ... | 5 | 15 | 20 | 20 | 10 | ... | ... | 20 | 20 | 15 | 5 |
| 78 | Betula alba . . | 5 | 20 | 45 | 35 | 25 | 5 | ... | 20 | 25 | 30 | 20 | 15 |
| 82 | ,, | 5 | 15 | 35 | 20 | 15 | ... | 5 | 15 | 30 | 40 | 15 | 5 |
| 18 | Prunus Padus . | ... | ... | 35 | 35 | 20 | ... | ... | ... | 25 | 35 | 15 | 5 |
| 22 | ,, | 10 | 15 | 55 | 40 | 20 | 5 | 5 | 5 | 40 | 45 | 25 | 5 |
| 93 | Ulmus campestris | ... | 25 | 65 | 50 | 35 | 5 | 5 | 30 | 55 | 45 | 30 | 10 |
| 94 | ,, | 5 | 25 | 65 | 45 | 30 | 5 | 5 | 20 | 60 | 30 | 15 | 15 |
| 97 | Fagus sylvatica . | ... | 5 | 40 | 40 | 35 | 10 | ... | 10 | 50 | 50 | 30 | 10 |
| 98 | ,, | 5 | 5 | 40 | 30 | 30 | ... | ... | 10 | 55 | 45 | 30 | 5 |
| 23 | Fraxinus excelr. | 5 | 25 | 30 | 35 | 15 | 5 | 5 | 15 | 35 | 20 | 10 | 5 |
| 75 | ,, | 5 | 20 | 25 | 5 | 5 | ... | ... | 5 | 40 | ... | ... | ... |
| 76 | Populus fastig. . | 5 | 10 | 35 | 65 | 60 | ... | ... | 5 | 10 | 60 | 50 | 10 |
| 87 | ,, | ... | 15 | 30 | 55 | 35 | ... | ... | 5 | 20 | 45 | 25 | 5 |
| 83 | Populus alba . | 5 | ... | 25 | 30 | 10 | 5 | ... | ... | 35 | 25 | 20 | 5 |
| 88 | Alnus glutinosa | ... | 20 | 40 | 40 | 20 | ... | 5 | 10 | 15 | 25 | ... | ... |
| 63 | Quercus Cerris . | ... | 15 | ... | 20 | 10 | ... | ... | 10 | 20 | 25 | 5 | 5 |
| 21 | Cytisus Labm. . | 5 | 15 | 35 | 25 | 15 | 5 | 10 | 5 | 15 | 25 | 20 | 10 |
| 19 | Cratægus Oxya. | 15 | 15 | 40 | 30 | 40 | 25 | ... | 15 | 35 | 20 | 15 | 5 |
| 96 | Salix, sp. . . | ... | 30 | 40 | 40 | 40 | 30 | ... | 20 | 40 | 60 | 35 | 10 |
| | Total . . . | ·85 | 3·60 | 10·50 | 9·35 | 6·80 | 1·50 | ·45 | 3·50 | 10·15 | 9·70 | 5·15 | 1·90 |
| | Percentage . | 2·5 | 11 | 32 | 29 | 21 | 4·5 | 1·5 | 11·5 | 33 | 31·5 | 16·5 | 6 |

TABLE IV. MONTHLY GIRTH-INCREASE OF THIRTY DECIDUOUS TREES—*continued.*

| | 1891. | | | | | |
|---|---|---|---|---|---|---|
| | April. | May. | June. | July. | Aug. | Sept. |
| Tilia europæa | ... | ... | 30 | 20 | 5 | ... |
| ,, | ... | ... | 25 | 20 | ... | ... |
| Acer Pseudo-platanus | ... | 10 | 40 | 40 | 25 | 5 |
| ,, | ... | 10 | 45 | 45 | 35 | 5 |
| Æsculus Hippocastanum | ... | ... | 20 | 35 | 20 | 5 |
| ,, | ... | 10 | 25 | 40 | 35 | 5 |
| Pyrus Aucuparia | ... | ... | 15 | 20 | 15 | 5 |
| ,, | ... | 5 | 15 | 40 | 20 | 10 |
| Quercus Robur | ... | 10 | 10 | 40 | 40 | 5 |
| ,, | ... | 5 | 10 | 30 | 10 | ... |
| Carpinus Betulus | ... | 5 | 15 | 15 | 15 | 5 |
| ,, | ... | 5 | 5 | 25 | 30 | 5 |
| Betula alba | ... | 10 | 30 | 25 | 30 | ... |
| ,, | ... | ... | 30 | 20 | 25 | 5 |
| Prunus Padus | ... | ... | ... | 15 | 30 | 25 |
| ,, | ... | 5 | 40 | 50 | 35 | 5 |
| Ulmus campestris | ... | 20 | 40 | 45 | 35 | 10 |
| ,, | ... | 15 | 45 | 35 | 30 | 5 |
| Fagus sylvatica | ... | 5 | 35 | 50 | 40 | ... |
| ,, | ... | 5 | 35 | 50 | 40 | 5 |
| Fraxinus excelsior | ... | 20 | 30 | 15 | 15 | ... |
| ,, | ... | 5 | 35 | 15 | 5 | ... |
| Populus fastigiata | ... | 5 | ... | 15 | 50 | 5 |
| ,, | ... | ... | 5 | 10 | 30 | ... |
| Populus alba | ... | ... | 15 | 20 | 15 | ... |
| Alnus glutinosa | ... | ... | 25 | 25 | 20 | ... |
| Quercus Cerris | ... | 15 | 5 | 15 | 10 | 5 |
| Cytisus Laburnum | ... | 10 | 20 | 25 | 30 | 5 |
| Cratægus Oxyacantha | ... | 5 | 20 | 25 | 30 | 20 |
| Salix, sp. | ... | 10 | 30 | 55 | 50 | 20 |
| Total | ... | 1·90 | 6·95 | 8·80 | 7·70 | 1·60 |
| Percentage | ... | 7 | 26 | 32·5 | 28·5 | 6 |

*April.* The annual average number of trees which yielded no increase in April was 21 of the 30. In the remarkably late season of 1891 not a single tree showed any April increase at all. The amount rarely exceeded 0·05, but 0·10 was twice recorded in *Cytisus Laburnum* and once in *Prunus Padus,* while *Cratægus Oxyacantha* once attained 0·15. Small as are these results, there is no reason to doubt their substantial accuracy, as my former observations on the older set of trees showed even more marked April growth. In one season their aggregate April increase actually exceeded that of May, and in a *Quercus conferta* the large amount of ¼ inch was twice recorded.

In *Tilia europæa* (two trees) *Æsculus Hippocastanum* (two) no April growth occurred; in *Acer Pseudo-platanus* (two) and

*Fagus sylvatica* (two) the only growth recorded was 0·05 once. On the other hand, in *Ulmus campestris* (two) April increase was recorded six times; in *Cratægus Oxyacantha* (one) three times; and in *Cytisus Laburnum* (one) four times. Hence there seems to be a greater tendency to April growth in some species than others.

The total amounts for April were 0·30 in 1887, 0·60 in 1888, 0·85 in 1889, 0·45 in 1890, and 0·00 in 1891.

*May.* The annual average of trees yielding no increase was four of the 30, and yielding only 0·05 it was eight; on the other hand, an annual average of seven trees reached 0·20 or upwards, while 0·30 was recorded once in both specimens of *Acer Pseudo-platanus,* and in *Salix* sp., and twice in *Ulmus campestris.*

The total amount of May growth was 3·25 in 1887, 4·20 in 1888, 3·60 in 1889, 3·50 in 1890, and only 1·90 in the very late season of 1891.

*June.* Growth failed altogether on an average in only one instance annually, and reached only 0·05 in the same ratio. These deficiencies were no doubt due to temporary causes. Many of the trees grew from 0·30 upwards, and the following, belonging to six species, reached half an inch or upwards: *Acer, Ulmus, Æsculus,* and *Populus,* 0·50; *Acer, Ulmus, Fagus, Populus, Prunus,* 0·55; *Acer, Ulmus,* 0·60; and *Ulmus,* 0·65.

The total June growth was almost identical in 1887 (10·20), 1889 (10·50), and 1890 (10·15), but was only 6·00 in 1888 and 6·95 in 1891. The latter depression was probably due to the late season; but in 1888 it was apparently owing to some fault in the month itself, as the season was early, the increase of April and May having been above average.

*July.* Total failure or very restricted growth was in nearly the same small ratio as in June. Many species increased 0·30 or upwards in a single year, and the following attained half an inch or more: *Acer, Populus, Fagus* (thrice in the two trees), *Ulmus,* 0·50; *Populus, Salix,* 0·55 and 0·60; *Populus,* 0·65.

The total July growth was 6·75 in 1887, 7·20 in 1888, 9·35 in 1889, 9·70 in 1890, and 8·80 in 1891.

*August.* Growth failed entirely in three out of the thirty trees, and was restricted to 0·05 in four, on an average annually. Half an inch was attained in only three instances —*Populus fastigiata*, 0·50 and 0·60, and *Salix*, 0·50; but *Cratægus* reached 0·45; and *Populus* (twice), *Fagus* (twice), *Cratægus, Salix, Quercus*, 0·40.

The total August growth was 3·95 in 1887, 4·75 in 1888, 6·80 in 1889, 5·15 in 1890, and 7·70 in 1891.

*September*. Growth failed entirely on an average in twelve of the thirty trees annually, and reached only 0·05 in thirteen, so that an annual average of only five in thirty attained 0·10 or upwards. Some substantial increases occurred, however, *Salix* reaching 0·20 and 0·30, *Cratægus* 0·20 and 0·25, and *Prunus* 0·25.

The total September increases were 1·00 in 1887, 1·05 in 1888, 1·50 in 1889, 1·90 in 1890, and 1·60 in 1891.

*b*. Monthly Proportion of Girth-increase in thirty Deciduous Trees, collectively.

TABLE V. PERCENTAGE OF AGGREGATE MONTHLY GIRTH-INCREASE IN THIRTY DECIDUOUS TREES FOR FIVE YEARS, 1887–1891.

| Year. | April. | May. | June. | July. | August. | Sept. |
|---|---|---|---|---|---|---|
| 1887 . . . | 1 | 13 | 40 | 26·5 | 15·5 | 4 |
| 1888 . . . | 2·5 | 18 | 25 | 30 | 20 | 4·5 |
| 1889 . . . | 2·5 | 11 | 32 | 29 | 21 | 4·5 |
| 1890 . . . | 1·5 | 11·5 | 33 | 31·5 | 16·5 | 6 |
| 1891 . . . | ... | 7 | 26 | 32·5 | 28·5 | 6 |
| General Average . | 1·5 | 12 | 31 | 30 | 20·5 | 5 |

Monthly Order of Precedence.

| June. | July. | August. | May. | September. | April. |
|---|---|---|---|---|---|
| 31 | 30 | 20·5 | 12 | 5 | 1·5 |

The aggregate results for the five years show that the chief growth took place in June and July, June having only a slight advantage over July. In round numbers, together they account for rather more than three-fifths of the whole increase, August follows with one-fifth, May with about one-eighth, September with a twentieth, and April with only about a sixty-fifth.

The monthly range of p.c. in the five years was from 0·0 to 2·5 in April, 7 to 18 in May, 25 to 40 in June, 26·5 to 32·5 in July, 15·5 to 28·5 in August, and 4 to 6 in September.

The range is greatest in the two earlier months, due no doubt to the great variety in the meteorological conditions of different springs, by which the early efforts at growth are apt to be much retarded, or even entirely stopped. But the variations in a particular month are, no doubt, not always entirely ruled by the meteorological conditions of the month itself. Previous unfavourable months may influence a month favourable in itself; and in an unusually late season the main growth may be pushed on, as it were, towards the end of the season. Thus the very high proportion (28·5) of August 1891 must apparently be due to this cause, as the spring growth was very deficient, while August itself was a cold and wet month. These disturbing influences make the study of the connection between weather and monthly growth very intricate.

*c.* Monthly Proportion of Girth-increase in Deciduous Trees, individually.

In Table VI. I have given the monthly p.c. of girth-increase, not only of the thirty-four young trees under observation from 1887 to 1891, but also of twenty-four of the older set observed between 1883 and 1887, making fifty-eight in all, belonging to twenty-two species. The Table gives the half-season p.c., as well as the monthly p.c., the trees being arranged in the order of greatest growth in the first half-season. The averages of the younger trees are almost all founded on five, and of the older ones on four years' observations.

It would take too much space to give all the results that might be derived from Table VI. I must limit myself to a few of the most obvious and striking ones.

*Species which show the largest proportional Increase in the different Months.*

*April.* The most reliable instance of a comparatively large proportion is in the quickest-growing species of all, *Quercus conferta*, the three trees of which attained 9, 9, and 8 p.c. of their total growth in this month. Larger results come out in No. 44, *Quercus palustris* (10 p.c.); No. 14, *Fagus* (11 p.c.); and in No. 33, *Carpinus* (17 p.c.), but these trees grew slowly and irregularly, and are not so reliable.

TABLE VI. MONTHLY AND HALF-SEASON PERCENTAGE OF GIRTH-INCREASE IN DECIDUOUS TREES OF THE YOUNGER AND OLDER SETS.

| | Species. | April. | May. | June. | First ½ Season. | July. | Aug. | Sept. | Second ½ Season. |
|---|---|---|---|---|---|---|---|---|---|
| 75 | Fraxinus excelsior . . | 2 | 26·5 | 53 | 81·5 | 15 | 3·5 | ... | 18·5 |
| 85 | Tilia europæa . . | ... | 17 | 54 | 71 | 21 | 2 | 6 | 29 |
| 69 | ,, | ... | 10 | 53 | 63 | 26·5 | 9 | 1·5 | 37 |
| *† 6 | Fraxinus excelsior . . | 2·5 | 30 | 30 | 62·5 | 30 | 7·5 | ... | 37·5 |
| 67 | Acer Pseudo-platanus . | ... | 10 | 47 | 57 | 33 | 10 | ... | 43 |
| 23 | Fraxinus excelsior . . | 2 | 21 | 34 | 57 | 27·5 | 13·5 | 2 | 43 |
| †28 | Acer Pseudo-platanus . | 6·5 | 10 | 40 | 56·5 | 37 | 6·5 | ... | 43·5 |
| 74 | ,, | 1 | 17 | 38·5 | 56·5 | 27·5 | 14 | 2 | 43·5 |
| 94 | Ulmus campestris . . | 2·5 | 15 | 36·5 | 54 | 24 | 17 | 5 | 46 |
| 71 | Acer Pseudo-platanus . | ... | 12 | 40·5 | 52·5 | 28·5 | 16·5 | 2·5 | 47·5 |
| †14 | Fagus sylvatica . . | 11 | 13·5 | 27 | 51·5 | 21·5 | 19 | 8 | 48·5 |
| †33 | Carpinus Betulus . . | 17 | 17 | 17 | 51 | 37 | 12 | ... | 49 |
| 88 | Alnus glutinosa . . | 1 | 11 | 38 | 50 | 33 | 16 | 1 | 50 |
| 82 | Betula alba . . . . | 2 | 11·5 | 36·5 | 50 | 28·5 | 18 | 3·5 | 50 |
| 78 | ,, | 1 | 18·5 | 29 | 48·5 | 21 | 19·5 | 6 | 51·5 |
| †* 7 | Acer Pseudo-platanus . | 2 | 8 | 37 | 47 | 43 | 10 | ... | 53 |
| 63 | Quercus Cerris . . | ... | 28 | 17 | 47 | 31 | 14 | 8 | 53 |
| 93 | Ulmus campestris . . | 1·5 | 15 | 30 | 46·5 | 26·5 | 22 | 5 | 53·5 |
| 22 | Prunus Padus . . | 2 | 8 | 36 | 46 | 32 | 18 | 4 | 54 |
| 21 | Cytisus Laburnum . . | 7 | 14·5 | 24·5 | 46 | 25·5 | 20 | 8·5 | 54 |
| †38 | Fagus sylvatica . . | 3 | 12·5 | 30·5 | 45·5 | 33·5 | 18 | 3 | 54·5 |
| 72 | Quercus Robur . . | 2 | 20·5 | 22·5 | 45 | 39 | 10 | 6 | 55 |
| †14 | Fagus sylvatica . . | 3 | 8 | 33·5 | 44·5 | 44·5 | 11 | ... | 55·5 |
| †55 | Quercus conferta . . | 9 | 13 | 22·5 | 44·5 | 34 | 20 | 1·5 | 55·5 |
| 81 | Carpinus Betulus . . | 4·5 | 7 | 33 | 44·5 | 28·5 | 23 | 4·5 | 55·5 |
| *†22 | Fagus sylvatica . . | ... | 20 | 24 | 44 | 48 | 8 | ... | 56 |
| †44 | Quercus palustris . . | 10 | 18 | 16 | 44 | 41 | 15 | ... | 56 |
| 77 | Pyrus Aucuparia . . | 2 | 6 | 36 | 44 | 34·5 | 14·5 | 7 | 56 |
| 83 | Populus alba . . . | 3 | ... | 40 | 43 | 33 | 20 | 4 | 57 |
| 98 | Fagus sylvatica . . | 1 | 8 | 34 | 43 | 33 | 23 | 1 | 57 |
| 19 | Cratægus Oxyacantha . | 4·5 | 9·5 | 28 | 42 | 22 | 24·5 | 11·5 | 58 |
| 73 | Æsculus Hippocastanum | ... | 10·5 | 30 | 40·5 | 35·5 | 20·5 | 3·5 | 59·9 |
| 80 | ,, | ... | 7·5 | 32 | 39·5 | 33 | 24 | 3·5 | 60·5 |
| † 8 | Fagus sylvatica . . | 5 | 9 | 25 | 39 | 30 | 25 | 6 | 61 |
| *† 9 | ,, | 5 | 16 | 18 | 39 | 40 | 21 | ... | 61 |
| *†15 | ,, | ... | 11·5 | 26·5 | 38 | 37·5 | 17 | 7·5 | 62 |
| *†12 | Quercus Robur . . | 7 | 24 | 7 | 38 | 41 | 14 | 7 | 62 |
| 97 | Fagus sylvatica . . | ... | 7·5 | 30 | 37·5 | 35 | 23·5 | 4 | 62·5 |
| †54 | Quercus conferta . . | 9 | 9 | 29·5 | 37·5 | 34 | 24·5 | 4 | 62·5 |
| 61 | Quercus rubra . . | 2 | 15 | 20 | 37 | 39 | 20 | 4 | 63 |
| 96 | Salix . . . . . | 1 | 13·5 | 22·5 | 37 | 26·5 | 26·5 | 10 | 63 |
| †18 | Tilia europæa . . | ... | 3 | 32·5 | 35·5 | 55 | 6·5 | 3 | 64·5 |
| 87 | Populus fastigiata . . | ... | 10 | 25 | 35 | 34 | 28 | 3 | 65 |
| †40 | Quercus conferta . . | 8 | 6·5 | 20 | 34·5 | 35·5 | 24·5 | 5·5 | 65·5 |
| 86 | Carpinus Betulus . . | ... | 9 | 25·5 | 34·5 | 27·5 | 29 | 9 | 65·5 |
| 18 | Prunus Padus . . | 1 | 2·5 | 30·5 | 34 | 38 | 23 | 5 | 66 |
| 2 | Quercus Robur . . | ... | 20·5 | 13 | 33·5 | 43·5 | 20·5 | 2·5 | 66·5 |
| † 4 | Castanea vesca . . | 6·5 | 11·5 | 15·5 | 33·5 | 36·5 | 25·5 | 4·5 | 66·5 |
| †43 | Quercus Cerris . . | 2 | 20 | 11 | 33 | 37 | 26 | 4 | 67 |
| *†10 | ,, | 3 | 22 | 6·5 | 31·5 | 35 | 30·5 | 3 | 68·5 |
| 70 | Quercus Robur . . | 2·5 | 12·5 | 16 | 31 | 38 | 26 | 5 | 69 |
| † 7 | Fagus sylvatica . . | 2 | 4·5 | 23·5 | 30 | 37 | 30 | 3 | 70 |
| 1 | Quercus Robur . . | ... | 11 | 18 | 29 | 42 | 22 | 7 | 71 |
| 79 | Pyrus Aucuparia . . | 1 | 5 | 22·5 | 28·5 | 40 | 25·5 | 6 | 71·5 |
| *† 5 | Betula alba . . . | ... | ... | 27 | 27 | 51 | 22 | ... | 73 |
| 76 | Populus fastigiata . . | 1·5 | 6·5 | 16 | 24 | 34·5 | 38 | 3·5 | 76 |
| *† 8 | Fagus sylvatica . . | 3 | ... | 16 | 19 | 42 | 29 | 10 | 81 |
| † 6 | Liriod. tulipifera . . | 2 | 4 | 4 | 10 | 34 | 43 | 13 | 90 |

* Craigiehall Trees. † Trees of the older set.

The same must be said of No. 28, *Acer*, with 6·5. The only other quite reliable instances of a proportion exceeding 5 p.c. are *Cytisus Laburnum*, with 7 p.c., and *Castanea vesca*, with 6·5 p.c. The only instances of 5 p.c. occur in *Fagus*, Nos. 8 and 9*; of 4·5 p.c. in No. 81, *Carpinus*, and No. 19, *Cratægus;* and no others exceed 3 p.c. Thus only thirteen of the fifty-eight exceed 3 p.c., and of these only nine are perfectly reliable.

*May.* Large proportions occur in all three specimens of *Fraxinus*, 21, 26·5, and 30 p.c.; in all three of *Quercus Cerris*, 20, 22, and 28 p.c.; in two of the five examples of *Q. Robur*, 20·5 each; in *Ulmus*, 25 p.c.; and *Fagus*, 22 p.c. Thus in only ten of the fifty-eight the proportion attained 20 p.c. or upwards, and it is remarkable that all the three *Ashes*, all the three *Turkish Oaks*, and two of the five English Oaks are included in this small number.

*June.* The largest proportions are in two of the three examples of *Tilia*, 54 and 53 p.c.; in all five of *Acer*, 37, 38·5, 40, 40·5, and 47 p.c.; in *Fraxinus*, 53 p.c.; *Populus alba*, 40 p.c.; *Betula*, 38·5 p.c.; *Alnus*, 38 p.c.; *Prunus*, *Pyrus*, and *Ulmus*, 36 p.c. each. Thus 35 p.c. was exceeded in fourteen of the fifty-eight, including all the five Sycamores and two of the three Limes. The tendency of certain species to a large proportion in this month is confirmed by the second specimens of *Betula*, *Prunus*, and *Ulmus* being near the average of the month. *Populus alba* and *Alnus* are single of their kind. Both the young Limes and one of the young Ashes accomplished more than half their annual growth in this month.

*July.* A high percentage in this month occurs above all in the genus *Quercus*. All the five specimens of *Q. Robur* figure with 36·5, 39, 41, 42, and 43·5 p.c.; the single *Q. rubra* and *Q. palustris* with 39 and 41 p.c.; two of the three specimens of *Q. Cerris* with 35 and 37 p.c.; and one of the three of *Q. conferta* with 35·5. The remaining examples of the genus, *Q. conferta* (two) and *Q. Cerris*, are well up, with 34, 34, and 31 p.c., all above the monthly average. Of the eleven examples of *Fagus*, five appear with 35, 37·5, 40, 42, and 48; and of the others only one is below the monthly average. The two specimens of *Pyrus* stand well, with 34·5 and 40 p.c.; also *Æsculus*, with 35 and 34; other cases with large July p.c., but in which the tendency of the species is not so well confirmed, are two of the four specimens of *Acer*, with 37 and 43 p.c.; *Carpinus*, with 37 p.c.; *Prunus*, with 38 p.c.; and, because it is single of its species, *Cratægus*, with 36·5. The very high proportions of 55 p.c. in *Tilia* No. 18, and 51 p.c. in *Betula* No. 5, both older trees, are quite contradicted in the younger specimens of their species.

Thus, twenty-three of the fifty-eight had upwards of 35 p.c. this month, and two increased more than a half of their total amount in it.

*August.* *Liriodendron tulipifera* is decidedly at the head, with 43 p.c.; No. 76, *Populus fastigiata*, alone approaches it, with 38 p.c. Thirteen others reach between 25 and 30·5 p.c., but as none of them indicate a special preference of the species for August, it seems unnecessary to detail them.

*September.* *Liriodendron* stands best in this month also, with 13 p.c., *Cratægus* coming next, with 11·5 p.c., both reliable. Three, *Salix*, *Quercus Robur*, and *Fagus* yield 10 p.c., but the two latter are old trees of slow growth. No. 86, *Carpinus*, with 9 p.c., *Cytisus* and *Quercus Cerris*, with 8 p.c., are quite reliable; but No. 14, *Fagus*, with 8 p.c., is questionable. Altogether, only nine of the fifty-eight attained 8 p.c. or upwards.

### *d.* Distribution of Girth-increase over the Growing Season in the Younger Group of Deciduous Trees.

There is a great variety in the period of time in which the trees got over the main part of their growth. Both the Limes and one of the Ashes, for example, accomplished more than half their increase in the month of June alone. Table VII. gives examples of these varieties in distribution.

Other examples nearly as well marked might be deduced from Table VII. The similarity of results in both specimens of *Tilia*, *Betula*, *Ulmus*, and *Fagus* indicate that the results are characteristic not only of individual trees but also of species. *Cratægus*, *Cytisus*, and *Salix*, being single of their species, yield results not so conclusive as the others, but there is no reason to suppose that their growth is abnormal.

Table VII.

| | | Monthly Percentage. | | | | | |
|---|---|---|---|---|---|---|---|
| | | April. | May. | June. | July. | Aug. | Sept. |
| Well distributed over the season. | Cratægus Oxyacantha | 4·5 | 9·5 | 28 | 22 | 24·5 | 11·5 |
| | Cytisus Laburnum . | 7 | 14·5 | 24·5 | 25·5 | 20 | 8·5 |
| Well distributed over five months. | Salix sp. . . . | 1 | 13·5 | 22·5 | 26·5 | 26·5 | 10 |
| | Betula alba . . | 1 | 18·5 | 29 | 21 | 19·5 | 6 |
| ,, | Ulmus campestris . | 2·5 | 15 | 36·5 | 24 | 17 | 5 |
| | ,, ,, . . | 1·5 | 25 | 30 | 26·5 | 22 | 5 |
| Well distributed over four months. | Fraxinus excelsior . | 2 | 21 | 34 | 27·5 | 13·5 | 2 |
| | Betula alba . . | 2 | 11·5 | 36·5 | 28·5 | 18 | 3·5 |
| Mainly confined to three months. | Tilia europæa . . | ... | 17 | 54 | 21 | 2 | 6 |
| | Æsculus Hippoc. . | ... | 7·5 | 32 | 33 | 24 | 3·5 |
| | Fagus sylvatica . | ... | 7·5 | 30 | 35 | 23·5 | 4 |
| | ,, | 1 | 8 | 34 | 33 | 23 | 1 |
| Mainly confined to two months. | Acer Pseudo-platanus | ... | 10 | 47 | 33 | 10 | ... |
| | Fraxinus excelsior . | 2 | 26·5 | 53 | 15 | 3·5 | ... |
| | Acer Pseudo-platanus | ... | 12 | 40·5 | 28·5 | 16·5 | 2 |
| | Tilia europæa . . | ... | 10 | 53 | 26·5 | 9 | 1·5 |

Distribution in the genus *Quercus*.

I have made a separate study of this genus, including the species of the older group, as there seems to be a tendency in it to early vigour, followed by a period of slower growth. This is seen most unequivocally in the three Turkish Oaks

Table VIII.

| No. | | April. | May. | June. | July. | No. | | April. | May. | June. | July. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 63 | Q. Cerris . | ... | 28 | 17 | 31 | 72 | Q. Robur . | 2 | 20·5 | 22·5 | 39 |
| 43 | ,, | 2 | 20 | 11 | 37 | *12 | ,, | 7 | 24 | 7 | 41 |
| 10 | ,, | 3 | 22 | 6·5 | 35 | 2 | ,, | ... | 20·5 | 13 | 43·5 |
| | | | | | | 70 | ,, | 2·5 | 12·5 | 16 | 38 |
| | Average . | 1·5 | 23 | 11·5 | 34 | 1 | ,, | ... | 11 | 18 | 42 |
| | | | | | | | Average . | 2·3 | 17·7 | 15.8 | 40·7 |
| 40 | Q. conferta | 9 | 13 | 22·5 | | | | | | | |
| 54 | ,, | 9 | 9 | 29·5 | | | | | | | |
| 55 | ,, | 8 | 6·5 | 20 | | †14 | Q. palustris | 10 | 18 | 16 | 41 |
| | | | | | | 61 | Q. rubra . | 2 | 15 | 20 | 39 |
| | Average . | 8·7 | 9·5 | 26 | | | | | | | |

(Table VIII.), in all of which the June percentage is much exceeded by that of May on the one side and July on the other, the general average of the three for from four to five years being 23 for May, 11·5 or exactly half for June, and

34 for July. In the three Hungary Oaks, the most vigorous growers in early spring of all my Deciduous trees, the same tendency is shown, but at an earlier stage and in a considerably less degree. In one the May growth slightly exceeds the April growth, in another they are equal, in the third April slightly exceeds May, and the general proportions are 8·7 and 9·5. Of the five British Oaks, only two show an actual inferiority in June compared with May, but in No. 72, the most reliable of all, the proportions are nearly equal; that of May is double its monthly average, and that of June nearly a third below its monthly average. The general average of the five British Oaks is 17·7 for May and 15·3 for June, in strong contrast with the proportions for the thirty trees in mass, which are 12 for May and 31 for June.

In the single *Q. palustris* June has only 16 p.c., while May has 18 p.c., but it is not a very reliable tree. In the single *Q. rubra* there is no actual inferiority, yet the tendency to it is probably shown by May being one-third above average, and June one-third below it. The tendency to halt in the Oaks is emphasized by the sudden jump from the month of depression to a very high proportion in the following one which characterizes them all. The only tree of another species which shows this tendency is the single Hawthorn, in which the July proportion (22) is below that of June (28) and of August (24·5); but it should be remembered that in the trees which show no actual retardation of growth in the Table, and particularly in such as have a nearly equal increase in neighbouring months, a tendency to halt might nevertheless come out if the observations were taken more frequently than monthly.

*e*. Proportion of Girth-increase in the First and Second Half-Seasons in Deciduous Trees.

The division of the growing season into two periods of three months each is the only practicable one, with observations at monthly intervals; but the periods of actual growth are not necessarily equal in these two divisions. Probably the period of growth is shorter in April than September, at least in young trees, as the percentage in my young group was only 1·5 in April, and was 5·0 in

September. At the same time, it is possible that the difference is due, not so much to the growth being shorter in point of time in April, as to its being slower.

In my older group the conditions are the reverse, the recorded April increase being considerably greater than that of September, but for various reasons the results are much less reliable.

Instead of the awkward terms "first and second half-season's increase" "spring and autumn increase" might have been adopted, but this would be misleading, as, after all, the main growth is in summer.

My earlier observations on older trees of eleven Deciduous species showed that some tended to increase in girth mainly in the first half-season, others in the second. In the new group, seven of these species and eleven new ones are included, and the results for the whole twenty-two are given in Table VI., in the order of greatest growth in the first half-season. As a proof that this difference in the period of greatest growth is a true characteristic of species, a glance over the Table shows that, as a rule, trees of the same species are near each other. Thus it is remarkable, among fifty-eight trees, to find the only two Horse Chestnuts standing together; also the only two young Birches and Limes; and two of the three Turkish Oaks; while two of the five Sycamores are together, separated by only one tree of a different species from two others of their own species, the fifth being not far off. The three Ashes are also separated by only three other trees. Or—to take the species with the largest number of examples—of eleven Beeches of very different ages, four are together, and four more are within thirteen places of them. Other less-marked examples, which nevertheless show the tendency, are the only two Elms, within ten places of each other, and two of the three Hungary Oaks within seven, all three being within eighteen. Taking the British Oaks, only one of the five is found among the first thirty-six trees, the other four being among the next seventeen. Of the thirteen Oaks of various species, only four are in the first thirty-six trees, and none higher than the seventeenth place, and nine are among the next seventeen. Remarkable exceptions no doubt occur; the two young specimens of *Prunus Padus*, *Pyrus Aucuparia*, and *Carpinus Betulus* are far apart, but it is to be presumed their conduct is due to exceptional causes.

It will be observed that equilibrium is established as high as the thirteenth and fourteenth trees in the list. Hence only twelve of the fifty-eight grew chiefly in the first period, and no less than forty-four chiefly in the last period. But as some species are much more largely represented than others, it is of consequence to ascertain the averages for the *species*, and I shall take the old and young groups separately, as the latter is more reliable than the former.

In the younger group (Table IX.) three species increased mainly in the first period; in three the proportions were equal; and in thirteen the increase was chiefly in the last period.

TABLE IX. PROPORTIONAL INCREASE IN GIRTH IN DECIDUOUS SPECIES IN THE FIRST AND SECOND HALF OF THE GROWING SEASON (YOUNG GROUP).

| Species. | Average of | First Half. | Second Half. | Species. | Average of | First Half. | Second Half. |
|---|---|---|---|---|---|---|---|
| Fraxinus excelsior | 2 trees | 69 | 31 | Fagus sylvatica | 2 trees | 40 | 60 |
| Tilia europæa | 2 ,, | 67 | 33 | Æsculus Hippoc. | 2 ,, | 40 | 60 |
| Acer Pseudo-pl. | 2 ,, | 54 | 45 | Prunus Padus | 2 ,, | 40 | 60 |
| Betula alba | 2 ,, | 50 | 50 | Carpinus Betulus | 2 ,, | 40 | 60 |
| Alnus glutinosa | 1 ,, | 50 | 50 | Quercus rubra | 1 ,, | 37 | 63 |
| Ulmus campestris | 2 ,, | 50 | 50 | Salix sp. | 1 ,, | 37 | 63 |
| Quercus Cerris | 1 ,, | 47 | 53 | Pyrus Aucuparia | 2 ,, | 36 | 64 |
| Cytisus Laburn. | 1 ,, | 46 | 54 | Quercus Robur | 4 ,, | 35 | 65 |
| Populus alba | 1 ,, | 43 | 57 | Populus fastigiata | 2 ,, | 30 | 70 |
| Cratægus Oxyac. | 1 ,, | 42 | 58 | | | | |
| | | | The same (older group). | | | | |
| Acer Pseudo-pl. | 2 trees | 55 | 45 | Quercus Cerris | 2 trees | 31 | 69 |
| Carpinus Betulus | 1 ,, | 51 | 49 | Castanea vesca | 1 ,, | 31 | 69 |
| Quercus palust. | 1 ,, | 44 | 56 | Betula alba | 1 ,, | 24 | 76 |
| ,, conferta | 3 ,, | 39 | 61 | Tilia europæa | 1 ,, | 24 | 76 |
| ,, Robur | 1 ,, | 38 | 62 | Liriodend. Tulip. | 1 ,, | 10 | 90 |
| Fagus sylvatica | 9 ,, | 38 | 62 | | | | |

Should it be necessary to take about a week of June from the second period and add it to the first, in order to make the two growing periods actually equal, the number of species on either side of equilibrium would probably be about the same. The extremes are—*Fraxinus*, 69, 31, and *Tilia*, 67, 33, against *Populus fastigiata* 30, 70, and *Quercus Robur*, 35, 65.

In the older group (Table IX.) the preference for the second period is much more marked. Of eleven species, the only one which prefers the first is *Acer*. In *Carpinus* there is almost an equilibrium. The extremes are—*Acer*, with 55, 45, and *Liriodendron*, with 10, 90.

Comparing the species which occur in both groups, a remarkable agreement is found in *Acer*, 56, 44, and 55, 45; in *Fagus*, 40, 60, and 38, 62; and in *Quercus Robur*, 35, 65, and 38, 62. But there is a considerable difference in *Carpinus*, 40, 60, and 51, 49; in *Q. Cerris*, 47, 53, and 31, 69; and a very great contrast in *Tilia*, 67, 38, and 24, 76; and *Betula*, 50, 50, and 24, 76.

On the whole, the proportions may be considered as well made out in *Acer*, *Quercus Robur*, and above all in *Fagus*, as the observations rest on a considerable number of trees in each case. Hardly less reliable, perhaps, in the younger group are *Tilia*, *Fraxinus*, *Ulmus*, *Betula*, *Æsculus*, and *Populus fastigiata*, because, although only two trees of each were measured, their proximity to each other in the list of fifty-eight inspires confidence in the reliability of the average deduced; and this notwithstanding the wide divergence of the single trees of the older group in the case of *Tilia* and *Betula*, which may be due to some abnormality produced by their slow growth.

The only thoroughly established additional species from the older group is *Q. conferta*, although the close agreement of the two specimens of *Q. Cerris* suggest reliability, notwithstanding the wide divergence of the single specimen in the younger group.

The remaining eleven species are more doubtful—*Carpinus*, *Prunus*, *Pyrus* of the younger group,—because of the wide divergence of the results in thetwo specimens of each; the others, because only one tree of each was measured, although there can scarcely be a doubt that the proportions in *Liriodendron* are substantially correct, its small proportion of 10 p.c. in the first period being fully accounted for by the fact that its leaves do not begin to grow till the end of June. Here the remarkable fact may be recorded that its leaf-buds are sometimes among the first to open in the garden. Many tender young leaves were exposed in April 1890 and 1891, the latter a very backward season, but they made no further progress till far on in June.

## (2) CONIFERÆ.

### *a.* Monthly Amount of Girth-increase in twenty Coniferæ, individually and collectively.

TABLE X.—MONTHLY GIRTH-INCREASE OF TWENTY CONIFERÆ IN HUNDREDTHS OF AN INCH.

| | | 1887. | | | | | | 1888. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | April. | May. | June. | July. | Aug. | Sept. | April. | May. | June. | July. | Aug. | Sept. |
| 64 | Araucaria imbricata . | 5 | 25 | 20 | 10 | 5 | ... | ... | 25 | 25 | ... | 5 | 5 |
| 65 | ,, | ... | 30 | 20 | 5 | 5 | ... | 10 | 20 | 30 | ... | ... | ... |
| 8 | Abies Lowiana . . . | 5 | 35 | 40 | 35 | 60 | 20 | 5 | 50 | 25 | 20 | 25 | 25 |
| 92 | ,, | 5 | 45 | 45 | 20 | 60 | 20 | 5 | 45 | 45 | 20 | 25 | 25 |
| 6 | Abies Douglasii . . | 5 | 25 | 25 | 20 | 15 | ... | 5 | 30 | 20 | 10 | 15 | ... |
| 66 | ,, | 5 | 25 | 25 | 25 | 15 | ... | 5 | 10 | 15 | 10 | 5 | ... |
| 2 | Pinus excelsa . . . | ... | 30 | 30 | 10 | 10 | 10 | 5 | 25 | 25 | 25 | 5 | 5 |
| 3 | ,, | 5 | 15 | 25 | 5 | 5 | 5 | 5 | 35 | ... | 15 | 5 | ... |
| 11 | ,, | 5 | 5 | 15 | ... | 5 | ... | 5 | 15 | 15 | ... | 5 | 10 |
| 9 | Cupressus Lawsoniana | ... | 10 | 20 | 5 | 5 | ... | 5 | 5 | 20 | 15 | ... | ... |
| 10 | ,, | ... | 20 | 10 | 10 | ... | ... | ... | 10 | 10 | ... | ... | ... |
| 20 | Larix europæa . . . | ... | 15 | 35 | 10 | 15 | ... | 5 | 20 | 50 | 25 | 15 | 10 |
| 89 | ,, | ... | 30 | 30 | 10 | 15 | 5 | ... | 30 | 30 | 30 | 15 | .. |
| 91 | Abies grandis . . . | 5 | 30 | 5 | 35 | 35 | 15 | 5 | 30 | 5 | 15 | 30 | 30 |
| 24 | ,, Hookeriana . | ... | 5 | 30 | 15 | 10 | ... | ... | 10 | 20 | 20 | 10 | ... |
| 26 | Pinus Pinaster . . . | 5 | 30 | 25 | 15 | 15 | 5 | 5 | 30 | 25 | 25 | 10 | ... |
| 28 | ,, austriaca . . | ... | 40 | 20 | 10 | 10 | ... | 5 | 25 | 25 | 15 | 15 | ... |
| 25 | ,, Murrayana . . | ... | 20 | 20 | 15 | 15 | 5 | ... | 30 | 5 | 20 | 15 | ... |
| 12 | Thuja gigantea . . . | 5 | 30 | 15 | ... | ... | ... | 5 | 25 | 15 | 15 | 10 | ... |
| 14 | Retinospora obtusa . | 5 | 25 | 10 | 5 | ... | ... | ... | 15 | 10 | ... | ... | ... |
| | Total . . . . . | ·55 | 4·90 | 4·65 | 2·65 | 3·00 | ·85 | ·75 | 4·85 | 4·15 | 2·80 | 2·10 | 1·10 |

Thirty of the Coniferæ, including sixteen species, were under observation, but I have rejected the ten slowest growers be-

TABLE X.—MONTHLY GIRTH-INCREASE OF TWENTY CONIFERÆ—*continued.*

| | | 1889. | | | | | | 1890. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | April. | May. | June. | July. | Aug. | Sept. | April. | May. | June. | July. | Aug. | Sept. |
| 64 | Araucaria imbricata . | ... | 15 | 10 | 10 | ... | ... | .. | 5 | 30 | 15 | 10 | ... |
| 65 | ,, | 5 | 30 | 10 | ... | ... | ... | ... | 25 | 15 | 15 | 15 | ... |
| 8 | Abies Lowiana . . | 5 | 45 | 35 | 20 | 50 | 30 | 15 | 45 | 40 | 20 | 35 | 35 |
| 92 | ,, | ... | ... | ... | 10 | 15 | 5 | ... | 5 | 25 | 40 | 20 | 10 |
| 6 | Abies Douglasii . . | ... | 10 | 5 | 10 | 15 | ... | 5 | 20 | 10 | 15 | 5 | ... |
| 66 | ,, | 10 | 35 | 20 | 25 | 20 | 10 | 10 | 30 | 10 | 30 | 25 | 20 |
| 2 | Pinus excelsa . . . | 15 | 25 | 30 | 20 | 20 | 10 | 15 | 25 | 20 | 30 | 15 | 5 |
| 3 | ,, | 10 | 15 | 10 | 15 | 10 | 5 | ... | 15 | 15 | 20 | 5 | ... |
| 11 | ,, | 10 | 20 | 25 | 20 | 15 | 10 | 10 | 20 | 30 | 30 | 20 | 20 |
| 9 | Cupressus Lawsoniana | 10 | 15 | 10 | 10 | ... | ... | ... | 25 | 15 | 15 | 5 | ... |
| 10 | ,, | 5 | 20 | 15 | 5 | 5 | ... | 10 | 25 | 15 | 15 | 5 | ... |
| 20 | Larix europæa . . . | 5 | 30 | 45 | 40 | 40 | 15 | ... | 20 | 60 | 30 | 10 | 20 |
| 89 | ,, | 5 | 30 | 30 | 30 | 15 | ... | 5 | 15 | 40 | 35 | 10 | 10 |
| 91 | Abies grandis . . . | 15 | 30 | 15 | 35 | 50 | 20 | 20 | 20 | 15 | 35 | 40 | 50 |
| 24 | ,, Hookeriana . . | ... | 10 | 25 | 15 | 15 | 5 | ... | ... | 25 | 15 | 10 | 5 |
| 26 | Pinus Pinaster . . . | 10 | 25 | 20 | 10 | 15 | ... | ... | 20 | 20 | 10 | 5 | 5 |
| 28 | ,, austriaca . . | 5 | 30 | 15 | 15 | 5 | ... | ... | 20 | 15 | 10 | ... | ... |
| 25 | ,, Murrayana . . | 5 | 20 | 20 | 10 | 10 | 10 | 5 | 20 | 15 | 15 | 15 | ... |
| 12 | Thuja gigantea . . . | 15 | 25 | 20 | 20 | 25 | 10 | 15 | 25 | 30 | 15 | 10 | 10 |
| 14 | Retinospora obtusa . | 10 | 20 | 10 | 10 | 5 | 5 | 10 | 10 | 10 | 15 | 5 | ... |
| | Total . . . . | 1·40 | 4·50 | 3·70 | 3·40 | 3·30 | 1·35 | 1·20 | 3·90 | 4·55 | 4·25 | 2·65 | 1·90 |

cause their rate was so low as to be abnormal and misleading. Hence only thirteen species are represented in Table X.

TABLE X.—MONTHLY GIRTH-INCREASE OF TWENTY CONIFERÆ—*continued.*

| | | 1891. | | | | | |
|---|---|---|---|---|---|---|---|
| | | April. | May. | June. | July. | Aug. | Sept. |
| 64 | Araucaria imbricata | ... | 15 | 15 | 10 | 10 | 5 |
| 65 | ,, | ... | 25 | 20 | 5 | 5 | 10 |
| 8 | Abies Lowiana | 5 | 35 | 60 | 20 | 25 | 20 |
| 92 | ,, | ... | ... | 35 | 20 | 25 | 20 |
| 6 | Abies Douglasii | 5 | 10 | 15 | 10 | 20 | 5 |
| 66 | ,, | 5 | 25 | 30 | 20 | 20 | 10 |
| 2 | Pinus excelsa | 10 | ... | 35 | 30 | 25 | 10 |
| 3 | ,, | 10 | 10 | ... | 15 | 5 | 5 |
| 11 | ,, | 5 | 10 | 25 | 20 | 25 | 15 |
| 9 | Cupressus Lawsoniana | ... | 15 | 15 | 10 | 5 | 5 |
| 10 | ,, | .. | 20 | 20 | 10 | ... | 5 |
| 20 | Larix europæa | ... | 5 | 20 | 25 | 40 | 5 |
| 89 | ,, | ... | 5 | 15 | 25 | 10 | ... |
| 91 | Abies grandis | ... | 35 | 15 | 30 | 45 | 35 |
| 24 | ,, Hookeriana | ... | ... | 25 | 15 | 5 | 5 |
| 26 | Pinus Pinaster | ... | 5 | 25 | 15 | 10 | 5 |
| 28 | ,, austriaca | ... | ... | 25 | 5 | 5 | ... |
| 25 | ,, Murrayana | ... | 10 | 15 | 10 | 10 | 10 |
| 12 | Thuja gigantea | 5 | 10 | 25 | ... | 10 | 10 |
| 14 | Retinospora obtusa | ... | 10 | 10 | 5 | 10 | 5 |
| | Total | ·45 | 2·45 | 4·45 | 3·00 | 3·10 | 1·85 |

*April.* The annual average number of trees which yielded no increase in this month was eight in the twenty, a much smaller proportion than the twenty-one in thirty of the Deciduous group. 0·10 was reached thirteen times, 0·15 six times, and 0·20 once. No less than seven of these twenty comparatively large amounts were due to three trees of *Pinus excelsa*. Of single trees, *Thuja gigantea* twice yielded 0·15, *Abies grandis* figures with 0·15 and 0·20, and *Retinospora* twice with 0·10. Thus a stronger tendency is apparently shown to a comparatively large April growth in some species than in others. The incidence of these larger amounts in the different years was very various. In 1887 no example occurred, in 1888 one, in 1891 two, in 1890 eight, in 1889 nine.

The total amounts for April were 0·55 in 1887, 0·75 in 1888, 1·40 in 1889, 1·20 in 1890, and 0·45 in 1891.

*May.* The annual average number of trees yielding either 0·00 or 0·05 was only about three in twenty, contrasted with twelve in thirty of the Deciduous group. An increase of 0·30 or upwards was reached twenty-eight times among the twenty trees in five years, *Abies Lowiana* appropriating seven of the twenty-eight. 0·40 and upwards was attained six times, five of them by *A. Lowiana*, and it alone reached half an inch.

The total amounts were 4·90 in 1887, 4·85 in 1888, 4·50 in 1889, 3·90 in 1890, and 2·45 in 1891.

*June.* Records of 0·00 or 0·05 occur only seven times; of 0·30 and upwards twenty-four times, and in only seven of the thirteen species; eight times in *Larix*; seven in *Ab. Lowiana*; four in *P. excelsa*; twice in *Araucaria*; once in *Ab. Hookeriana*, *Ab. Douglasii*, and *Thuja gigantea*. Increases of 0·50 and 0·60 in *Larix*, and of 0·50 in *Ab. Lowiana*, were recorded. No other species reached half an inch.

The total amounts were 4·75 in 1887, 4·15 in 1888, 3·70 in 1889, 4·55 in 1890, and 4·45 in 1891.

*July.* Records of 0·00 or 0·05 occur fifteen times; of 0·30 and upwards fifteen times, in five species—five times in *Larix*, four in *P. excelsa*, three in *Ab. Lowiana*, twice in *Ab. grandis*, and once in *Ab. Douglasii*. 0·45 in *Larix* was the greatest amount in this month.

The total amounts were 2·65 in 1887, 2·80 in 1888, 3·40 in 1889, 4·25 in 1890, and 3·00 in 1891.

*August.* Records of 0·00 or 0·05 occur thirty-six times; of 0·30 and upwards eleven times, confined to the three species—*Ab. grandis,* five times, *Ab. Lowiana* four times, *Larix* twice. 0·60 was attained twice and 0·50 once by *Ab. Lowiana,* and 0·50 once by *Ab. grandis.*

The total amounts were 3·00 in 1887, 2·10 in 1888, 3·30 in 1889, 2·65 in 1890, and 3·10 in 1891.

*September.* Records of 0·00 or 0·05 occurred sixty-five times, or about two-thirds of the whole; of 0·30 or upwards five times, in *Ab. grandis* three times, in *Ab. Lowiana* twice; of 0·20 and upwards fifteen times,—eight in *Ab. Lowiana,* four in *Ab. grandis,* and once in *Ab. Douglasii, P. excelsa,* and *Larix.* No less than half an inch was attained once by *Ab. grandis* in this last month of the growing season.

The total amounts were 0·85 in 1887, 1·10 in 1888, 1·35 in 1889, 1·90 in 1890, and 1·85 in 1891.

*b.* Monthly Proportion of Girth-increase in twenty Coniferæ, collectively.

TABLE XI. PERCENTAGE OF AGGREGATE MONTHLY GIRTH-INCREASE OF TWENTY CONIFERÆ IN FIVE YEARS, 1887–1891.

| Year. | April. | May. | June. | July. | August. | Sept. |
|---|---|---|---|---|---|---|
| 1887 . . . | 3·5 | 29·5 | 28 | 16 | 18 | 5 |
| 1888 . . . | 5 | 30·5 | 26·5 | 18 | 13 | 7 |
| 1889 . . . | 8 | 25·5 | 21 | 19 | 18·5 | 8 |
| 1890 . . . | 6·5 | 21 | 25 | 23 | 14·5 | 10 |
| 1891 . . . | 3·5 | 16 | 29 | 19·5 | 20 | 12 |
| General average | 5 | 24·5 | 26 | 19 | 17 | 8·5 |

Order of Precedence.

| June. | May. | July. | August. | September. | April. |
|---|---|---|---|---|---|
| 26 | 24·5 | 19 | 17 | 8·5 | 5 |

The result for the five years is that the chief growth was in June and May. Together they account for half the total increase, June having no great advantage over May; July claims a fifth of the whole, August a sixth, September a twelfth; and April a twentieth.

Besides the general average, it is desirable to take that of several groups.

(*a*). The two Larches should be separated, as being not evergreen, and in their monthly average 2, 19, 32·5, 24, 17, 5·5, they are more allied to the Deciduous trees than to the other quick-growing Pinaceæ.

(*b*). Four of the quick growers, Nos. 6, 66, 11, and 92, were much affected by transplantation early in the period, but, as it turns out, their averages, 6, 21·5, 23·5, 19·5, 20, 9, do not seriously affect the general proportions.

(*c*). The two remaining quick growers, Nos. 8 and 91, exercise a preponderating influence on the average of the two later months, 5, 21·9, 15, 16·5, 25, 17.

(*d*). The remaining twelve trees, all of comparatively slow growth, some of them certainly abnormally slow, yield 5·5, 31, 29, 19, 11, 4·5. The effect of excluding the quick growers is to materially reduce the proportions for August and September, to increase those of May and June, while April and July remain the same, and to alter the monthly sequence by putting May slightly ahead of June.

Perhaps the fairest general average for the evergreen is obtained by deriving it from the averages of the *species*, excluding trees affected by transplantation.

GENERAL MONTHLY PERCENTAGE OF ELEVEN EVERGREEN SPECIES (YOUNG TREES).

| April. | May. | June. | July. | August. | September. |
|---|---|---|---|---|---|
| 5·5 | 28 | 26·5 | 18·5 | 14·5 | 7 |

Sequence.

| May. | June. | July. | August. | September. | April. |
|---|---|---|---|---|---|
| 28 | 26·5 | 18·5 | 14·5 | 7 | 5·5 |

This average does not greatly differ from that obtained from the whole number of trees, except by placing May a little ahead of June, and slightly increasing the amount for these two months at the expense mainly of that for August.

The annual monthly range in the twenty trees was from 3·5 to 8 in April, 16 to 30·5 in May, 21 to 29 in June, 16 to 23 in July, 13 to 20 in August, 5 to 12 in September.

### *c.* Monthly Proportion of Girth-increase in Coniferous Species and Trees, individually.

As in the Deciduous class, I have added to the younger group a number of the older trees, twenty-one of the former and thirteen of the latter, thirteen species in all, appearing in Table XII. The introductory remarks under the same heading for the Deciduous group are applicable here also.

TABLE XII. MONTHLY AND HALF-SEASON PERCENTAGE OF GIRTH-INCREASE IN CONIFERÆ OF THE OLDER AND YOUNGER SET.

| | | April. | May. | June. | First ½ Season. | July. | Aug. | Sept. | Second ½ Season. |
|---|---|---|---|---|---|---|---|---|---|
| 65 | Araucaria imbricata | 3 | 44·5 | 31·5 | 79 | 11 | 5 | 5 | 21 |
| †34 | " | 13 | 29 | 35·5 | 77·5 | 22·5 | ... | ... | 22·5 |
| 10 | Cupressus Lawsoniana | 6·5 | 40·5 | 30 | 77 | 17 | 4 | 2 | 23 |
| †35 | Araucaria imbricata | 23 | 23 | 29 | 75 | 9 | 16 | ... | 25 |
| 28 | Pinus austriaca | 3 | 36·5 | 32 | 71·5 | 17·5 | 11 | ... | 28·5 |
| † 1 | Sequoia gigantea | 3 | 27 | 41 | 71 | 20·5 | 7·5 | 1 | 29 |
| 64 | Araucaria imbricata | ... | 33·5 | 37 | 70·5 | 16·5 | 7·5 | 5·5 | 29·5 |
| 14 | Retinospora obtusa | 11 | 36·5 | 23 | 70·5 | 16 | 9 | 4·5 | 29·5 |
| 9 | Cupressus Lawsoniana | 6 | 29·5 | 33·5 | 69 | 23 | 6 | 2 | 31 |
| *† 4 | Araucaria imbricata | 9 | 24·5 | 34·5 | 68·5 | 24·5 | 7 | ... | 31·5 |
| 12 | Thuja gigantea | 11 | 29·5 | 27 | 67·5 | 11 | 14·5 | 7 | 32·5 |
| *† 2 | Pinus austriaca | 17·5 | 25·5 | 22 | 65 | 17·5 | 12·5 | 5 | 35 |
| † 2 | Sequoia gigantea | 2·5 | 18·5 | 43 | 64 | 24·5 | 9 | 2·5 | 36 |
| 26 | Pinus Pinaster | 5 | 28 | 29·5 | 62·5 | 19·5 | 14 | 4 | 37·5 |
| *† 1 | Cupressus Lawsoniana | 9 | 25 | 27·5 | 61·5 | 31 | 7·5 | ... | 38·5 |
| 3 | Pinus excelsa | 10·5 | 31·5 | 17·5 | 59·5 | 25 | 10·5 | 5 | 40·5 |
| † 27 | Sequoia gigantea | 4 | 21 | 34·5 | 59·5 | 21 | 16·5 | 3 | 40·5 |
| 6 | Abies Douglasii | 6 | 28 | 22·5 | 56·5 | 21 | 21 | 1·5 | 43·5 |
| 89 | Larix europæa | 2 | 23·5 | 31 | 56·5 | 26·5 | 14 | 3 | 43·5 |
| 2 | Pinus excelsa | 8 | 21·5 | 26 | 55·5 | 21 | 14 | 9·5 | 44·5 |
| † 31 | Abies Lowiana | 9 | 27·5 | 18·5 | 55 | 22·5 | 22·5 | ... | 45 |
| 25 | Pinus Murrayana | 3 | 28·5 | 23 | 54·5 | 20 | 18·5 | 7 | 45·5 |
| 66 | Abies Douglasii | 7 | 25·5 | 20 | 52·5 | 22·5 | 17 | 8 | 47·5 |
| 11 | Pinus excelsa | 8·5 | 17 | 27 | 52·5 | 17 | 17 | 13·5 | 47·5 |
| 24 | Abies Hookeriana | ... | 8·5 | 42·5 | 51 | 27 | 17 | 5 | 49 |
| 20 | Larix europæa | 1·5 | 15 | 33·5 | 50 | 21·5 | 20·5 | 8 | 50 |
| 8 | Abies Lowiana | 4 | 23·5 | 22·5 | 50 | 13·5 | 22·5 | 14 | 50 |
| † 39 | Cedrus atlantica | 4 | 20 | 24 | 48 | 26 | 24·5 | 1·5 | 52 |
| 92 | Abies Lowiana | 2 | 16 | 25·5 | 43·5 | 18·5 | 24·5 | 13·5 | 56·5 |
| † 1 | Cedrus Deodara | 3 | 14·5 | 21 | 38·5 | 29 | 28 | 4·5 | 61·5 |
| 99 | Abies Douglasii | 4·5 | 22 | 11·5 | 38 | 24·5 | 26 | 11·5 | 62 |
| † 2 | Cedrus Deodara | 3 | 12 | 21·5 | 36·5 | 30 | 27 | 6·5 | 63·5 |
| 91 | Abies grandis | 6 | 19·5 | 7·5 | 33 | 20 | 27 | 20 | 67 |
| †29 | Cedrus Deodara | 2 | 6·5 | 15·5 | 24 | 33·5 | 33·5 | 9 | 76 |

* Craigiehall Trees. † Trees of the older set.

*Species which show the largest Proportions in the different Months.*

*April.* The most reliable instance of a large April proportion is in the healthy, quick-growing Craigiehall *Pinus austriaca*, where it amounted for the quinquennial period to 17·5 p.c. of the total increase. In the Botanic Garden specimens it was only 3 p.c., but this tree is not thriving. Large proportions are likewise shown in the three old *Araucarias*, 9, 13, and 23 p.c., but they were decaying trees, and the two young trees yielded only 3 p.c. between them. Species which show a comparatively high result in all their examples are *Pinus excelsa*, 8, 8·5, 10·5 p.c.; *Cupressus Lawsoniana*, 6, 6·5, 9 p.c.; the single *Thuja* and *Retinospora*, 11 p.c. each. On the other hand, the three trees of *Sequoia* and of *Cedrus* give only 2·5, 3, 4, and 2, 3, 3 p.c. The April proportion exceeded 3 p.c. in twenty-one and 5 p.c. in sixteen of the thirty-four trees.

Examples of a large incidence of species or individuals on one of the three chief growing months are not so common here as in the Deciduous group, as in the latter the proportions are not so equally diffused over the months.

*May.* Only two trees reach 40 p.c.,—a Cypress with 40, and an *Araucaria* with 44·5 p.c. The most reliable example of a species with a low proportion is *C. Deodara*, whose three trees yield 6·5, 12, and 14·5 p.c.

*June.* *Abies Hookeriana*, with 42·5, is the only tree of the younger group that reaches 40 p.c.; and in the older group, two of the *Sequoias*, with 41 and 43 (the third being well up with 34·5), are the sole representatives. *C. Deodara* is again low, with 15·5, 21·5, and 21·5 p.c.

*July.* No tree attained 40 p.c., and only three, all of the old group, reached 30 p.c. Two of these were Deodars, the third of the species being close up, with 29 p.c. The highest of the younger trees is *Ab. Hookeriana*, with 27 p.c.

*August.* A Deodar, with 33·5, stands at the head, and no other tree reaches 30 p.c. The contrasts of species are more marked in this month. The three trees of *C. Deodara* yield 27, 28, and 33·5 p.c.; the three of *Ab. Lowiana* 22·5, 22·5, and 24·5 p.c.; the four of *Araucaria* only 0, 5, 7·5, and 16;

the three of *Cupressus* 4, 6, and 7·5; and of *Sequoia*, 7·5, 9, and 16·5.

*September*. The most reliable species with a comparatively high proportion are *P. excelsa*, with 5, 9·5, and 13·5 p.c.; the two young *Ab. Lowiana*, with 13·5 and 14; and above all the single but most reliable *Ab. grandis*, with 20 p.c. Nine of the thirty-four reached 8 p.c. or upwards in this last month of the growing season.

*d.* Distribution of Girth-increase over the Growing Season in the Younger Group of Coniferæ.

There is apparently less tendency in the Coniferæ than in the Deciduous trees to confinement of the main girth-increase within narrow limits of time. Three of the latter grew above half their amount in a single month, but the only Coniferous trees which approached at all nearly to this were *Araucaria*, 44·5, *Ab. Hookeriana*, 42·5, and *Cupressus*, 40·5 p.c. Again nine of the thirty-four Deciduous trees, but only three of the twenty-one Coniferæ increased 70 p.c. and upwards within two months, the three highest examples of the former yielding 80, 79·5, and 79·5 p.c.; and of the latter, 75, 70·5, and 70·5. But it is in a three-month period that the contrast is most striking. Twenty-four of the thirty-four Deciduous trees grew 80 p.c. or upwards within three months, and of these four grew 90 p.c. and upwards. But of the twenty-one Coniferæ, only six entered the first of these categories, and none reached the second, and one of the six, a Larch, is not evergreen. Among the twenty-four Deciduous trees which grew 80 p.c. or more in three months are included both specimens of *Fraxinus, Tilia, Prunus, Carpinus, Pyrus, Fagus, Æsculus*, and *Populus fastigiata*, and three of the four of *Acer* and *Quercus*. Both examples of *Araucaria* and both of *Cupressus* occur in the five evergreens of the same category.

The most striking examples among the Evergreens of growth extending well over the whole season are—

| | April. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| 12. Thuja gigantea, | 11 | 29·5 | 27 | 11 | 14·5 | 7 |
| 2. Pinus excelsa, | 8 | 21·5 | 26 | 21 | 14 | 9·5 |
| 11. Pinus excelsa, | 8·5 | 17 | 27 | 17 | 17 | 13·5 |
| 66. Abies Douglasii, | 7 | 25·5 | 20 | 22·5 | 17 | 8 |
| 91. Abies grandis, | 6 | 19·5 | 7·5 | 20 | 27 | 20 |

Retardation of Girth-increase in Mid-Season in certain Coniferæ.

I have shown that a retardation of growth took place in the genus *Quercus*, and possibly in *Cratægus Oxyacantha*, among the Deciduous trees, but the same tendency is more distinct in certain of the Coniferæ, as the following Table shows.

TABLE XIII.

| | April. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| 12. Thuja gigantea . | 11 | 29·5 | 27 | 11 | 14·5 | 7 |
| 3. Pinus excelsa, . | 10·5 | 31·5 | 17·5 | 25 | 10·5 | 5 |
| 66. Abies Douglasii, . | 7 | 25·5 | 20 | 22·5 | 17 | 8 |
| 99. Abies Douglasii . | 4·5 | 22·5 | 11·5 | 24·5 | 26 | 11·5 |
| 8. Abies Lowiana, . | 4 | 23·5 | 22·5 | 13·5 | 22·5 | 14 |
| 92. Abies Lowiana, . | 2 | 16 | 25·5 | 18·5 | 24·5 | 13·5 |
| 91. Abies grandis, . | 6 | 19·5 | 7·5 | 20 | 27 | 20 |

The results in *Thuja* and *P. excelsa* may be accidental, the former being a single tree of its species, and the latter because its two companions do not show the same tendency; but that retardation is characteristic of some species of *Abies* can hardly be doubted as it occurred in five of the six trees of the three quick-growing reliable species. In a paper in the Transactions and Proceedings of our Society, 1891, p. 106, giving the results of weekly measurements, I have entered more fully into this question, and have shown that in Nos. 8 and 91, the quickest growers and most reliable of all, the retardation was most marked, and that 91 actually took a complete rest of a fortnight, early in summer, two years in succession.

*e.* Proportion of Girth-increase in the First and Second Half-Seasons in the Coniferæ.

Here, as in the Deciduous class, a tendency to law is seen by merely inspecting the position of the trees in Table XII., where they are arranged in the order of greatest growth in the first half-season.

In a list of thirty-four trees, thirteen of the old and twenty-one of the new set, the four examples of *Araucaria* are found within eleven places of the top; the three of *C. Deodara* within five of the bottom, their near relative

*C. atlantica* being separated from them only by a single place. The three each of *Ab. Douglasii, Cupressus, Sequoia, Ab. Lowiana,* and *P. excelsa,* are within fourteen, thirteen, twelve, nine, and nine places respectively of each other. Taking a wider view, the seven trees of four species of *Abies* are all in the lower half of the list, and six of the seven trees of four species of *Pinus* are within thirteen places in the middle of the list.

Equilibrium is established as high as the thirteenth and fourteenth of fifty-eight trees in the Deciduous group, but here it is so low as the twenty-fifth and twenty-sixth of thirty-four. Hence twenty-four grew chiefly in the first period and only eight chiefly in the second. Taking the average of species instead of trees, and taking the old and new trees separately, we get the results given in Table XIV.

TABLE XIV. PROPORTIONAL INCREASE IN GIRTH IN CONIFERÆ IN THE FIRST AND SECOND HALF OF THE GROWING SEASON.

| Young Group. | | | | Old Group. | | | |
|---|---|---|---|---|---|---|---|
| Species. | Av. of | 1st Half. | 2nd Half. | Species. | Av. of | 1st Half. | 2nd Half. |
| Araucaria imb. . | 2 trees | 75 | 25 | Araucaria imb. | 3 trees | 73 | 27 |
| Cupressus Laws. | 2 ,, | 73 | 27 | Sequoia gigantea | 4 ,, | 66 | 34 |
| P. austriaca . | 1 ,, | 71·5 | 28·5 | P. austriaca . . | 1 ,, | 64 | 36 |
| Retinosp. obtusa | 1 ,, | 70·5 | 29·5 | Cupressus Laws. | 1 ,, | 63 | 37 |
| Thuja gigantea . | 1 ,, | 67·5 | 32·5 | Ab. Lowiana . . | 1 ,, | 56 | 44 |
| P. Pinaster . . | 1 ,, | 62·5 | 37·5 | Cedrus atlantica . | 1 ,, | 48 | 52 |
| P. excelsa . . | 3 ,, | 55·5 | 44·5 | Taxus baccata . | 4 ,, | 45 | 55 |
| P. Murrayana . | 1 ,, | 54·5 | 45·5 | Cedrus Deodara . | 4 ,, | 34 | 56 |
| Ab. Douglasii . | 3 ,, | 54 | 46 | | | | |
| Ab. Hookeriana | 1 ,, | 51 | 49 | | | | |
| Ab. Lowiana . | 2 ,, | 47 | 53 | | | | |
| Ab. grandis . | 1 ,, | 33 | 67 | | | | |

In the group of young trees, six of the twelve species grew to a marked extent chiefly in the first period, three did so to a less well-marked extent, in one the periods were about equal, and in two the excess fell in the second period. The extremes are *Araucaria,* with 75 p.c. in the first period, and *Ab. grandis,* with 67 p.c. in the last period.

The older group contains some trees and one species which are not included in Table XII.; of the eight species four are not represented in the younger group. In five of the eight the superiority of the first period is well marked; in one there is nearly an equality; and in two the advantage lies with the second period. The extremes are—*Araucaria*, with 73 p.c. in the first period, and *Cedrus Deodara*, with 66 p.c. in the second.

Of the species that occur in both groups the proportions in Araucaria are almost identical, and in the three others there is at least no violent contrast.

The proportions of *Araucaria*, *Cupressus*, *P. excelsa*, *Ab. Douglasii*, *Ab. Lowiana*, *Sequoia*, *Taxus*, and *Cedrus Deodara* may be considered as well ascertained in a general way, the differences between members of the same species in the older and younger groups being perhaps due to differences in age. The results in the others require confirmation, as they rest on measurements of single specimens.

## III. General Remarks.

*Length of the Growing Season.*—This can only be indicated in a rough kind of way by observations at monthly intervals. I have given it as including the six months from April to September; but although it is true that girth-increase may go on in the trees as a body during the whole of this period in a favourable season, it is certainly exceptional for any tree individually to occupy so much time, and probably the majority get over their growth in less than five months. In a paper founded upon weekly observations (Trans. and Proc., 1891, p. 103), I have discussed this question fully, and have shown that in the highly favourable season of 1890 growth could be traced in *Abies Lowiana*, No. 8, and *Pinus excelsa*, No. 2, for twenty-seven weeks, beginning about April 6th. These are probably exceptionally favourable cases. On the other hand, the very healthy and vigorous *Æsculus Hippocastanum* No. 80 grew for only seventeen weeks, beginning so late as May 17th. As a rule, the Coniferæ occupy a longer time than Deciduous trees, beginning earlier and ending later.

*Progressive Rate of Girth-Increase throughout the Growing Season.*—The Tables show that the great majority of the trees grew from zero in spring to a maximum in summer, and then declined to zero in autumn, although rarely in a regular proportion, often indeed very irregularly. But to this rule certain species offer a remarkable exception. In the genus *Quercus*, and especially in *Q. Cerris*, a decided tendency to halt in mid-season was shown, and this was still more marked in the genus *Abies*, and particularly in *Ab. Lowiana* and *grandis.* My weekly observations show that in the latter there was not merely a retardation of growth in mid-season, but an actual stoppage for at least two weeks in two successive years.

From this and other facts which do not come within the scope of this paper it appears that the progressive rate of increase in girth, in some species at least, follows laws which to a great extent are independent of temperature or other meteorological causes.

*Distribution of Girth-Increase over the Growing Months.*—The maximum of girth-increase falls on very different months in the different species, but is less widely distributed in the Deciduous than in the Evergreen class. In the former it falls almost always on June or July, the only exceptions in my old and young trees being *Liriodendron tulipiferum*, where it falls on August, no doubt normally, and *Carpinus betulus*, No. 86, and *Populus fastigiata*, No. 76, in which it also falls on August, but probably abnormally; in several other instances, however, the proportions for July and August are equal, or very nearly so. But in the Coniferæ, although June and July are also highly favoured, a considerable number of the maxima fall very regularly and decidedly on May, and in *Ab. Douglasii*, No. 99, and *grandis*, No. 91, August takes the first place.

Generally the girth-increase is more evenly distributed over the season in the Coniferæ than in the Deciduous species.

As a rule, the Deciduous species get over the main part of their growth earlier than the Coniferæ, but there are remarkable exceptions in both classes. For example, nearly four-fifths of the increase in *Araucaria imbricata* took place in the first half of the season, and nine-tenths of the increase in *Liriodendron tulipiferum* in the last half.

*Connection of Girth-Increase with Development of the Leaf.*—The tendency in the species to an early or late preponderance of girth-increase is not necessarily dependent on an early or late development of the leaf. *Cedrus Deodara* is one of the earliest among the Evergreens to put out its young shoots in spring, but is the latest among my measured Coniferæ to put on the mass of its girth-increase. Indeed, I have shown in the paper already quoted that a very considerable girth-increase takes place in some Pines before the leaf-buds open. This increase may be accomplished in them by aid of the old foliage; but even in the Deciduous group it is remarkable that girth-increase begins in some species as soon as the leaf-buds swell, and before they have opened, and that *Acer Pseudo-platanus*, one of the first to appear in full foliage, is slow to start its girth-increase, while it is the reverse with the much later *Quercus*.

*Monthly Range of Girth-Increase in the Species.*—As a very general rule, the range of increase in each month, year by year, is great both in trees individually and in species, showing, it is to be presumed, a great susceptibility to meteorological influences; nevertheless a remarkable general agreement between members of the same species is frequent, and proves obedience to law. Exceptions are, no doubt, due to some special cause affecting the health of individual trees, which in some cases can be pointed out.

*Monthly Rate of Girth-Increase.*—This varies much in the different species, particularly in the first and last months, when some increase substantially enough, while others do not increase at all. Generally speaking, the rate of the Coniferæ is greater than that of the Deciduous trees in these months. Among the young trees 0·15 was the highest rate attained by any specimen of the Deciduous group in a single April, and 0·20 by one of the Coniferæ. Similarly for September the figures were 0·25 and 0·50. In May none of the Deciduous trees grew half an inch, but *Abies Lowiana* attained it once. In June, during the quinquennial period, instances of half an inch or upwards of girth-increase occurred sixteen times in the Deciduous group, and only once in the Coniferæ; in July eleven times among the former, and not at all among the latter; in August six times in the Deciduous class and thrice in the Coniferæ; and in September once in the Coniferæ only. The species which showed this amount of vigour of growth in a single month were *Acer Pseudo-platanus*, *Prunus Padus*, *Populus fastigiata*, *Ulmus campestris*, *Æsculus Hippocastanum*, *Fagus sylvatica*, *Salix* sp., among the Deciduous group; *Abies Lowiana* and *Ab. grandis* among the Pinaceæ. *Ulmus* twice, and *Populus* once, increased 0·65 in a single month; *Abies Lowiana* three times attained 0·60. These are the maxima.

*Comparison of the Monthly Percentage of Girth-Increase in the Older and Younger Groups* :—

| | April. | May. | June. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| | | | Deciduous. | | | |
| Old group . | 6 | 11 | 18 | 41 | 22 | 2 |
| Young group . | 1·5 | 12 | 31 | 30 | 20·5 | 5 |
| | | | Coniferæ. | | | |
| Old group . | 8 | 22 | 26 | 23 | 18 | 2 |
| Young group . | 5·5 | 28 | 26·5 | 18·5 | 14·5 | 7 |

In the Deciduous trees the chief difference is the preponderance of April and July in the older set. The former is apparently partly due to a falling off soon after the spring start in many of the old trees rather than to a greater amount of increase in April itself. The preponderance of July among the older trees may be characteristic of age or infirmity, but requires further explanation. In the Coniferæ the differences are not greater than might be expected in two groups observed at different periods of time, and only partly of the same species.

A NEW SOUTH AFRICAN ALGA, *Phacelocarpus disciger*, Holmes. By E. M. HOLMES, F.L.S.

POISONING OF SHEEP BY *Pieris floribunda*, Benth. et Hook. f. (*Andromeda floribunda*, Pursh.). By ROBERT LINDSAY.

About three weeks ago I received a letter from Colonel Nimmo, Westbank, Falkirk, enquiring if it was well known that *Pieris floribunda* (*Andromeda floribunda*, Pursh.) was a poisonous plant. He stated that two weeks previously a score of sheep were put into a field to eat down the foggage, when two of them died. Along one side of the field is a shrubbery, and the owner of the sheep, Mr Wm. Gilchrist, supposed they had eaten part of some of them. The only one, however, that bore evidence of having been slightly nibbled was *Pieris floribunda*, of which Colonel Nimmo enclosed a sprig. On making inquiry, I found that the other plants in the shrubbery consisted of *Cupressus Lawsoniana*, species of *Juniperus* and *Retinospora*, *Skimmia japonica*, and several hybrid forms of Rhododendron, but none of these had been nibbled by the sheep. The sheep were put into the field on a Saturday, and by twelve o'clock next day five of them were ill. The first death occurred on Sunday night and the second on Monday morning; two of the others took two days to recover, and the other three days. The two which died were opened by Mr Lawson, Veterinary Surgeon, and leaves and flowers of *Pieris floribunda* found in the stomach, but more of the flowers than leaves. Two leaves showing their condition were sent.

I am not aware of any previous case having occurred in Scotland of animals having been poisoned through eating this shrub, but there are two remarkable cases recorded in the Gardeners' Chronicle as having occurred in England. In this paper, of date April 20, 1878, Mr Robins of Stoke Park, Slough, mentions that he lost a valuable horse through its having eaten a very small quantity of *Pieris floribunda*. "The horse was working a mowing machine, and during the absence for a few minutes of the man in charge it ate a very little of *Andromeda floribunda*, and died in great agony in less than twenty-four hours. The contents of the stomach were examined, and found to consist of a small quantity of the shrub, and this mostly the flower-buds."

In an article "On the Poisonous Properties of certain Species of *Pieris* (*Andromeda*) in the Himalayas" by Dr Cleghorn, in the Transactions of this Society, vol. ix. p. 410, attention is directed to the following passage in the Gardeners' Chronicle of 17th March 1866, p. 256, describing the poisonous effects upon a flock of sheep of *Pieris floribunda*:—"Mrs Deacon of Mapledon has recently lost no fewer than eighteen sheep through their eating a poisonous shrub. It appears that a short time ago the gates leading into the pleasure-grounds were left open, and thirty-eight sheep which were grazing in a field near strayed into the grounds, and while there they ate ravenously of *Andromeda floribunda*, a most poisonous plant from North America. Mr Hewitt, the bailiff, at once treated the sheep, thirty-seven of whom showed symptoms of poison, and then called in Dr Gregory, and under their united treatment nineteen of them recovered."

*Pieris floribunda* was introduced into England from North America in 1811. It is one of the earliest and handsomest of hardy shrubs, but it should be excluded from places where sheep or other such animals are at all likely to have access.

Dr CLEGHORN remarked that the shepherds on the Himalayas recognise the poisonous properties of *Pieris ovalifolia*, D. Don, especially when the leaves are still in the bud.

Mr RUTHERFORD HILL said, on seeing this paper of Mr Lindsay's on the billet, he was reminded of some recent researches as to the poisonous constituent of the narcotic Ericaceæ, and had looked up some of the references. The first to separate the poisonous principle was Professor Eykman, who in 1883 obtained a glucoside from *Pieris japonica* (*Andromeda japonica*), to which he gave the name asebotoxin. This substance he found to be exceedingly powerful, the fatal dose for a rabbit being ·003 gramme or about $\frac{1}{20}$th of a grain. He also obtained a second glucoside called asebotin, which possessed a bitter taste but was non-poisonous. The investigation was repeated by Professor P. C. Plugge in the following year. He obtained two substances from *Pieris japonica*, which proved to be identical with these separated by Eykman. Plugge succeeded in getting the poisonous glucoside in fine silky needles having the formula $C_{31}\ H_{51}\ O_{10}$. He gave it the name andromedotoxin, by which it is now universally known. It possesses, in a very high degree, the physiological properties of the poisonous Ericaceæ. Within the last few years Professor Plugge and Herr Zaayer have examined a large number of ericaceous plants, and have found andromedotoxin in the following :—

Leaves and wood of Pieris japonica, Benth. et Hook.
„ young twigs of Andromeda polifolia, Linn.
„ „ Andromeda polifolia angustifolia.
„ „ Cassandra calyculata, Don.

Leaves and flowers of Leucothoe spinulosa, Don.
,, ,, Azalea indica, Linn.
,, ,, Rhododendron maximum, Linn.
,, ,, ,, ponticum, Benth. et Hook.
,, ,, ,, chrysanthum, Pall.
,, ,, ,, hybridum.
Berries of Kalmia latifolia, Linn.
Leaves and twigs of Kalmia angustifolia, Linn.
Entire herb of Monotropa uniflora, Linn.

Andromedotoxin was found in largest quantity in the leaves of *Kalmia angustifolia*, which is known as "Lamb-kill" in America. The same body probably exists in *Pieris mariana*, which bears the significant name of "Stagger-bush" in America. He had been led to take an interest in this matter because of a paper by Dr Thresh of Buxton, and Dr Stockman, of Edinburgh, on the poisonous honey of Trebizonde, read before the Pharmaceutical Society a few years ago. An extract prepared from this honey was found to produce the characteristic symptoms of andromedotoxin poisoning. This was attributed to the bees having visited plants of *Azalea pontica* and *Rhododendron ponticum* which grew abundantly in the neighbourhood, but nothing definite was known as to the poisonous properties of either plant until the researches of Plugge and Zaayer pointed to *Rhododendron ponticum* as the probable source. This honey was interesting because it was believed to be identical with the famous honey which proved so disastrous to Xenophon's army, and the symptoms recorded of that instance corresponded closely with those produced by andromedotoxin. As showing the toxic effects of *Rhododendron ponticum*, it was stated that at Syndall Park, Faversham, eight sheep which ate the leaves of the plant were found dead next morning. Plugge and Zaayer did not seem to have examined *Pieris floribunda*, but the general conclusion to which they came was that andromedotoxin was the poisonous constituent in all narcotic ericaceous plants.

On Temperature and Vegetation in the Royal Botanic Garden, Edinburgh, during February 1892. By Robert Lindsay, Curator of the Garden.

During February the thermometer was at or below the freezing point on twenty occasions, indicating collectively 114° of frost for the month as against 79° for the corresponding month last year. The lowest reading occurred on the 19th, when the thermometer went down to 7°, or 25° of frost. This is the lowest reading that has occurred at the garden since December 1882. From various districts in Scotland several degrees below zero were registered on the 19th. Fortunately, the ground was well covered with snow, which afforded great protection to dwarf-growing plants during this severe frost. Other low readings occurred on the 16th, 20°, 17th, 19°, 18th, 23°, 20th, 15°. The lowest day temperature was 33°, on the 16th, and the highest 54°, on the 9th. Snow began to fall on the 15th, and frequent heavy falls took place till the 21st, which did not disappear until near the end of the month.

A good many plants have been more or less injured by the severe frost. Amongst those which have suffered most are various species of Japanese Bamboos, New Zealand Veronicas, *Olea ilicifolia*, Golden Holly, &c. *Rhododendron Nobleanum* and *R. præcox* have had their flower-buds destroyed. The following spring-flowering plants annually recorded to the Society came into flower in February, viz., *Galanthus nivalis* on the 2nd, *Eranthis hyemalis* on the 6th, *Leucojum vernum* 9th, *Tussilago fragrans* 9th, *Dondia Epipactis* 10th, *Rhododendron atrovirens* 10th, *Crocus Susianus* 12th, *Bulbocodium vernum* 12th, *Scilla sibirica* and *S. præcox* 12th, *Corylus Avellana* 12th, *Symplocarpus fœtidus* 23rd, *Daphne Mezereum* 24th.

On the rock-garden 31 species and varieties came into flower during the month, the most interesting being *Crocus Imperati*, *C. Olivieri*, *Hyacinthus azureus*, *Leucojum carpaticum*, *Colchicum crociflorum*, *Helleborus abschasicus*, *H. olympicum*, *Narcissus minimus*, *Saxifraga Burseriana*, *S. imbricata*, *Galanthus Imperati*, and *G. Redoutei*.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during February 1891.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 37° | 38° | 43° | 16th | 20° | 24° | 33° |
| 2nd | 28 | 29 | 42 | 17th | 19 | 28 | 34 |
| 3rd | 29 | 35 | 43 | 18th | 23 | 28 | 36 |
| 4th | 25 | 33 | 42 | 19th | 7 | 17 | 33 |
| 5th | 31 | 32 | 43 | 20th | 15 | 29 | 37 |
| 6th | 32 | 35 | 43 | 21st | 27 | 32 | 39 |
| 7th | 35 | 42 | 54 | 22nd | 31 | 34 | 44 |
| 8th | 37 | 40 | 52 | 23rd | 30 | 35 | 45 |
| 9th | 35 | 42 | 54 | 24th | 33 | 34 | 47 |
| 10th | 43 | 45 | 54 | 25th | 27 | 31 | 40 |
| 11th | 42 | 44 | 50 | 26th | 31 | 34 | 45 |
| 12th | 37 | 42 | 54 | 27th | 30 | 33 | 44 |
| 13th | 30 | 35 | 45 | 28th | 29 | 38 | 44 |
| 14th | 34 | 41 | 46 | 29th | 33 | 35 | 42 |
| 15th | 30 | 35 | 42 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of February 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| 1 | 28·902 | 48°·0 | 37°·3 | 40°·1 | 39°·0 | W.S.W. | Cum. | 10 | W.S.W. | 0·030 |
| 2 | 28·765 | 42·9 | 30·7 | 31·9 | 30·2 | W.S.W. | ... | 0 | ... | 0·025 |
| 3 | 29·162 | 40·2 | 31·1 | 36·2 | 33·1 | N.W. | Cum. | 8 | N.W. | 0·000 |
| 4 | 29·401 | 39·8 | 27·4 | 35·0 | 31·2 | W.S.W. | Cir. | 5 | W. | 0·115 |
| 5 | 29·218 | 41·5 | 33·8 | 35·3 | 34·1 | W.S.W. | ... | 0 | ... | 0·005 |
| 6 | 29·551 | 40·5 | 34·6 | 36·8 | 35·4 | W. | ... | 0 | ... | 0·042 |
| 7 | 29·548 | 44·9 | 36·0 | 44·9 | 44·2 | W.S.W. | Cum. | 10 | W. | 0·170 |
| 8 | 29·559 | 50·0 | 39·7 | 39·8 | 39·2 | W. | ... | 0 | ... | 0·050 |
| 9 | 30·067 | 49·8 | 36·1 | 43·9 | 43·0 | W. | Cum. | 10 | W. | 0·005 |
| 10 | 30·161 | 51·0 | 43·2 | 45·0 | 43·7 | W. | Cum. | 8 | W. | 0·000 |
| 11 | 30·279 | 49·1 | 42·4 | 45·6 | 44·4 | W. | Cir. / Cum. | 2 / 3 | W. / W. | 0·000 |
| 12 | 30·349 | 49·9 | 39·1 | 41·5 | 40·1 | W. | ... | 0 | ... | 0·010 |
| 13 | 30·533 | 51·4 | 32·9 | 35·6 | 33·9 | Calm. | Cum. | 6 | N. | 0·012 |
| 14 | 29·944 | 41·8 | 35·0 | 41·4 | 41·0 | W. | Nim. | 10 | W. | 0·545 |
| 15 | 29·662 | 44·1 | 33·1 | 36·0 | 33·0 | E.N.E. | Cum. | 10 | E. | 0·335 |
| 16 | 29·872 | 38·5 | 27·0 | 28·0 | 27·5 | N.E. | Nim. | 10 | N.E. | 0·090 |
| 17 | 29·241 | 31·6 | 20·7 | 29·7 | 29·6 | Calm. | Cir. | 4 | N. | 0·012 |
| 18 | 29·231 | 34·9 | 25·0 | 27·4 | 24·9 | N. | ... | 0 | ... | 0·000 |
| 19 | 29·370 | 31·5 | 8·4 | 18·5 | 17·7 | W. | Cum. | 5 | N. | 0·005 |
| 20 | 29·465 | 31·7 | 16·0 | 30·2 | 28·1 | N.E. | Cum. | 10 | N.E. | 0·160 |
| 21 | 29·468 | 34·9 | 30·0 | 32·8 | 32·8 | E. | Nim. | 10 | E. | 0·205 |
| 22 | 29·426 | 37·7 | 32·0 | 36·0 | 35·8 | Calm | Fog | 10 | ... | 0·005 |
| 23 | 29·651 | 40·1 | 33·6 | 38·9 | 37·5 | S.E. | Cum. | 10 | S.E. | 0·000 |
| 24 | 29·719 | 44·6 | 35·6 | 35·9 | 35·4 | Calm | Fog | 10 | ... | 0·015 |
| 25 | 29·800 | 43·6 | 30·3 | 32·7 | 32·7 | Calm | Fog | 10 | ... | 0·010 |
| 26 | 29·979 | 38·4 | 32·2 | 35·9 | 35·8 | E. | Cum. | 10 | E. | 0·005 |
| 27 | 30·113 | 42·9 | 33·9 | 35·0 | 34·5 | E. | Cum. | 10 | E. | 0·020 |
| 28 | 29·994 | 40·7 | 33·2 | 36·8 | 35·4 | E. | Cum. | 10 | E. | 0·010 |
| 29 | 29·963 | 41·9 | 36·0 | 36·7 | 35·3 | N.E. | Cum. | 10 | N.E. | 0·010 |

Barometer.—Highest Reading, on the 13th, =30·533. Lowest Reading, on the 2nd, =28·765. Difference, or Monthly Range, =1·769. Mean=29·669.

S. R. Thermometers.—Highest Reading, on the 13th, =51°·4. Lowest Reading, on the 19th, =8°·4. Difference, or Monthly Range, =43°·0. Mean of all the Highest =42°·0. Mean of all the Lowest=31°·9. Difference, or Mean Daily Range, =10°·1. Mean Temperature of Month=36°·9.

Hygrometer.—Mean of Dry Bulb=36°·0. Mean of Wet Bulb=34°·8.

Rainfall.—Number of Days on which Rain, or Snow, fell=24. Amount of Fall, in inches, =1·891.

A. D. RICHARDSON, *Observer*.

On Temperature and Vegetation in the Botanic Garden, Glasgow, during February 1892. By Robert Bullen, Curator of the Garden.

The unusually mild weather which prevailed at the end of last month became very boisterous on the first week of this month, showers of snow and sleet were frequent, and on the first four nights frost was registered.

The second week was remarkable for the fine summer weather experienced. From the 9th to the 13th the mean temperature both day and night was very high for the season; 67° was registered in the sun on the 13th.

The third week was the most winterly we have had. Snow fell on the 15th, and a heavy fall took place during the night of the 16th. Night frosts prevailed the whole week, and of the 56° recorded as being the total for the month, 34° was registered during the nights of the 17th, 18th, and 19th. The lowest day reading was 34°, on the 19th. With the exception of cold north and east winds, the last week was comparatively mild. The leaf-buds of most hardy shrubs are in an advanced state.

## MEETING OF THE SOCIETY,

Thursday, April 14, 1892.

Dr David Christison, President, in the Chair.

Professor Robert Wallace was elected Resident Fellow of the Society.

Presents to the Library and Herbarium at the Royal Botanic Garden were announced.

The Curator exhibited, from the Royal Botanic Garden, *Shortia galacifolia*, *Primula Reidii*, *P. Clusiana* and *Crocus Imperati albiflora* in flower; also cut blooms of seedling varieties of *Helleborus orientalis*.

Dr Paterson sent for exhibition from Bridge of Allan a spike of *Cymbidium Loweanum*, Provost Russell's variety.

Mr John Campbell sent from his Garden at Ledaig, Argyllshire, cut blooms of *Berberis Darwinii*, *Acacia linearis* *Corchorus japonica*, and *Orchis mascula*, all from plants grown in open air.

Mr J. Grieve, Pilrig Nursery, exhibited *Acer Griffithii* in fruit, also *Forsythia Fortunei* and *Rhododendron Grievii*, as well as a spadix of fruit of *Chamærops Fortunei* ripened in open air at Ryde, Isle of Wight.

The following Papers were read:—

### The Effects of Transplantation on Girth-increase of Trees. By David Christison, M.D., President.

The following healthy young trees in the Royal Botanic Garden, Edinburgh, were transplanted at various dates between spring 1887 and spring 1889. Monthly girth-measurements were taken during the growing seasons of the



Issued May 1892.

years 1887 to 1890 for general purposes on a large number of young trees, but as the exigencies of the garden service required that the particular trees referred to should be transplanted, advantage has been taken of the opportunity to record the effects upon the trees, especially on the girth-increase.

No. 67. *Acer Pseudo-platanus.* A handsome, symmetrical tree girthing 6·75 inches at 3 feet from the ground, transplanted in spring 1887. In that year it produced very few but large healthy leaves, and in each succeeding year the foliage increased, although it is still deficient.

| | April. | May. | June. | First Half. | July. | Aug. | Sept. | Second Half. | Year. |
|---|---|---|---|---|---|---|---|---|---|
| 1887 | ... | ... | 10 | 10 | ... | ... | ... | ... | 10 |
| 1888 | ... | 5 | 10 | 15 | 5 | ... | ... | 5 | 20 |
| 1889 | ... | 5 | 20 | 25 | 5 | ... | ... | 5 | 30 |
| 1890 | ... | 5 | 20 | 25 | 20 | 5 | ... | 25 | 50 |
| 1891 | ... | ... | 10 | 10 | 20 | 10 | ... | 30 | 40 |
| Total, | ... | 15 | 70 | 85 | 50 | 15 | ... | 65 | 1·50 |

The figures in the tables represent hundredths of an inch.

In estimating the evident deficiency in girth-increase after transplantation, I have no measurements on quite so young a tree of the same species for comparison, but one girthing 8·45 inches at 5 feet up increased almost an inch in 1887, and at the rate of 1·10 inch for five years afterwards. It is evident therefore that the increase in No. 67 has been greatly retarded, although the tree has apparently been perfectly healthy, for at least five years, the total increase in that period being only 1·50, and the annual rate 0·30. It is worthy of note also that by far the greater proportion of increase occurred in the first half of the growing season for the first three years, and more than half of it in the month of June, while no increase took place in April, August, or September. In the last two years growth in the second half season became equal to or greater than that in the first, and increase appears in August. There is also a gradual increase in the amount year by year, except a slight decline in 1891, due probably to the very backward season.

No. 61. *Quercus rubra.* A handsome young tree, girthing 5·40 inches at 3 feet from the ground, transplanted in spring

1887. That year the foliage was very scanty and poor. In 1888 the shoots of the previous year had died, and the tree was almost leafless. In 1889 the foliage had considerably improved, in 1890 it was healthy-looking and fair in amount, and in 1891 was quite thick. The progressive improvement in girth-increase, from zero in 1888 to 1 inch in 1891, is in correspondence with the improvement of the foliage.

| | April. | May. | June. | First Half. | July. | Aug. | Sept. | Second Half. | Year. |
|---|---|---|---|---|---|---|---|---|---|
| 1887 | ... | 10 | ... | 10 | ... | ... | ... | ... | 10 |
| 1888 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1889 | 5 | 5 | 10 | 20 | 5 | 5 | ... | 10 | 30 |
| 1890 | ... | 10 | 20 | 30 | 40 | 15 | 5 | 60 | 90 |
| 1891 | ... | 10 | 15 | 25 | 45 | 25 | 5 | 75 | 1·00 |
| Total, | 5 | 35 | 45 | 85 | 90 | 45 | 10 | 1·45 | 2·30 |

No. 68. *Abies Douglasii.* Girthed 5·40 inches at 3 feet above ground in spring 1887, when it was transplanted. The foliage has been thin, shabby, and at times sickly-looking, and the new shoots very short, till 1890, when a general improvement took place, but it fell off again in 1891, and is apparently dying. Its girth-increase in 1891 fell to 0·10.

| | April. | May. | June. | First Half. | July. | Aug. | Sept. | Second Half. | Year. |
|---|---|---|---|---|---|---|---|---|---|
| 1887 | 10 | 10 | 10 | 30 | ... | 5 | ... | 5 | 35 |
| 1888 | 5 | 15 | 5 | 25 | ... | 10 | ... | 10 | 35 |
| 1889 | 5 | 15 | 5 | 25 | 5 | 15 | ... | 20 | 45 |
| 1890 | 5 | 10 | ... | 15 | 5 | 5 | ... | 10 | 25 |
| 1891 | ... | 10 | ... | 10 | ... | ... | ... | ... | 10 |
| Total, | 25 | 60 | 20 | 1·05 | 10 | 35 | ... | 45 | 1·50 |

The retardation here can be estimated by comparison with two trees of the same species and of about the same age, which each increased almost an inch in 1887.

No. 66. *Abies Douglasii.* A healthy young tree, densely clothed with foliage to the ground in spring 1887, and 6·50 inches in girth at 5 feet above ground, transplanted in autumn of the same year. It fell off much in appearance afterwards, and the new shoots of 1888 and 1889 were short. It did not regain a well-clothed appearance till 1891, but its girth-increase was only checked for a single year, and has been above an inch for the last three years.

| | April. | May. | June. | First Half. | July. | Aug. | Sept. | Second Half. | Year. |
|---|---|---|---|---|---|---|---|---|---|
| 1887 | 5 | 30 | 20 | 55 | 25 | 15 | ... | 40 | 95 |
| 1888 | 5 | 10 | 15 | 30 | 10 | 5 | ... | 15 | 45 |
| 1889 | 10 | 35 | 20 | 65 | 25 | 20 | 10 | 55 | 1·20 |
| 1890 | 10 | 30 | 10 | 50 | 30 | 25 | 20 | 75 | 1·25 |
| 1891 | 5 | 25 | 30 | 60 | 20 | 20 | 10 | 50 | 1·10 |
| Total, | 35 | 1·30 | 95 | 2·60 | 1·10 | 85 | 40 | 2·35 | 4·95 |

No. 6, *Abies Douglasii*, girthed 4½ feet from the ground in spring 1887, and was densely clothed with foliage to the ground; it was transplanted a few yards in spring 1889, and lost its top-shoot. The young shoots in 1889 did not appear till late in July, and grew only about an inch. Did not look at all vigorous in 1891, but is improving. The girth-increase fell after transplantation to 0·40, but rose in the next two years to 0·55 and 0·65.

| | April. | May. | June. | First Half. | July. | Aug. | Sept. | Second Half. | Year. |
|---|---|---|---|---|---|---|---|---|---|
| 1887 | 5 | 25 | 25 | 55 | 25 | 15 | ... | 40 | 95 |
| 1888 | 5 | 30 | 20 | 55 | 10 | 15 | .. | 25 | 80 |
| 1889 | ... | 10 | 5 | 15 | 10 | 15 | ... | 25 | 40 |
| 1890 | 5 | 20 | 10 | 35 | 15 | 5 | ... | 20 | 55 |
| 1891 | 5 | 10 | 15 | 30 | 10 | 20 | 5 | 35 | 65 |
| Total, | 20 | 95 | 75 | 1·90 | 70 | 70 | 5 | 1·45 | 3·35 |

No. 11. *Pinus excelsa.* Girth 3·70 inches at 4 feet above ground, when transplanted in spring 1887; looked sickly that season and shabby the next, but improved very much in 1889, and in 1891 is handsome and well clothed to the ground.

| | April. | May. | June. | First Half. | July. | Aug. | Sept. | Second Half. | Year. |
|---|---|---|---|---|---|---|---|---|---|
| 1887 | 5 | 5 | 15 | 25 | ... | 5 | ... | 5 | 30 |
| 1888 | 5 | 15 | 15 | 35 | ... | 5 | 10 | 15 | 50 |
| 1889 | 10 | 20 | 25 | 55 | 20 | 15 | 10 | 45 | 1·00 |
| 1890 | 10 | 20 | 30 | 60 | 30 | 20 | 20 | 70 | 1·30 |
| 1891 | 5 | 10 | 25 | 40 | 20 | 25 | 15 | 60 | 1·00 |
| Total, | 35 | 70 | 1·10 | 2·75 | 70 | 70 | 55 | 1·95 | 4·10 |

The depression in girth-increase was evidently severe the first year after transplantation, and continued, although to a less extent, next year, but appeared to be at an end in 1889.

No. 90. *Retinospora obtusa.* Girth 3·05 inches 1 inch above ground in spring 1887; was transplanted in the following spring. No apparent effect on the healthy foliage.

| | April. | May. | June. | First Half. | July. | Aug. | Sept. | Second Half. | Year. |
|---|---|---|---|---|---|---|---|---|---|
| 1887 | ... | 15 | 10 | 25 | 5 | 15 | ... | 20 | 45 |
| 1888 | ... | ... | ... | ... | 10 | 10 | ... | 20 | 20 |
| 1889 | ... | 5 | ... | 5 | ... | 5 | ... | 5 | 10 |
| 1890 | ... | ... | ... | ... | 10 | ... | ... | 10 | 10 |
| 1891 | −5 | 15 | ... | 10 | 5 | 5 | ... | 10 | 20 |
| Total, | −5 | 35 | 10 | 40 | 30 | 35 | ... | 65 | 105 |

Although the shrub looks perfectly healthy and vigorous, yet the average rate of girth-increase for four years after transplantation has been only 0·15 inch, or one-third of the amount in the year before transplantation.

*General Remarks.* It is possible that the effects of transplantation in some of these instances were unusually unfavourable, as the early part of the season of 1887 was very dry. It is remarkable that although the falling off in girth-increase might generally be predicated from the poor condition of the foliage, yet in some instances there was no apparent relation of the kind between the two. Thus in *Abies Douglasii*, No. 66, although the foliage was exceedingly poor in 1889, and had not improved much in 1890, nevertheless the girth-increase in the former year sprang up from 0·45 of the previous depression to 1·20, and this rate was fully maintained in 1890—probably a normal rate for a tree of its age. Again, in *Retinospora obtusa*, No. 90, the foliage seemed absolutely unaffected by transplantation, but the girth-increase for four successive years has been reduced to an average of one-third of the rate in the year previous to transplantation.

A very shabby appearance in a tree even for some years after transplantation should not cause despair as to ultimate perfect recovery. Sir Robert Christison was informed by the elder Mr Macnab that the large Yew, now 6 feet in girth, and one of the chief ornaments of the Botanic Garden, took many years to recover from its third transplantation to its present site; and my example, *Quercus rubra*, No. 61, proves that even after the total loss of the young wood of a season, a tree may rapidly recover perfect health.

ON A RAPID METHOD OF SHARPENING KNIVES FOR SECTION-CUTTING. By A. N. M'ALPINE, B.Sc.

A plane iron of the best quality is most suitable for my form of microtome. A rectangular strip of steel is fastened across the plane iron in such a way that the anterior edge of the rectangle is parallel to the edge to be sharpened. By this attachment, the plane iron is rendered virtually hollow ground and the sharpening is accordingly both rapid and true. When sharpening, the edge of the iron and the anterior margin of the steel band are ground together on the stone, and the edge is finished on a leather strop which ought to be fixed to a rigid support in order to prevent rounding.

Mr FORGAN asked leave of the Society to say that the device which Mr M'Alpine had brought before the Society was not a new one. It was referred to in Holtzappel's "Mechanical Manipulation" published at least forty years ago and might be then of very old date. Mr Forgan said he had used it himself more than thirty years ago when sharpening plane irons, to which it gave a very fine and equal edge. The statement in regard to it will be found in the second volume of Holtzappel, page 497, and is to the following effect: "When the minute chamfer of the plane iron is almost parallel with the sole of the plane, it will for a short time be entirely effective. Thus as an experiment, drive the iron a very small quantity through the sole, and sharpen it by allowing the oilstone to rub both on the edge and on the wood behind, this will produce a very accurate edge, and the iron when set back, will cut beautifully." The second volume of Holtzappel was published in 1846 by Holtzappel & Co., 64 Charing Cross and 127 Long Acre.

With reference to Mr M'Alpine's statement that he used a leather strop to fine the edge of the plane iron after it came from the hone, Mr Forgan pointed out that the same subject was discussed at the Royal Scottish Society of Arts about five years ago, when the late Dr Sang stated during the discussion that he never used a strop to improve the edge of a razor after it had been sharpened on the hone, as he considered that the flexible strop had the effect of rounding the edge it had received from the hone and thus destroying its cutting power. Dr Sang said he invariably shaved with a razor straight from the hone, and did not use a strop for the above reason. Mr Forgan said he had followed this plan himself, and found that if due attention was paid to the one sharpening, no strop would improve the cutting edge. He showed to the meeting a very fine large hone which had been bought by his grandfather more than 100 years ago and was of excellent quality. These hones come from slate quarries near Ratisbon.

Mr M'Alpine remarked that while for the purposes of shaving it might be possible to use a knife straight from the hone, for microtome sections it was necessary to use the strop after the hone.

Mr Gustav Mann pointed out that examination through the microscope of the edge of a razor straight from the hone showed a serrated edge which was fatal to microtome sections, especially if the "rocker-microtome" was used; the unevenness of edge must be removed by the strop before cutting fine sections.

## On Grafting Fruit Trees for Transport. By James Grieve.

The author exhibited specimens of grafted apples of a convenient size for transport by post. The stocks may be either two-year seedling crab or one-year Paradise cuttings, and are potted in the autumn into three-inch pots, and grafted in February or March under glass. The grafting wax used is composed as follows:—

| | | | |
|---|---|---|---|
| Resin, . | 1 lb. | Tallow, . | $\frac{1}{2}$ lb. |
| Pitch, . . | 1 lb. | Beeswax, . | $\frac{1}{4}$ lb. |

The ingredients are melted together, and the composition is put on with a brush when in a warm liquid state. The quantity above mentioned should seal several hundreds of grafts. A plant one-year-old weighs not more than three or four ounces, and can therefore be transported at minimum cost.

Note on Some Recent Botanical Work. By Professor Bayley Balfour.

Professor Balfour gave an account of Treub's work on the Casuarineæ, and of Guignard's recent researches upon the nucleus.

On Temperature and Vegetation in the Royal Botanic Garden, Glasgow, during March 1892. By Robert Bullen, Curator of the Garden.

The spring month of March was in reality the winter of 1891–92. Frost and snow was in excess of anything we have experienced in the same month for many years, not even excepting March of last year which was an unusually cold month. Frost was registered on 23 nights, and the total registered for the month was 120°.

Night frosts were continuous for the first half of the month, and heavy snow fell during the second week; on the 16th a misty rain and thaw set in. On the night of the 19th, frost was again recorded and continued with more or less severity to the end of the month. The day temperature, especially during the latter half of the month, was above the average; hard frosty nights being succeeded by bright sunny days. The sun thermometer frequently registering from 70° to 76°. Very dry weather prevailed after the heavy snow fall. All vegetation is much retarded.

On Temperature and Vegetation at the Royal Botanic Garden, during March 1892. By Robert Lindsay, Curator of the Garden.

The past month has been exceedingly wintry with much snow and frequent frost, which proved a great hindrance to the progress of vegetation. The thermometer was at or below the freezing point on twenty-six occasions, indicating collectively for the month, 156° of frost as against 130° for the corresponding month last year.

The lowest readings occurred on the 6th, 22°; 15th, 20°; 16th, 20°; 28th, 16°; 29th, 17°. The lowest day temperature was 37° on the 27th, and the highest 64° on the 31st.

It is evident that many plants have suffered severely during this long and trying winter, but the full extent of the damage done will not be known till later on in the season. Among those killed or very badly injured, are the following plants which have stood unprotected for several years past, viz.:—*Cordyline australis, Edwardsia microphylla, Olearia macrodonta, O. Gunniana, Phormium tenax, Benthamia fragifera, Leptospermum Scoparium, Myrsine undulata, Corokia Cotoneaster, Phlomis fruticosa, Eucalyptus coccifera.*

The following spring-flowering plants annually recorded to the Society, came into flower in March: *Tussilago nivea* on the 2nd; *T. alba*, 4th; *Iris reticulata*, 17th; *Nordmanica cordifolia*, 20th; *Scilla bifolia*, 19th; *S. bifolia alba*, 20th; *S. bifolia taurica*, 22nd; *Arabis albida*, 22nd; *Erythronium Dens-canis*, 23rd; *Sisyrinchium grandiflorum*, 23rd; *S. grandiflorum album*, 23rd; *Mandragora officinalis*, 24th; *Narcissus pumilus*, 27th; *Orobus vernus*, 30th; *Rhododendron Nobleanum*, 30th; *Ribes sanguineum*, 31st.

On the rock-garden 39 species and varieties came into flower during the month. The most interesting were—*Corbularia nivalis, Chionodoxa Luciliæ, Crocus Sieberi, C. etruscus, Corydalis angustifolia, Draba Aizoon, Iris reticulata, Mandragora vernalis, Ranunculus anemonoides, Saxifraga media, S. juniperina, S. lutea purpurea, Synthiris reniformis, Veronica anomala.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during March 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 32° | 35° | 42° | 17th | 39° | 49° | 55° |
| 2nd | 31 | 32 | 38 | 18th | 46 | 47 | 59 |
| 3rd | 29 | 31 | 38 | 19th | 34 | 49 | 61 |
| 4th | 28 | 31 | 40 | 20th | 32 | 46 | 60 |
| 5th | 29 | 31 | 43 | 21st | 26 | 42 | 52 |
| 6th | 22 | 24 | 40 | 22nd | 26 | 33 | 46 |
| 7th | 29 | 31 | 40 | 23rd | 30 | 40 | 56 |
| 8th | 30 | 31 | 45 | 24th | 39 | 45 | 60 |
| 9th | 24 | 27 | 40 | 25th | 31 | 44 | 56 |
| 10th | 24 | 30 | 39 | 26th | 35 | 40 | 49 |
| 11th | 25 | 31 | 42 | 27th | 24 | 32 | 37 |
| 12th | 25 | 30 | 43 | 28th | 16 | 35 | 45 |
| 13th | 26 | 32 | 37 | 29th | 17 | 35 | 45 |
| 14th | 25 | 30 | 48 | 30th | 24 | 38 | 55 |
| 15th | 20 | 26 | 45 | 31st | 30 | 44 | 64 |
| 16th | 20 | 25 | 49 | | | | |

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of March 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 30·082 | 41·2 | 34·5 | 37·1 | 34·1 | E. | Cum. | 10 | N.E. | 0·000 |
| 2 | 30·274 | 40·0 | 33·1 | 34·5 | 31·6 | E. | Cum. | 10 | E. | 0·000 |
| 3 | 30·351 | 35·4 | 31·1 | 32·7 | 31·1 | E. | Cum. | 10 | E. | 0·000 |
| 4 | 30·362 | 34·8 | 30·3 | 32·8 | 31·2 | S. | Cum. | 10 | S.E. | 0·000 |
| 5 | 30·318 | 36·9 | 31·1 | 33·9 | 31·9 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 6 | 30·159 | 38·4 | 25·7 | 30·5 | 29·5 | W. | ... | 0 | ... | 0·000 |
| 7 | 29·969 | 37·7 | 29·9 | 33·2 | 31·1 | S. | Cum. | 10 | S. | 0·000 |
| 8 | 29·801 | 37·7 | 30·2 | 34·2 | 32·0 | W. | Cum. | 9 | W. | 0·010 |
| 9 | 29·383 | 42·5 | 25·1 | 29·5 | 26·9 | N.W. | Cum. | 2 | N. | 0·080 |
| 10 | 29·324 | 34·9 | 26·5 | 30·9 | 29·2 | N. | ... | 0 | ... | 0·175 |
| 11 | 29·626 | 36·9 | 28·1 | 31·2 | 31·1 | N.N.W. | Cum. | 6 | N.N.E. | 0·175 |
| 12 | 29·574 | 40·8 | 29·0 | 32·0 | 29·8 | N.N.E. | Cum. | 4 | N.N.E. | 0·145 |
| 13 | 29·322 | 38·6 | 31·6 | 32·8 | 32·0 | N. | Cum. | 5 | N.E. | 0·045 |
| 14 | 29·326 | 36·8 | 26·8 | 33·7 | 31·7 | W. | Cum. | 6 | N. | 0·000 |
| 15 | 29·352 | 41·2 | 21·3 | 28·4 | 27·5 | Calm | ... | 0 | ... | 0·000 |
| 16 | 29·703 | 39·9 | 23·5 | 26·5 | 25·9 | Calm | ... | 0 | ... | 0·000 |
| 17 | 29·667 | 51·2 | 26·0 | 49·9 | 46·8 | S.S.W. | Cum. | 8 | S.S.W. | 0·000 |
| 18 | 30·076 | 55·3 | 47·9 | 51·2 | 49·0 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 19 | 30·215 | 60·6 | 37·2 | 46·2 | 41·5 | S.E. | ... | 0 | ... | 0·000 |
| 20 | 30·244 | 58·7 | 35·0 | 40·8 | 38·1 | E.S.E. | Cum. | 5 | E.S.E. | 0·000 |
| 21 | 30·244 | 48·8 | 28·8 | 34·1 | 33·0 | N.W. | ... | 0 | ... | 0·025 |
| 22 | 30·520 | 43·9 | 36·3 | 42·1 | 38·4 | W. | ... | 0 | ... | 0·085 |
| 23 | 30·444 | 49·8 | 38·4 | 47·3 | 45·0 | W. | ... | 0 | ... | 0·000 |
| 24 | 30·174 | 56·0 | 34·7 | 44·9 | 42·2 | W. | ... | 0 | ... | 0·000 |
| 25 | 29·859 | 51·8 | 39·0 | 43·8 | 41·1 | W. | Cum. | 10 | W. | 0·000 |
| 26 | 29·489 | 46·2 | 38·0 | 45·9 | 43·0 | W. | Cum. | 10 | W. | 0·390 |
| 27 | 29·878 | 46·5 | 26·1 | 29·8 | 28·0 | N.E. | Cum. | 5 | N.W. | 0·020 |
| 28 | 29·917 | 34·0 | 19·2 | 33·8 | 30·4 | W. | ... | 0 | ... | 0·025 |
| 29 | 30·433 | 40·6 | 20·8 | 32·5 | 28·4 | W. | ... | 0 | ... | 0·000 |
| 30 | 30·488 | 41·7 | 28·1 | 40·4 | 36·9 | W. | Cir. | 2 | N. | 0·000 |
| 31 | 30·415 | 51·3 | 33·2 | 46·5 | 40·1 | W. | Cir. | 2 | W. | 0·000 |

Barometer.—Highest Reading, on the 22d, = 30·520. Lowest Reading, on the 13th, = 29·322. Difference, or Monthly Range, = 1·198. Mean = 29·967.

S. R. Thermometers.—Highest Reading, on the 19th, = 60°·6. Lowest Reading, on the 28th, = 19°·2. Difference, or Monthly Range, = 41°·4. Mean of all the Highest = 43°·5. Mean of all the Lowest = 31°·2. Difference, or Mean Daily Range, = 12°·3. Mean Temperature of Month = 37°·4.

Hygrometer.—Mean of Dry Bulb = 36°·9. Mean of Wet Bulb = 34°·5.

Rainfall.—Number of Days on which Rain, or Snow, fell = 11. Amount of Fall, in inches, = 1·175.

A. D. RICHARDSON,
*Observer.*

## The Embryo-sac of Myosurus minimus, L.: A Cell Study.[1] By Gustav Mann.

(With Plates IIIa and IV.)

(Read at the Meeting of the Society on January 28, 1892.)

In a previous paper* a short account was given of some facts which seemed to me to disprove the view generally held that the embryo-sac of Angiosperms is a macrospore. As several treatises on the same subject have since then come to my hand, and as I have made out some further interesting points in the structure of nuclei and nucleoli, a detailed account of my researches, accompanied by illustrations, may, I hope, prove to be of service to all who consider the study of cells the surest way of gaining an insight into the great problem of Life.

The methods employed in my investigation were shortly these: Flowers in all stages of development were fixed and hardened in my picro-corrosive-alcohol,† this fluid being very gradually replaced by pure absolute alcohol, by chloroform and ultimately by paraffin. Great care was taken to raise the flowers gradually to the temperature of melted paraffin (50° C.), and not to leave them longer at this temperature than was absolutely necessary for perfect imbedding. Finally the paraffin was allowed to cool gradually.

For sectioning I have used the Cambridge rocking-microtome, the feed consisting for ordinary work of two teeth (thickness of sections equal to 1·27 $\mu$ or $\frac{1}{20,000}$ of an inch), but whenever a doubtful point arose the feed was made to consist of only one tooth (thickness of section equal to ·635 $\mu$ or $\frac{1}{40,000}$ of an inch). The sections were fixed serially by means of Schällibaum's fixative on ordinary microscopic slides, or for special investigation on No. 1 cover-glasses ($1\frac{1}{2} \times 3$ inches). The mounting on thin cover-glasses has the advantage of allowing one to study the sections from two sides.

As staining reagents I have used with preference Kleinenberg's hæmatoxylin No. 1 with 20 p.c. of absolute

* Trans. Bot. Soc. Edin., vol. xix. (June 1891) p. 136. See also Trans. Bot. Soc., xix. pp. 67 and 89.

† Trans. Bot. Soc., vol. xviii. p. 432.

[1] Received for publication April 1892. Issued July 1892.

alcohol superadded to avoid as much as possible the hydration with the subsequent dehydration of tissues; for I find that sections treated with watery stains show when mounted in balsam, a shrinkage of delicate structures which is absent if aniline dyes dissolved in absolute alcohol are used as staining reagents, and which is very slight if reagents be employed containing a high percentage of alcohol. To obtain good results with Kleinenberg's hæmatoxylin, place glass-slides with the serial sections in a vessel containing the dye, and keep the vessel for twelve hours at a temperature of 30° C., then remove the slides to a second vessel containing a saturated solution of bismarck-brown in methylated spirit; leave in this vessel also for twelve hours at 30° C. In this way a double staining is produced, as the nucleus and nucleolus are stained a very transparent violet, while the cell-walls appear brown. The method, employed in the laboratory of the Royal Botanic Garden, of using glass vessels (3½ inches high with a 2 inches diameter at the base and a 3 inches diameter at the brim) as the receptacles for dyes, absolute alcohol, &c., is very handy, for a dozen slides can be stained simultaneously, and both hæmatoxylin and bismarck-brown be used again and again. Ehrlich's acid-hæmatoxylin I have also used, but find that it does not give the same transparency to nucleoli, &c. Here a word of warning may not be out of place to all who intend to investigate the nucleolus. Beware of overstaining! A section with deeply stained nuclei looks beautiful under a low magnifying power, but is of no use whatever for minute investigations. Other stains used for differentiating the nucleolus were heliocin and methylene blue, nigrosin and eosin, nigrosin and hæmatoxylin.* Sections stained as indicated should be very thoroughly dehydrated, then cleared in resinified turpentine (not in clove oil, as the latter causes considerable shrinkage) and mounted in canada-balsam dissolved in turpentine, as this balsam has a considerably lower refractive index than either chloroform-balsam or benzol-balsam.

If these instructions be followed in all their details I believe my results will be confirmed, in the main points at any rate, if not entirely so.

* Trans. Bot. Soc. Edin., vol. xix. (January 1891) p. 46.

The sections were examined with a one-twelfth Homogen. Immers. Zeiss, for the loan of which I have to thank Dr H. Stiles, and with Professor Rutherford's one-eighteenth Homogen. Immers. Zeiss. I take this opportunity to express my sincerest thanks to Professor Rutherford for the great kindness and courtesy shown me whilst working in his laboratory, and also to thank his assistant Dr Carlier for his constant willingness to help me in my difficult investigation, a help the more valuable to me for the great experience and capability of the latter as a microscopist. All my drawings were sketched with the help of a Zeiss' camera lucida, and not only the outlines of cells, but the minutest details were traced in this way.

After this long, but not unnecessary introduction, I shall give a description of the development of the embryo-sac based on my illustrations, Plates III*a* and IV.

When a flower of *Myosurus* is fully expanded the gynæceum consists of an elongated axis bearing at its base a number of mature achenes, at its apex a number in earlier stages of development. This condition enables one, as Strasburger points out, to get in one longitudinal section most of the essential stages illustrative of the ordinary development of an ovule, still I did not rely for the study of the earlier stages on sections made through expanded flowers alone, but preferred to select for examination of each of the earlier phases such flowers as showed most ovules in the required stage, for I soon found if two ovules be selected at the same stage of development, but one be taken from the apex of a matured flower while the other be taken from the base of a young flower, that in the latter each individual cell attains a larger size.

The life-history of the ovule up to the time of fertilisation may conveniently be divided into three stages :—

1. An early stage including the formation of the embryo-sac-cell.
2. An intermediate period ending with the formation of eight nuclei within the embryo-sac.
3. A final stage, during which the ovum matures and the primary endosperm-cell is formed by a conjugation of two sexual primordial cells.

### A. EARLY STAGE.

In a young ovule (fig. 1) we may readily distinguish a differentiation of cells into a protective layer or dermatogen (*derm.*), a generative layer or periblem (*peribl.*), and a conductive axis or plerome (*pler.*).

The dermatogen does not show anything peculiar except the slightly elongated shape of the cells at the apex.

The periblem-cells are evidently much elongated radially, abutting with one end on the plerome-axis and with the other end on the dermatogen. The central periblem-cell (*xx*) forming the direct elongation of the plerome is the physiological archesporium, *i.e.*, the cell which will perform its physiological function of ultimately giving rise to sporocytes. It is surrounded by a number of non-physiological archesporia, which, for reasons we shall understand better afterwards, do not perform their physiological function of developing into sporocytes.

The terminal plerome-cell shows a number of facets, each of which corresponds to the basal end of a periblem-cell.

In a slightly more advanced stage (fig. 2) the ovule has commenced to curve downwards and the true archesporium (*A.S.*), now evidently the largest cell in the ovule, is about three times longer than it is broad; if, however, the carpellary leaf interfere with the downward curvature of the ovule and if it press against the apex of the ovule, the archesporium cannot increase so much in length, but evidently makes up for this defect by attaining a great breadth. In this way we have to account for the difference in the form of archesporia (*A.S.*) seen in figs. 2 and 5, as compared with those shown in figs. 3 and 4. After the archesporium has attained a size as in figs. 2, 3, its lateral walls lose their straight outline and begin to bulge out (figs. 4 and 5), without producing, however, any visibly injurious effects on the periblem-cells surrounding it. The nucleus keeps step with the increase in size of the archesporium (fig. 4), almost touching the lateral or periclinal walls, while the nucleolus remains small.

During division the nucleus gives rise to a large monaster (fig. 5), one pole of which is placed very close to the dermatogen, while the other pole is placed at some distance from the plerome-element; in other words the greater portion of the monaster occupies the apical half of the archesporium, *i.e.*, the half lying next the dermatogen, and the position of the chromatin-segments gives us an indication as to the level at which the cell-plate will be laid down later on. The monaster figured shows two sets of filaments or fibrils, a set of thick, deeply stained and centrally placed ones to which the chromatin-segments are attached, and a peripheral set of delicate feebly stained ones, to which no chromatin-segments are attached.

In a later stage of division (fig. 6), in which the new cell-wall is being laid down in the form of granules we note an inequality in the size of the two daughter-cells *x* and *y*, the cell *y* lying next the plerome-elements being the larger, the nucleus of the cell *y* is elongated radially, *i.e.*, the long axis of the nucleus is parallel to the long axis of the mother-cell, while the nucleus of the cell *x* is elongated tangentially, *i.e.*, the elongation is at right angles to the long axis of the mother-cell. The meaning of this difference in the shape of the two nuclei becomes evident on studying the future history of the two cells derived from the archesporium (figs. 7 and 8). In fig. 7 the nucleus of the cell *x* has become still more broadened out tangentially; in fig. 8 it is represented as a diaster; and in fig. 9 division has been completed. Similarly we find in fig. 7 the nucleus of the cell *y* of fig. 6 in the diaster stage, and its division completed in fig. 8. Thus the cell *x* (fig. 6) has divided anticlinally (fig. 9), while the cell *y* (fig. 6) has divided periclinally (fig. 8), and we must look upon the slightly oval shape of the two nuclei *x* and *y* (fig. 6) at this early stage of nuclear reconstruction as an indication of what will take place later on:—each nucleus is already elongated at right angles to the plane of division, and therefore its long axis corresponds to the direction of the nuclear barrel.

Four cells are thus derived from the physiological archesporium (figs. 2, 3, 4, *A.S.*), as the latter divides firstly by a periclinal wall (fig. 6) into a larger basal cell *y*, and a smaller apical cell *x*, and as the cell *y* redivides periclinally into two cells (*y* and *E.S.*, figs. 7, 8); the cell *x* redividing anticlinally into two cells (figs. 7, 9$^{a}$). Only once I found the apical cell *x* to divide undoubtedly periclinally (fig. 9$^{b}$), and such a division may also have occurred in the ovule (fig. 12), in which the cell *x* shows a sharply defined and deeply stained portion beneath the dermatogen.

The division of the archesporium into four cells seems to be the rule in the ovules of a young bud; if, however, ovules be examined which develop at or after the time a bud has fully expanded into a flower, the archesporium is found to give rise to only three cells (figs. 10 *a–d*, 11–13 *a*), as no division of the cell *x* (figs. 6 and 7) takes place. The explanation of this difference does not seem to be difficult:—The basal ovules of a young flower will be better supplied with nourishment than the apical ovules of a mature flower, and hence the greater amount of nutritive material at the disposal of a basal ovule will give each individual cell in that ovule a greater chance of fulfilling its function. How different if food is scarce and the competition between cells severe! The cell placed most advantageously for having its wants supplied will thrive, while the remaining cells have to struggle against odds, and will succumb in the end. This bitter struggle is clearly shown in the ovule; for what is the cause of the development of the central periblem-cell into the archesporium (fig. 2, &c.), of the unequal division of the archesporium (fig. 6), of the larger cell thus derived preceding its sister-cell in division (figs. 7, 8), or the smaller cell (figs. 11, 13 *a*) not undergoing division at all?—The reason has to be looked for in the fact that the successful cell lies in each case in close contact with the plerome-elements, and that hence it is supplied directly with food-material, which travels to the ovule along the plerome-tract. For the same reason each one of the four cells derived from the physiological archesporium may attain an exceptional size, if the competition in the ovule has not been as great as usual, due to the development of a smaller number of periblem-cells than normal (fig. $9^a$).

The next change we have to notice is a peculiar gelatinous swelling of the walls of the three or four cells derived from the archesporium (figs. $9^a$, $9^b$, 10 *a–d*). This change is in most cases restricted to the two periclinal walls between the cells *x*, *y*, and *E.S.* (fig. 10 *a*); next in frequency the condition is found in which again the two transverse walls are swollen, but in addition also portions of the anticlinal walls of the cells *x* and *y* (fig. 10 *b*). Not at all unfrequently, especially in vigorous ovules, all the walls, with exception of those lying in direct contact with the plerome and the dermatogen (fig. 9[a], 10 *c*, 10 *d*), show the characteristic change. During the early stages of the gelatinisation the cell-walls stain deeply with Kleinenberg's hæmatoxylin, and on surface section (fig. 10 *c*, *y*) the whole cell-wall may appear as a dark violet plate.

This gelatinous swelling of the cell-walls occurring in the three or four cells derived from the archesporium is in every respect analogous to the swelling which takes place in the sporocyte-walls of other sporangia, *e.g.*, in the pollen-sacs of Angiosperms, in *Selaginella*, &c. As further, this change in the walls is, at least in *Myosurus*, not restricted to those cells not undergoing further development, but as it also occurs in the young embryo-sac-cell, all the cells derived from the archesporium and showing this gelatinisation must be regarded as sporocytes. Of the number of sporocytes formed in Angiosperms one only normally undergoes further development, and ultimately gives rise to the embryo-sac with its eight nuclei.

That the embryo-sac of Angiosperms must correspond to one sporocyte was a conclusion I had arrived at in my last paper *; but, notwithstanding this, I reason on the very next page that it must be the equivalent of two sporocytes. This mistake was brought about thus: Trying to disprove the view that the archesporium might be regarded as a sporocyte, I stated that it did not always give rise to four cells, but that it might give rise to a number of cells, varying from two to seven; as further, my mind had been greatly impressed by the constancy with which each sporocyte in the higher plants gives rise to four spores, and, as finally, I was aware of two groups of four nuclei always occurring in the embryo-sac, I was led to believe each of the two groups of four nuclei to be derived from one sporocyte, which naturally would make the embryo-sac the equivalent of two sporocytes. This latter conclusion being at variance with the conclusion I had arrived at at first, an explanation was sought, which resulted in the following:—"The division of the embryo-sac makes the

* Trans. Bot. Soc. Edin. (June 1891), pp. 136–148. The conclusion will be found on p. 140.

impression, as Ward points out distinctly, of being similar in nature to those preceding it. We know, further, that the walls of spore-mother-cells" (*i.e.*, sporocytes) "break down whenever spores are reaching their maturity—that they are, in other words, very transient; in the embryo-sac this process of dissolution of the wall seems to take place even before spore-formation, or rather no definite wall can be laid down, partly due to the vacuole," &c.

I was led to criticise my own paper on reading an article by Guignard,* on the formation of sexual nuclei in plants, who comes to the conclusion that the nucleus of a pollen-mother-cell (sporocyte) is comparable to the primary nucleus of the embryo-sac, as he finds that in *Lilium Martagon* both nuclei contain at the time of their formation twenty-four chromatin-segments, and that on their division each daughter-nucleus contains only twelve segments, *i.e.*, the number of chromatin-segments has been reduced by half in the four pollen-grains and in the eight nuclei within the embryo-sac,—a deficiency to be made up again at the time of fertilisation. A similar reduction in the number of chromatin-segments is stated to occur in *Fritillaria*, *Tulipa*, *Allium*, *Alstrœmeria* and *Listera*. The nuclei of the pollen-mother-cell (sporocyte) and of the embryo-sac being thus comparable, the author comes to the conclusion that the embryo-sac is comparable to the pollen-mother-cell, *i.e.*, it must be a sporocyte.

How this discovery affects our interpretation of the eight structures within the embryo-sac, I shall discuss after I have described the changes in the embryo-sac leading to the formation of the two groups of four nuclei.

Before proceeding with the investigation as to the fate of the young embryo-sac and its sister-cells, I shall state briefly the changes in the non-physiological archesporia, and describe shortly the early development of the single integument of the ovule.

The non-physiological archesporia, some of which, in direct contact with the true archesporium, equal the latter in size during the early stages of development (fig. 1), soon undergo oblique divisions (figs. 2, 3; × has been placed on the oblique division-walls) and periclinal divisions (fig. 7 on the

* Comptes Rendus, cxii., 1891, p. 1074. My attention was drawn to this paper by a review in the Trans. Roy. Micr. Soc., London.

right side of the cells derived from the true archesporium. That the sections through the ovules are not oblique, and that we are really dealing with oblique divisions, is proved by fig. 4, in which the cell *a* is showing a diaster with the equatorial plane placed obliquely to the long axis of the cell. The development of the integument from the dermatogen is shown in figs. 2, 4, $9^a$, 12, 14, 15. The integument grows more vigorously on the superior convex surface of the ovule as compared with the lower concave surface. How the curvature of the ovule upon itself causes a compression of the cells of the dermatogen just where the ovule is connected to the mother-axis, and how this same curvature leads to disorganisation of the integument between the funicle and the nucellus or body of the ovule, may also be gathered from the above figures. This compression and disorganisation proves that the ancestral ovule must have been an erect structure, with an integument surrounding it on all sides; but, that from some cause or other—maybe by the rapid growth of the carpellary leaf, the latter ensheathing the ovule on all sides—the upward growth of the ovule was interfered with, and that it thus was forced to grow downwards in the direction of least interference.

## B. The Intermediate Period.

We have already seen how of several original archesporia only one performs its physiological function of giving rise to a number of sporocytes, and we shall find that of these sporocytes, again, only one will fulfil its physiological function of giving rise to spores. This latter I shall call—analogously to the terminology applied to the archesporium—the physiological sporocyte, while those sporocytes not undergoing further development will be the non-physiological ones.

It has been pointed out, how, of the sporocytes derived from the archesporium, the one lying next the plerome (figs. 7–$9^a$, *E.S.*) is the one placed under the most favourable conditions with regard to the supply of food, and how, further, its cell-wall, abutting on the plerome, does not undergo gelatinisation,—a fact which can be explained on the supposition that the embryo-sac-cell has become parasitic in its habits, and that a swelling of its wall lying next the source of food would interfere with the absorption of the latter, an explanation which must be admitted from an evolutionary standpoint.

Following out the history of the young physiological sporocyte or embryo-sac-cell, we find it at first of the same size as the non-physiological sporocytes (fig. 7), but soon greatly enlarged (fig. 10 *b*, 10 *c*, 10 *d*). This enlargement does not, *per se*, produce compression and degeneration of the other sporocytes, for one finds that the protoplasmic contents of the latter retain their normal appearance for a considerable time (figs. 8, 13 *a*). Later on, however, a marked change takes place, due to two causes, namely, starvation—as all available nourishment is taken up by the embryo-sac-cell—and pressure exerted by the surrounding nucellar cells. We see, therefore, in fig. 11 the sister-cell *y* of the embryo-sac-cell starved to such a degree that its lateral walls are no longer able to resist the pressure of the surrounding cells, with the result that they have been pushed in. Instead of the sister-cell being the first to degenerate we frequently find the sporocyte *x* of figs. $9^a$, 11, to collapse first as shown in fig. 14. Sooner or later all the other sporocytes are starved to death by the embryo-sac-cell, their nuclei and protoplasm travel towards the apical part of each cell and there form a readily stained mass (figs. 12, 13 *a*, *x*). Ultimately only traces of the non-physiological sporocytes remain, forming a covering for the apex of the physiological sporocyte, which Strasburger very appropriately calls the cap of the embryo-sac-cell (figs. 15, *x*, *y*, 25–27, 29, 30).

The physiological sporocyte or embryo-sac-cell at the time of its formation is filled with finely granular protoplasm, and possesses a comparatively large nucleus, poor in chromatin, and a nucleolus which occasionally seems to give rise to a number of accessory nucleoli (fig. 8, *E.S.*). As the cell gets older the chromatin-matter of the nucleus increases in amount, the nucleolus swells markedly (figs. $9^a$, 11, 13 *a*, 13 *b*, 14),* and a vacuole makes its appearance close to the apical part of the nucleus (fig. 12), increasing gradually in size (fig. 15). The apical part of the embryo-sac-cell seems to be the usual site in which the vacuole appears, if

* The minute structure of the nucleus and nucleolus will be described later, p. 383.

ovules taken from a fully expanded flower be examined, and only very rarely does it arise in the basal half of the cell, fig. 16.* In ovules taken from immature flowers I have frequently found in the earlier stages an apical and a basal vacuole (fig. 14) or three vacuoles (fig. 9[a]), and in the later stages a great number of vacuoles of all sizes towards the apex and the base of the embryo-sac-cell (fig. 13 *a*, 13 *b*). Whether this bears out Went's observations,† that vacuoles never appear *de novo*, but that each vacuole is derived from a pre-existing one, just as each nucleus and each cell is derived from a previous nucleus or cell, I am unable to say, but I have been unable to detect a vacuole in very young sporocytes.

What are these vacuoles? Have they to be considered as indications of degenerative processes going on in the protoplasm of the cell? Is the protoplasm becoming infirm and old and no longer able to fulfil its task and to keep step with the growth of the cell? These views can hardly be accepted, if we consider for one moment what an amount of energy there is in the young cell and how complicated the changes are it must undergo before it can give rise to the mature embryo-sac. May we not consider vacuoles as expansions of the channels by which fluid is normally conducted in the cell, rather than holes arising in the protoplasm because of senile changes? Expansions developed to play an important part in the physiology of the cell and to perform definite functions? One of these functions seems to be that of dilating the cell-wall to allow the protoplasm and the nucleus to react on the tense walls, and to model them according to requirements. But how can a vacuole perform this function? The sap within the vacuoles is rich in salts, hence a tendency to diffusion of fluids of less high specific gravity into the vacuole must exist, and this tendency regulated by the protoplasm in direct contact with the vacuole according to its needs, will cause a pressure to be exerted on the cell-walls from within.

The effect of the increase in size of the embryo-sac-cell

* All the figures from fig. 16–45 are arranged in such a way that the apical or micropylar part of the embryo-sac is pointing upwards, while the basal or antipodal part is pointing downwards.

† Went in Pringsheim's Jahrbücher, vol. xxi., 1890.

on the nucellar cells surrounding it is shown in an early and in two advanced stages in figs. 15, $27^a$, 30.

The next step in the life-history of the cell is its division, and I regret to say that, amongst the many thousands of sections I have made through flowers of all ages, I have not found a single ovule throwing light upon the way in which this division takes place. From Strasburger's brilliant researches we know that indirect division occurs in other plants, but how it takes place in *Myosurus*, and what becomes of the vacuoles during the time of division I am unable to state. Strasburger states that no division of the protoplasm occurs after the division of the nucleus of the sporocyte (Strasburger's primary nucleus of the embryo-sac-cell), and therefore concludes that the two newly formed nuclei can not be regarded as the nuclei of two sporocytes (Warming-Vesque view), but that they must belong to one individual structure, namely, the female prothallus of a macrospore; in other words, that the cell I have called the physiological sporocyte is a spore giving rise to a female prothallus, and is not the equivalent of two sporocytes. Already it has been pointed out that the embryo-sac-cell must be a sporocyte, because of the gelatinisation occurring in its walls, and because of the nucleus of the embryo-sac-cell being comparable to the nucleus of a male sporocyte according to Guignard's observations, and a third reason will become apparent as we trace the further history of the two nuclei.

The earliest stage I have found after the division of the nucleus of the physiological sporocyte (Strasburger's primary nucleus of the embryo-sac) is represented in fig. 16, showing a sac with an apical and a basal nucleus surrounded by protoplasm and a large vacuole in the centre of the protoplasm. There is thus no division of the protoplasm corresponding to that of the two nuclei. In the next figure ($17^a$) the vacuole is bounded at both ends by a mass of finely granular plasm, on the left by the sac-wall, and on the right by a delicate layer of plasm connecting the apical nucleus with the basal one. Fig. $17^b$ shows the protoplasm of the sac aggregated at the two ends and the vacuole in direct contact with the cell-wall.

What may happen next is the formation of a membrane (*m*, fig. $17^c$), which separates the apical part of the protoplasm from the vacuole and thus form the basal part of the sac. This membrane is not always laid down, but may, on careful examination, be found in at least 50 p.c. of ovules, and it is seen in figs. 18, 19, 21, 22, 23. Fig. 18 shows the membrane *m* placed obliquely [the anterior margin *a* has been represented as a darker line than the posterior one *p*], evidently separating the apical portion of the embryo-sac from the basal one, and bounded on either side by a vacuole. The apical vacuole is brought about thus:—As the ovule elongates, the embryo-sac keeps step with the elongation, and the apical protoplasm gradually recedes from the membrane, which latter, by retaining its position, indicates the basal limit of the apical protoplasm soon after the division of the sporocyte-nucleus. In fig. 19 the membrane exhibits a distinct double outline, and fig. 21, although a later stage in the development of the embryo-sac, shows a portion of the apical protoplasm still adhering to this membrane. Once I found two distinct membranes crossing the embryo-sac (fig. 22), and I believe the lower membrane $m^1$ to have been formed first, the membrane $m^2$ afterwards.

The question arises:—What is the significance of this membrane? If the embryo-sac is nourished by food coming from the plerome-elements on which the basal half of the sac abuts, one would not expect that the apical half would shut itself off from the supply of nourishment by a double barrier, namely, the vacuole and this membrane, provided it was not able to procure its food-supply from some other source. Such another source seems to exist, for the constantly increasing size of the embryo-sac results in the compression and the degeneration of the periblem-cells surrounding it, and I believe that by the death of these cells albuminoid materials are set free which serve as food-material for the apical cell. This suggestion would also explain why in many ovules no membranous partition is formed:—If food-material is not procured in sufficient quantity from the degenerating periblem-cells, then the apical nucleus and its protoplasm must rely for their supply partly on the nutriment brought to the basal end by the plerome-elements, and hence a protoplasmic communication between the two halves of the embryo-sac becomes necessary and no membrane will be formed.

As this membranous partition divides the embryo-sac into an apical portion lying next the micropyle of the ovule, and into a basal portion, in which latter the so-called antipodal cells are developed, the apical and basal portions will henceforward be called the micropylar and the antipodal ones.

To return to Strasburger's contention that the embryo-sac is a macrospore:—Is it likely that an embryological-cell, such as a macrospore, whose function it is to give rise to one prothallus, will divide into two portions or cells quite independent of one another? By a supposed analogy to the microspore or pollen-grain, the view was advanced, that the first division of the nucleus of the embryo-sac-cell gave rise to a vegetative and a reproductive part, the former corresponding to the basal half of the embryo-sac, while the latter corresponded to the apical half. But is the reproductive cell of a pollen-grain independent of the vegetative cell? Certainly not, for to the vegetative cell falls the share of producing the pollen-tube, while the reproductive cell is concerned in fertilisation.

We have seen that the micropylar half of the embryo-sac may lead an existence independent of the antipodal half, a fact which compels one to regard the two halves of the sac as homologues.

One more question must be answered: Why does the embryo-sac-cell, after the division of its nucleus, not lay down a definite cell-wall, and separate into an apical and a basal half? One reason may be that the vacuole or vacuoles, which arise in the micropylar and antipodal ends of the embryo-sac-cell before its division, are shifted in some special way either during or after karyokinesis into a position midway between the two newly formed nuclei, *i.e.*, into the very place where normally a new cell-wall should be laid down. Another reason may be this:—If the embryo-sac-cell is a sporocyte, then its first division will correspond to the first of the binary divisions of other sporocytes, *e.g.*, pollen-grains, and we know that in pollen-grains the second of the binary divisions may follow upon the first, without a cell-wall having been laid down after the first division. A third reason has been fully explained at the bottom of the previous page (363).

In the antipodal end of the sac a small vacuole (fig. 19) is sometimes developed, which, on the division of the antipodal nucleus, takes up a position between the two newly formed nuclei (fig. 23).

After a time division of the two nuclei in the embryo-sac (figs. 16, $17^{a}$–$^{c}$, 19) takes place, and thus four nuclei are formed (figs. 20–23). In fig. 20 we see that the antipodal nucleus is both the most advanced in division and that it gives rise to a much larger diaster than the micropylar nucleus. In several sections I have noticed in the embryo-sac, both at this stage (fig. 23) as also after the formation of eight nuclei, spherical colloid-like masses not stained by hæmatoxylin (*H. B.*), the origin of which I was unable to make out. In fig. 24 the four nuclei within the embryo-sac are undergoing division to give rise to eight nuclei. Similarly as in fig. 20 we notice how the two antipodal nuclei are more advanced in division than the two micropylar ones, and that again of the two antipodal ones, the one next the plerome has advanced the furthest. The centre of the sac is occupied by a large vacuole, and there is no protoplasmic connection between the apical or micropylar, and the basal or antipodal halves of the embryo-sac.

One diaster (*syn*) is placed at the very apex with its long diameter at right angles to the long axis of the sac; it is again seen in a later stage of division in fig. $25^{a}$, and after completion of the division *syn*, in figs. $25^{b}$, 26, 27, $29^{b}$. The two cells arising from this diaster have been called by Strasburger, the synergidæ, as they were believed to play an important part in conveying the male fertilising-element of the pollen-grain to the egg-cell. The second micropylar diaster (*ov.* fig. 24) is placed obliquely, and its function is to give rise to two nuclei, one of which surrounds itself with a mass of protoplasm, and forms a thin membrane on the outside of this protoplasm, and thus shuts itself off from its sister-nucleus. This third cell arising in the micropylar half of the sac and provided with a definite membrane, develops into the egg-cell or ovum (*ov.* figs. $25^{a}$, $25^{b}$, $26^{a}$, 28, 30, 31). The sister-nucleus of the egg-nucleus lies imbedded in a mass of protoplasm (*m. p. c.*, fig. $25^{a}$), and does not surround itself with a definite membrane, and has therefore to be regarded as the nucleus of a free or primordial cell. The latter is bounded above by the two synergidæ and the ovum, below by the vacuole, and on its sides by the walls of the embryo-sac. This fourth cell I propose to call, because of its position and its nature, the micropylar primordial cell (*m. p. c.*, figs. 25[a], 25[b], 26, 27, 28).

In the basal half of the embryo-sac (fig. 24), we again find two diasters, one occupying the very base of the sac (*ant.*) and a second one (*ant.* + *p.*) placed obliquely to the former. The diaster (*ant.*) gives rise to two antipodes, which occupy the base of the sac (fig. 25) the line *i–i* indicating their upper border, while the remaining diaster (*ant.* + *p.*, fig. 24) gives rise to two nuclei, one of which surrounds itself with protoplasm and a cell-wall, and becomes the third antipode, while its sister-nucleus surrounded by naked protoplasm is equivalent to a primordial cell, bounded above by the vacuole, below by the antipodes, and laterally by the embryo-sac-walls (*a. p. c.*, figs. 25[a], 25[b], 26, 27, 28). This primordial cell occurring in the basal half of the embryo-sac I shall call the antipodal one, to distinguish it from the cell arising in the apex of the sac, namely the micropylar primordial cell.

To recapitulate shortly we find the embryo-sac to contain in its micropylar end two synergidæ, one ovum and a primordial cell; in its basal end a primordial cell and three antipodes, *i.e.*, each end of the sac contains four cells, making in all eight cells.

What changes take place in the ovule during the maturation of the embryo-sac will have to be studied next, as these changes throw much light on facts which constantly occur in connection with the two groups of four cells enclosed by the sac.

During the earlier stages of development the embryo-sac increases in size mainly at its micropylar end, and hence the periblem-cells of the ovule lying between that end and the dermatogen are the first to suffer; they degenerate and form, along with the remains of the non-physiological sporocytes, the cap round the apical one-third of the sac. When the embryo-sac is no longer able to increase in the micropylar direction, it begins to bulge out laterally, enfeebles the nucellar periblem-cells surrounding it, and ultimately kills them. This latter change takes place in a very definite way, as the degeneration spreads from the apex of the ovule down to its base (fig. 27). That this should be so is explainable, for the cells nearer the base of the ovule are older, more resisting and better fed than those at the apex. At the time of maturation we find the ovule (fig. 30) to consist of the dermatogen, the remains of the nucellar periblem-cells and the enormously increased parasitic sporocyte or embryo-sac.

Let us return to the two groups of eight cells within the sporocyte-sac. The synergidæ at the time of their formation (fig. $25^a$, *syn*) are attached by a broad base to the most apical part of the embryo-sac, are almost isodiametric and enclosed in a firmer wall than the ovum or egg-cell. Very soon, however, the synergidal cells change their shape, due to growth taking place parallel to the long axis of the ovule (fig. $25^b$), and still later one vacuole is formed in the basal end of each cell (fig. 26, *syn*). To what extent the synergidæ may elongate can be gathered from fig. $29^a$; (the elongation and vacuolation are not seen in figs. 27, 30, 31 as the lower ends of the synergidæ are lying in the next serial sections).

The egg-cell is placed on a slightly deeper plane than the synergidæ (figs. $25^a$, 28, *ov*) with its nucleus and the greater part of its protoplasm towards the antipodal end, the micropylar end being occupied by a vacuole. Thus we have, as has been pointed out by Strasburger long ago, in the ovum or egg-cell a condition the very reverse of that occurring in the synergidæ; a difference well seen in fig. 28, showing one synergida (*syn*) with a vacuole in its antipodal half, and an ovum (*ov*) with a vacuole in its micropylar half. How we may account for this phenomenon, I shall attempt to explain, after I have alluded to the fate of the two primordial cells.

The micropylar (*m.p. c*) and the antipodal (*a.p. c*) cells are at first not connected by protoplasmic strands (fig. $25^a$, $25^b$), but later protoplasmic connections are established (figs. 26, $27^a$, 28, $29^a$, 30, 31), and the nucleus of the antipodal cell travels towards the nucleus of the micropylar cell, both nuclei unite and give rise to what Strasburger has called the secondary nucleus of the embryo-sac. Thus a protoplasmic connection is established between the micropylar and the antipodal halves of the embryo-sac. To return to the synergidæ and the ovum:—It has been pointed out how the enlargement of the embryo-sac leads to a degeneration of the nucellar periblem-cells, a degeneration which commences at the apex of the ovule and then gradually spreads towards its base. We find now at the time of the formation of the synergidæ the retrogressive changes of the periblem-cells restricted to the apical portion of the ovule, and it is quite conceivable that by the breaking down of cells, food-materials will be set free which are directly available to the cells lying in the apical portion of the embryo-sac. Glancing at figs. 24 and 25 *a* we see that the two synergidæ (*syn*) occupy the most apical position in the sac, in other words, that they are the two cells next the supply of food, and it is natural that as the embryo-sac elongates, the nuclei and the protoplasm of the two synergidæ should continue to lie in as close a connection as possible with the apical part of the sac, *i.e.*, the supply of food. To accomplish this the cells must keep step with the elongation of the sac, and hence a vacuole is formed in the basal end of each cell; its function being to increase the tension within the cell and to allow the nucleus and the bulk of the protoplasm to recede from the basal unprofitable end to the micropylar end where supply is plentiful.

The egg-cell is usually placed to one side of the two synergidæ, and at a somewhat lower plane, *i.e.*, further removed from the region in which nucellar cells are degenerating. If then my contention of food-material passing into the micropylar end of the embryo-sac be correct, the egg-cell will not be supplied with nourishment to the same degree as the two synergidæ; and the sister-cell of the ovum, the primordial cell, which, as we have seen above, lies below the synergidæ and the ovum, will be as regards nutriment, the most unfavourably placed cell in the micropylar half of the embryo-sac. The latter cell placed under these disadvantages begins to look out for a new source of food, its protoplasm streams over the inner aspect of the embryo-sac and ultimately comes in contact with the protoplasm of the antipodal micropylar cell (figs. 25–31). The latter, however, is in the same distress as its neighbour, as I judge from the facts, that its protoplasm also is wandering over the inner aspect of the embryo-sac evidently in search of food, and that as in fig. 27 a branch (*l*) has even been sent out, between the antipodes and the sac-wall, to reach the plerome-elements which are the conductors of food-material to the ovule.

As the two primordial cells, whom hunger has driven to make acquaintance, cannot get any or only little nourishment from either the antipodal or the micropylar ends of the sac, they would have to degenerate if it were not for the presence of the large vacuole in the centre of the sac. This vacuole exerts pressure on the surrounding nucellar cells, enfeebles them and causes their degeneration ; a degeneration which supplies the primordial cells with nutriment. It has already been pointed out how this degeneration proceeds from above downwards, therefore most nourishment will be flowing into the micropylar end of the sac. This fact may explain why the nucleus of the antipodal primordial cell travels upwards into the micropylar half of the sac.

This history of the primordial cells gives us a clue as to the position of the vacuole in the egg-cell :—As the latter does not occupy the very apex of the embryo-sac, a position held by the synergidæ, and as further the growth of the embryo-sac during its early development is chiefly a growth in length, taking place at the very apex, the synergidæ will consume all available nutriment coming from the degenerating cells and leave the egg to its own resources. We have further seen how the two primordial cells were the most starved, and how through degeneration of the periblem-cells they were supplied with nutriment; as now the micropylar primordial cell lies in close contact with the ovum (figs. 26, 28, &c.), the latter will receive its food-supply from the degenerating periblem-cells through the medium of the protoplasm of the micropylar primordial cell. Fig. 28 illustrates how the protoplasm of the primordial cell (*m. p. c.*) forms a thick layer just beneath the ovum (*ov*), its sister-cell. As in the synergidæ, so here the nucleus and the bulk of the protoplasm tend to occupy that side of the cell through which nutriment is flowing in.

The three antipodes may be arranged in various ways according to the breadth of the basal end of the embryo-sac. To find all three placed side by side, with their long axes parallel to the long axis of the sac is common (figs. $25^a$, $25^b$, 26, 27), yet one cell is usually at a higher level than the two others, and this higher cell is the sister-cell of the antipodal primordial cell ; it may even (fig. $29^a$) be placed above one of the other two antipodes.

Very rarely do we meet with a condition as shown in fig. 28, due to the diaster (*ant.*, fig. 24) being placed in the long axis of the sac instead of being placed, as usual, at right angles to it; in this ovule the third antipode (sister-cell to the antipodal primordial cell) was placed alongside the two shown.

At first the antipodes bulge into the cavity of the embryo-sac (fig. 25[a]) and may continue to do so up to a comparatively late stage (figs. 27, 28, 29[a], 30), but as a rule they become concave on that surface next the interior of the sac, from two causes, namely, pressure of the central cell (the result of the fusion of the two primordial cells), and by being pulled outwards and stretched by the enlarging embryo-sac (figs. 25[b], 26, 31).

We shall have to consider next the difficult problem:—What is the nature of the eight cells within the embryo-sac.

Strasburger's researches have undoubtedly thrown the most light on the phenomena taking place within the embryo-sac, for he demonstrated how the "primary nucleus" of the embryo-sac divides into two nuclei, how these again divide and redivide, thus giving rise to eight nuclei, how, further, two of these develop into the two synergidæ, while one forms the ovum, three others form the antipodes, and the remaining two nuclei fuse and give rise to the "secondary nucleus" of the embryo-sac, a "nucleus" concerned in the formation of endosperm.

That these changes take place in the embryo-sac has been confirmed again and again, and their very confirmation has led botanists to accept the interpretation given to the embryo-sac by Strasburger after Hofmeister. Strasburger believes the embryo-sac to correspond to a macrospore, and considers the cells within the sac as the cells of a female prothallus. Yet facts have been discovered since Strasburger's researches were published, which show that the embryo-sac-cell can not be a macrospore, whatever else it may represent.

It has been pointed out in my previous papers, and also above, that the walls of the embryo-sac in *Myosurus* show a gelatinisation identical with that occurring in the sporocytes of all other sporangia, and that Guignard has established the important fact, that the nucleus of the embryo-sac is comparable to the nucleus of a male sporocyte, namely, the pollen-mother-cell.

If then the embryo-sac-cell is not a macrospore but a sporocyte, then it must give rise to spores, and the question arises, to how many spores ?

As during the further development of the embryo-sac-cell we find at successive stages, one, two, four, or eight nuclei within the sac, we might imagine that any one of the four stages could correspond to the period of spore-formation, *i.e.*, that the sporocyte or embryo-sac-cell might give rise to one, to two, to four, to eight spores respectively. Let us consider these four possibilities:—

If the sporocyte gave rise to only one spore, it would have to be converted directly from the sporocyte-condition into the spore-condition, and the eight nuclei within the mature embryo-sac would have to be regarded as eight nuclei of one prothallus developed from one spore.

Against this interpretation the following objections may be raised:—

1. A direct conversion of one sporocyte into one spore would have no analogue in the remaining vegetable kingdom.
2. The evident individuality of each half of the embryo-sac-cell after the division of the first nucleus, as manifested by the micropylar end receiving its nourishment from the degenerating periblem-cells, while the basal end is fed by the plerome-elements and by the formation of a plate on the basal surface of the micropylar cell (see p. 363), point against our accepting the two halves of the embryo-sac as belonging to the same individual structure.
3. The great constancy with which four cells arise in either end of the sac, also points to the two halves of the embryo-sac being the homologues of one another, and not vegetative and reproductive portions of one prothallus.
4. If, further, the apical half of the sac was a reproductive portion, while the basal half was a vegetative part, how could we explain the conjugation of the two primordial cells ?

5. The cell-wall-formation round six of the nuclei is not in accordance with the normal way in which prothallus-cells grow, but is, as we shall see later, quite in accordance with the division of nuclei and the subsequent cell-formation as they occur in other sporocytes.
6. We have no indication of changes in the sporocyte, which we could explain as being due to the supression or non-development of the remaining three spores, supposing the division of a sporocyte into four spores as the normal.

May then the embryo-sac be the equivalent of two spores? If so, the first division of the nucleus of the sporocyte (Strasburger's primary nucleus of the embryo-sac) would have to be considered as the stage of spore-formation, and the two groups of four cells within the embryo-sac would correspond to two prothalli, namely, an apical one consisting of the two synergidæ, the ovum and the micropylar primordial cell, and a basal one consisting of the three antipodes and the antipodal primordial cell.

I shall discuss this two-spore hypothesis after having explained what a four- and an eight-spore hypothesis would lead us to.

If the sporocyte gave rise to four spores analogously to the way in which the male sporocyte or pollen-mother-cell gives rise to four pollen-grains, then the first division of the nucleus of the female sporocyte or embryo-sac-cell (figs. 16–19) would correspond to the first of the binary divisions of the male sporocyte, and the period at which four nuclei are found in the sac (figs. 20–23) would correspond to the time when the four pollen-grains are formed in the pollen-mother-cell.

We know that each of the four nuclei within the embryo-sac redivides, figs. 24 and 25, and that thus they give rise to differently named structures, namely:—

1. One nucleus gives rise to the two synergidæ.
2. " " to the egg-cell and micropylar primordial cell.
3. " " to the two antipodes next the plerome-element.

4. One nucleus gives rise to the antipodal primordial cell, and the third antipode which is placed on a slightly higher level than the two other antipodes.

Do these four groups, of two cells each, correspond to four two-celled prothalli? Are we dealing with eight spores? Or what interpretation has to be given to the eight cells?

Much light has been thrown on this difficult question by Dodel * in an able paper, which the author was so kind as to send me. While investigating the phenomena of fertilisation in *Iris sibirica* the author incidentally discovered the important fact that besides the egg-cell, one or both synergidæ may occasionally be fertilised, and even give rise to a few-celled embryo or embryos (*l.c.*, figs. 14, 16, 17). This discovery is summed up in the words: "There can no longer be any doubt that the synergidæ of *Iris sibirica* not unfrequently possess the characters of an egg-cell, as they have the power of receiving a sperm-nucleus, and of undergoing a true fertilisation in consequence of which even a several-celled embryo may develop."

Quite independently of Dodel's researches Overton † has discovered the same phenomenon in *Lilium Martagon*, and figured it. If then both synergidæ and the ovum may be fertilised by sperm-nuclei they must all three be sexual cells; but also the fourth apical cell (the micropylar primordial cell) must be a sexual cell as it conjugates with a cell from the basal or antipodal end of the embryo-sac. We find thus the micropylar half of the embryo-sac to contain four sexual cells, while the antipodal half contains normally only one. If we interpret the embryo-sac as the equivalent of two prothalli, we would have to consider the micropylar prothallus as consisting of four sexual and no vegetative cells, while the antipodal prothallus would be a prothallus giving rise to three vegetative cells and one sexual cell, which latter fuses with one sexual cell from the micropylar region.

The objection I have to the two-spore-hypothesis is shortly this:—Sporocytes normally divide into four spores

* Dodel, Befruchtungs-Erscheinungen b. *Iris sibirica*, Zürich, 1891.

† E. Overton, Entwickelung und Vereinigung d. Geschlechts-producte b. *Lilium Martagon*, Zürich, 1891, fig. 16.

as, *e.g.*, in the sporangia of vascular Cryptogams (whether heterospory occur or not) and in the microsporangia or anther-sacs of Gymnosperms and Angiosperms. As, further, no doubt exists about the sporocyte nature of the embryo-sac-cell we are compelled to explain the embryo-sac-cell on the four-spore-hypothesis.

Attention has already been drawn to the facts (p. 372) that of the four nuclei (figs. 20 and 23) of the embryo-sac, each gives rise to two nuclei, each of which in their turn develops into two cells (figs. 24, 25); that two groups of two cells arise thus in the micropylar end of the sac (*i.e.*, the two synergidæ + the ovum and the primordial cell), and that finally each one of these four cells may play the part of a sexual cell. In other words, the two spores lying in the micropylar half of the embryo-sac give rise to four sexual cells, *i.e.*, each spore gives rise to two sexual cells.

A comparison with the male spores or pollen-grains renders this explanation highly probable, for each pollen-grain divides normally into a vegetative and a reproductive cell, and the latter redivides, thus giving us two sexual cells for each pollen-grain or spore. Four pollen-grains being formed in each male sporocyte, and two reproductive cells in each pollen-grain will make a total of eight reproductive cells developed from one pollen-mother-cell, or male sporocyte.

Similarly the female sporocyte or embryo-sac-cell gives rise to four macrospores, and these in their turn to eight female sexual cells. The non-formation of cell-walls round the four macrospores, as well as the absence of all vegetative cells, may then be explained as due to the parasitic habit of the spores. It is quite conceivable that the microspores, which have to lead an independent existence for a longer or a shorter time, should not have been reduced to the same extent as the parasitic macrospores, and that for this reason vegetative cells still occur in the former.

Of the eight female sexual cells, one, the ovum or egg-cell, is fertilised by a male sexual cell, namely, one of the two sperm-cells developed from one pollen-grain; two sexual cells arising from different spores (the micropylar and antipodal primordial cells) conjugate and give rise to one large centrally placed cell, the primary endosperm-cell, the nucleus of which corresponds to Strasburger's "secondary nucleus"; while the remaining five sexual cells (the two synergidæ and three antipodes) normally undergo no further development. That the synergidæ may be fertilised and thus play the part of true sexual cells has been proved, as stated above, by the researches of Dodel and Overton. It remains therefore to be proved that the antipodes are sexual cells, that they, in other words, have the power of conjugating. Whether they do conjugate I am unable to state definitely, but as I have found in *Scilla nutans* appearances as shown in figs. 49 *a*, 49 *b*, it is likely that they may do so. Both ovules, from which these drawings were made, are fully developed, the synergidæ degenerating and the ova unfertilised. In the antipodal halves of either ovule the cells figured are seen; in fig. 49 *a* the uppermost cell, which has formed a paranucleolus (*p n*), is the sister-cell of the ovum, but which of the four cells in fig. 49 *b* corresponds to the micropylar primordial cell it is impossible to say definitely, but it seems to be the cell marked (*m. p. c. ?*). The two groups of two cells flattened against one another at their point of contact in the second figure, certainly look very much as if they were on the point of conjugation.

Can we give a reason why the synergidæ and the antipodes normally do not behave as sexual cells?

We have already seen how the synergidæ, during their early development, are better supplied with food, derived from the degenerating periblem-cells, than either the egg-cell or the micropylar primordial cell;—how each synergida surrounds itself with a thick membrane, and thus shuts itself off from its fellow and from the rest of the embryo-sac;—how their nuclei lie at the micropylar end of each cell, *i.e.*, next the supply of food, while vacuoles are developed at the basal ends. Thus, every means has been taken by each synergida to procure for itself as much nourishment as possible, with the result that both thrive and assume bigger proportions than the egg-cell, and that both would fulfil their function, *i.e.*, be fertilised by sperm-nuclei from a pollen-grain, if it was not for the supply of nourishment becoming exhausted in the apical region of the ovule before the latter is fully developed. This new factor changes the whole aspect of matters, for the very causes which ensured the success and the development of the synergidæ during their early development will now prevent nourishment getting to the nuclei of the synergidæ, with the result that the nuclei gradually degenerate and the synergidæ die.

If it is the want of nourishment that causes synergidæ to degenerate, why then do the antipodes, being freely supplied with nourishment, not undergo conjugation as the two primordial cells do? Because the very fact of each antipode being supplied abundantly with nourishment, will awaken in it the tendency to develop individually, a tendency associated with the loss of all desire to unite for individual benefit with another cell of its own kind. This individualisation of the antipodes seems to become so marked that the originally sexual cells may assume vegetative functions, and, parthenogenetically, give rise to the primordial endosperm in plants like *Zea Mais, Coix lacryma, Panicum Crus-galli, Salvia pratensis*, and some scrophularineous plants, for Westermeyer, who is the authority on antipodes, does not seem to have made out any conjugation of the antipodes, analogous to the appearances shown in fig. 49 *a*, 49 *b*.

In my previous paper it was shown that the fusion of the two nuclei was in reality only the last step in the conjugation of two cells, and I proposed to call the newly formed cell, the endosperm-cell, as it gives rise to the endosperm, and to call its nucleus the endosperm-nucleus. I imagined I had been the first to recognise this fact, but since then I have learned from Hartog's paper (*vide* later) that Le Monnier of Nancy was really the first person to express this view clearly.* Dodel (*l.c.*) has proposed to call the secondary nucleus the "primary" endosperm-nucleus, and I have adopted this full name for obvious reasons.

As formerly I held the view that the embryo-sac was the equivalent of two sporocytes I naturally came to the conclusion that the two conjugating cells were the equivalents of two spores, but as I have changed my views since then, and now regard the embryo-sac as one sporocyte, and the eight cells within it as corresponding to the eight male reproductive cells which develop from one pollen-mother-cell, I must modify my previous explanation, and therefore state that I believe the endosperm-cell to arise by the union of two sexual cells which are derived from different spores. This

* In Morot's Journ. d. Bot., vol. i. p. 140 (June 1887).

endosperm-cell must, however, in any case be regarded as a true embryo, as it results from the union of two sexual cells. It is destined to act as a storehouse for the stronger embryo which develops from the cross fertilised egg-cell,—meaning by cross-fertilisation, the fertilisation by an extraneous sexual cell, *i.e.*, a sexual cell derived from the anther-sac or microsporangium of the same or of a different flower.

My new interpretation of the embryo-sac does away also with the suggestion that we might regard the micropylar end of the embryo-sac as a female sporocyte, giving rise to four macrospores, while the antipodal end was to be regarded as a male sporocyte giving rise to four microspores, a conclusion I stated thus :—“ The egg-cell in the micropylar region receives the contents of the pollen-tube and develops into the embryo; it is therefore a true female cell, and its sister-cell I would expect to be also a female cell, and I find that the nucleus of the antipodal cell travels towards the nucleus of the primordial micropylar cell, and that in *Myosurus* the two nuclei meet in the micropylar half of the sac.”

Reasons different from those I imagined lead to the conjugation of the two primordial cells, the main of which I believe to be *hunger* as has been pointed out already. Let us study next, how this hunger is satisfied.

### C. FINAL STAGE.

Before commencing with our study of conjugation, it is necessary to give a number of definitions of terms used :—

The cell-plasm is that plasm of a cell outside the nuclear membrane.

The nucleus is the plasm between the nuclear and nucleolar membranes.

The nucleolus is the plasm within the nucleolar membrane.

I have thus made the nuclear and the nucleolar membranes the land-marks for the division of the protoplasm of a cell into three zones, and have avoided classing the membranes under any one of these three layers, although I am inclined to consider the nuclear membrane as part of the cell-plasm (after Strasburger), just as the nucleolar membrane will probably have to be regarded as the innermost portion of the nucleus, as will become apparent later on.

We have already seen how the micropylar primordial cell (*m. p. c.*, fig. 25[a]) occupies a position beneath the two synergidæ (*Syn*) and the ovum (*ov*), and how the antipodal primordial cell (*a. p. c.*, fig. 25[a]) lies in close contact with and above the three antipodal cells (*ant*). The cell-plasm of the micropylar cell does not occupy a large portion of the embryo-sac-wall, while the antipodal cell on the right is attached by a broad base to the sac-wall. As the ovule gets older, the cell-plasmata of both primordial cells commence to wander over the inner aspect of the sac (fig. 25[b]), and thus shut off the vacuole from the sac-wall in the upper and lower portions of the embryo-sac, but as yet the vacuole touches the wall at the places (*p. p.*, fig. 25[b]). In a slightly older ovule (fig. 26[b]), the cell-plasm of the micropylar cell has commenced to stream over the inner aspect of the sac, and we see, in a mesial section through the same ovule (fig. 26[a]), how the antipodal cell has also sent out long pointed processes, how further, two of these processes, one from either end of the embryo-sac, have formed a distinct protoplasmic connection between the two primordial cells (see left side of same figure). Thus the initial step in the conjugation of the two primordial cells has been brought about; the movement of the protoplasm reminding one vividly of the formation of pseudopodia in an amœba, or of the plasmodia in a myxomycete.

In fig. 27[b], the inner aspect of the sac is lined by protoplasm arranged in a reticulate manner with nodular swellings, while in fig. 27[a], representing the next section through the same ovule, the position of the two nuclei of the primordial cells is illustrated; we see, further, in the same figure that the antipodal cell-plasm has made its way between the true antipodes and the nucellar cells (*l*).

The conjugation of the cell-plasmata then becomes very evident along one side of the sac, fig. 28, and the antipodal nucleus (*a. n.*) begins to travel towards the apical end of the sac, while the micropylar nucleus (*m. n.*), lying close to the membrane of the egg-cell (or below and between the egg-cell and the synergidæ, fig. 27[a]), remains stationary. The antipodal nucleus may, in some instances, continue to move along the wall of the sac, but one more commonly finds a thick strand of protoplasm detaching itself from the wall and forming a column which joins the antipodes with the synergidæ; along this strand the antipodal nucleus approaches the micropylar (fig. 29[a], 29[c]). The nuclei are represented in three stages of approximation in figs. 29[a], 29[b], 29[c], both are evidently lying in the micropylar half of the embryo-sac, close to the synergidæ or ovum; in 29[b] the nuclei have not as yet come in contact; in 29[c] they are markedly flattened off against one another, and in 29[a] the two nucleoli have come into contact. In fig. 30 the embryo-sac is seen to be lined by a thick layer of protoplasm, sending strands and columns to the conjugating nuclei; while in fig. 31, after the fusion of the nuclei, the main bulk of the protoplasm is aggregated round the newly formed primary endosperm-nucleus, comparatively little protoplasm remaining in contact with the wall of the sac.

Let us study next the details of this conjugation of nuclei resulting in the formation of the primary endosperm-nucleus; figs. 30–43 illustrate the process as it occurs in *Myosurus*, and figs. 45–47 show a few steps of the conjugation in *Scilla nutans*. The latter plant, being a Monocotyledon, has large nuclei, the details of whose structure are more readily made out than in the comparatively small nuclei of Dicotyledons. The preparations of *Scilla* were made by me in the Laboratory of the Royal Botanic Garden by my picro-corrosive method for Professor Bayley Balfour while acting as his Assistant.

After the micropylar and the antipodal nuclei have come in contact with one another, we see, in hæmatoxylin-preparations (fig. 32), each nucleus enclosed by a very delicate, feebly-stained envelope, the nuclear membrane (*n. m.*), the inner surface of which lies in direct contact with the chromatin-granules (*chr*) of the nucleus proper. Within the nucleus lies a large deeply-stained nucleolus (*nll.*) enclosed by a very faintly-stained nucleolar membrane (*nll. m.*).* The protoplasm of the nucleus seems to be divided into a peripheral darker (*1*), and a perinucleolar fainter (*2*), portion. This appearance of the nucleo-hyaloplasm may be really indicative of the normal structure of a nucleus, as Frommann points out, or may be in this instance simply an artificial product, brought about by a separation and retraction of the fibrils of the nucleo-hyaloplasm from the nucleolar membrane, due to my imperfect method of fixing. But even if this

* The nulcleolar membrane has not been represented in fig. 32.

area be an artificial product, it will help us in our study, for on account of differences in the tension, arrangements, &c., of the fibrils of the hyaloplasm during conjugation, the latter must assume various shapes in retracting when acted upon by the same medium.

Still studying the fig. 32, we find within the micropylar nucleus (*M. N.*) two homogeneous, globular bodies (*p. n.*) with a dark centre, and one similar body in the antipodal nucleus (*A. N.*, *p. n.*). In addition to these three globular bodies a number of homogeneous bodies (*m*) flattened out against the nuclear membrane (*n. m.*) are seen in both nuclei. The globular bodies seem to originate thus: When the nuclei about to conjugate have come in contact, one or two small nucleoli arise by the unequal division of the primary nucleolus (fig. 45, *p. n.*, in the micropylar nucleus of *Scilla nutans*). These secondary nucleoli seem to have at first the power of division, but gradually they lose this power and their property of becoming deeply-stained, and change into globular colloid-looking masses with a central more deeply-stained spot. I propose to call these bodies paranucleoli because of their origin, they may always be found in the micropylar nucleus and occasionally also in the antipodal nucleus (figs. 32, 33 (35 ?), 36, *p. n.*). Fig. 33 shows two nuclei flattened against one another with the approximated sides appearing as an oblique septum. In fig. 34 the septum runs across the conjugating nuclei at right angles to their long axes, and it has begun to give way in the centre (*f*), a point corresponding to those parts of the two nuclear membranes which first come into contact with one another, and which therefore have been able to react upon one another for the longest time.

The perinucleolar hyaloplasms (fig. 34) of the two nuclei have just come in contact, and are seen to have apparently fused in fig. 35, as the septum is still more absorbed. On the left of the same figure two bodies (*p* ?) are seen, which may be paranucleoli, and which are separated by the septum. The next step in the conjugation is an approximation of the two nucleoli brought about by the antipodal nucleolus travelling towards the micropylar one (fig. 36$^a$). It almost seems to have crossed the line where one would have expected to find the septum in the earlier stages of conjugation. An actual fusing of the two nucleoli is seen in fig. 36[b]; they have met in the micropylar end of the already fused nuclei, and this formation of the new nucleolus has been completed in figs. 37, 38.

Synchronously with the blending of the two nucleoli into the nucleolus of the primary endosperm-nucleus a new structure makes its appearance. This body (*n. b.*) is seen in figs. 37–43, and corresponds, I believe, to the nucleolar membrane of the antipodal nucleolus. It usually lies in close contact with the nuclear membrane of the primary endosperm-nucleus, and shows, in its earlier stages, a finely dotted or granular appearance, but gradually becomes more homogeneous looking. I should have traced its origin more minutely but for the rapidity with which the two nucleoli fuse. This fusion occurs so rapidly that the preparation from which fig. 36[b] was drawn only came into my possession after two years of patient searching. The newly formed nucleolus gradually descends towards the antipodal half of the endosperm-nucleus and ultimately occupies its centre (figs. 37–44).

Before attempting to give an explanation of the phenomena of fertilisation as seen during the act of conjugation, an explanation bound up as it is in a knowledge of the minute structure of the nucleus and nucleolus, let me briefly summarise the stages in the formation of the endosperm-cell, as follows:—

1. Amœboid movements of the cell-plasmata of the two primordial cells leading to conjugation of the cell-plasmata.
2. Approximation of nuclei and formation of para-nucleoli.
3. Flattening of nuclei on contact, and absorption of intervening nuclear membrane.
4. Conjugation of nuclei.
5. Approximation of nucleoli.
6. Conjugation of nucleoli and casting off of (male ?) nucleolar bag.

Yet another body or bodies are seen a short time after the completion of the conjugation, for we find in fig. 38, two bodies *x* and *y*, of which the former is clear and hyaline, possessing a granular border, while the latter seems to be a colloid mass stained by hæmatoxylin. In fig. 40[a], one large body (?) is partly covered by the nucleolar bag (*n. b.*). Two minute bodies each with an ill-defined central feebly-stained spot are shown in fig. 41 towards the basal end of the nucleus, while towards its micropylar end a number of spherical bodies, each with a dark central spot, occur, two of which (perhaps a third one on the left side) are outside the nucleus, while two are within the nuclear membrane. Fig. 31 evidently shows a primary endosperm-nucleus with a large nucleolus in its upper half and a number of globular bodies, each with a central deeply-stained spot in its lower half. These globular bodies almost seem to have arisen by division of the large body (?) shown in fig. 40[a]. Fig. 39 may perhaps throw some light on the manner in which the globular bodies with a dark centre get outside the nuclear membrane, for we see three very distinct spherical bodies lying outside the nucleus at its micropylar end, and a clear strand (*k*) running from them to the nucleus. A number of indefinite bodies (*x* ? and *y* ?) are seen close to the basal end of the nucleus. How these bodies arise I am unable to say, they may have some connection with the paranucleolar bodies (*p. n.*, figs. 32, 33, 35, 36[b]), as fig. 35 would make me incline to believe, for here we find two bodies very like paranucleoli lying in close contact with one another and only separated by the disappearing septum of the nucleus.

Whether these paranucleoli of two different nuclei have the power of conjugation just as the nucleoli have, I shall endeavour to find out, as soon as I have more time at my disposal; but a plant with larger nuclei than *Myosurus* will have to be taken for examination.

These bodies outside the nuclear membrane I saw first in September 1890, but was unable to explain them, but now I believe them to be identical with the paranuclei of Von la Valette St George, or the "sphères attractives" of v. Beneden, or the "Centrosomata" and "Archoplasm" of Boveri, or O. Hertwig's "Polkörperchen,"* or the "directing bodies" of English authors,† or v. Tieghem's "Tinoleucites."

* Max Schultze's Archiv. f. mikroscop. Anat. xxxvi., 1890, p. 29.

† "Polar bodies" of English authors correspond to the "Richtungskörper" (*i.e.*, directing bodies) of O. Hertwig.

## MINUTE STRUCTURE OF NUCLEI AND NUCLEOLI.

Let us next study the minute structure of nuclei and nucleoli, by beginning with fig. 45, which shows two nuclei of *Scilla* just commencing to conjugate.

Both nuclei are surrounded by a comparatively thick unstained nuclear membrane (*n. m.*), having a refractive index almost the same as that of turpentine-balsam. This membrane is traversed by a number of radial pores which are visible, because they contain a substance which has a less-high refractive index than the nuclear membrane. Lining the inner aspect of the membrane are a number of irregularly lenticular-shaped chromatin-elements (*chr. 1*), which may or may not be in communication with one another by means of fine strands of chromatin, and which often are arranged as the beads of a rosary. The difference, in their thickness, as shown in the figure, is only apparent, for the chromatin-plates being arranged in a globular fashion, will not be all in focus at the same time. In addition to these peripheral somata (*chr. 1*), a number of more or less central ones (*chr. 2*) are arranged along nuclear threads ($n. f.^1$) which pass from the nuclear to the nucleolar membrane (*1*). Some of the threads are distinctly tubular, and show a double outline (*n. f.*), while others are either too minute to be recognised as tubes, or perhaps consist of solid strands ($n. f.^2$). Working even with the very best appliances, and taking every precaution, I have found it sometimes impossible to trace a filament along its entire length, and it is just possible that, what I describe as solid strands, corresponds to the anastomosing branches connecting the chromosomes with one another.

Surrounding the nucleolus is a nucleolar membrane (*1*), fainter, and of a higher refractive index than the nuclear membrane. Similarly as in the nuclear membrane, a number of very minute dark radially-placed pores or striæ can be observed, and on careful focussing it is possible to see that these striæ are continued into very delicate cilia-like fibrils (*5*) radiating out from the nucleolar membrane into the nuclear hyaloplasm (*n. h.*). The fibrils are not stained by hæmatoxylin, and are only visible because of their refractive index being lower than that of the nucleo-hyaloplasm.

The nucleolus (*3*) is differentiated into an outer zone and an inner zone. The outer zone is less deeply stained, and on careful examination is found to be made up of a circle of peripheral endonucleoli,* which are slightly elongated radially. The inner zone of the nucleolus is very darkly stained, and shows a number of large and irregularly disposed endonucleoli (*4*).

Fig. 46 is very similar to the figure preceding it, but in addition it shows a paranucleolus (*p. n.*) in the upper nucleus; the septum of the nucleus thinner in the middle, and wavy, still unbroken, however, and separating therefore the peripheral chromatin-granules; and only one large central endonucleolus in each nucleolus, and a finely granular area in the upper nucleolus.

For a full account of the literature on nuclei, I must refer the reader to two excellent papers by Courchet and v. Bambeke. Courchet † has specially referred to the early literature on the endonucleoli, and has given a short *resumé* of papers by Flemming, Leydig, Hessling, Lacaze-Duthiers, O. Hertwig, Schrön, J. M. Macfarlane, and Frommann. Von Bambeke ‡ has treated very systematically the various nomenclature introduced by the different masters in cell-study, and has also devoted special attention to the endonucleoli, giving the views of Flemming, Frommann, Leydig, Carnoy, van Beneden, and himself.

Fig. 47 represents the nucleolus of a micropylar primordial cell after the formation of a paranucleolus. The remarkable fact is a radial striation (*r. f.*) of the nucleolar chromatin-matter, and although the striation is by no means very distinct, I believe this figure to fill a gap which exists in figs. 45 and 46, as we shall see afterwards.

In how far can we corroborate these observations in *Myosurus*:—

The resting nucleolus of the sporocyte, or embryo-sac-cell (figs. $9^a$, 11, $13^a$, $13^b$, 14) displays a large central unstained

* Various terms have been used and are still in use referring to the unstained areas in the nucleoli, such as "the granule of Schrön," or "nucleololus," or "nucleolo-nucleus," or "vacuoles," and I propose therefore to use the term "endonucleolus," which was suggested to Dr Macfarlane by Professor Rutherford ten years ago.

† Lucien Courchet, Du Noyau, Paris, 1884.

‡ Von Bambeke, Structure du Noyau Cellulaire à l'état de Repos, Gand, 1885.

area, the central endonucleolus, and a great number of minute oval unstained points close to its periphery, the peripheral endonucleoli. A similar appearance is shown by the nucleolus of the primary endosperm-nucleus, fig. 31.

In fig. 44[a], representing the primary endosperm-nucleus some time after its formation, a large nucleolus is seen with a number of minute structures, which have been diagramatically represented in fig. 44[b], namely:—

1. A thin unstained nucleolar membrane.
2. A great number of peripheral endonucleoli.
3. A deeply-stained, apparently structureless, layer.
4. A corona of minute, slightly elongated, endonucleoli surrounding.
5. A large central endonucleolus.

Fig. 43[a], 43[b]. The nucleolus has been represented amplified in 43[b], and is made up of:—

1. An unstained nucleolar membrane (*nl. m.*).
2. A not very deeply-stained submembranous area traversed by radiating filaments (*r. f.*).
3. A very deeply-stained portion, with four comparatively large endonucleoli at its central border (*x*).
4. A large number of small radially-elongated endonucleoli (the proximal ones).
5. A large central endonucleolus surrounded by an annular outbulging or fold (*fold*).

Figs. 41 and 42 are very similar to fig. 43, for in fig. 41 we find a large central endonucleolus with a highly refractive plate-like body (*plate*), surrounded by seven small endonucleoli of varying diameter. The nucleolus being rather deeply stained further details could not be made out. Fig. 42 shows again the large central endonucleolus (*4*) surrounded by a number of minute endonucleoli smaller and less numerous than those in fig. 43. The body (*5*) corresponds to one of the endonucleoli marked (*x*) in fig. 43. A nucleolar membrane could again be made out, but nothing further.

The stages, figs. 41 to 44, are very near one another, but any connection between them and the figures preceding them I have not been able to make out as yet, and I shall trace the stages of the formation of the primary endosperm-nucleus gradually backwards to the best of my ability.

The nucleolus of fig. 40 contains a number of spherical endonucleoli, perhaps arranged as the beads of a rosary. Those endonucleoli marked with an *x* seemed to touch one another, although they were lying at different levels, while the uncrossed areas were placed so deeply that I could not convince myself definitely as to whether they formed a chain or not. This one nucleolus cost me three days hard work, as sketches of the endonucleoli had to be made again and again, after revolving the stage, changing the light, &c., &c.

The nucleolus, fig. 39, is surrounded by a nucleolar membrane which seems to be bulging out at the micropylar end, and leading apparently to the directing bodies (*dir. b.*). Several larger and smaller endonucleoli are arranged in a line across the nucleolus.

Figs. 38, 37, show respectively four small and one large, and four small and two large, endonucleoli.

In fig. $36^b$, illustrating the act of conjugation of the two nucleoli, both of these are seen to be enclosed by a membrane. The micropylar nucleolus contains two large endonucleoli embedded in nucleoloplasm which has a mottled appearance, while the antipodal nucleolus shows an indistinct spongy appearance.

In fig. $36^a$ both nucleoli have nucleolar membranes; the micropylar one contains three, and the antipodal one contains nine endonucleoli.

The nucleoli in fig. 35 show again a set of peripheral small endonucleoli, and, respectively, one and two excentrally placed large endonucleoli.

Figs. 34, 33, 32 show large nucleoli with ill-defined endonucleoli.

We learn thus from figs. $9^a$, 11, $13^a$, $13^b$, 14, 31, 35, 41–47, that the nucleolus possesses a very complicated structure, and I have endeavoured to bring the details together revealed by the different nucleoli, nuclei, and cell-plasmata, and have constructed fig. 48 to illustrate my conception of the achromatin of a normal highly-developed cell.

A cell may be divided into three zones—a nucleolar or intra-nuclear (*6*), a nuclear (*4*), and an extra-nuclear (*2*) zone, which latter forms the "body" of the cell. These three parts are separated from one another by the nuclear (*3*) and nucleolar (*5*) membranes, membranes which are, as has already been pointed out, probably the inner denser areas of the body-plasm and nuclear plasm respectively, and which do not correspond to the outer denser parts of the nucleolus and nucleus.

In the same fig. 48, two sets of strands or fibrils have been represented, one set as dark lines radiating from the centre of the nucleolus, *i.e.*, from the central endonucleolus (*a*); and a second set as dotted lines radiating from two paranuclei (*m*) just outside the nuclear membrane.

Let us study next the endonucleolar plasm more minutely (fig. 48).

In a resting cell, *i.e.*, a cell not about to undergo either division or conjugation, the centre of the nucleolus is occupied by a large endonucleolus (*a*), which sends out minute fibrils (*c*) through the nucleolar substance (*6*). Each fibril has a proximal (*b*) and a distal (*d*) swelling, and the proximal swellings of the various fibrils form conjointly a corona surrounding the central endonucleolus, while the distal swellings give rise to a light area just internal to the nucleolar membrane. From the distal enlargements the endonucleolar fibrils pass through the peripheral nucleolar area, and then through the nucleolar membrane into the nuclear achromatin.* Here they may be recognised, as they possess a lower refractive index than the turpentine-balsam.

On turning to fig. 45 we find a large number of pores in the nuclear membrane, most of which differ, however, from the nucleolar pores in being much larger (*p. a*), a fact which could be accounted for in several ways, either the endonucleolar fibrils (which I have represented as passing through the nuclear membrane in fig. 48) receive an envelope of nuclear achromatin, or the endonucleolar fibrils undergo an increase in thickness in the nuclear area, or perhaps the larger pores in the nuclear membrane (figs. 45, 46) are for the transmission of structures other than endonucleolar ones, structures which may pass either from the cell-plasm to the nucleus or in the opposite direction. In this

* Synonyms: Kernsaft (O. Hertwig); Zwischensubstanz, Achromatin (Flemming); Karyochylema (Strasburger); Paralinin (Waldeyer).

case I believe the endonucleolar fibrils probably to pass through the finer pores in the nuclear membrane (*p.* $\beta$ fig. 48).

The fibrils have been represented in the diagram as sending branches to the achromatic network of a chromosome (*chr.*) before they pierce the nuclear membrane, and, after they have entered the cytoplasm, to form anastomoses, and ultimately to project through the cell-wall, either to communicate with similar fibrils originating in the endonucleoli of neighbouring cells, or with the medium surrounding the cell in question.

What relation the tubular nuclear filaments (fig. 45, *n. f.*), along the sides of which the central chromosomes occur, have to the endonucleolar filaments I was unable to make out, but as the number of the nuclear strands is comparatively very small, while the endonucleolar filaments occur in large numbers, I am inclined to believe that these two sets of strands exist independently of one another in the nucleus, meaning by the term independent, that each of the main strands pursues its own course, having special functions to fulfil.

In what way the nuclear "chromatin" is governed by the endonucleolar matter I was unable to make out, but conjecture that the endonucleolar filaments constitute the linin element of the chromosomes, a hypothesis which would allow us to understand how the chromosomes are influenced by the endonucleolar matter.

Quite recently Fayod* has written a paper on the structure of living protoplasm. By both injecting vegetable and animal cells with powdered indigo or carmine, and by allowing cells to absorb these substances *intra vitam*, the author has come to the following conclusions:—

The "hyaloplasm" of Hofmeister, de Bary, Leydig, or "paraplasm" of Kupfer, or "chylema" of Strasburger, the "interfilar Substanz" or "paramitom" of Flemming, the "interfilar Substanz" of Altmann, &c., consists of a reticulated framework of strands called "spirospartes," each of which shows two spiral tubes or "spirofibrilles" surrounding a central axis-cylinder, which latter also possesses a spiral structure.

The spirofibrilles equal in diameter the *Spirillum tenue*,

* M. V. Fayod in Rev. Gén. de Bot. (Bonnier), iii. (1891), pp. 193–228, pl. xiv.

and are believed to be built up of still finer spiral tubes. One of the two spirofibrilles in each spirospart serves for the upward conduction, while the other serves for the downward conduction of plastids, and the author says he has been even successful in seeing the plastids move along the hollow spirofibrilles. These plastid substances we are in the habit of staining with our ordinary histological methods, the walls of the spirals taking on no stain. Vacuoles are further believed to correspond to enormously dilated spirofibrilles, and the nucleus to be the meeting point of several spirosparts.

I am as yet unable to criticise these views of Fayod, but shall do so fully as soon as I have repeated the various experiments described in this highly interesting paper. Simply judging by the illustrations (figs. 1, 2, 3, 4), I would be inclined to say that spirofibrilles exist, but certainly I would not be able to construct from these four figures the diagrams figs. 6 and 7.

To return to fig. 48. External to the nuclear membrane (*3*), two paranuclei (*m*) have been figured as lying close to one pole of the nucleus, and sending branches to the nucleolar (*p*), nuclear (*o*), and extranuclear (*n*) achromatin.

Two paranuclei (*m*) have been figured, as according to Flemming * and Guignard,† two bodies are usually, if not always, to be found in a resting cell. Each paranucleus consists of a "central body" (v. Beneden), surrounded by a pale area—the "attractive sphere" (v. Beneden) [Boveri's "centrosome" and "archoplasm" respectively]. The "attractive sphere" is represented as sending out filaments in all directions.‡ The archoplasm of paranuclei does not consist, however, of a homogeneous mass, for Platner § says that the paranucleus of the resting spermatocytes of *Helix pomatia*

* W. Flemming, Neue Beiträge z. Kenntniss d. Zelle, in Archiv. f. Mikrosc. Anat. xxxvii. p. 701.

† L. Guignard, Sur l'existence d. "sphères attractives" dans les cellules végétales, in Comptes Rend. Ac. d. sc. Paris, 9 Mars 1891.

‡ The best stain for the centrosome is, according to Flemming (Archiv. f. Mikr. Anat. xxxvii. p. 686) orange G. [(the sodium salt of anilin-azo-β-naphtal disulfosäure) Grübler]. Hermann (Archiv. f. Mikr. Anat. xxxiv. and xxxvii. pp. 571, 583) uses his platino-chlorid-osmo-acetic mixture, with subsequent reduction of the osmium by wood-vinegar, or—a modification of Pal's hæmatoxylin.

It was in sections stained with Kleinenberg's No. 1 hæmatoxylin, and decolorised in bismarck-brown, that I first observed these bodies, three years ago.

§ Archiv. f. Mikrosc. Anat. B. 26 and 33.

contains a coiled filament, which, at the commencement of division, breaks up into six (*Helix*) or eight (*Limax*) rods; that these in their turn divide longitudinally, move asunder, and form the chief rays of the polar radiation. Prenent * saw also ribbon-shaped filaments in the sphères attractifs, and considers them as rudimentary forms of the paranuclei. Hermann † has seen twelve crescentic filaments in *Helix*, and also groups of short S-shaped or looped filaments surrounding the "central body" in the spermatocytes of *Proteus anguineus*.

Hermann has further, ‡ in his description of the spermatogenesis of the Salamander, pointed out that in the paranucleus a globular body (the middle piece of the ripe spermatozoon) is stained red by saffranin, while a ring-like body (the spiral membrane on the tail of the mature spermatozoon) is stained violet by gentian-violet. In the same paper a method of differential nucleolar staining is given, namely, the nucleoli red, by saffranin, and the rest of the cell violet, by gentian-violet, in resting cells, while during division monasters and diasters are stained red, and everything else stained violet.§ The author, besides mentioning the facts of the differential nucleolar staining, and that a part of the paranucleus is stained violet while another part is stained red, has either not deemed it prudent to draw a comparison between the staining reactions of the nuclei and paranuclei, or has overlooked the fact.

I believe the fact just stated, that it is possible to stain the paranucleus analogously to the nucleus, to be of the

* La Cellule, IV. 1.

† Archiv. f. Mikrosc. Anat. 37, p. 585.

‡ Hermann, Hodenstudien' in Archiv. Mikrosc. Anat. xxxiv.

§ Guignard was the first to put on record a method for differential nucleolar staining with methyl-green and fuchsin, or with hæmatoxylin and saffranin, in 1885 [Ann. Sc. Nat. sér 6, T. xx. p. 318]. Hermann comes next with his saffranin and gentian-violet method, in April 1889 [Archiv. Mikr. Anat. xxxiv. p. 60]. I then published an account in Jan. 1891, Trans. Bot. Soc. Edinb., showing that differential stains might be produced by heliocin and methylene-blue, or eosin (erythrosin) and methylene-blue, or nigrosin and eosin, or nigrosin and hæmatoxylin.

Flemming, in his latest paper, Neue Beiträge z. Kennt. d. Zelle, 24th April 1891, Arch. Mikrosc. Anat. xxxvii. p. 697, says that he demonstrated double stains as far back as 1884, at the Kopenhagen Medical Congress, and that since that time he has frequently demonstrated the same phenomenon. Flemming uses for differential staining, saffranin, hæmatoxylin, saffranin-mannein, or saffranin-gentian-violet.

It is evident that I knew of Guignard's method, but not of Hermann's; that Hermann and Flemming also, quite independently of one another, made the same observations as to the different behaviour of the nucleolar and nuclear matters in regard to staining reagents.

highest importance, and specially in combination with the other fact that the paranuclei have a nuclear origin, as pointed out above, and as also believed by Hermann, who, in the same paper, p. 88, states that the paranucleus is, in all probability, derived from the interior of the nucleus as an originally non-stainable body. These various facts seem to justify us in considering the paranuclei as diminutive nuclei.

Amongst botanists, Guignard * pointed out the presence of paranuclei, or, as he calls them, "attractive or directing spheres," in vegetable tissues, *e.g.*, in the primordial mother-cells of the pollen of *Lilium*, *Listera*, *Naias*, and in the mother-cell of the embryo-sac, and confirms the observations of zoologists as to the part they play in cell division. Wildeman † confirms Guignard's observations, and states that very typical paranuclei are found in *Spirogyra nitida*, and that they also occur in the mother-cells of the spores of *Anthoceros lævis* and *Isoetes Duricui*, further in *Funaria hygrometrica*, *Ceratodon purpureus*, and *Bryum cæspitosum*. Van Tieghem ‡ proposes to call the paranuclei the "directing leucites," or tinoleucites.

## What is Known about the Functions of the Nucleus, the Nucleolus, and Endonucleolus ?

To attribute to these organs the "functions" of fertilisation and division is impossible, as both fertilisation and division must be regarded only as phenomena in the life-cycle of a cell, determined by factors injurious to the maintenance of the individuality of each cell. To put it differently :—

Each cell once formed will endeavour to develop and to retain its individuality as long as extrinsic and intrinsic agencies will allow it to do so. Should, however, the equilibrium existing between the various organs of a cell be upset, an equilibrium necessary for the normal fulfilment of the different physiological functions, then, if the cell be not killed outright, a tendency to restore the disturbed equilibrium may lead, on the one hand, to the division of a cell, or, on the other hand, to the conjugation of two

* Comptes Rend., cxii. (1891), pp. 539–42.
† E. De Wildeman, in Bull. Acad. Roy. Sci. Belgique, lxi. (1891), pp. 594–602.
‡ P. Van Tieghem, in Journ. de Bot. (Morot) v. (1891), pp. 101–2.

cells. Division and conjugation, however, will put a stop to the individuality of the cell in question, but though such has been lost, yet the individuality of the plasms constituting the cell has been preserved, and it is this maintenance of an individual plasm which, though it lead to the loss or death of individual cell-life, yet serves to perpetuate the species.

As the various organs of a cell, we may consider the endonucleolus, the nucleolus, the chromatin and achromatin of the nucleus, the chromatin and achromatin of the cytoplasm, the various plastids, the paranucleus with its chromatic and achromatic elements, and the cell-wall. Each of these structures will have to fulfil definite functions, and probably such functions as the different organs of a highly developed animal or plant perform. We must localise in a cell the channels in which the unelaborated food travels, organs which will act on the food, organs which will distribute the elaborated material, organs for respiration and secretion, and a centre which acts as a trophic centre. Such a centre would be the seat of the essential plasm of a cell, the plasm which stamps a cell with the character of its species, which is the common bond for the various organs, which regulates income and expenditure, and which, through its organs, becomes modified itself.

In such a plasm would be contained the principle of life, and well we might call it the "psychoplasm" of a cell.

What is known about the various functions of the nucleus has been brought together by Hofer * in an admirable paper. The author, after referring to work done by K. Brandt, Nussbaum, Gruber, Verworn, Balbiani, Schmitz, Klebs, Haberlandt, Korschelt, gives a very lucid account of his experiments on *Amœba proteus*, which led him to the conclusions that the nucleus, firstly, possesses a direct influence over the movement of the protoplasm, inasmuch as it is a regulating locomotory centre; and that, secondly, it influences the digestion, as only by the co-operation of nucleus and protoplasm a secretion of digesting fluids is possible; that further, thirdly, the nucleus is neither concerned in respiration; nor, fourthly, in the control of the contractile vacuole.

* B. Hofer, Einfluss, d. Kernes auf d. Protopl., in Jenaisch. Zeitschr. für Naturwiss., Bd. xxiv., Nov. 1889.

Verworn * holds, however, that a nucleus has nothing to do with the movements of the body-plasm, and believes enucleated masses of plasm to perform exactly the same movements as nucleated masses do.

Eimer † considers the nucleus in general as that organ of the cell which originates and governs the processes of life, and believes it to act in unicellular animals as a central nervous organ, and points out that also in the higher animals the nucleus plays a very important part as a centre of nerve-force, for in ganglion-cells the nuclei reach an enormous size; in *Beroe* a nerve-fibril may be traced from the nucleolus of one nucleus to the nucleoli of all the other nuclei which lie on the road of the fibril; in *Medusa* the nerve-fibres pass in the sensory cells through the nucleoli, and end ultimately in the cilia; in non-sensory cells, as muscle-cells and epidermis, the nerves terminate in nuclei; and in the nerve-cells the nerve-fibrils can be seen to radiate out from the nucleoli, and to form a fibrillar network in the nucleus.

A similar network is said to occur also in the germinal vesicle of the egg-cell, due to fibrils radiating out from the germinal spot. It is believed that these radiating fibres serve in the egg, at first, as paths of nourishment, and that later on, due to firming or the consolidation of these strands, they become transformed into nerve-fibrils.

The author further states that these strands correspond to Weismann's idioplasm, *i.e.*, to that firm substance which conveys the characters of the species from generation to generation.

Brass' ‡ book I have not been able to procure, and am therefore unable to state which views are held by the author.

Fayod, in the above quoted paper, I understand to have made out that the hyaloplasm (Hofmeister) of a cell serves as the condenser of oxygen, *i.e.*, that it plays the part of a respiratory organ, and that of the two spirofibrilles surrounding each axis, one serves as a conductor of elaborated material, while the other is a channel for unelaborated substances.

* Verworn, Psycho-physiologische Protistenstudien, Jena, 1889.
† Organic Evolution, 1890, Engl. Transl., p. 349.
‡ Brass, Die Zelle das Element d. organischen Welt, Leipzig, 1889.

Strasburger gives it as his opinion that the formative processes of the cell are regulated by the hyaline plasma of the nucleus, the nucleo-idioplasm (chromatin of Flemming), and believes that the greater the amount of this idioplasm, the more readily does the division of a cell take place.

R. Hertwig * also considers the chromatin of the nucleus to be the most essential factor in the cell, and the carrier of hereditary tendencies, and the achromatin only to play a part in cell-multiplication (p. 52).

The function of the nucleolus, according to Flemming, consists in the latter acting as a special reservoir for the reproduction and accumulation of chromatin.

Strasburger considers the nucleolus to be a mass of reserve-material for the nucleus, and to take no part in the functions of the nucleus.

Pfitzner believes the nucleolar chromatin during division to become transformed into nuclear chromatin, and therefore proposes to call the nucleolar substance "prochromatin."

Carnoy holds that the nucleoli form a mass of reserve-material for the nuclear plasma, *i.e.*, that just as the protoplasm uses up its deposits, so does the nucleus use up the nucleoli.†

Some facts which came under my own notice are shortly these:—(*1*) Actively budding yeast washed in distilled water to remove all sugar, killed and fixed by my picro-corrosive alcohol, washed and then stained with Ehrlich's acid hæmatoxylin, eythrosin, or eosin, shows in the youngest buds a deeply-stained granule, which may be either a nucleolus or a nuclear chromosome. This constant occurrence of a deeply-stained granule suggests that it may be the cause of the budding, *i.e.*, of the change in the wall of the mother-cell.

(*2*) A comparison of the relative position of the nucleus and vacuole in the synergidæ, and the ovum shows, as has already been suggested, that the synergidæ receive their food-supply from the apex of the ovule, while the ovum receives its nourishment from the basal part of the embryo-sac.

(*3*) In transverse sections of chick-embryos, 48–60 hours old, fixed by my method, it is constantly found that in the individual cells, the nuclei are lying in that part of the cell

* R. Hertwig, Lehrbuch d. Zoolog., 1891.
† Van Bambeke, pp. 59, 60.

nearest the yolk, and that in the nuclei the nucleoli are lying in the direction of the source of food-supply.

Facts 2 and 3 point out evidently that the nucleus and nucleolus are concerned in the assimilation of food-material. They may, indeed, only owe their partial stainability to the fact that they serve as store-houses of highly elaborated albuminoid materials, materials which will be converted into the still higher achromatic elements of the cell. This suggestion seems to be highly probable if one takes Hofer's experiments into account, which showed distinctly that albuminoid materials, taken up by an amœba, the more they are elaborated, *i.e.*, digested, the deeper they are stained by a dilute bismarck-brown solution. These observations, conducted by staining amœbæ, or rather their food-supply *intra vitam*, are of the very highest physiological importance.

(*4*) In following out the history of the parasitic embryo-sac, we found that all the cells in the mature sac, with exception of the three antipodal cells, show a feeble development of the nuclear chromatin, the nucleolar and the achromatic element predominating evidently. This may, perhaps, have its reason in the antipodal cells being to a less degree parasitic than their sister-cells, as they lie next the plerome, and receive probably less elaborated nourishment through this channel than the synergidæ, ovum, and endosperm-cell, which, for their supply of nourishment, depend on the death of the nucellar cells surrounding the sac.

If my view be correct, then what I have stated under fact 3, in conjunction with Hofer's experiments, would show the nuclear chromatin to be a less highly elaborated and less assimilative albuminoid material than the nucleolar chromatin.

(*5*) On the assumption just stated, we could explain also why we find in the parasitic cells of the embryo-sac, at the time of maturation, portions of nucleolar matter detaching themselves from the main nucleolus to undergo a peculiar gelatinous change. The gelatinous change would correspond to a conversion of the assimilative material into achromatic elements, an explanation which would also explain the disappearance of nucleoli during the division of a cell. The fragmentation of the nucleoli, on the other hand, would correspond to a division of the achromatic element of the nucleolus, *i.e.*, the endonucleolus, brought about by the large amount of directly available food-material.

It is thus evident that I have not been able to assign definitely any special functions to either the nucleus or the nucleolus, but I believe the hypothesis that the nuclear chromatin-segments and perhaps the nucleoli are organs for the conversion of assimilated material into material directly available for the achromatic elements of the cell, to be not quite erroneous.

What the function of the paranuclei may be is not known as yet. They play a very important part during the division of the cell, a fact I have already alluded to. For a summary of the recent literature, I must refer the reader to Flemming.*

Not only during division, but also during fertilisation, the paranuclei have been shown to be active by Fol and Guignard, to whose researches I shall refer when I speak about the phenomena of fertilisation. My assumption that the paranuclei may be concerned in exerting a trophic influence on the nuclei is based on the phenomena of nuclear division, as I have already explained, but whether they have any other function I am unable to say, and would only warn the reader not to take a teleological view, by considering paranuclei to have been developed for the purposes of nuclear division or cell-conjugation.

To consider the functions of the achromatic parts of a cell would be our next task.

From my description of the conjugation of the two primordial cells, the reader will have gathered, how, the definite structure of the nucleolus is lost more and more as we approach the act of fertilisation, and, how, after the completion of the act, a new nucleolus results with a structure similar to that of either individual nucleolus before fertilisation, a structure, which I have diagrammatically represented in fig. 48, showing a central, proximal and distal endonucleoli and radiating fibres.

This endonucleolar matter permeating the nucleolus, the nucleus and the cell seems to be the trophic centre for all the organs concerned in assimilation and dissimilation. It is

* Flemming, Neue Beiträge z. Kenntniss. d. Zelle, in Archiv. f. Mikros. Anatomie, xxxvii. p. 701.

this plasm which plays so important a part in the conjugation of cells, and how it does so I have represented in figs. 50, *a–g*.

Describing simply the mechanism of conjugation, I believe it to take place thus:—The endonucleolar fibrils running through the body-plasm of the two sexual cells (in the centre of the embryo-sac) are brought into contact with one another whenever the pseudopodial processes of the two cells have met. As soon as a union of fibrils has taken place, each fibril will commence to contract similarly to a muscular fibril, with the result that the two nuclei are gradually brought together; that they become flattened off against one another, because of the resisting nuclear membrane; that the nucleoli become flattened off because of the nucleolar membrane, and that, ultimately, fusion of the two endonucleolar plasms occurs. During this conjugation, in all probability, we have no "fusion" of analogous cell-elements of the two conjugating cells, *i.e.*, we have the individuality of the corresponding organs, *e.g.*, the chromatin-elements retained.

If the view just stated be correct, that, namely, the endonucleolar matter has the power of bringing cell-plasms, nuclei, and nucleoli together, probably because of its intimate union with these different organs, and because of its contractility, and if the paranuclei (v. La Valette St George) are similar in structure to the nuclei, *i.e.*, if they too contain a plasm corresponding to the endonucleolar plasm of the nuclei, and if this plasm is permeating amongst other organs, also the structures within the nuclear membrane, then many difficulties could be explained, which I, without such a hypothesis, cannot explain.

Given then in a cell, firstly, a nucleus with a trophic centre for the whole cell, namely, the endonucleolus; and, secondly, an extra-nuclear structure—the paranucleus—with a trophic centre for the nucleus; and, thirdly, an attachment to or union of these two trophic-centre-filaments with the various nuclear elements, then we could understand how, in a resting-cell, the intra-nuclear centre may influence the various cell-structures in such a way as to arrange them concentrically round itself.

Should, however, by any means the trophic influence of the intra-nuclear centre be weakened, and a corresponding weakening not occur in the extra-nuclear centre, then the latter will be able by its filaments to exert a stronger pull on the various nuclear elements, and arrange these round its own centre, or rather two centres, as normally two paranuclei can be found in a resting-cell. In attracting the nuclear elements, I would expect the extra-nuclear centre to affect, firstly, the essential intra-nuclear trophic centre, and only, secondarily, the chromatin-segments, &c. That such a hypothesis as just propounded, is not only possible, but highly probable, seems to be proved by F. Hermann's figures and description * of cell-division, which the author has studied in the spermatocytes of *Salamandra maculata*. During the resting condition of the cell a mass of "archoplasm" is to be found near the nucleus, sending indistinct fibrils into the body-plasm of the cell, but not showing a centrosome. (This body has been, however, observed by the same author in the spermatocytes of *Proteus anguinis*.) During the spirem stage two centrosomes are seen, and these, as karyokinesis progresses, move asunder, remaining, however, in connection with one another by strands of very delicate fibrils. Simultaneously, the nuclear membrane is dissolved gradually, but before its complete disappearance, the chromatin-elements of the nucleus occupy a position in the nucleus diametrically opposite to the region in which the two archoplasms and the centrosomata occur. This massing together of the chromatin leads to the achromatic portion of the nucleus being brought in contact with the archoplasm, and it is possible to see the achromatic-fibrils of the nucleus running towards the archoplasm.

How this retraction of the chromatin-filaments is brought about is, of course, a difficult question, and the author, not believing in an active mobility of the chromatin-segments, suggests that at that pole of the nucleus which is in close contact with the archoplasm, the continuity between the nucleus and the body-plasm gives way first, and that through this dissolution of continuity, certain streaming movements into the interior of the nucleus are set up along the achromatic filaments, and that the streams of fluid force the chromatin-segments against the opposite side of the nucleus, where as yet the nuclear membrane is not dissolved, and

* Beitrag z. Lehre v. d. Entsth. d. Karyok. Spindel. Taf. xxxi., Archiv. f. Mikroscop. Anat. xxxvii. p. 569.

where, therefore, no continuity between the interior of the nucleus and the cell-plasms exists.

Studying the figures, an explanation has suggested itself to me different from that offered by the author, for although I share with him the opinion that the chromatin-segments are not able to change their position in a cell by themselves, I believe the achromatin of the nucleus (both the achromatin proper and the endonucleolar filaments) to be in direct communication with the centrosomes even in the resting-cell, and to have a greater affinity for the archoplasm than the chromatin-segments, and for this reason to aggregate on that side of the nucleus lying next to the archoplasm and its centrosome. Such a massing together of the achromatin must of necessity lead to the chromatin being gradually pushed to that side of the nucleus, away from the centrosome.

In conclusion, let us study shortly how male and female tendencies are impressed on a cell.

Minot's and v. Beneden's theories have been aptly called compensation theories by Waldeyer,* for Minot supposed that all body-cells, and unripe sexual cells, were hermaphrodite or neutral, and contained two opposite properties, which, in the matured egg and spermatozoon, only occurred singly.

The female element he called the thelyblast, and the male element the arsenoblast, and any cell containing only either male or female elements, the genoblast. Fertilisation or sexual reproduction was believed to occur when a thelyblast (or female cell) from one source united with an arsenoblast (or male cell) from another source; the two by their fusion forming a perfect cell, which is called the impregnated ovum.

Van Beneden suggests that all ordinary body-cells are hermaphrodite, containing two different elements which stand in a sexual contrast to one another, as during the first, as well as subsequent divisions of the fertilised egg, each daughter-cell receives an equal share of male and female chromatin-segments. If, however, every cell in the body is hermaphrodite, then the sexual cells must also contain both male and female organs, and hence, during some period of

* W. Waldeyer, Ueber Karyokinese u. ihre Bezieh. z. d. Befruchtungsvorg. Archiv. f. Mikrosc. Anat. xxxii.

its development, the egg-cell has to get rid of its male element, and the spermatozoon of its female element. We have just seen that Minot holds the same view, but while the latter considers the polar bodies as the homologues of spermatozoa, and, therefore, as male cells, v. Beneden believes the polar bodies not to represent cells, but male nuclear structures (chromatin-segments) got rid off by a process of pseudokaryokinesis. This pseudokaryokinesis would then render the nucleus of the egg-cell of necessity unisexual and female, and such a nucleus containing only one sexual element, and unable to undergo division, he termed a pronucleus.

The nucleus being only a pronucleus, will further, of necessity, render the egg-cell an incomplete cell, incapable of division (gonocyte femelle), till by the reception of a male pronucleus the pronucleus of the egg-cell has regained its full power, and the faculty of undergoing division.*

Brooks † seems to hold that reproductive elements are the result of a division of physiological labour in different directions, but how this differentiation took place, has not been defined.

Ralph ‡ defines a male as a less nutritive and therefore smaller, hungrier, and more mobile organism; the female as the more nutritive and usually more quiescent organism, in which metabolism is more marked than in the male.

Geddes and Thompson § believe a fundamental difference to exist between "the nutritive, vegetative, or self-regarding processes within the plant or animal, as opposed to the reproductive, multiplying, or species-maintaining processes." As the nutritive changes may be resolved into constructive (anabolic) and destructive (katabolic) metabolism, and as "anabolism" and "katabolism" stand in continuous antithesis, and as further the sexual organisms (female and male) also show an antithesis, in as far as the female is inclined to passivity, while the male is inclined to activity, a parallelism between the processes of nutrition and reproduction is

* For a full account of the various theories, see the admirable paper by O. Hertwig, Vergleich d. Ei und Samenbild. b. Nematoden. (Archiv. f. Mikroscop. Anat. xxxvi. p. 1), where these theories have also been criticised.

† W. K. Brooks, The Law of Heredity, Baltimore, 1883.

‡ W. H. Ralph, Biologische Probleme, Leipzig, 1884.

§ The Evolution of Sex. The Contemporary Science Series, 1889.

suggested; "the male reproduction is associated with preponderating katabolism, and the female with relative anabolism. In terms of this thesis, therefore, both primary and secondary sexual characters express the fundamental physiological bias characteristic of either sex" (p. 27). Later, on p. 117, the following sentence occurs: "This much, however, is distinctly maintained, that future developments of the theory of sex can only differ in degree, not in kind from that here suggested, inasmuch as the present theory is, for the first time, an expression of the facts in terms which are agreed to be fundamental in biology, those of the anabolism and katabolism of protoplasm."

On pages 122, 123, we find further: "Protoplasm is an exceedingly complex and unstable substance or mixture of substances, undergoing continual chemical change or metabolism. On the one hand it is being continually reconstructed by an income of nutritive material, which, at first more or less simple, is worked up by a series of chemical changes till it reaches the climax of complexity and instability. These upbuilding, constructive, synthetic processes are summed up in the phrase anabolism. But, on the other hand, the protoplasm is continually, as it 'lives,' breaking down into more and more stable compounds, and finally into waste products. There is a disruptive, descending series of chemical changes known as katabolism. Both constructive and disruptive changes occur in manifold series. The same summit [*i.e.*, of fully formed protoplasm] may be gained or left by many different paths, but at the same time, there is, as it were, a distinct watershed,—any change in the cell must tend to throw the preponderance towards one side or the other. In a certain sense, too, the processes of income and expenditure must balance, but only to the usual extent, that expenditure must not altogether outrun income, else the cell's capital of living matter will be lost,—a fate which is often not successfully avoided. The disruptive, or katabolic, or energy-expending set of changes, may be obviously greater in one cell than in another, in proportion to the constructive or anabolic processes. Then we may shortly say that the one cell is more katabolic than the other, or *vice versa* on the opposite supposition." "Income too may continuously preponderate, and we increase . . . . . in anabolism. Conversely, expenditure may predominate and . . . . . we may live on for a while with loss of weight, or in katabolism. This losing game of life is what we call a katabolic habit, tendency, or diathesis; the converse gaining one being, of course, the anabolic habit, temperament, tendency, or diathesis." "After what we have just said, it is evident that there are but three main physiological possibilities,—preponderant anabolism, or preponderant katabolism, or an approximate (*i.e.*, oscillating) equilibrium between these tendencies. A growing surplus of income, a lavish expenditure of energy, or a compromise in which the cell lives neither far below nor quite up to its income."

I have quoted the above sentences *verbatim*, to allow the reader to judge whether in my criticism I have, perhaps unfairly, attributed views to the authors which they themselves did not intend to express.

If the letter C represent the capital of living matter in a cell, and if A stand for anabolism and K for katabolism, then in a cell living "neither far below nor quite up to its income" (a cell intermediate between an anabolic and a katabolic cell), we might represent C=100, A=20, and K=19, *i.e.*, we have a slight preponderance of anabolism over katabolism, a condition which the authors believe to be essential for the existence of a normal non-sexual cell.

In a fully formed male or katabolic cell with a distinct preponderance of katabolism over anabolism, we might represent C by 100, A by 20, and K by 30, and analogously in a mature female or anabolic cell, C by 100, A by 20, and K by 10.

On comparing then a normal non-sexual cell with a male and a female cell, we would find:—

| | | Ultimate Capital. |
|---|---|---|
| Non-sexual, . | C=100, A=20, K=19 | =C=101. |
| Male, . . | C=100, A=20, K=30 | =C= 90. |
| Female, . . | C=100, A=20, K=10 | =C=110. |

Or, in other words, that in the male cell a reduction, while in the female cell an increase, of the original capital of living matter had taken place.

Before proceeding, it may be as well to point out that to several passages of the authors a different explanation may be given from the one just stated, namely, that we have not an absolute katabolism in the male cell, but a relative katabolism, or if in a

| | |
|---|---|
| Non-sexual cell, . | C=100, A=20, K=19, that in a |
| Male cell, . . | C=100, A=20, K=18, and in a |
| Female cell, . . | C=100, A=20, K=10. |

This view would result in giving us at the maturity of the male cell a capital=102, and for the female cell a capital of 110, and we would have a relative anabolism of the female cell over the male cell.

That the second view just elaborated was not taken by the authors seems to be proved, firstly, by the sentences "conversely, expenditure may predominate and . . . . . we may live on for a while with *loss of weight or in katabolism.* This losing game of life is what we call a katabolic habit," &c.; and secondly, by the view stated in the chapter on the physiology of fertilisation, when the male nucleus is degraded to the position of a carrier of waste materials. But more about this latter point anon.

To return to the view I stated in the first place, and which I believe to be the author's view, that a male cell is "absolutely" more katabolic than a female cell, *i.e.*, that such a cell is spending more than it is able to take in.

Whence, then, does such a katabolic cell obtain the material for the excess of destructive metabolism? It cannot obtain it from without, and must therefore draw on its capital of living matter; but the capital being attacked and spent to maintain the life of the cell, must, of necessity, become reduced in amount, and the cell as a whole must become smaller, if we do not suppose that the waste products accumulating within the cell help to increase its bulk.

It has been suggested that all sexual organisms have probably to pass, during a certain early stage of their development, through an hermaphrodite condition, before either primary sexual characters, *i.e.*, such characters as are directly associated with the essential functions of the sexes, or secondary sexual characters, as the numerous distinctions in size, colour, skin, skeleton, &c., are developed; in other words, before male (katabolic) or female (anabolic) tendencies have arisen.

I assume now, according to the hypothesis of katabolism and anabolism, that as soon as distinct evidences of, say, male characteristics can be demonstrated in a unisexual individual, that the respective individual has acquired a katabolic habit. We have, however, seen that the term katabolism is equivalent to a reduction in the amount of the cell's capital of living matter.

Let us now take "man" as an illustration. At the fourth month of intra-uterine life the sexes are distinct, and if the fœtus be a male, then we must suppose that it has acquired already a katabolic habit, and that the older it gets, *i.e.*, as its primary and secondary sexual characters develop more and more, that katabolism will keep step with this development, nay, what is more, that it will be the cause of this special development. The natural question arises, if a four month old fœtus has acquired a katabolic habit, and if the units building up the fœtus, *i.e.*, if its cells, are katabolic, how can the fœtus develop into a strong man? Each cell, katabolic at the fourth month, and living on its capital of protoplasm, undergoes division, and the daughter-cells, more katabolic than their parents, must reduce the original capital even more. Notwithstanding this continual and ever-increasing loss of capital, the fœtus develops into the active boy and the vigorous man. Surely katabolism must stop somewhere and anabolism take its place, or how could we have an increase in bulk?

A cell whose original capital has been reduced by katabolism from 100, say to 80, divides, and if division be equal, each daughter-cell will obtain a capital equal to 40, and each daughter-cell, following in the habits of its mother, will reduce the capital even more, say to 30, and will, on division, provide either of its offsprings with only a capital of 15. Such a habit would very soon lead to an exhaustion of the capital, or, in other words, there would be no plasm left to undergo division, and the fœtus, instead of growing to maturity, would become reduced to a heap of waste products (katastates).

If, then, we cannot imagine a katabolic male embryo to develop into an adult organism without anabolism preponderating, *i.e.*, constructive metabolic changes, after each cell-division, increasing the bulk of capital received by each daughter-cell, then it is erroneous to speak of the male animal as katabolic as long as it has not reached maturity, and therefore, also primary, and many secondary, sexual characteristics cannot be the outcome of katabolism.

To prove in a similar way that the female is not an anabolic organism is not possible, as the authors suppose a female to be living considerably below its income, but although it cannot be proved directly that the female does not owe its female characters to preponderant anabolism, still we may, I believe, justly infer that if katabolism be not the factor producing maleness, that neither will anabolism produce femaleness, as both anabolism and katabolism, femaleness and maleness are, according to the author's views, antithetic.

Is it possible that the authors, notwithstanding many sentences to the contrary, meant to convey as their conviction, that the female was *relatively* more anabolic than the male ?

Take man again as an illustration. We could suppose two fœtuses to exist in their fourth month, having exactly the same weight, and becoming simultaneously differentiated into a male fœtus, M, and a female fœtus, F. If, further, an equal amount of food-material be assimilated by both M and F, then according to the supposition of the relative anabolism of F, with each successive month and year, say up to an age of twenty years, the difference in weight and bulk between M and F ought to become more and more marked. If we resolve the anabolic F into its units, we would find that greater relative anabolism in a cell means that it will grow to a greater size than a corresponding cell of M would. Two possibilities suggest themselves to me: either such an enlarged cell must divide at a quicker rate than the relatively katabolic M-cell to keep its size within certain limits, corresponding to those of M, or if the rate of division in M and F be the same, then with each successive division the cells of F must result in two daughter-cells larger than those of the corresponding division in M.

Whatever possibility we take into account, it is obvious that, owing to the enormous number of generations of cells intervening in the period of twenty years, an originally exceedingly small difference in relative anabolism would be sufficient to cause a great difference either in the number or the size of cells between M and F, a difference which must make itself evident by the larger size of F at the time of maturity.

We find, however, statistically, not only the male child to be bigger and heavier at birth, but also the man heavier than the woman; facts which are decidedly against the view of the female being relatively more anabolic. Another fact* might also be brought forward, that, namely, adults remain of practically the same size for the rest of their lives, thus showing that the processes of anabolism and katabolism are exactly balanced. That also in sexual cells we have constructive and destructive metabolism balancing one another, I shall endeavour to show afterwards.

The only objection that could be raised against my endeavour to show that females are not relatively more anabolic is this:—I supposed that both M and F were supplied with, and assimilated an equal amount of nourishment, and that the relative anabolism of F was due to katabolism proceeding in it at a slower rate than in M. It could be urged that F, from the very fact of being anabolic, would require less nourishment than M, that therefore less nourishment would be taken up, and that such a difference in size need not result, as I have endeavoured to show, must result if an equal amount of food be assimilated by both M and F. To this I might answer, if the smaller amount of katabolism in F leads to a lessening of the anabolism, then we might say that the metabolism in F was slower than in M. If, however, the difference between M and F consist in respectively rapid and slow metabolism, and I believe this to be the case, we could hardly stretch the term anabolic to cover female tendencies, nor the term katabolic to cover male propensities.

I cannot therefore accept the view that only one theory of sex can be the correct one, namely that as femaleness was developed due to a preponderance of either *absolute* or *relative* anabolism, while similarly maleness owed its origin to katabolism.

Ryder,† in a paper, remarkable for its style and reasoning,

* As was pointed out to me by Mr Graham Kerr.

† J. A. Ryder, The Origin of Sex through Cumulative Integration, &c., Proc. Am. Phil. Soc. xxviii., 1890, p. 109.

endeavours to show that "Cumulative Integration," or assimilation beyond the current needs of the organism, is responsible for the evolution of asexual, sexual, and parthenogenetic modes of reproduction. An earlier paper by the same author,* I have not been able to procure, and assume that the second paper contains a fuller and more matured account of the ideas evolved in the previous paper, and I give therefore a short *resumé* of the paper on Cumulative Integration.

Ryder considers the flagellate forms of Schizomycetes the most ancient form of all free mobile organisms, and wanting in a differentiation into nuclear and cytoplasmic matter (p. 118), and believes that the male element (spermatozoon) represents, morphologically, a perpetuation of the most primitive form of organised existence (p. 117), and that therefore maleness, or the condition of the flagellate spore, is the primitive one (p. 143). As further, Schizomycetes possess no cytoplasm, but only chromatin, the author speaks of chromatin as the essentially male plasma (p. 123), which requires a longer time for its elaboration than the cytoplasm; and in support of the view that chromatin is the highest and latest product of cellular metabolism, the following proofs are mentioned:—It is primitively the most central element of the cell; it is most homogeneous and least like an emulsion; it is the latest to appear when developed in great quantity from the nuclei of egg-like spermatogonia.

Chromatin is further stated to control the process of intussusception of new material, a process which falls on the shoulders of the cytoplasm, and the cytoplasm in its turn to become gradually changed into chromatin (p. 121), or, in other words, the cytoplasm to be the real agent in the production of the nucleoplasm or chromatin (p. 145). If I understand the author correctly, he believes that in the most primitive forms of life, nourishment being scarce, the cytoplasm was only formed in such quantities as to be converted at once into chromatin, and that for this reason in any individual no differentiation into nucleoplasm and cytoplasm took place. After, in this way, a certain amount of chromatin had been formed, the latter broke up into smaller pieces, by direct division, and each of these smaller pieces increased in size, till from some physiological reason it split up again into

* The Origin and Meaning of Sex, Am. Naturalist, June 1889, pp. 501–508.

small fragments. Gradually, however, nourishment becoming more plentiful, the rate at which cytoplasm was formed became greater than the rate by which it was transformed into chromatin, and this resulted of necessity in an accumulation of cytoplasm round the nucleus, or as the author puts it, in the production of a "cytoplasmic field." This cytoplasmic field allowed the nucleus a larger area to exhibit its activity, and as a result karyokinesis was ultimately developed, as the most elaborated form of nuclear division.

Simultaneously with the production of a cytoplasmic field, the habit of cells to adhere to one another after division arose, and thus unicellular organisms became multicellular. Also synchronously with the development of a cytoplasmic field, sex originated. For individuals differentiated into nucleoplasm and cytoplasm attained a large size, and spermatogonia [zoosporangia, G. M.] were developed, whose function it was to give rise to a number of primitive flagellated individuals or spermatozoa [zoospores, G. M.]. Thus far reproduction is still asexual; but gradually some of these spermatogonia in their turn assimilated food material to such a degree and developed cytoplasm in such quantity, that their nuclei (*i.e.*, the chromatin) were incapable of governing the cytoplasm. The spermatogonia, cast off the parent, were then either unable to develop chromatin in a sufficient quantity to allow the latter to govern the cytoplasm, and to divide it into spermatozoa, when an ovum resulted, which, for its future development, depended on an active and more primitive spermatozoon bringing in new chromatin, or ;—a parthenogenetic ovum resulted which was able to undergo further development without the aid of fertilisation.

It is therefore evident that, according to Ryder's view, the "ovum" is nothing but a spermatogonium, *i.e.*, a cell which ought to give rise to a number of asexual flagellated primitive individuals, but which has lost this power due to an excessive assimilation of food-material. That such an ovum still attempts to give rise to spermatozoa seems to the author an established fact, for he considers the formation of polar bodies as an endeavour of the ovum to break up into spermatozoa, and therefore the polar bodies as spermatozoa. "Sexuality was then the outcome of the unequal growth of germ cells of the same species, induced by the self-regulative influences exerted by internal physiological conditions operating under the influence of varying external conditions. The determination of the sex of an embryo has depended in some way upon a tendency early established, through some internal equilibration of the forces of growth in response to outer conditions of nutrition, &c." (p. 120). A male cell is defined as a cell with a tendency towards a preponderance of chromatin, and a female cell as one with a tendency towards a preponderance of cytoplasm (p. 121), and "the female individual may therefore be regarded in the light of a male organism, in which the excessive tendency to sporulation has been repressed or retarded" (p. 148).

We may ask, justly, why should Schizomycetes be considered the most primitive organisms, simply because of their small size and flagella? The Schizomycetes are considered, and, I believe justly, to be degraded forms of Algæ, or of Fungi; and how as regards the flagella, which certainly do not consist of chromatin material identical to that found in the body of the respective individuals? Yet the author says, "that the growth of the lowest forms of living beings is effected in the main, or ends, principally in the production of a single kind of living matter" (p. 153). To call the chromatin "the most primitive plasma," and "the male plasma," is also erroneous, for the author states himself (p. 145), that "there is the best evidence that the cytoplasm is the real agent in the production of the nucleoplasm; the latter grows, as we know, at the expense of the former." In this sentence, as in many others (p. 143), the term nucleoplasm has been used as synonymous with the term chromatin. Chromatin can, however, not be both the most primitive substance and be developed at the same time out of cytoplasm, and for this reason it is wrong to speak of male chromatin as being the primary, and female cytoplasm the secondary, constituent of a cell. To be consequent, the author should have stated that the female element, or cytoplasm, was the older, and the male element, or chromatin, the younger plasm.

I myself hold that assimilation is the only factor in determining sex, as Claude Bernard stated long ago, but do not believe it consistent with fact that female cells are nothing but retarded male cells, or cells which would have broken up into spermatozoa if they had not been overfed. Starting with a non-sexual cell, or individuum, I believe it to have the power of developing either male or female tendencies, according to the facilities in acquiring and assimilating food.

There is still another point in which I cannot agree with Ryder, namely, that the chromatin of the nucleus is the most highly developed constituent to the cell; the researches during the last few years all tend to show that the achromatin is the really essential part of the cell, and I have to repeat what I stated above, that in all probability those constituents of the chromatin segments of the nucleus which we are in the habit of staining with the anilin dyes are only simple albuminoid compounds on the road towards a transformation into the achromatic elements of the cell, in other words, that we are in reality not staining a constituent part of the living cell, but only food particles contained in the achromatic meshwork of the nuclear and nucleolar organs of assimilation.

Hartog * defines a zygote as a cell resulting from the fusion of gametes, and a gamete as a cell which fuses with another, cytoplast with cytoplast, and nucleus with nucleus. Gametes are believed to have arisen thus, p. 79:—"Two distinct modes of fission occur in relation to the growth of the organism in Protozoa and Protophytes; in the first, after each division the daughter-cells grow to the size of the parent (more or less) before dividing in turn; in the second, the intervals of growth are suppressed, and a series of successive fissions takes place, resulting in a brood of small individuals (swarmers, zoospores, &c.). We call this second type of fission 'brood-formation,' the resulting individuals 'brood-cells.' Necessary, like facultative, gametes are essentially, in origin at least, modified brood-cells. Hence, when the ancestral development is not lost, gametes will always be produced by brood-formation, while tissue-cells (except in the earlier embryonic state) are formed by the first mode of fission."

Given this origin of gametes, the author seeks to explain the origin of binary sex, or, in other words, of maleness and femaleness, by the phenomena of gamete-formation, as seen

* M. Hartog, Some Probl. of Reprod. &c., Quart. Journ. Micr. Soc., vol. xxxiii., part 1, Dec. 1891.

in *Ulothrix*, or in *Pandorina*. In *Ulothrix* the gametogonia give rise to gametes, which vary in their number inversely to their size, while in *Pandorina* each gametogonium gives rise to eight gametes, large, medium, or small, as the case may be. Supposing, now, that gametogenic divisions in a species were inconstant, "broods of gametes would be formed, whose size was inversely proportional to the number of the brood, the extreme forms would be small, active gametes, and large, sluggish ones respectively. As the latter are ill-fitted to conjugate among one another in the struggle for pairing [*why! ?*], the small, numerous active ones would be most likely to find pair with these large ones, and the rejuvenescence of such unions would be the more efficaceous, because of the difference of temperament between the parent gametes. The middle forms being produced in smaller numbers than the little gametes, and less useful either way, would tend to disappear. The difference in size between the micro- and mega-gametes would tend to increase, and a division of labour take place, the megagamete tending to accumulate nourishment, to give its zygote a good start, the microgamete gaining activity and delicate sensibility, and by this differentiation of temperament, the zygote would be the gainer. This I take to be the Origin of Sex." . . . . . "I accept, then, one main thesis of the Evolution of Sex (Geddes and Thomson), that male and female are distinguished by their respective temperaments."

If in this way binary sex, with its advantages, has been developed, what then led to "Sex" being developed at all?

Hartog quotes Haberland's, Grüber's, and Eimer's observations on nuclei, and comes to the following conclusion:—"We have ample direct evidence for regarding the apparently 'resting' nucleus in a cell as having the same sort of relation to the cytoplast as a nerve-centre has to an organism, a view supported, too, by the fact that the nucleus approximates in chemical composition to nerve-substance, being richer in lecithin and phosphorus generally than the cytoplasm. Now, in ordinary cell-division, on the principle of continuity, there is no essential change in brood-cytoplast and brood-nucleus, and the result of repeated cell-fission is merely a multiplication of these. But we know that a nerve-centre ceases to respond readily to a continued or repeated stimulus of the same kind. It would seem, then, probable that, after a prolonged association in life continued through a series of fissions, the nucleus would respond less readily to the stimuli received from the cytoplast; consequently its directive powers would be diminished; and, conversely, the protoplasm would do its work more imperfectly; the nucleus again would be less nourished, and a vicious circle of deterioration would set up in the cell, ending in senescence and death. To prevent "degeneration and loss of constitutional vigour produced by the over-prolonged association of nucleus and cytoplast, unchanged through a long chain of fissions, the escape lies through a rejuvenescence of the 'firm,' as we may term them."

This rejuvenescence may be brought about by—

1. Rest, as in the agamous Monadineæ.
2. Change of the mode of life by Polymorphism or by Heterœcism (as pointed out by Marshall Ward, "On the Sexuality of the Fungi," Quart. Journ. Micr. Sc., 1884).
3. Nuclear migration, *i.e.*, the transference of a nucleus to a portion of cytoplasm with which it has not been associated (in apocytial plants), as through the clamp-connections and anastomoses of the Fungi with septate hyphæ.
4. Plasmodium formation, that is the cytoplastic union of cells without nuclear fusion.
5. Karyogamy, or the fusion of two or more nuclei, as well as of their cytoplasts into a uninucleate cell, the zygote. In binary union, the cytoplast of one of the gametes may be practically nil.
6 Fusion of apocytial gametoids. (Probably only a subdivision of plasmodial formation or karyogamy).

We see thus that karyogamy, *i.e.*, a union of gametes involving fusion of their nuclei, is equivalent to "the formation of a nucleus new to the cytoplast with which it is associated, a change in the constitution of the 'firm' and 'staff,' to speak metaphorically," which results in a rejuvenesced or constitutionally invigorated zygote.

Hartog's paper is undoubtedly a great boon to all who study the problems of reproduction, for a clearer and more concise account of the phenomena of reproduction, as far as these are known to occur up to the present time, in both vegetable and animal life, could not have been written. Yet I must differ in some points, as the observations I have been fortunate enough to make in my study of the embryo-sac, point to a solution of the problems of sex in a different direction.

We must be very guarded in attributing special functions to the different organs of a cell, and although the "nucleus" of a cell seems to have "the same sort of relation to the cytoplast as a nerve-centre has to an organism," we are not as yet able to say which part of the nucleus has such a function. Is it the endonucleolus with its radiating fibres, the nucleolus, the nuclear-chromatin or achromatin, &c.?

That cytoplast and nucleus react upon one another mutually I admit, but cannot agree to the view that this reaction ceases, due to prolonged stimulation of the nucleus by its own cytoplast. The author points out himself that continuous vegetative reproduction is interfered with in *sexually* differentiated organisms; but as in primarily non-sexual organisms, and in those which have returned from a sexual to a non-sexual condition (as, *e.g.*, often occurs in the Banana), we have unlimited vegetative growth, I believe all the author could imply would be that in sexually differentiated organisms the nucleus had become specially sensitive to reactions of its own cytoplasm, and that for this reason it was soon tired out. Then sex would be equivalent to the development of a higher degree of sensibility on part of the nucleus; a sensibility which was readily blunted by the same kind of stimuli arising in its own protoplasm, and which was restored in the zygote by the nucleus coming in contact with new cytoplasm, producing different kinds of stimuli from those it has been accustomed to in its own cell.

The author has also omitted to point out why the gametogonium of *Ulothrix* gives rise to either many microgametes or to comparatively few megagametes, and how in *Pandorina*, in which the number of gametes is always eight, an impulse is given to the development of either large or small gametes.

To assume, further, that the megagamete prepares itself for the reception of the microgamete by storing up nourishment "to give its zygote a good start," and that the microgamete developes "activity and delicate sensibility" to be able to hunt up the megagamete, is a purely teleological view of matters, and must be abandoned. Microgametes and megagametes are developed, due to certain physiological causes inherent to the parent, and that they are capable by their union to give rise to a vigorous zygote, is only a secondary accident, which is of the highest importance for the maintenance of the species, but, in multicellular organisms, of no interest to the parent organism, and not only of no interest to the individual, but directly injurious.

Weismann's view as to "sex" may be shortly summed up thus:—Nothing, if not teleological in his view, he considers the simplest form of sexual reproduction to have arisen from conjugation, and the latter to have been brought about by a desire to strengthen the organism in relation to reproduction, whenever, from some external cause, such as want of oxygen, warmth, or food, the growth of the individual to the extent necessary for reproduction could not take place.

After conjugation had once been established, the process soon acquired a new significance, for the mixing and blending of various hereditary tendencies which it necessarily implied, conferred upon forms possessing it a higher degree of hereditary variability, or, in other words, the power of adapting themselves to surrounding and varying conditions. This power of adaptation to changes in environment is obviously of so profound importance to the survival of the various organisms, as to account for the all-pervading existence of sexual reproduction.

A fundamental difference between male and female, or between the nuclei of the reproductive elements, Weismann does not believe in, and to prove their physiological identity, he refers to Boveri's experiments, in which echinoderm ova were enucleated, and spermatozoa introduced in their place, whereupon the ova in several cases underwent normal segmentation, and even produced a larva. He also refers to the case of *Ectocarpus*, where in certain cases the normally male element may germinate and give rise to a new plant.

R. Hertwig,* in his book, p. 52, considers the chromatin of nucleus as that part of the cell which determines the character of a cell, which influences all activities of the

* Lehrbuch d. Zool., Jena, 1891.

(cyto) plasm, and which is the real carrier of the hereditary-substance.

After this short account of the more recent theories as to the origin of sex, we must proceed to a study of the significance of the various phenomena observed during the act of fertilisation, and see how these phenomena have been interpreted by the various investigators.

Martin Barry (1843) seems to have been the first who observed spermatozoids in the ovum of the rabbit. Leuckart made the same observation in the frog (1849), Nelson in *Ascaris mystex* (1852), and Keber observed the actual entrance of the spermatozoon into the egg of the common mussel. How the spermatozoon affected the egg was not known till, in 1872, Bütschli observed two nuclei in the fecundated egg of *Rhabditis dolichura*, and till, in 1874, Auerbach, quite independently, made the same observation in two other worms, *Ascaris migrovenose* and *Strongylus auricularis*. To O. Hertwig (1875), however, belongs the credit of having demonstrated that the second nucleus is the head of the spermatozoon. Hertwig, however, at first supposed that the other nucleus was the germinal spot of Wagner, set free by the destruction of the germinal vesicle, an error which was corrected by Van Beneden, and the other nucleus was soon shown to be, as Bütschli had previously conjectured, the germinal vesicle. Van Beneden further described (1875) the fusion of the two nuclei, and compared this fusion to the conjugation of the Protonozoa and Protophyta, and in 1883 advanced our knowledge on this subject greatly by his magnificent monograph on the fecundation of *Ascaris megalocephala*. Fol (1877), however, not only observed the entrance of the spermatozoid into the eggs of *Asterias glacialis*, *Echinus*, &c., but also figured the phenomena that ensued, phenomena confirmed by many naturalists.* I cannot do better than describe these phenomena in Hertwig's words:—" The egg sends out a projection to meet the spermatozoon, and then takes it up into the interior of the yolk.

" In the protoplasm of the egg the achromatic end of the

* For this short historical account I am indebted to Prof. M'Kendrick, who, in his text-book of Physiology, pp. 223, 224, has given above account, which, apart from the condensation, has been copied almost literally.

sperm-nucleus causes an intense radiation, analogous to that observed during division. In advance of the radiation, the sperm-nucleus travels towards the egg-nucleus, it reaches the latter, unites with it, and forms, conjointly with the egg-nucleus, a single nucleus, the division-nucleus (Furchungs-kern), which latter soon develops into a nuclear spindle, the division-spindle (Furchungs-spindel), and thus gives an impulse to the commencement of embryonic development, namely, to the division of the egg. As only now fecundation has been completed, we arrive at the fundamental proposition, that the essence of fecundation consists in the union of egg-nucleus and sperm-nucleus (Echinoderm). In many instances an abbreviation of the process may occur, inasmuch as the stage of the division-nucleus (Furchungs-kern) is omitted, when the egg-nucleus and sperm-nucleus, without previous union, proceed at once to the stage of the nuclear-spindle (Furchungs-spindel), as in *Ascaris*," a fact which had been worked out by v. Beneden and Boveri.

Strasburger also considers fecundation to depend on a union of the sperm-nucleus with the egg-nucleus, and the cell-substance (cytoplasm), not to share in the process.

Guignard,* from a study of the process of fertilisation in *Lilium Martagon* and *Fritillaria*, concludes that fertilisation does not consist only in the fusion of the two nuclei of different sexual origin, but also in the fusion of the cyto-plasma of the two sexual cells, as he observed the coalescence of the paranuclei ("directing spheres, or tinoleucites"). The process is shortly this:—After the division of the reproductive cell of the pollen-grain into two daughter-cells, the anterior one of the two is provided with two tinoleucites in front of the nucleus, while the egg has its two tinoleucites above the nucleus. Thus the two pairs of tinoleucites are brought in close contact with one another, they fuse, and only two tinoleucites are now seen in the egg. The newly formed pair of tinoleucites then separates, in order to allow the nuclei to fuse. Later on the tinoleucites form the poles of the zygote-nucleus, the latter divides, and induces a division of the zygote. Thus fertilisation is completed.

Sachs (Physiology of Plants, p. 768) defines fertilisation as the act by which "something" is added to the substance

* Compte Rend., C. xii. (1891), pp. 1320–2.

of the oosphere (or gamete), which was hitherto wanting to it, and which it needs for further development, and suggests that this "something" may be a ferment.

Weismann does not believe that there is any fundamental distinction between the two sexes, or between the nuclei of the reproductive elements which represent them in their most condensed form, as has already been pointed out. He further maintains that the normal egg in the higher animals gets rid of its oxogenetic plasma by the formation of the first polar body, and then removes one-half of its germplasma (and with this one-half of its hereditary tendencies) by the formation of the second polar body. This removal of the female germplasma necessitates the acquirement of some new germplasma, which latter is brought to the egg by the spermatozoon.

Fertilisation then consists in the acquirement of a certain amount of germplasma (and with it of a certain number of new hereditary tendencies), which doubles the amount of the germplasma in the egg, and thus leads to a segmentation of the ovum. Hence the segmentation of the egg depends simply on mere quantity of germplasma.

As Weismann's views are purely teleological and inspired by a desire to explain heredity, it is only natural that the author should have arrived at the very ingenious, but decidedly wrong, notion about the "functions" of the polar bodies, and that he should have considered his germplasma to be so isolated a substance in the body, uninfluenced by any environmental conditions that may act on the soma of the parent.

Strasburger maintains that sexual cells contain proportionally a smaller amount of nucleo-idioplasm than the asexual cells, and that for this reason they are not capable of undergoing further division. Therefore, between asexual and sexual cells, no qualitative, but only a quantitative, difference exists, due to the varying amount of nucleo-idioplasm. Fertilisation, according to this view, is equivalent to an increase of the mass of nucleo-idioplasm in the ovum, an increase which leads to the division of the egg.

Strasburger and Weismann then agree to fertilisation being brought about by a doubling of the chromatin-elements of the female gamete-nucleus.

Ralph believes conjugation to occur whenever nutrition is diminished, and holds therefore conjugation to be merely a special form of nutrition, and the less nutritive, smaller, hungrier, and more mobile organism, or male cell, to seek out the large, well-nourished female. Conjugation is said to be equivalent to "isophagy," the latter taking the place of "heterophagy."

Cienkowski also regards conjugation as a process of rapid assimilation.

Simon says two similar cells unite, "in order to reach the limit of their individuality," and that the union brings about a chemico-physical process, which makes the female cell capable of independent nutrition and growth, and evokes potential properties into actual life (Geddes and Thomson, p. 161).

Geddes and Thomson, p. 162, state—"In regard to the origin of fertilisation, that the almost mechanical flowing together of exhausted cells is connected by the stages of multiple conjugation with the ordinary form of the latter, while the respective differentiation of the two elements effects the transition to fertilisation proper. Historically, then, fertilisation is comparable to mutual digestion, and, though bound up with reproduction, has arisen from a nutritive want. With the differentiation of the elements on anabolic and katabolic lines, the nature of the fertilising act becomes more definite. The essentially katabolic male cell getting rid of all accessory nutritive material contained in the sperm-cap and the like, brings to the ovum a supply of characteristic waste products or katastates, which stimulate the latter to division. The profound chemical differences, surmised by some, are intelligible as the outcome of the predominant anabolism and katabolism in the two elements. The union of the two sets of products restores the normal balance and rhythm of cellular life. Ralph's suggestion is thus included and defined."

Granted that, historically, fertilisation was really comparable to [partial, G. M.] mutual digestion of two exhausted cells flowing almost mechanically together, I might understand how a new cell arises more vigorous than either parent, the [essential, G. M.] constituents of the two cells being able to feed on one another's albuminoid materials, but I cannot imagine an egg feeding on a mass of waste products or katastates, nor am I able to see how such katastates could be the carriers of the tendencies of the male parent. Surely only half-assimilated material, or partly, or entirely dissimilated material, will never together form a new protoplasm, the bearer of the characteristics of both male and female parent. Why further, should a katabolic male cell "get rid of all accessory nutritive material"?—For the sake of a change of diet?

Although I cannot agree with the authors in their views as to the origin of sex and the interpretation to be given to the phenomena of fertilisation, yet their "Evolution of Sex" led me to my inquiry, and seems also to have led Ryder and Hartog into an investigation of this highly fascinating subject. Should my paper bring us a step nearer the solution of this difficult problem I shall rest contented.

Ryder, as we have already seen, considers sex to have arisen as the result of "Cumulative integration," the zoosporangia (spermatogonia) "either increasing enormously in size to become ova, or running down, as a result of rapid karyokinesis, into minute male elements, which are rapidly dehisced and set free." The most evident part of the egg being the cytoplasm, and of the spermatozoon being the nucleoplasm, the author concludes, p. 134, "that the origin of sex at any rate hinges upon the decision of how the disproportion between the chromatin and cytoplasm arose in the sexual products of the two sexes," and that a restoration of this disproportion between two cells has led to fertilisation.

"The male and female elements become reciprocally attractive to one another (sometimes through the production of certain chemical substances in the vicinity [Pfeffer.]), and in that their idioplasm is less different from one another than that of other cells, there is no bar to their fusion, which is also favoured by the fact that in the male cell, with its preponderant chromatin, there is now an attraction or need developed for more cytoplasm similar to its own diminished quantity, while conversely there is a similar need or attraction developed in the egg for additional chromatin, in consequence of its preponderating cytoplasm. This leads to the highest form of cumulative integration through direct fusion of the male or female elements, or what I shall call reciprocal integration without loss of molecular identity, or as it is commonly called, to 'fertilisation.' Fertilisation is a reciprocal restoration of the equilibrium between the chromatin or nucleoplasm and the cytoplasm of both ovum and spermatozoon; this takes place not with accompanying molecular disintegration, but by actual fusion of both elements without the sacrifice of the molecular identity of either.

"Mutual digestion is not possible, for both elements are already composed of similar molecules. This molecular similarity constitutes the means through which the hereditary traits and tendencies of the male and female are transmitted" (p. 155). "The one sex appears to supply the field for segmentational activity [the ovum], the other the segmentational impulse itself" [the spermatozoon] (p. 140).

Hartog seems to hold that the essential factor in fertilisation is the transplantation of a new nucleus into the ovum, to avert the dangers of over-stimulation of either sexual nucleus by its own cytoplasm. That this hypothesis is not likely I have already mentioned above.

My conception as to the Origin of Sex is based upon views to which I have been led by the study of cell-structure.

It will have become apparent that I consider the plasm of a cell to be achromatic; that further, the stainability of a cell by ordinary anilin dyes, carmine, hæmatoxylin, &c., is merely due to food-materials in various degrees of transition into achromatic substance. The chromatin-segments of the nucleus would then be organs consisting of an achromatic network, in the interstices of which food-materials in a process of transformation are being stored (fig. 48, *chr.*).

The nucleolus would either be an organ for the further transformation of substances already elaborated by the nucleus, or simply a storehouse for food-material, which has been already transformed by the nucleus into substances directly available for the nourishment of the achromatic elements of the cell.

I have been also led to the conclusion that the achromatic frameworks of the various organs of a cell will vary from one another, inasmuch as they have undergone specialisation according to the functions which they have to perform.

Let us suppose that a primitive cell consisted of an aggregation of similar plasmic molecules, *i.e.*, there being no specialisation of any one molecule or groups of molecules; then it is highly probable that in such an aggregate of identical molecules, should they become interdependent, special molecules or group of molecules would become modified in certain special directions, according, as owing to relative position, they are differently affected by environmental conditions, such as food-supply, light, heat, &c.

If now the various functions of each of the original unmodified molecules be represented by, say, A, B, C, D, E, then specialisation in one organ might be represented by A, B, C, D, E, and that in another organ by A, B, C, D, E, and so on.

Further, if we suppose that a group of molecules least exposed to environmental conditions (*i.e.*, a group probably of central position) does not undergo functional specialisation, but simply benefits by the specialisation of the other groups of molecules, then such a centre, owing to its non-specialisation and entire dependence on its neighbours, will of necessity be influenced by all the changes which take place in the cell, changes which will be either directly beneficial or injurious to its welfare. It is this necessity which has led the non-specialised portion to become a trophic centre.

In a normal unicellular organism the demand for, and the supply of, food will tend to balance one another, the amount of food taken up depending directly on the hunger of the trophic centre and the other plasms of the cell, hunger being an unsatisfied affinity of one element or a group of elements for another element or group of elements.

When this desire for food is being satisfied, then new molecules, in some way, arise in the cell identical with those already existing. This increase in the number of molecules must lead to an increase in the bulk of the cell; but as soon as a certain size has been reached, then factors unfavourable for a ready assimilation of food, will make their appearance, as Leuckart–Spencer have pointed out, for whereas the surface increases in only two dimensions, the cell increases in three. The first plasma to be affected will be that furthest removed from the food supply, *i.e.*, the trophic centre, which, finding it impossible to get the necessary nourishment, will start the division of the cell. Division of a cell means, however, a restoration to its pristine condition.

Such would be the life-history of an asexual unicellular organism, which has been developed along such lines as to enable it to procure not only a definite kind, but also a certain amount of that special nourishment. If, however, any increase or decrease in the amount of nourishment to which the cell has been accustomed occur, then the nutrition of the trophic centre within the cell will be altered in one of two directions:—

A. Excess of Food.—When this obtains, the organs of the cell are able to manufacture food for the trophic centre in such quantities that the latter, always finding sufficient material for its wants, loses the habit of urging the organs to increased activity. This diminution of trophic influence will allow the cell to become larger than normal, and may even end in loss of power of division.

B. Deficiency of Food.—This condition results in one of two conditions, either, firstly, in death by starvation, or, secondly, in diminution of food elaborated by the organs; hunger of the centre, and increased stimulation of the organs, the latter leading to movement in search of food, *i.e.*, the cell as a whole becomes active. But this activity necessitates greater expenditure, hence still greater food-supply. The cell will be directed by its centre to go where it can obtain the greatest amount of food with the least possible expenditure, *i.e.*, it will tend to go towards a cell of its own species, which is over-fed, and which can therefore supply it with an abundance of exactly such food as, under more favourable conditions, it itself would have elaborated.

Although in the way just described a varying amount of available food may lead either to a loss of influence of the trophic centre over its organs, or, on the other hand, to a display of excessive energy, we must ask ourselves are there yet other causes which could produce the same effect? I believe there are; for quite apart from the food-supply, two cells resulting from one division need not be constituted alike. One cell may be abnormally strong on the trophic side, but weak in its organs, or *vice versa*; or a cell's trophic centre may be normal, but the organs not able to maintain the wants of the centre; or the organs may be able to perform their physiological function, and yet the trophic centre be deficient in amount or quality to govern the organs. Let us suppose that two unicellular organisms have the same opportunity of acquiring food, but that they differ from one another in this respect, that in the cell T the balance between the trophic centre and its organs is in favour of the trophic centre, while in the cell O the reverse is the case. Then the organism T will not be able to assimilate food in sufficient quantity to satisfy its centre, while reversely in the organism O, more nourishment will be at the disposal of the trophic centre than it requires, and, by the same reasoning as above, when the amount of available food was supposed to vary I conclude again that in the organism T we will have great activity developed, while O will be characterised by its passivity.

Whatever cause may produce this loss of balance between the trophic centre and its organs, it is evident that a union of two cells, one deficient in the activity, and the other characterised by an excessive activity of its centre, would tend to restore the normal balance between the centre and its organs. It is this restoration of the balance which I believe to be the essential element in fertilisation.

Conjugation of two cells is then equivalent to the new-formation of one cell thus constituted that the trophic centre is capable of exerting its influence over the various organs, and that the organs are able to maintain their trophic centre by satisfying its chemical affinities. How this loss of equilibrium between the trophic centre and its organs is restored in the zygote is a question which I believe my observations have began to throw light upon.

I do not believe the active male cell to effect the restoration of the equilibrium, as manifested by the division of the passive female cell, by acting either as a ferment (v. Sachs), or by simply doubling the amount of chromatin in the female cell (Strasburger, Weismann, Ryder), or by being the carrier of katastates (Geddes and Thomson), or by restoring the susceptibility of the female nucleus to stimuli from its own cytoplasm (Hartog); nor have we digestion of the two cells, or isophagy as Ralph believed; but, as I have endeavoured to show, feeding of the starving cell on the surplus nourishment of the over-fed cell, with no digestion of the living achromatic plasm, whether this be in a non-specialised condition as endonucleolar or archoplasmic matter, or in the specialised condition forming the frameworks of the nuclear and other organs.

The union of the trophic centres (archoplasmic and endonucleolar) of the two conjugating cells by "their mutual molecular attraction" (Ryder), will result, as soon as the activities of the female centre have been roused, by the want of nourishment :—a want which will make itself felt, sooner or later, as, to all intent and purpose, the male trophic centre acts as a parasite. The corresponding organs of the conjugating cells, such as nuclear chromosomes, nucleoli and paranuclear chromatic elements, are only of secondary importance during the act of conjugation, and they may, or, what is more likely, may never fuse with one another.

We must distinguish between fertilisation and heredity, as Boveri pointed out in his famous paper on *Ascaris megalocephala*. Fertilisation will be equivalent to the restoration of trophic influence of the "female" centre over its organs, and to a satisfied hunger of the "male" centre. Heredity will be bound up mainly with the performance of those functions of the various organs which are required for the maintenance of the newly formed trophic centre: functions which will be performed as well as environmental conditions will allow; functions which, gradually, will become modified by environment, and which, as they become modified, will provide the trophic centre with a new kind of food, and thus lead perchance to Evolution.

## EXPLANATION OF FIGURES IN PLATES III*a*. AND IV.

### ILLUSTRATING MR MANN'S PAPER ON THE EMBRYO-SAC OF *Myosurus minimus*.

Gynæceum: at the time when a flower expands.

Fig. 1. Young ovule: *Derm.*, dermatogen. *Peribl.*, periblem. *Pler.*, plerome. *A. S.*, physiological archesporium (*x. x.*); *x*, non-physiological archesporia.

Figs. 2 and 3, same lettering as in fig. 1. *Int.*, integument.

Fig. 4. *a*: cell undergoing oblique division.

Figs. 2 and 4 show increase in the size of the physiological archesporium.

Fig. 5. Monaster stage of archesporium, with 8 chromatin-segments.

Fig. 6. Later stage, showing inequality in the size of the two cells derived from the archesporium, *x* and *y*.

Fig. 7. The cell "*y*" of previous figure precedes its sister-cell (*x*) in division, and gives rise to the physiological embryo-sac, *E. S.*

Fig. 8. The embryo-sac, *E. S.* Apex of carpellary leaf, *C. L.*

Figs. $9^a$, $9^b$. Embryo-sac with vacuoles, *E. S.*, and three non-physiological embryo-sacs, $x + x$ and *y*.

Fig. 10, *a–d*. The gelatinisation of the walls of the physiological and non-physiological embryo-sacs takes place in various degrees.

Fig. 11. Degeneration of the cell *y*. Peripheral endonucleoli and a central one in the nucleolus of the embryo-sac, *E. S.*

Fig. 12. Cells *x* and *y* degenerate.

Fig. $13^{a-b}$. Vacuolation of the embryo-sac, *E. S.* Its nucleolus with peripheral endonucleoli and a central one.

Fig. 14. The non-physiological archesporia have given rise to a layer of periblem, *Peribl.* The cell *y* has escaped degeneration.

Fig. 15. The embryo-sac, *E. S.*, with large vacuole towards its micropylar end, *M. E.*, and the nucleus towards the antipodal end, *A. E.* The periblem cells and cells *x* and *y* degenerating.

Fig. 16. The embryo-sac with a central vacuole, *v*, and an apical (micropylar) nucleus, *a. n.*, and a basal (antipodal) nucleus, *b. n.*

Fig. $17^{a-c}$. The vacuole enlarges, and the apical cell of the embryo-sac becomes cut off from the lower one by a distinct membrane, *m.*

Fig. 18. Embryo-sac consisting of a micropylar cell, *M. C.*, and an

antipodal cell, *A. C.*, which are separated from one another, by a plate, *Pl.*, showing on focussing an anterior, *a*, and a posterior, *p*, margin.

Fig. 19. Ditto; the antipodal cell, *A. C.*, shows a vacuole, *v.*

Fig. 20. The antipodal cell, *A. C.*, precedes its sister-cell, *M. C.*, in division as proved by the more advanced karyokinesis.

Fig. 21. The micropylar portion of the embryo-sac *M. C.*, with two nuclei, separated from the lower antipodal portion, *A. C.*, by a plate, *Pl.*

Fig. 22. Ditto. The membrane $m^1$ is formed before the membrane $m^2$.

Fig. 23. Ditto. Several hyaline bodies, *H. B.*, in the micropylar cell, *M. C.* The two nuclei of the antipodal cell separated by a vacuole, *v.*

Fig. 24. Young embryo-sac giving rise to the typical number of eight nuclei—two will form the synergidæ, *syn.;* two the ovum, *ov.*+apical primordial cell, *a. p.;* two the antipodes, *ant.;* two the third antipode and antipodal primordial cell, *ant.*+*p.* *V.*, The central vacuole.

Fig. $25^a$. Embryo-sac with two synergidæ, *syn.*, one ovum, *ov.*, and micropylar primordial cell, *m. p. c.*, in its apical portion, *m.;* three antipodes, 3 *ant.*, and an antipodal primordial cell in its basal portion, *a.; i–i*, septum between the two basal antipodal cells and the third antipodal cell+the primordial cell. *V.*, vacuole.

Fig. $25^b$. Ditto. *Peribl.*=periblem cells derived from the non-physiological archesporia, and cap, *cap*, derived from the non-physiological embryo-sacs. *deg.* c.=degenerating periblem cells. *P*, level at which wall of vacuole is without a covering of plasm. *M. N.*, nucleus of micropylar primordial cell. *a. p. c.*=antipodal primordial cell.

Figs. $26^{a-b}$, $27^{a-b}$. Same lettering. Showing the amœboid processes sent out by the two primordial cells, *Pl.* Fig. $27^a$, *l.*, separation of antipodal cell from the nucellar cells.

Fig. 28. Later stage, with vacuolation of synergidæ and ovum, and fusion of the protoplasm of the two primordial cells.

Fig. $29^{a-c}$ and fig. 30 represent the gradual approach of the nucleus of the antipodal primordial cell, *A. N.*, for purposes of fusion with the micropylar nucleus, *M. N.*

Fig. 31. Mature embryo-sac with a fully formed primary endosperm nucleus, *p. e. n.*, occupying the centre of the endosperm cell, *E. C.*

Figs. 32–45. Various stages in the formation of the primary endosperm nucleus. The following lettering holds good for all figures: *M. N.*, micropylar nucleus; *A. N.*, antipodal nucleus; nuclear membrane, *n. m.;* peripheral chromatin elements, *chr.*; dark nuclear substance, *1*; pale perinucleolar area, *2*; nucleolus, *n. ll.*; endonucleolus, *end.*; paranucleoli, *p. n.*; degenerated paranucleoli, *m* ?

Fig. 33. Two nuclei have met obliquely, but are as yet separated from one another by the nuclear membrane which forms a septum, *s*.

Fig. 34. The two perinucleolar areas have approached one another at "*f*."

Fig. 35. The perinucleolar areas have fused, *2*. Two paranucleoli lying in close contact, probably about to fuse, *p.* ?

Fig. $36^{a-b}$. The nucleolar membranes are touching, and then the two nucleoli fusing. [Lower half of fig. $36^{b}$ has simply been sketched.]

Fig. 37. A nucleolus with kidney-shaped endonucleoli.

In Figs. 37–43 the nucleolar membrane of the antipodal nucleolus is seen as an empty bag, *n. b.*

In Fig. 38, two bodies, the nature of which is questionable, are shown, *x* and *y*. *x* = perhaps a vacuole.

Fig. 39. A pale streak, *k*, running from the nucleolus towards the directing bodies, *dir. bod.* ?

Figs. 40, 41. Several questionable bodies ? and *dr. b.*

Fig. $40^{b}$ is a nucleolus containing a series of endonucleoli arranged as the beads of a rosary.

Fig. $42^{b}$ represents a nucleolus, with a nucleolar membrane, *1*; a peripheral densely-stained portion, *2*; a corona of small endonucleoli, *3*; a larger endonucleolus, *5*, lying above, *i.e.*, outside the central endonucleolus.

Fig. $43^{b}$. A nucleolus with a nucleolar membrane, *n. l. m.*, radiating fibrils, *r. f.* in a peripheral paler zone of the nucleolus; four comparatively large endonucleoli, *x.*; a set of proximal or coronal endonucleoli, *prox. end.*, and a fold, *fold*, around the central endonucleolus, *c. end.*

Fig. $44^{b}$. A diagrammatic representation of the various layers of a nucleolus: *1*, a nucleolar membrane; *2*, a peripheral set of small endonucleoli; *3*, an apparently homogeneous layer; *4*, the corona of small endonucleoli surrounding the large central endonucleolus, *5*.

Figs. 45–47 illustrate the conjugation of the two nuclei in *Scilla nutans*. We see a nuclear membrane, *n. m.*, with broad, *p. a*, and narrow, *p.* $\beta$, pores; peripheral chromosomes, $chr.^{1}$, and central ones, $chr.^{2}$; nuclear hyaloplasm, *n. h.*, with tubular fibrils, *n. f.*, and solid strands, $n. f.^{2}$.

The nucleolus fig. 45, 47, exhibits a nucleolar membrane, *n. m.* and *1*; a peripheral set of endonucleoli, fig. 45, *2*, 47, *p. n.*; a ground substance, *3*; endonucleoli, *4*; and radiating fibrils, fig. 45, *5*.

Fig. 47. The ground substance of the nucleolus exhibits a radial striation; peripheral, *p. e.*, and a central, *c. e.*, endonucleoli, &c.

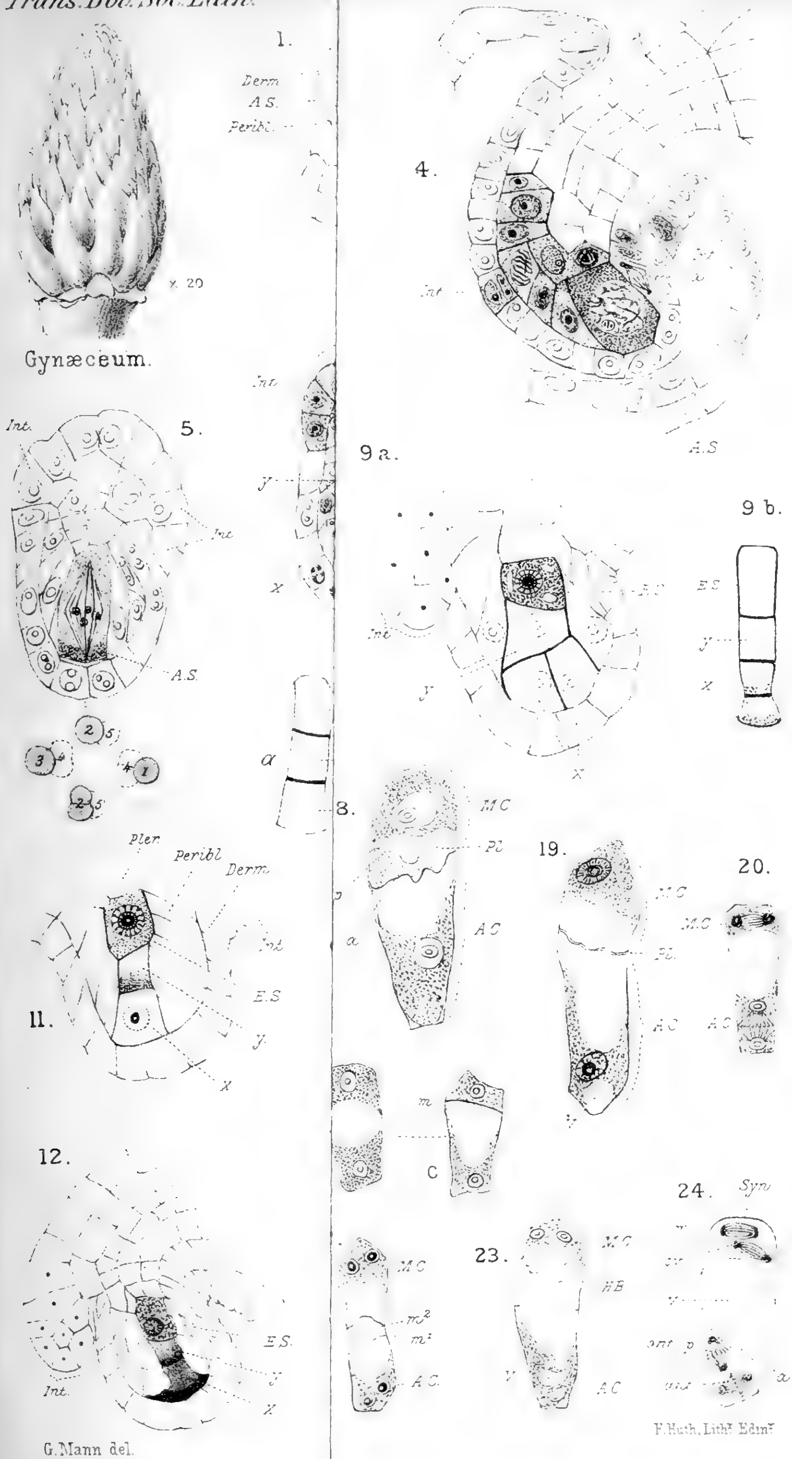
Fig. 48 is a diagrammatic representation of the achromatic elements of a normal cell. We find a cell membrane, *1;* a cell zone, *2;* a nuclear membrane, *3;* a nuclear zone, *4;* a nucleolar membrane, *5;* a nucleolar zone, *6*.

The dark lines indicate the endonucleolar network, consisting of the central endonucleolus—(*a*); the proximal or coronal set of small endonucleoli (*b*); the distal set of endonucleoli (*d*); in communication with "*a*" and "*b*" by the fibril·*c;* *e*, the pores in the nucleolar membrane; *f*, the nuclear framework giving off branches to the achromatic framework of the nuclear chromosomes, *chr.;* *g*, the pores in the nuclear membrane; *h*, endonucleolar fibrils permeating the cell substance and intercommunicating at *i;* *k*, the endonucleolar fibrils establishing the continuity of the plasm between neighbouring cells.

The dotted lines are meant to indicate the paranuclear achromatic substance in the centrosome, *l;* in the archoplasm, *m*, in the cell zone, *n;* in the nuclear zone, *o*, and in the nucleolar zone, *p*.

Fig. $49^{a-b}$. Cells as occasionally met with in the antipodal region of embryo-sac in *Scilla nutans*, suggesting that the true antipodal cells may undergo conjugation analogously to the two primordial cells forming the primary endosperm cell—*m. p. c.*, micropylar cell; *2 a. p. c.*, two antipodal cells; *p. n.*, paranucleolar body.

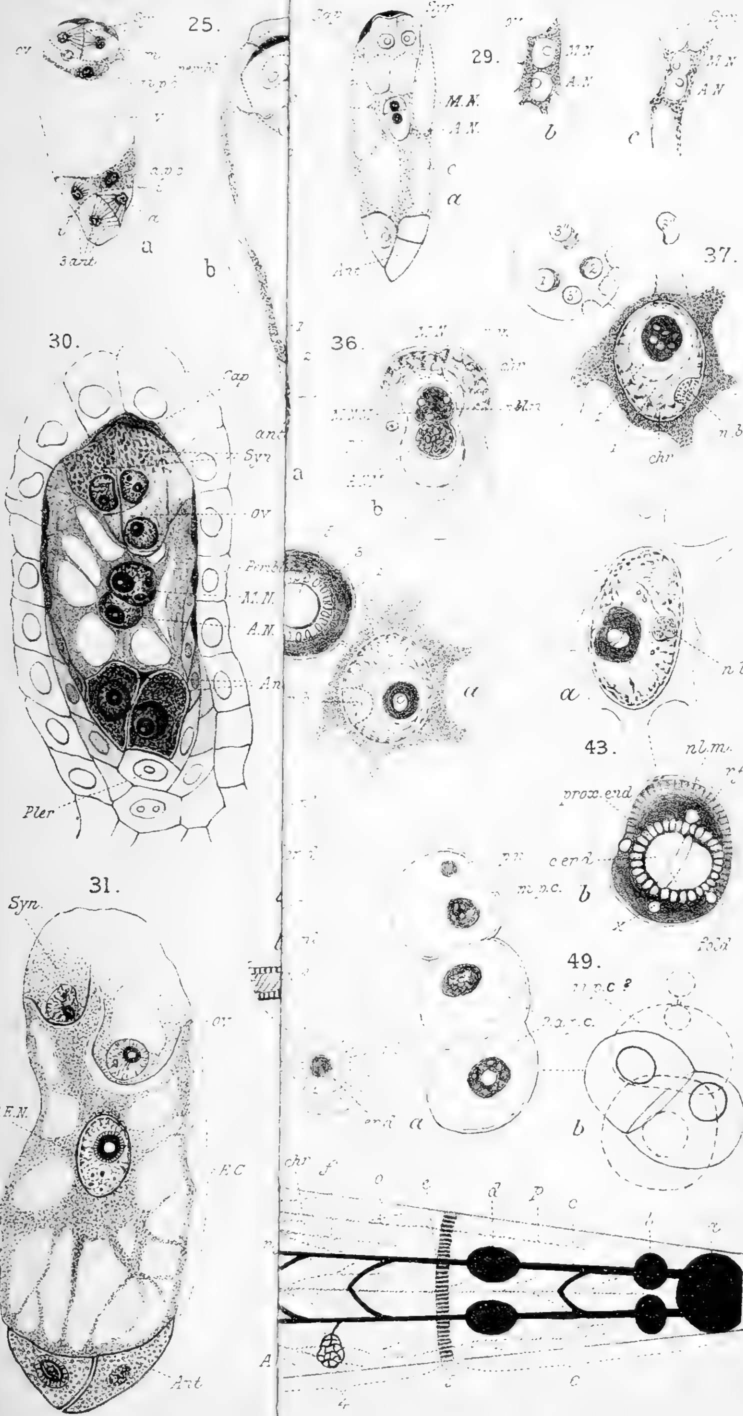
Fig. $50^{a-g}$. The mechanism of conjugation. The endonucleolar fibrils pulling the nuclei, *n*, the nucleoli, *nl.*, and ultimately the endonucleoli, *end.*, together, and then rearranging themselves round the newly-formed endonucleolus, *g, end.*




G. Mann del.

F. Huth, Lith^r Edin^r


MANN — ON THE EMBRYO-SAC OF MYOSURUS MINIMUS

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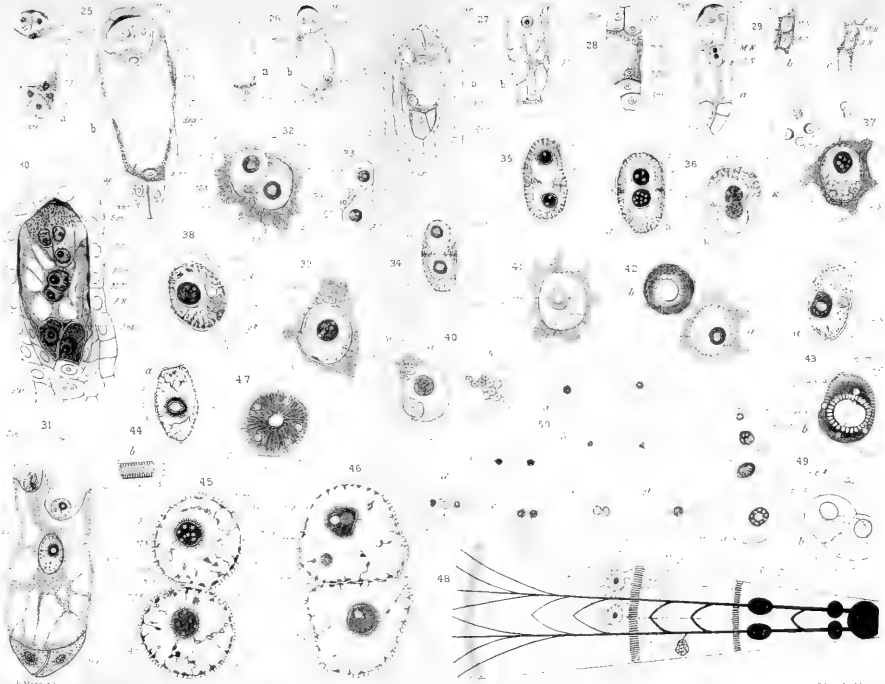

G. Mann del.

MANN — ON THE EMBRYO-SAC OF MYOSURUS MINIMUS.

Botanical Society of Edinburgh

## MEETING OF THE SOCIETY,

Thursday, May 12, 1892.

Dr David Christison, President, in the Chair.

The death of Dr Edouard von Regel, Honorary Foreign Fellow of the Society, was announced.

Presents to the Library, Museum, and Herbarium at the Royal Botanic Garden were announced.

Amongst the presents to the Library was a copy of the "Annual Report of the Agricultural Research Association for 1891," presented by Mr Jamieson, F.I.C., Lecturer on Agriculture in the University of Aberdeen, in which is published the paper "On Root-hairs," read before the Society at its meeting in November 1891 (see page 202).

Professor Bayley Balfour announced that Dr George Watt, C.I.E., Reporter on Economic Products to the Government of India, who is at present in this country for the purpose of completing the "Dictionary of Economic Products of India," now in course of publication under the auspices of the Indian Government, had offered, and the offer has been accepted by H.M. Board of Works, to present to the Royal Botanic Garden, when he returns to India towards the end of 1893, his private Herbarium. "It is comprised in 22 cabinets, weighs 6 tons, is all mounted, named and arranged according to Bentham and Hooker's "Genera Plantarum," and Hooker's "Flora of British India," and represents sixteen years' botanical work conducted over the greater part of India." One feature of it is the large representation of the cultivated and economic plants of India, which Dr Watt hopes "may not only prove of interest to merchants who may have dealings with India, but afford to students of Botany a field for useful investigation into the origin of cultivated plants." The gift is still further enhanced by Dr Watt's promise to add to it from the additional collections he hopes to make on his return to India.



Issued December 1892.

Lieut.-Col. BAILEY remarked upon the extreme value of this gift.

On the motion of the President, the Society recorded its appreciation of Dr Watt's generosity.

Mr SANDERSON exhibited pot specimens of the following orchids in flower:—*Dendrobium Bensoniæ*, *Lælia harpophylla*, *Miltonia Warcewiczii*, *Odontoglossum Alexandræ*, good varieties, *O. nebulosum*, *Oncidium phymatochilum*; also cut blooms of several species of *Masdevallia*.

Mr NEILL FRASER exhibited specimens of selected improved seedling *Polyanthus*.

Mr BOND SPRAGUE exhibited specimens of "sea-balls" formed of the fibres of *Posidonia* collected at Antibes, where they occur in large numbers.

Professor BAYLEY BALFOUR pointed out the resemblance of these "sea-balls" to specimens of "lake-balls," which he showed from the Museum of the Royal Botanic Garden, composed of the needles of *Pinus*, and brought from Loch Tay; and also to similar balls of *Cladophora ægagrophila* brought from Uist.

Professor BAYLEY BALFOUR exhibited, from the Museum of the Royal Botanic Garden, models made by Deyrolle of Paris illustrating the various modes of grafting and budding; also some new models made by Deyrolle illustrating structure of root and other parts of plants.

The CURATOR exhibited, from the Royal Botanic Garden, the following pot plants in flower:—*Anemone Robinsoniana*, *Daphne rupestris*, *Erpetion reniforme*, *Gentiana verna*, *Iberis petræa*, *Narcissus Calathinus*, Oxlip (hose-in-hose), *Primula algida*, *P. ciliata purpurata*, *P. denticulata purpurea*, *P. intermedia*, *P. intricata*, *P. longiflora*, *P. reticulata*, *Ranunculus montanus*, *R. Traunfelnerii*, *Saxifraga aretioides*, *S. aretioides primulina*, *S. calyciflora*, *S. flagellaris*, *S. ponæ*, *S.* seedling (Mr Potts), *S. virginiensis*, *Darlingtonia californica*, *Cyrtanthus M'Kenii*, *Magnolia fuscata*, *Masdevallia leconto-glossa*, *Drosera auriculata*, *D. binata*, *D. dichotoma*, *D. filiformis*, *Sarracenia Drummondi*, *S. flava*, *Rhododendron lepidotum*, *Xanthosia rotundifolia*, and cut blooms of *Rhododendron Nuttalii.*

The following papers were read:—

On a Germinating Apparatus. By A. N. M'Alpine, B.Sc.

The author exhibited a germinating apparatus made by Mr Duncan M'Laren, Bread Street, Edinburgh, constructed as follows:—There is first a wooden frame 3 ft. long by 2 ft. broad, and 2½ ft. or 30 in. high, standing on four legs, and enclosed all round half-way down with wood; into this is fitted a trough or tank holding 22 galls. water, and fitted with a well in the centre, 12 inches in diameter and 3 inches in depth, with a copper bottom—while through the tank run six pipes or tubes, 1½ diameter, three from each end, and with two openings on each tube, one opening at end of tube and the other 8 inches from the end—both outlets above the water—and through these pipes the fresh cold air is admitted; but passing through the tubes lying in the hot water, the air is delivered at whatever temperature is desired. All round the upper edge of this tank runs a half-round rone, filled also with water, and in which the frame or top part of the germinator stands, and, being in water, is air-tight. The frame is straight up at each end, and slopes to 8 inches at the top, and is surmounted with a piece of perforated zinc, in the form of a door, through which the seeds are put in and taken out. The sides of this frame are fitted with glass, so that anyone can see what is going on inside without opening the case. A grating lies on the top of the tank, above the open water and air outlets, and this grating is covered with felt, on which the seeds, on strips of blotting-paper, are laid. Into the side of the well, at the bottom of the tank, is fitted a stop-cock, with a tube-filler, so that you can keep the tank filled with water without disturbing the seed, or to empty the tank if required; and underneath this well is fitted a Bunsen, of peculiar construction, with a No. 0 Cockspur Jet, the smallest jet made—yet, this small burner is sufficient to keep the 22 galls. water steady at 70° Fahr., at less than 1d. per week.

The whole apparatus can be taken to pieces or put together in two minutes, and locked with lock and key that no one but those in possession of the key can get access.

He claimed that the conditions for germination in the apparatus are very perfect, and closely approach those that may be obtained in the open field. Whilst the seeds are kept moist and at a uniform temperature, the circulation of warmed fresh air prevents the growth of fungi, a most important matter for good germination; and by the arrangement of the air-pipes the entrance of the acetylene produced by the combustion of the coal-gas, which plays havoc with the germination, is prevented.

Mr ALEXANDER MACKENZIE asked whether the results obtained in this germinator had been compared with those in actual practice. It appeared to him that the percentage of seeds that would germinate under such nicely-adjusted conditions would be largely in excess of that under natural conditions.

Mr M'ALPINE pointed out that germination of the seed was a different thing from development of a seedling plant, and that whilst a number of seeds would show in his apparatus incipient germination, proving their vitality, all of them would not produce ultimately plants.

Mr JAMES GRIEVE remarked that in his experience, seeds sown in pots of finely-prepared soil in a temperature of 60° to 70° give a more correct return than those sown on bricks, wet cloths, &c. He also pointed out that the time of gathering and time of sowing affect the germination. Seeds of clover, *Daphne*, and other plants, if very ripe when harvested, take longer to germinate than if gathered before they are hard and dry. *Daphne Mezereum*, red-berried variety, gathered before the berries become red will braird in spring, but if left till ripe and red, will remain in the ground for two years. White mezereon has white berries, and shows the same features. Trials sown in November, December, and January do not give such a good return as those sown later, which in the good clear days vegetate quicker and give a larger percentage in germination.

Note on the occurrence of Tannin in Dacrydium cupressinum, Soland., and Dacrydium Franklinii, Hook. fil. By James Adam Terras, B.Sc.

In both species the phloem-elements of the stem are, as in most of the Taxineæ, arranged in a comparatively regular manner, and the general structure will be most easily understood if we conceive of the whole phloem as composed of concentric hollow cylinders fitting closely outside one another. These are alternately thin and thick; the former are, as a rule, one cell thick, but in places two cells in thickness, and are seldom complete. The latter, on the other hand, contain from six to eight cells in each radial row. Both series of cylinders are traversed at right angles by numerous medullary rays which vary in height from two to six cells and in length according to their age.

The thinner cylinders are composed of tannin-sacs, and these in *Dacrydium Franklinii* lie above one another in small spindle-shaped groups of from seven to nine cells. The central cells of each group are roughly cylindrical, while the terminal ones are somewhat wedge-shaped with the edge directed radially; the whole having the appearance of being derived from a single cambial cell by transverse partition.

The tangential walls of these cells are equally thickened all over, and contain minute crystals of oxalate of lime in considerable quantities; while the radial and transverse walls show irregular cribriform markings with calcium-oxalate crystals in the thickened portions. Each cell is lined with a thin layer of protoplasm, imbedded in which is a nucleus lying usually on one of the lateral walls, but the remainder of the cavity is occupied by tannin.

In the thicker hollow cylinders alternating with those just described, the elements are arranged in distinct radial rows composed of fibres, sieve-tubes, and cells. Each row usually contains from one to four fibres, alternating with which, and in most cases terminating the row, are the sieve-tubes. At intervals where, if this alternating arrangement were strictly carried out, one would expect to find a fibre, we have instead a group of cells similar to a tannin-sac group but containing only protoplasm. Similar elements in neighbouring rows do not in most cases correspond in position so as to form concentric circles, but rather alternate with each other.

The fibres are rectangular in cross section with the longer diameter directed tangentially, and about twice the length of the radial diameter; the tangential walls are concave outwards, while the radial walls are convex,—both are considerably thickened and provided with somewhat wide pits.

The sieve-tubes are also rectangular in cross section and of the same tangential dimension as the fibres, but are much compressed in a radial direction. They are provided with a single row of distinct circular or elliptical sieve-plates on their radial walls.

In *Dacrydium cupressinum* the arrangement of the phloem in alternate cylinders is scarcely recognisable, and the tannin-sacs form tangential groups of four to ten cells rather than concentric cylinders extending round the stem.

The structure of the individual tannin-sacs is also quite different from that seen in *D. Franklinii.* They do not form vertical groups as in that species, but each group is represented by a single large spindle-shaped cell which is much swollen, and consequently very irregular in outline. Generally the radial walls by which the neighbouring cells press against one another are flat, while the tangential walls are convex outwards. At those points where the tannin-sacs are crossed by medullary rays they are considerably constricted in both lateral dimensions, and not unfrequently they send out along the course of the rays, generally towards the centre of the stem, long blind diverticula which end in more or less sharp points. The tangential walls are slightly and equally thickened all over, as are also the walls of the radially directed diverticula, and both contain large numbers of minute crystals of calcium-oxalate. The radial walls, on the other hand, are crossed at intervals by transverse bands of thickening matter which, wider at the margin than at the centre, leave large circular or broadly elliptical interspaces on which no thickening has taken place. These cells, at least in the adult state, contain neither nucleus nor protoplasm, but are completely filled with tannin.

Besides them the phloem contains other elements, viz., cells, sieve-tubes, and fibres.

The first of these are very numerous, and form, as in *D. Franklinii,* vertical spindle-shaped groups of from six to nine members which are circular in cross section, except that the radial walls are somewhat flattened where neighbouring similar elements come in contact with each other. This flattened area is provided with a single series of large circular or elliptical areas, where no thickening matter has been deposited, otherwise the cell-wall is equally, if but slightly, thickened all over. The wall is lined by a thin layer of tannin-containing substance which has imbedded in it a nucleus, and on its inner side bears numerous mammilliform projections which stand out into the empty interior of the cell. These elements are disposed somewhat irregularly, but in a general way they form separate tangential plates one cell thick, and composed of from two to eight groups of cells applied to each other by their radial walls. Each tangential face is usually in contact with a sieve-tube, which appears in cross section to be more or less meniscus with the concave side next the cell, and the opposite convex side applied to one of the tangential walls of a fibre. In this species there are no cells containing only protoplasm, at least in the phloem of an old stem if one excepts those of the medullary rays.

The sieve-tubes and fibres are similar to those found in *D. Franklinii,* but the latter are much less numerous.

In both species tannin also occurs in considerable amount in ordinary parenchyma-cells of the pith and cortex, but not in all of them. *Dacrydium cupressinum* has, moreover, a number of tannin-sacs in the xylem-cylinder. These are thin-walled elements which differ from the surrounding tracheids only by the absence of thickening layers on the walls and the presence of contents.

The substance which I have so far alluded to merely as tannin probably contains several other ingredients. As it exudes from a cut surface of *D. cupressinum,* it is a watery liquid of a pale yellow colour, which on drying leaves only a thin varnish-like residue. It is so extremely fluid that, as soon as a cell containing it is injured in the process of section-cutting, it escapes, leaving the cell quite empty;

consequently observations cannot be carried on with fresh material, and that preserved in alcohol is equally useless since the tannin is completely dissolved by it. If, however, pieces of bark are allowed to lie in a strong aqueous solution of ferric chloride for some days, the contents of the tannin-sacs become solid, and at the same time assume the well-known blue-black colour of tannate of iron.

Without entering into the chemistry of the subject, it seems to me that we have here to do with either a mixture or a compound of tannic acid and albumen, or some allied substance. The following reactions will, I think, make this clear:—

Ferric chloride coagulates the whole contents of the sacs, causing them to shrink slightly in the process, and at the same time colours them blue-black.

Potassium dichromate has a similar reaction, except that the colour is in this case red-brown.

Mercuric chloride has the same coagulating effect, but, of course, no colour reaction.

Dilute nitric acid acts in the same way as mercuric chloride.

Nessler's reagent does not coagulate the cell contents, but produces in the cells a yellow precipitate due to the tannic acid.

Ammonium molybdate dissolved in a solution of ammonium chloride gives in the same way an orange precipitate.

These various substances were applied simply by allowing pieces of bark to soak in their aqueous solutions for several days, then sectioning and examining microscopically.

## NOTE ON BARNADESIA ROSEA. By JOHN H. WILSON, D.Sc.

On Temperature and Vegetation in the Botanic Garden, Glasgow, during April 1892. By Robert Bullen, Curator of the Garden.

Another unusually cold, wintry month falls to be recorded. Frost was registered on ten mornings, the total readings for the month being 56°; but frequently the temperature was at or little above the freezing point, probably owing to the distant hills being heavily clad with snow, which fell frequently, and heavily so, on a few days about the middle of the month. Apart from the snow, the rainfall was very light. Vegetation is in a backward state: the hardiest kinds of herbaceous plants, and the earliest leafing deciduous trees, were equally backward with more tender subjects. An old plant of *Cydonia japonica*, which I have had occasion to note in former years as being in bloom in Januaiy and February, is only in bloom at the end of this month.

On Temperature and Vegetation in the Royal Botanic Garden, Edinburgh, during April 1892. By Robert Lindsay, Curator of the Garden.

The month of April was, for the most part, excessively cold and dry. Vegetation, in consequence, is in a very backward condition, hardy spring flowers are late, and many of them injured by frost. Most forest trees were still in their winter condition at the close of the month.

The thermometer was at or below the freezing point on eleven occasions, the total amount of frost registered for the month was 72° as against 56° for April 1891. The lowest readings were on the mornings of the 14th, 22°; 15th, 21°; 16th, 23°; 17th, 22°; 18th, 23°. The total amount of frost registered this season up to the end of April is 620° as against 611° for the same period last year. The following is the distribution for each month:—October, 20° of frost; November, 41°; December, 83°; January, 136°; February, 112°; March, 156°; April, 72°. The lowest point reached this season was 7° Fahr., or 25° of frost, which occurred on the 19th February last.

On the rock-garden 119 species and varieties came into flower during the month, the same number as for last April. Among the more interesting were *Andromeda fastigiata*, *Arnebia echioides*, *Draba aizoides*, *Dentaria enneaphylla*, *D. pentaphylla*, *Epigæa repens*, *Erythronium giganteum*, *Pachystima Canbyi*, *Petrocallis pyrenaica*, *Primula cashmiriana*, *P. rosea*, *Ranunculus montanus*, *Rhodothamnus chamæcistus*, *Salix Sadleri*, *Saxifraga Boydii*, *S. retusa*, *Trillium grandiflorum*, *Xanthorrhiza apiifolia*. Of the forty spring-flowering plants whose dates of flowering are annually recorded, the following came into flower:—*Draba aizoides* on April 3rd; *Omphalodes verna*, April 4th; *Adonis vernalis*, April 9th; *Aubrietia grandiflora*, April 9th; *Narcissus Pseudo-Narcissus*, April 11th; *Corydalis solida*, April 10th; *Hyoscyamus Scopolia*, April 20th; *Symphytum caucasicum*, April 25th.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during April 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 37° | 48° | 65° | 16th | 23° | 33° | 42° |
| 2nd | 27 | 55 | 70 | 17th | 22 | 24 | 52 |
| 3rd | 32 | 35 | 60 | 18th | 23 | 35 | 52 |
| 4th | 30 | 37 | 69 | 19th | 24 | 37 | 60 |
| 5th | 36 | 47 | 66 | 20th | 37 | 50 | 67 |
| 6th | 40 | 46 | 51 | 21st | 40 | 48 | 61 |
| 7th | 39 | 40 | 48 | 22nd | 37 | 50 | 60 |
| 8th | 37 | 38 | 48 | 23rd | 36 | 50 | 58 |
| 9th | 33 | 41 | 48 | 24th | 36 | 50 | 57 |
| 10th | 34 | 42 | 50 | 25th | 35 | 46 | 57 |
| 11th | 34 | 37 | 54 | 26th | 34 | 41 | 56 |
| 12th | 36 | 37 | 45 | 27th | 34 | 38 | 55 |
| 13th | 25 | 41 | 47 | 28th | 38 | 42 | 51 |
| 14th | 22 | 33 | 48 | 29th | 31 | 38 | 53 |
| 15th | 21 | 32 | 51 | 30th | 35 | 41 | 56 |

## REGISTER OF SPRING-FLOWERING PLANTS, SHOWING DATES OF FLOWERING, AT THE ROYAL BOTANIC GARDEN, EDINBURGH, DURING THE YEARS 1890, 1891, AND 1892.

| No. | Names of Plants. | First Flowers opened. | | |
|---|---|---|---|---|
| | | 1890. | 1891. | 1892. |
| 1 | Adonis vernalis, . . | April 2 | April 18 | April 9 |
| 2 | Arabis albida, . . | Feb. 1 | Feb. 17 | March 22 |
| 3 | Aubrietia grandiflora, . | April 9 | April 13 | April 9 |
| 4 | Bulbocodium vernum, . | Jan. 29 | Feb. 25 | Feb. 12 |
| 5 | Corydalis solida, . | March 20 | April 9 | April 10 |
| 6 | Corylus Avellana, . . | Jan. 15 | Feb. 6 | Feb. 12 |
| 7 | Crocus susianus, . . | Jan. 26 | Feb. 7 | Feb. 12 |
| 8 | ,, vernus, . . | Jan. 30 | Feb. 18 | Feb. 24 |
| 9 | Daphne Mezereum, . . | Jan. 24 | Feb. 17 | Feb. 24 |
| 10 | Dondia Epipactis, . . | Jan. 6 | Jan. 30 | Feb. 10 |
| 11 | Draba aizoides, . . | March 9 | April 13 | April 3 |
| 12 | Eranthis hyemalis, . . | Jan. 15 | Feb. 11 | Feb. 6 |
| 13 | Erythronium Dens-canis, . | March 10 | April 6 | March 23 |
| 14 | Fritillaria imperialis, . | April 10 | May 3 | . |
| 15 | Galanthus nivalis, . . | Jan. 13 | Jan. 31 | Feb. 2 |
| 16 | ,, plicatus, . . | Jan. 17 | Jan. 30 | Jan. 26 |
| 17 | Hyoscyamus Scopolia, . | March 23 | April 10 | April 20 |
| 18 | Iris reticulata, . . | Feb. 16 | March 6 | March 17 |
| 19 | Leucojum vernum, . . | Jan. 16 | Feb. 7 | Feb. 9 |
| 20 | Mandragora officinalis, . | Feb. 18 | March 14 | March 24 |
| 21 | Narcissus Pseudo-Narcissus, | March 15 | April 13 | April 11 |
| 22 | ,, pumilus, . . | March 8 | March 19 | March 27 |
| 23 | Nordmannia cordifolia, . | Feb. 2 | Feb. 19 | March 20 |
| 24 | Omphalodes verna, . . | March 11 | April 20 | April 4 |
| 25 | Orobus vernus, . . | March 9 | March 29 | March 30 |
| 26 | Rhododendron atrovirens, . | Jan. 18 | Jan. 21 | Feb. 10 |
| 27 | ,, Nobleanum, | Jan. 20 | March 1 | March 30 |
| 28 | Ribes sanguineum, . . | March 22 | March 31 | March 31 |
| 29 | Scilla bifolia, . . | Feb. 15 | March 3 | March 19 |
| 30 | ,, ,, alba, . . | Feb. 28 | March 14 | March 20 |
| 31 | ,, præcox, . . | Jan. 6 | Feb. 8 | Feb. 12 |
| 32 | ,, sibirica, . . | Jan. 7 | Feb. 12 | Feb. 12 |
| 33 | ,, taurica, . . | March 5 | March 5 | March 22 |
| 34 | Sisyrinchium grandiflorum, | Jan. 31 | March 23 | March 23 |
| 35 | ,, album, | Feb. 4 | March 28 | March 23 |
| 36 | Symphytum caucasicum, . | Feb. 1 | April 20 | April 25 |
| 37 | Symplocarpus fœtidus, . | Jan. 31 | Feb. 12 | Feb. 23 |
| 38 | Tussilago alba, . . | Jan. 19 | Feb. 10 | March 4 |
| 39 | ,, fragrans, . . | Dec. 12 1889 | Jan. 26 | Feb. 9 |
| 40 | ,, nivea, . . | Jan. 30 | Jan. 16 | March 2 |

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of April 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 ft. above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| 1 | 30·375 | 58°·6 | 40°·0 | 53°·3 | 44°·5 | W. | Cir. | 2 | W. | 0·000 |
| 2 | 30·332 | 62·8 | 31·6 | 53·0 | 45·0 | W. | ... | 0 | ... | 0·000 |
| 3 | 30·189 | 66·8 | 34·9 | 50·8 | 44·8 | Calm. | ... | 0 | ... | 0·000 |
| 4 | 29·836 | 57·8 | 31·2 | 41·2 | 40·8 | Var. | ... | 0 | ... | 0·000 |
| 5 | 29·840 | 62·8 | 38·4 | 48·0 | 46·4 | S.W. | Nim. | 10 | S.W. | 0·000 |
| 6 | 29·956 | 59·0 | 43·5 | 48·0 | 46·4 | N.E. | St. | 10 | N.E. | 0·000 |
| 7 | 30·022 | 48·2 | 40·8 | 41·7 | 41·0 | E.N.E. | Cum. | 10 | E.N.E. | 0·000 |
| 8 | 30·092 | 43·9 | 39·5 | 39·8 | 39·6 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 9 | 30·121 | 43·9 | 35·4 | 41·6 | 39·1 | E. | Cum. | 10 | E. | 0·000 |
| 10 | 30·056 | 47·1 | 35·8 | 41·8 | 39·8 | E. | Cum. | 9 | E. | 0·000 |
| 11 | 29·965 | 49·1 | 36·0 | 37·6 | 37·0 | N.E. | Cum. | 10 | N.E. | 0·010 |
| 12 | 29·977 | 50·3 | 37·0 | 39·8 | 37·8 | E. | Cum. | 10 | E. | 0·045 |
| 13 | 29·752 | 40·1 | 27·9 | 37·0 | 34·0 | N. | ... | 0 | ... | 0·100 |
| 14 | 29·672 | 42·9 | 25·1 | 35·1 | 31·3 | W. | ... | 0 | ... | 0·000 |
| 15 | 29·681 | 42·7 | 24·4 | 36·4 | 33·2 | W. | ... | 0 | ... | 0·000 |
| 16 | 29·622 | 44·6 | 27·8 | 36·0 | 34·0 | N.E. | Cum. | 4 | N.E. | 0·010 |
| 17 | 29·725 | 39·9 | 24·2 | 38·8 | 33·7 | N.W. | ... | 0 | ... | 0·070 |
| 18 | 29·965 | 47·1 | 25·8 | 39·2 | 35·8 | W. | ... | 0 | ... | 0·025 |
| 19 | 30·219 | 46·8 | 28·2 | 38·0 | 34·9 | N.W. | Cum. | 5 | N.W. | 0·010 |
| 20 | 30·030 | 56·2 | 37·1 | 54·6 | 49·6 | S.W. | Cum. | 5 | W. | 0·000 |
| 21 | 29·850 | 60·8 | 43·0 | 51·5 | 46·9 | W. | Cum. | 8 | W. | 0·010 |
| 22 | 29·925 | 56·7 | 45·4 | 54·0 | 48·6 | W. | Cum. | 2 | W. | 0·000 |
| 23 | 30·111 | 58·3 | 41·8 | 51·7 | 46·2 | W.S.W. | ... | 0 | ... | 0·000 |
| 24 | 30·110 | 56·3 | 38·5 | 50·3 | 44·0 | W. | Cum. | 5 | N.W. | 0·010 |
| 25 | 29·733 | 56·9 | 37·8 | 48·1 | 42·6 | W. | { Cir. / Cum. | 3 / 2 } | N.W. | 0·210 |
| 26 | 29·766 | 55·6 | 36·0 | 42·7 | 36·9 | N.W. | Cum. | 10 | N.W. | 0·170 |
| 27 | 29·399 | 49·4 | 34·7 | 39·9 | 38·9 | S. | Cum. | 10 | S.W. | 0·380 |
| 28 | 29·834 | 50·5 | 36·2 | 41·1 | 36·2 | N. | Cum. | 9 | N. | 0·005 |
| 29 | 29·939 | 48·0 | 33·3 | 40·5 | 35·9 | Calm. | Cum. | 6 | N. | 0·000 |
| 30 | 29·964 | 50·5 | 36·8 | 46·8 | 43·2 | W. | Cum. | 10 | W. | 0·000 |

Barometer.—Highest Reading, on the 1st, = 30·375. Lowest Reading, on the 27th, = 29·399. Difference, or Monthly Range, = 0·976. Mean = 29·935.

S. R. Thermometers.—Highest Reading, on the 3rd, = 66°·8. Lowest Reading, on the 17th, = 24°·2. Difference, or Monthly Range, = 42°·6. Mean of all the Highest = 51°·8. Mean of all the Lowest = 34°·9. Difference, or Mean Daily Range, = 16°·9. Mean Temperature of Month = 43°·4.

Hygrometer.—Mean of Dry Bulb = 43°·9. Mean of Wet Bulb = 40°·3.

Rainfall.—Number of days on which Rain or Snow fell = 13. Amount of Fall, in inches, = 1·055.

A. D. RICHARDSON,
*Observer.*

## MEETING OF THE SOCIETY,

Thursday, June 9, 1892.

DR WILLIAM CRAIG, Vice-President, in the Chair.

The CURATOR exhibited *Amorphophallus campanulatus*, *Masdevallia Harryana*, *Sandersonia aurantiaca*, *Olearia insignis*, *Anemone alpina*, *A. palmata*, *Anthericum liliastrum*, *Androsace lactea*, *A. foliosa*, *Geranium argenteum*, *Gentiana verna*, *Galtonia candicans*, *Exharrhena Lyallii*, *Hippocrepis helvetica*, *Houstonia cœrulea*, *Fritillaria kamtschatica*, *Oxytropis uralensis*, *Primula farinosa*, *Saxifraga longifolia*, *S. Macnabiana*, *S. lingulata* (seedling), *Scilla verna*, *Ramondia pyrenaica*, and var. *alba*, all in flower in the Royal Botanic Garden; also a curious composite raised from seed sent by Mr Kingsmill from Mexico, which has not yet flowered.

Mr WELLWOOD H. MAXWELL sent branches of *Pseudotsuga Douglasii*, var. *Stairii*.

Mr NEILL FRASER exhibited *Asplenium adulterinum*, Milde, a hybrid between *A. Trichomanes* and *A. viride*.

Professor BAYLEY BALFOUR exhibited, from the Museum, a stem of Ash presented by Professor Somerville showing well the burrows of *Hylesinus fraxini*; also a series of plants collected by Dr Julius John Wood in India, and paintings from nature of *Gloriosa superba* and *Poinciana regia* by the same gentleman.

Dr CRAIG exhibited, on behalf of Mr Ivison Macadam, a specimen of the flower stems of *Fritillaria meleagris* showing two flowers on each stem.

Professor BAYLEY BALFOUR exhibited seedlings of British species of *Plantago*. *Plantago arenaria*, *P. Coronopus*, *P. lanceolata*, and *P. maritima* form one group; *Plantago major*

Issued December 1892.

and *P. media* form another. In the first group the cotyledons are linear, in the second oval. There are various minor differences between the seedlings in each of the two groups as regards length of hypocotyl, of cotyledon hairiness, and so forth; but one remarkable point in the habit of the members of the first group is that the tip of the cotyledons, especially in the species in which the cotyledon is long, *e.g.*, *P. arenaria*, curl downwards, and may clasp an adjacent object, thus performing the function of a support to the seedling. The curling may continue to so great an extent that the tip completely surrounds the object with which it is in contact. *P. lanceolata* has cotyledons as long as those of *P. arenaria*, but not curling to such an extent. The cotyledons in *P. maritima* are shorter, but curl as much as those in *P. lanceolata*. *P. Coronopus* has cotyledons shorter than those of the other three in the group, and they do not curl so much.

The following paper was read :—

NOTE OF EXPERIMENTS IN THE DEAN FOREST, GLOUCESTERSHIRE, TO SHOW THE EFFECT UPON THE GROWTH OF OAK TREES —(1) OF TRANSPLANTING THEM, AND (2) OF LIFTING THEM AND REPLACING THEM IN THE SAME HOLES. By LIEUT.-COLONEL BAILEY, R.E.

The facts submitted to the meeting were given to me by Sir James Campbell, Bart., by whom the experiments have been carried out for the past 38 years. The first of them was undertaken by one of his predecessors in 1784, and the second was begun by himself in 1861.

The former was intended to show the effect upon the growth of oak-trees, of "(*a*) transplanting them at a tolerably early age; (*b*) treating them in this way at a more advanced period; and (*c*) leaving them in the original seed-bed or nursery." In pursuance of this object, a number of young trees, 16 years old, were transplanted in the year 1800; and a number of others, then 25 years old, were transplanted in 1807. Girth-measurements of these, and of certain other marked trees left standing in the nursery, were commenced in 1809, and have been continued every second year. The last measurements were made in October 1890, when the trees were 106 years old. Six of the marked trees were unfortunately cut down, but the results of the experiment, as shown by the measurements of the eight surviving trees, are very remarkable; they are as follows:—The average girth of two trees transplanted at 16 years of age was 89 inches; that of three trees transplanted at 23 years of age was 88 inches; but the average girth of three trees left in the nursery was only 58¼ inches. It will be observed that when the measurements were first recorded, the average girth of the transplanted trees was considerably less than that of the trees which were left, and which have now been so far distanced by them. It is possible that the latter had not so much room and light as the former, and it is probable that this was the case for some years at any rate; but the record is one of great interest. Sir James Campbell observes that "at this rate of progression it is not too much to expect that transplanted oak-trees will come to maturity 50 years sooner than non-transplanted trees."

These results led him, in 1861, to undertake a second experiment "to test the value, if any, of merely lifting the trees and replanting them in the same holes without change of soil or situation, and without giving increased space." In 1861, the aggregate girth of six *lifted* trees was less by 2½ inches than that of six untouched trees; but, in 1886, the former had equalled the latter, and in 1892 had surpassed them by 5⅞ inches. Should the increased rate of growth of the lifted trees be maintained, the experiment will prove a most noteworthy one. I understood Sir James Campbell to say that the cost of lifting the trees, which, in 1861, were 25 years old, was not more than threepence each.

In connection with this question, I may mention the difficulty I have experienced in taking accurate girth-measurements of any but young trees with smooth bark; for where the bark is rough, and in process of scaling off, there is not only a liability to actual change of girth, due to the expansion or the falling off of bark-scales, but it is exceedingly difficult, when measuring over the rough surface, to arrive at exactly the same figure twice in succession, even if one measurement be made immediately after the other.

If the interval between two periodical measurements be long, so that the growth in the interval has been considerable, there is not so much likelihood of obtaining an unreliable record; but such measurements cannot be relied on to determine small increments.

ON TEMPERATURE AND VEGETATION IN THE BOTANIC GARDEN, GLASGOW, during MAY 1892. By ROBERT BULLEN, Curator of the Garden.

No frost was registered here during the month, but on several nights the temperature was near the freezing point. The first twelve days of the month were very dry; the sun thermometer on most days registered from 70° to 83°.

On and after the 13th very variable weather was experienced, with frequent and often heavy rain, which was much needed, vegetation at the time being in a starved and backward state. From this time what is commonly known as good growing weather prevailed to the end of the month, and all hardy plants made rapid growth, but still the season is a late one. As these lines are being written (June 6) I notice the common Ash is only developing its leaf-buds.

Late sown seeds of Californian and other annuals have had the advantage of those sown three weeks earlier, owing to the dry days and cold nights of early May.

ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, EDINBURGH, during MAY 1892. BY ROBERT LINDSAY, Curator of the Garden.

The past month of May has been on the whole very favourable. During the latter portion of the month an abundant supply of rain fell; this being succeeded by warm genial weather, vegetation advanced at a rapid rate. The foliage of deciduous trees came rapidly forward, and towards the end of the month was remarkably fine and luxuriant.

The flowering of the ordinary ornamental trees and shrubs is far above the average this season in wealth of blossom. Horse-chestnut, various species of *Pyrus* and *Prunus*, Lilac, *Rhododendron*, and *Azalea* presented a very rich appearance; Hawthorn and Laburnum are well covered with flower buds, and promise to be very fine. Hollies also show abundance of flower this season.

During the month the thermometer was at or below the freezing point on two occasions, indicating 4° of frost. The lowest readings were on the 1st, 32°; 2nd, 28°; 10th, 33°; 12th, 33°; 21st, 33°. The lowest day temperature was 51° on the 4th, and the highest 78° on the 31st.

On the rock-garden 282 species and varieties came into flower during May as against 260 for the corresponding month last year. Among the most interesting were:—*Aciphylla squarrosa, Adonis pyrenaica, Anemone alpina, A. sulphurea, A. baikalensis, A. polyanthes, Androsace lactea, A. sarmentosa, Aquilegia Stuarti, Aubrietia croatica, A. Leichtlini, Azalea procumbens, Bryanthus erectus, Cornus canadensis, Cytisus decumbens, Campanula Allioni, Daphne cneorum, Dianthus glacialis, Dodecatheon integrifolium, D. splendens, Dryas Drummondi, Enkianthus himalayensis, Edraianthus serpyllifolius, Heuchera sanguinea, Gentiana verna, Gypsophila cerastioides, Polemonium humile, P. reptans, Potentilla aurea, Pentstemon Menziesii, Onosma tauricum, Oxytropis campestris, Patrinia nudicaulis, Primula viscosa, P. Wareii, Saxifraga muscoides purpurea*, &c., &c.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during May 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 32° | 35° | 67° | 17th | 40° | 50° | 61° |
| 2nd | 28 | 50 | 58 | 18th | 36 | 45 | 60 |
| 3rd | 37 | 42 | 58 | 19th | 41 | 50 | 62 |
| 4th | 43 | 48 | 51 | 20th | 45 | 55 | 60 |
| 5th | 35 | 49 | 60 | 21st | 33 | 45 | 60 |
| 6th | 38 | 45 | 55 | 22nd | 35 | 47 | 56 |
| 7th | 36 | 44 | 59 | 23rd | 40 | 53 | 60 |
| 8th | 38 | 49 | 62 | 24th | 40 | 57 | 72 |
| 9th | 39 | 55 | 72 | 25th | 48 | 51 | 63 |
| 10th | 33 | 52 | 70 | 26th | 43 | 60 | 70 |
| 11th | 36 | 46 | 56 | 27th | 46 | 52 | 73 |
| 12th | 33 | 46 | 58 | 28th | 45 | 50 | 55 |
| 13th | 46 | 50 | 61 | 29th | 44 | 49 | 69 |
| 14th | 49 | 54 | 64 | 30th | 48 | 54 | 74 |
| 15th | 40 | 55 | 65 | 31st | 44 | 68 | 78 |
| 16th | 43 | 45 | 60 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of May 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| 1 | 29·866 | 52°·8 | 33°·8 | 51°·0 | 46°·1 | W. | Cum. | 5 | W. | 0·000 |
| 2 | 29·912 | 62·6 | 31·8 | 52·2 | 45·2 | S.E. | ... | 0 | ... | 0·000 |
| 3 | 29·979 | 54·8 | 40·2 | 44·0 | 40·8 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 4 | 29·990 | 50·0 | 41·0 | 42·9 | 39·0 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 5 | 29·987 | 48·7 | 37·1 | 48·0 | 44·0 | W. | Cum. | 5 | N.E. | 0·000 |
| 6 | 30·175 | 53·4 | 36·8 | 45·8 | 39·2 | N.E. | ... | 0 | ... | 0·000 |
| 7 | 29·921 | 53·8 | 39·8 | 50·5 | 44·8 | W. | Cum. | 5 | W. | 0·020 |
| 8 | 30·003 | 56·0 | 41·8 | 46·5 | 44·0 | Var. | Cum. | 9 | N.W. | 0·000 |
| 9 | 30·065 | 55·3 | 41·2 | 55·1 | 52·6 | W. | Cum. | 9 | W. | 0·000 |
| 10 | 30·175 | 65·3 | 36·7 | 51·1 | 48·0 | N. | ... | 0 | ... | 0·000 |
| 11 | 30·388 | 65·8 | 39·2 | 46·3 | 43·4 | E. | Cum. | 5 | S.E. | 0·000 |
| 12 | 30·390 | 50·2 | 36·9 | 48·1 | 45·3 | E.N.E. | Cum. | 5 | E.N.E. | 0·115 |
| 13 | 30·048 | 53·3 | 46·3 | 53·1 | 52·2 | S. | Nim. | 10 | S. | 0·195 |
| 14 | 29·753 | 59·6 | 52·0 | 56·9 | 51·9 | W. | Cum. | 1 | W. | 0·005 |
| 15 | 29·520 | 60·0 | 44·0 | 55·3 | 51·6 | W.S.W. | Cum. | 10 | W.S.W. | 0·040 |
| 16 | 29·267 | 60·8 | 44·5 | 49·1 | 48·0 | W. | Nim. | 10 | W. | 0·095 |
| 17 | 29·785 | 57·0 | 42·0 | 49·0 | 43·8 | N.E. | Cum. | 10 | W. | 0·045 |
| 18 | 29·810 | 55·9 | 39·0 | 45·9 | 44·9 | S.W. | Nim. | 10 | S.W. | 0·145 |
| 19 | 29·738 | 57·3 | 43·2 | 52·7 | 47·2 | W. | Cum. | 6 | W. | 0·135 |
| 20 | 29·497 | 58·5 | 48·9 | 54·8 | 50·2 | W. | Cum. | 10 | W. | 0·295 |
| 21 | 29·832 | 57·6 | 34·0 | 49·2 | 45·9 | W. | Cum. | 10 | W. | 0·025 |
| 22 | 29·889 | 55·0 | 38·0 | 46·5 | 42·0 | E. | Cum. | 10 | Var. | 0·500 |
| 23 | 29·639 | 54·0 | 42·4 | 54·0 | 53·0 | N.W. | Cum. | 9 | W.S.W. | 0·250 |
| 24 | 29·561 | 58·0 | 51·3 | 58·0 | 53·4 | S.W. | { Cir.<br>Cum. | 3<br>2 } | S.W. | 0·150 |
| 25 | 29·618 | 65·7 | 48·8 | 51·1 | 50·2 | S.S.W. | Cum. | 10 | S.S.W. | 0·210 |
| 26 | 29·739 | 62·6 | 47·1 | 58·2 | 54·3 | Var. | Cum. | 4 | S.W. | 0·335 |
| 27 | 29·654 | 64·6 | 47·1 | 57·7 | 56·6 | W.S.W. | Cum. | 7 | W.S.W. | 0·000 |
| 28 | 29·845 | 66·7 | 48·1 | 51·3 | 50·2 | E.N.E. | Cum. | 10 | E.N.E. | 0·010 |
| 29 | 29·588 | 56·8 | 47·0 | 56·8 | 52·6 | S.W. | Cum. | 9 | S.W. | 0·005 |
| 30 | 29·741 | 63·8 | 49·9 | 56·6 | 54·9 | S.W. | Cum. | 8 | S.W. | 0·010 |
| 31 | 29·715 | 68·8 | 51·3 | 65·2 | 59·8 | S. | Cum. | 9 | S.S.W. | 0·210 |

Barometer.—Highest Reading, on the 12th, =30·390. Lowest Reading, on the 16th, =29·267. Difference, or Monthly Range, =1·123. Mean=29·842.

S. R. Thermometers.—Highest Reading, on the 31st, =68°·8. Lowest Reading, on the 2nd, =31°·8. Difference, or Monthly Range, =37°·0. Mean of all the Highest=58°·2. Mean of all the Lowest=42°·6. Difference, or Mean Daily Range, =15°·6. Mean Temperature of Month=50°·4.

Hygrometer.—Mean of Dry Bulb=51°·7. Mean of Wet Bulb=48°·2.

Rainfall.—Number of Days on which Rain fell=20. Amount of Fall, in inches, =2·795.

A. D. RICHARDSON,
*Observer.*

## MEETING OF THE SOCIETY,

Thursday, July 14, 1892.

ROBERT LINDSAY, Vice-President, in the Chair.

DAVID HARVIE and JULIUS JOHN WOOD, M.B., were elected Resident Fellows of the Society.

The death of AUGUSTINO TODARO, Professor of Botany and Director of the Botanic Garden, Palermo, Corresponding Member of the Society, was announced.

Mr WILLIAM SANDERSON exhibited a large specimen of *Oncidium Wentworthianum.*

The CURATOR exhibited *Albuca* sp., Natal, *Brachycome Sinclairii, Erica cinerea atrosanguinea, Edraianthus dalmaticus, Disa grandiflora, Fuchsia triphylla, Goodyera pubescens, Myosotis alpestris* (Ben Lawers), *Pentapterygium rugosum, Polemonium pauciflorum, Primula Poissonii, Silene pusilla, Saxifraga cuscutæformis* in flower in the Royal Botanic Garden.

The following paper was read:—

ON RORIDULA DENTATA. By Professor BAYLEY BALFOUR.

ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, EDINBURGH, during JUNE 1892. By ROBERT LINDSAY, Curator of the Garden.

The past month has been rather cold and wet for June still it has well maintained its character of being the "leafy month." The main feature has been the rapid growth which took place during the month. Frost was registered on the morning of the 14th, a most unusual occurrence so late in the season. The lowest readings were on the 12th, 38°; 13th, 35°; 14th, 32°; 17th, 35°; 18th, 39°. The lowest day temperature was 54° on the 11th, and the highest 84° on the 9th. A severe gale of westerly wind occurred on the 2nd, and a thunderstorm on the 17th. The foliage of deciduous trees and shrubs is most luxuriant and perfect, the heavy rains having assisted in their development and in clearing them of insect pests. Hardy herbaceous plants of all kinds have grown well, and are flowering freely.

The rock-garden was most attractive during June from the large number of plants in flower; 330 species and varieties came into bloom for the month as against 359 for the corresponding month last year. Many of the species lasted a much longer time in flower than usual; the following were the most interesting:—*Anthyllis erinacea, Arum palæstinum, Aquilegia pyrenaica, Barbarea vulgaris fl. pl., Clintonia Andrewsiana, Campanula abietina, Cathcartia villosa, Celmisia spectabilis, Cypripedium parviflorum, Calochortus cœruleus, Delphinium nudicaule, Dianthus alpinus, D. cæsius, D. neglectus, Edraianthus pumiliorum, E. dalmaticum, Gentiana lutea, Lonicera pyrenaica, Linnæa borealis, Lithospermum Gastoni, L. graminifolium, Lilium Leichtlini, Mimulus Jeffreyanus, Morina betonicoides, Oxytropis uralensis, Ramondia pyrenaica alba, Ranunculus parnassifolius, R. bulbosus fl. pl., Saponaria cæspitosa, Swertia Hookerii, Veronica Bidwillii, V. amplexicaule, V. carnosula.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during June 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 51° | 59° | 79° | 16th | 43° | 56° | 65° |
| 2nd | 40 | 48 | 64 | 17th | 35 | 50 | 60 |
| 3rd | 42 | 55 | 60 | 18th | 39 | 46 | 62 |
| 4th | 49 | 55 | 67 | 19th | 43 | 50 | 59 |
| 5th | 47 | 49 | 65 | 20th | 40 | 45 | 59 |
| 6th | 43 | 55 | 69 | 21st | 41 | 50 | 67 |
| 7th | 50 | 68 | 78 | 22nd | 46 | 51 | 69 |
| 8th | 48 | 68 | 80 | 23rd | 47 | 50 | 65 |
| 9th | 47 | 70 | 84 | 24th | 41 | 59 | 67 |
| 10th | 45 | 47 | 56 | 25th | 47 | 58 | 65 |
| 11th | 41 | 44 | 54 | 26th | 51 | 59 | 77 |
| 12th | 38 | 55 | 59 | 27th | 51 | 63 | 69 |
| 13th | 35 | 50 | 61 | 28th | 46 | 60 | 68 |
| 14th | 32 | 49 | 68 | 29th | 47 | 60 | 68 |
| 15th | 44 | 66 | 72 | 30th | 41 | 59 | 71 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of June 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·485 | 70·8 | 51·8 | 65·8 | 55·2 | W.S.W. | Cir. / Cum. | 2 / 2 | S. / WSW. | 0·215 |
| 2 | 29·372 | 64·8 | 44·1 | 49·1 | 48·8 | E. | Nim. | 10 | S.E. | 0·070 |
| 3 | 29·501 | 60·0 | 44·0 | 50·7 | 46·8 | W.S.W. | Cum. | 10 | W.S.W. | 0·030 |
| 4 | 29·764 | 59·5 | 44·0 | 55·1 | 50·9 | W.S.W. | Cum. | 8 | W.S.W. | 0·315 |
| 5 | 29·543 | 62·3 | 49·4 | 50·2 | 50·0 | Calm. | Nim. | 10 | Calm. | 0·030 |
| 6 | 30·067 | 57·7 | 46·5 | 56·7 | 53·3 | W. | Cum. | 9 | W. | 0·000 |
| 7 | 30·256 | 68·5 | 53·5 | 68·2 | 62·9 | W. | Cum. | 7 | W. | 0·000 |
| 8 | 30·288 | 71·8 | 51·9 | 66·7 | 61·9 | W. | ... | 0 | ... | 0·000 |
| 9 | 30·191 | 74·4 | 51·9 | 70·7 | 63·1 | W. | ... | 0 | ... | 0·010 |
| 10 | 30·022 | 80·6 | 48·4 | 48·7 | 47·8 | E. | Nim. | 10 | E. | 0·355 |
| 11 | 29·816 | 51·8 | 44·3 | 45·2 | 43·8 | E. | Nim. | 10 | E. | 0·275 |
| 12 | 29·784 | 53·8 | 41·2 | 52·7 | 48·6 | W. | Cum. | 9 | W. | 0·245 |
| 13 | 30·077 | 56·8 | 36·8 | 49·0 | 43·9 | N.W. | Cum. | 9 | N. | 0·025 |
| 14 | 30·167 | 54·6 | 37·0 | 51·0 | 44·0 | N.E. | ... | 0 | ... | 0·000 |
| 15 | 29·951 | 61·4 | 47·1 | 58·4 | 52·0 | N.W. | Cir. / Cum. | 2 / 2 | N. / N.W. | 0·115 |
| 16 | 29·813 | 66·4 | 45·0 | 50·1 | 45·2 | E. | Cum. | 10 | N.W. | 0·005 |
| 17 | 29·784 | 57·0 | 38·1 | 49·4 | 45·5 | W. | Cum. | 9 | N.W. | 0·095 |
| 18 | 29·841 | 55·8 | 44·0 | 49·8 | 46·7 | N.W. | Cum. | 10 | N. | 0·180 |
| 19 | 29·759 | 56·9 | 43·1 | 53·8 | 48·6 | N. | Cum. | 9 | N. | 0·465 |
| 20 | 29·664 | 58·9 | 45·2 | 46·9 | 45·8 | E.N.E. | Cum. | 10 | E.N.E. | 0·020 |
| 21 | 29·811 | 55·8 | 43·9 | 54·1 | 48·8 | E.N.E. | ... | 0 | ... | 0·030 |
| 22 | 29·758 | 61·4 | 44·0 | 52·9 | 51·1 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 23 | 29·616 | 61·7 | 49·6 | 53·7 | 51·5 | N. | Cum. | 10 | N. | 0·010 |
| 24 | 29·794 | 60·7 | 45·1 | 57·2 | 54·2 | N.W. | Cum. | 8 | N.W. | 0·000 |
| 25 | 29·792 | 58·2 | 49·9 | 56·4 | 53·0 | S.E. | Cum. | 10 | S. | 0·310 |
| 26 | 29·675 | 60·4 | 54·9 | 57·6 | 55·1 | S.W. | Nim. | 10 | S.W. | 0·100 |
| 27 | 29·713 | 68·3 | 53·6 | 62·1 | 56·1 | W.S.W. | Cum. | 2 | W.S.W. | 0·000 |
| 28 | 30·076 | 66·2 | 47·6 | 59·1 | 53·8 | W. | Cum. | 1 | W. | 0·000 |
| 29 | 30·032 | 65·8 | 50·7 | 55·1 | 52·2 | E.N.E. | Cir. / Cum. | 5 / 1 | W. / E.N.E. | 0·000 |
| 30 | 30·093 | 62·4 | 44·0 | 59·7 | 54·9 | W. | Cum. | 5 | W. | 0·000 |

Barometer.—Highest Reading, on the 8th, =30·288. Lowest Reading, on the 2nd, =29·372. Difference, or Monthly Range, =0·916. Mean=29·850.

S. R. Thermometers.—Highest Reading, on the 10th, =80°·6. Lowest Reading, on the 13th, =36°·8. Difference, or Monthly Range, =43°·8. Mean of all the Highest=62°·2. Mean of all the Lowest=46°·4. Difference, or Mean Daily Range, =15°·8. Mean Temperature of Month=54°·3.

Hygrometer.—Mean of Dry Bulb=55°·2. Mean of Wet Bulb=51°·2.

Rainfall.—Number of Days on which Rain fell=20. Amount of Fall, in inches, =2·900.

A. D. RICHARDSON,
*Observer.*

On Temperature and Vegetation in the Botanic Garden, Glasgow, during June 1892. By Robert Bullen, Curator of the Garden.

No frost was registered here during the month, but the temperature was frequently very low and much below the average for June. Much wet weather was also experienced. The days recorded as fine only number one week, and of these only two (7th and 8th) were real summer days; the sun thermometer then registered 93° and 95° respectively.

As a result of the low mean temperature, nearly everything in the way of vegetation is backward, most hardy herbaceous plants were fully a fortnight behind their usual blooming season; and unless much warmer weather prevails shortly nearly all annuals, even the hardy sorts, must be a failure.

On the other hand, all hardy trees and shrubs, although late, have made vigorous growth.

# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH.

## SESSION LVII.

## MEETING OF THE SOCIETY,

Thursday, November 10, 1892.

Dr. David Christison, President, in the Chair.

The following Officers of the Society were elected for the Session 1892–93:—

### PRESIDENT.

David Christison, M.D., F.S.A. Scot.

### VICE-PRESIDENTS.

Hugh F. C. Cleghorn, M.D., LL.D., F.R.S.E., F.L.S.
George Bird.
William Craig, M.D., F.R.S.E., F.R.C.S.E.
William Sanderson.

### COUNCILLORS.

Thomas A. G. Balfour, M.D., F.R.S.E.
William Murray.
William B. Boyd, of Faldonside.
Malcolm Dunn.
John H. Wilson, D.Sc., F.R.S.E.
Rev. David Paul, M.A.
Symington Grieve.
Patrick Neill Fraser, F.R.S.E.
Professor F. O. Bower, D.Sc., F.R.SS. L. & E., F.L.S.
Robert Lindsay.



Issued November 1893.

*Honorary Secretary*—Professor Sir DOUGLAS MACLAGAN, M.D., LL.D., P.R.S.E.
*Honorary Curator*—The PROFESSOR OF BOTANY.
*Foreign Secretary*—ANDREW P. AITKEN, M.A., D.Sc., F.R.S.E.
*Treasurer*—RICHARD BROWN, C.A.
*Assistant Secretary*—JAMES ADAM TERRAS, B.Sc.
*Artist*—FRANCIS M. CAIRD, M.B., C.M.
*Auditor*—ROBERT C. MILLAR, C.A.

## LOCAL SECRETARIES.

*Aberdeen*—A. STEPHEN WILSON of North Kinmundy.
,, Professor J. W. H. TRAIL, M.A., M.D., F.L.S.
*Beckenham, Kent*—A. D. WEBSTER.
*Berwick*—FRANCIS M. NORMAN, R.N.
*Birmingham*—GEORGE A. PANTON, F.R.S.E., 73 Westfield Road.
*Bridge of Allan*—ALEXANDER PATERSON, M.D.
*Calcutta*—GEORGE KING, M.D., F.R S., Botanic Garden.
,, DAVID PRAIN, M.D., F.R.S.E., F.L.S., Botanic Garden.
*Cambridge*—CHARLES C. BABINGTON, M.A., F.R.S., Professor of Botany.
,, ARTHUR EVANS, M.A.
*Chirnside*—CHARLES STUART, M.D.
*Croydon*—A. BENNETT, F.L.S.
*Glasgow*—Professor F. O. BOWER, D.Sc., F.R.S., F.L.S.
*Kelso*—Rev. DAVID PAUL, M.A., Roxburgh Manse.
*Kilbarchan*—Rev. G. ALISON.
*Leicester*—JOHN ARCHIBALD, M.D., F.R.S.E.
*Lincoln*—GEORGE MAY LOWE, M.D., C.M.
*London*—WILLIAM CARRUTHERS, F.R.S., F.L.S., British Museum.
,, E. M. HOLMES, F.L.S., F.R.H.S.
*Manchester*—BENJAMIN CARRINGTON, M.D., Eccles.
*Melbourne, Australia*—Baron FERDINAND VON MUELLER, M.D., K.C.M.G., F.R.S.
*Nova Scotia*—Professor GEORGE LAWSON, LL.D., Dalhousie.
*Ottawa, Ontario*—W. R. RIDDELL, B.Sc., B.A., Prov. Normal School.
*Perth*—F. BUCHANAN WHITE, M.D., F.L.S.
*Saharumpore, India*—J. F. DUTHIE, M.D., F.L.S.
*Silloth*—JOHN LEITCH, M.B., C.M.
*St. Andrews*—Professor M'INTOSH, M.D., LL.D., F.R.SS. L. & E.
*Wellington, New Zealand*—Sir JAMES HECTOR, M.D., K.C.M.G., F.R.SS. L. & E.
*Wolverhampton*—JOHN FRASER, M.A., M.D.

Presents to the Library at the Royal Botanic Garden were announced.

The CURATOR exhibited, from the Royal Botanic Garden, specimens of the capsules of the *Papaver somniferum* pierced by tits, and branches of *Pernettyia* in fruit.

Professor BAYLEY BALFOUR exhibited specimens in spirit, from the Museum of the Royal Botanic Garden, of *Cabomba aquatica*, showing its heterophylly, and of the pitcher of *Nepenthes bicalcarata*.

The PRESIDENT (Dr. David Christison) delivered the opening address, taking for his subject "The Actual Size of the Largest Trees of Species Native or Long Naturalized in Britain, particularly in Scotland, with a Discussion of the Question of their Probable Age." The address is elaborated in the following paper:—

## THE SIZE, AGE, AND RATE OF GIRTH-INCREASE ATTAINED BY TREES OF THE CHIEF SPECIES IN BRITAIN, PARTICULARLY IN SCOTLAND. By Dr. D. CHRISTISON, President.

CONTENTS OF THE PAPER.



The Presidential address on which this paper is founded was designed to show the actual size of the largest trees of species, native or long naturalized, in Britain, particularly in Scotland, and to discuss the question of their probable age. The extended form in which it is now presented gives greater completeness to the subject by the addition of information as to the size that species of more recent introduction have attained, and by a consideration of the allied subject of the rate of girth-increase. A work of the kind is necessarily, to a large extent, one of compilation from material already published, but I have also utilized a considerable mass of unpublished matter, the result of original inquiries by my father and myself. It is also a work which may seem somewhat below the level which should be aimed at in a scientific paper, but the study of forestry in a scientific spirit being as yet only in its infancy in this country, it is mainly by a patient collection of facts that a safe foundation for it can be laid; and as notices of the dimensions and rate of growth of trees, although very numerous, are so scattered abroad as to be of little value, except to excite a momentary curiosity, it seemed to me that, by collecting together and showing in one view the most reliable data, particularly from sources which are not generally accessible, I might confer no mean service on the student of Forestry. The main sources of my information have been—(1) A series of Tree Measurements taken in the middle of last century by Mr. R. Marsham, of Stratton, Norfolk, communicated by Mr. Beevor to a volume of Letters and Papers on Agriculture, Planting, etc. Bath, 1780. (2) A Descriptive Catalogue of Important Trees, by Professor John Walker, of Edinburgh University, from measurements made in the latter part of the eighteenth century, published in a volume of Essays in 1808 after his death. These catalogues are of much value, from their antiquity, and the evident care with which they have been drawn up by men devoted to scientific pursuits. (3) Strutt's well-known Sylva Britannica, 1822–26. (4) The series of Prize Essays in the Transactions of the Highland and Agricultural Society, 1881-1892, by Mr. Robert Hutchison, with tables of measurements of a very large number of Scottish trees, chiefly taken by foresters and others under his directions. (5) Statistics of Conifers in the British Islands, collected in a careful and systematic manner by Mr. Malcolm Dunn for the Conifer Conference, and published in the Journ. Hort. Soc. 1891. (6) Information acquired, or original observations, by my father and myself. Loudoun's Arboretum and the Journals of Forestry and Arboriculture I have made little use of, as they are more accessible to those who are likely to interest themselves in the subject.

After some introductory remarks on the mode of ascertaining the size and age of trees, I have divided the detailed part of my subject under the heads of native or long naturalized trees, and trees of comparatively recent introduction; and in place of dealing with the species in their scientific order, I have preferred to take them either according to their importance, or to the amount of reliable data which I have been able to get for them.

I have to thank a number of gentlemen, whose names appear in the course of this Paper, for their assistance. I may specially mention Mr. Robert Hutchison and Mr. Malcolm Dunn, without whose previous labours in the field my own could hardly have been undertaken. No inconsiderable part of my information about individual trees comes from foresters and gardeners on the spot, who have invariably answered my inquiries in the most careful and accurate manner.

## INTRODUCTORY REMARKS.

Size of Trees.—To form a right idea of the size of a tree, we ought to ascertain its cubic contents of timber; the height to which the foliage towers aloft and spreads horizontally; the length and girth of the stem;—but the last of these characteristics is almost universally used as the best single index of size. With this limitation it might be expected that the actual size of the most remarkable trees within the small compass of our islands would be accurately known; nevertheless there are few subjects of popular and scientific interest in which our knowledge is so vague. This has arisen mainly from the most reckless carelessness in making or recording measurements, and from the want of a recognised standard of position of measurement. Multitudes of girths have been recorded without the position being mentioned, while in many others the point selected gives no true index of the size for comparison with others. Mr. R. Marsham as early as the middle of last century appears to have been the first to adopt a scientific mode of measurement. He chose 5 feet as the most convenient height for girthing a tree, and "as being clearer of the swelling of the roots." Failing this, he took the narrowest point. He, however, took no pains to make his views known, and, in ignorance of them, Sir Robert Christison was the first to insist publicly upon the necessity of establishing a common standard of position, and, in a Paper communicated to this Society in 1878, he showed that this must be chosen where the stem is unaffected by the swelling downwards towards the buttresses and upwards towards the great branches—in fact, at the narrowest part of the stem, a point generally to be found about 5 feet from the ground, although in very old trees it may be higher, and in unusually short stems it may be lower. Of late years this principle has been very generally adopted, although from the neglect of it the vaguest statements as to the size of trees are still not unfrequently met with. In the present Paper I have adopted the girth of 5 feet from the ground, or, if necessary, at the narrowest point, as the single criterion of size, recording, however, other measurements in special cases.

AGE OF TREES.—Considering that life is annually renewed in our forest trees, there is no evident reason, apart from disease, why their vitality should come to an end; yet it would seem that, just as in the animal world, which has no such annual rejuvenation, so in the vegetable world, each species of tree has its natural limit of life. The average limits of the species, however, have not been determined, any more than the age which exceptionally favoured individuals may reach, and it is only by the gradual accumulation of facts that we can hope to form some estimate on these points. The main obstacle, however, is the difficulty in ascertaining the age of very large trees.

As to the modes of ascertaining the age of trees in general, the most reliable is when the date of planting is known, but it is surprising how seldom, in Scotland at least, this kind of evidence is to be had, even for trees of moderate age, and it is quite unavailable for aged veterans, except in a legendary and fabulous form.

Good evidence may also be obtained, but only in fallen or felled trees, from counting the annual rings. The correspondence between these and the age may not be precise in the stems of very old trees, as they may have ceased to lay on wood below while still growing above, but the method is probably reliable enough up to a very considerable age, although rarely, if ever, available in the case of aged veterans.

At one time it seemed as if a simple and reliable mode of estimating the age of trees had been established by De Candolle, who, relying on observation of the annual rings in many tree sections, published as a well-ascertained fact that, after a period of greater activity in early youth, the annual rate of girth-increase continued throughout life at a tolerably uniform rate. But Sir Robert Christison* showed that De Candolle must have been misled by using sections taken near the ground, where the tendency to a conoidal swelling as age advances tends to equalize the rings; and that above this conoidal swelling, in the great majority of cases, there is a gradual although irregular decrease in the width of the rings with age. Hence although De Candolle's rule might answer near the base, it was inadmissible higher up. But Sir Robert also showed that even at the base it was unreliable, as the rings frequently vary much in width there within short periods of time. Hence it is not possible to ascertain the age of a tree merely by ascertaining its recent rate of girth-increase.

The age of trees even of very considerable size may sometimes be estimated, in a rough way, simply by measuring the girth, as pretty numerous data exist showing the rate of growth and the age of trees in some species at various sizes. But, in working thus by comparison, it is necessary to take the circumstances of each tree into consideration, and it is only in a few species that sufficient data for the purpose have been collected.

It is when we come to gigantic trees, however, that the most serious difficulties occur, chiefly from the almost total deficiency of data bearing on their growth during the latter part of their career. We may form some notion

* Trans. Bot. Soc. Ed., 1878, p. 225.

of the rate of girth-increase in such a tree till it attained, say, 15 feet in girth, by using the data already referred to, but we probably have none to help us for the period during which the girth increased to 20 or 30 feet. The only mode which appears to offer itself in such cases is to ascertain the recent rate of girth-increase, and to allow for a gradual diminution in the rate from that of the calculated period at, say, 15 feet, to the ascertained rate at, say, 20 or 30 feet. But it may be said that the rate varies so much in the recorded data as almost to nullify this system. I believe, however, that we are not likely to err, if we take the quickest growers for our models, as my experience in tree-measuring goes far to prove that quick growth goes along with vigour, and I also found in connection with the great frosts of 1879–80–81 that the quick-growing trees of each species suffered least.

We have still to consider the modes of ascertaining the present or recent rate of girth-increase. The most accurate and ready means is by using borers to extract cylinders of wood on which the annual rings can be counted. Mr. J. E. Bowman* was the first to adopt this simple method, but it was unaccountably neglected at the time, and it was left to the German foresters to revive or rediscover it in recent years. Mr. Bowman's borer penetrated only to a depth of a few inches, but cylinders can now be extracted to a much greater depth, and, if taken at several points at the same level, yield most valuable and reliable results. But although no harm is done to the trees by this instrument, permission to use it is not likely to be granted by the owners of interesting old trees, and the only remaining plan is the tedious one of taking girth measurements for several successive years. This plan has one advantage over boring, as it shows whether the stem is still continuing to grow, and it is eligible enough in trees of very great size which retain their health and vigour.

But in gnarled, "bumpy," and particularly in decaying stems, neither by this nor by any other means can we hope to arrive at any satisfactory result. The chief difficulties in estimating the age of such decaying veterans

* Ann. of Nat. Hist., 1837, i., N.S., p. 28.

are—(1) We probably have no means of ascertaining how long the stage of decay has lasted. That it may endure for several centuries we have sufficient reason to believe, at least in yews and oaks. (2) We do not know whether in this stage of decay annual rings may or may not be formed in the stem, either regularly or occasionally. Mr. Strutt, indeed,* quotes the statement of a Mr. South that an ancient hollow oak had increased some inches in twenty years, though "as hollow as a tub"; and hence "that hollow trees have not attained their great bulk when sound, as the shell increases when the substance is no more." But no proof of the alleged increase is given, and faith in it is not increased by the conclusion "that a tree which at 300 years of age was sound, and 5 feet in diameter, would, if left to perish gradually, in its thousandth year become a shell of 10 feet diameter." (3) To measure these ancient stems accurately, covered as they generally are with bumps and excresences, broken into, it may be, by gaps, and with scaling bark, is well nigh impossible. Moreover, any apparent growth may be only due to the bumps, and should therefore be regarded rather as a diseased than a natural increase. On the whole, I fear we must conclude that any estimate beyond the roughest guess at the age of many such veterans is scarcely possible.

## A. DECIDUOUS TREES.

### I. The Oak (*Quercus robur*).

Scottish Oaks.—The oak rarely attains in Scotland the size and vigorous look so commonly met with among its English brethren. The stem often enough gains considerable proportions, but the branches are rarely thrown out in the free manner ordinarily met with in English oaks, and the foliage is comparatively thin. In mature oaks left standing in Highland copses the arms are often widespread and picturesque, but the poverty of the foliage is usually quite remarkable, the leaves being in scanty small tufts, and the shade cast by the trees consequently imperfect. The test of girth measurement clearly proves

* Sylva, p. 5.

the greater growing power of the oak in England, the recorded trees in that country above 30 feet in girth at 5 feet from the ground being more numerous than those above 20 feet north of the Tweed. Nevertheless, in some favoured localities of the north, large and handsome oaks do occur. The most remarkable of them for girth or height have probably found their way into Mr. Hutchison's catalogue of 151 Scottish oaks (Trans. H. and Agr. Soc. Scot., 1881, xiii., 218), from which we have extracted those that reach or exceed 20 feet in girth, at 5 feet up, or at the probable narrowest point.

| | Girth. | | Height of Bole. | Height of Tree. | Spread of Branches. |
|---|---|---|---|---|---|
| | Ft. | In. | Ft. | Ft. | Ft. |
| *Lochwood, Dumfriesshire, . . | 20 | 0 | 19 | ... | ... |
| Invernytie, Perthshire, . | 20 | 10 | 30 | 76 | ... |
| Cadzow, Lanarkshire, . . | 21 | 0 | 12 | 45 | 66 |
| Do. do. . . | 22 | 9 | 30 | 48 | 100 |
| Lee, Lanarkshire, . . | †23 | 0 | 8 | 68 | ... |
| ‡Methven, Perthshire, . . | 20 | 1 | 8 | ... | ... |
| **100 feet or upwards in height.** | | | | | |
| Hopetoun, West Lothian, . | 8 | 8 | 93 | 110 | ... |
| Binning, East Lothian, . | 11 | 6 | 20 | 103 | ... |
| Springwood Park, Roxburgh, | 16 | 0 | 35 | 100 | ... |

* None there above 17 feet in girth, fairly measured (D. Christison, 1890).
† At 3 feet, probably the narrowest part of a short stem.
‡ At 3 feet, the narrowest of a fine symmetrical 8 ft. stem (Col. Smythe, 1893).

Number recorded above 15 feet in girth.

| | |
|---|---|
| 20 feet in girth and upwards, . . . . . . | 5 |
| 19 to 20 feet in girth, . . . . . . . . . | 3 |
| 18 to 19 ,, ,, . . . . . . . . . . | 4 |
| 17 to 18 ,, ,, . . . . . . . . . . | 6 |
| 16 to 17 ,, ,, . . . . . . . . . . | 5 |
| 15 to 16 ,, ,, . . . . . . . . . . | 32 |
| Total 15 feet and upwards, . . . | 55 |

The Lee oak measures 28 feet 6 in. at 5 feet, but this large result must be due to the swelling towards the limbs, as at 3 feet the girth is only 23 feet. From the massiveness of the arms, however, it is probably the biggest oak in Scotland, although the Springwood Park tree, 100 feet high and 16 feet in girth, must be one of the grandest.

In 1771 Dr. Walker estimated the girth of the "Wallace Oak," Torwood, Stirling, to have been about 22 feet at 4 feet up, but apparently only half the circumference of the trunk remained; and he mentions an oak on the north side of Loch Arkeg, Lochaber, measuring 24 feet 6 in. at 4 feet up, as being "the largest oak of which we have any account in Scotland."

ENGLISH OAKS. — NEWLAND, FOREST OF DEAN, GLOUCESTERSHIRE.—By common consent the oak is king of British trees, but which is the king of British oaks is not so easily decided. By the single test of greatest girth, however, the Newland oak is entitled to the honour, as it is the only one in which the stem girths nowhere less than 40 feet. In April 1893, with the aid of the Rev. Mr. Bagnall Oakeley and Dr. John Beddoe, F.R.S., I measured it at four points. Other measurements yielding much higher results have been published, but as our observations agreed, within a few inches, with the girths taken for me three years previously by Mr. and Mrs. Oakeley, the combined results here given may be accepted as substantially correct, considering the "bumpy" nature of the surface dealt with.

| | | | |
|---|---|---|---|
| Girth at the ground, . | 45 ft. 7 in. | Spread of foliage, N. to S., | 65 ft. |
| ,, 3 ft. up, . . | 45 ft. | ,, ,, E. to W., | 57 ft. |
| ,, 4 ft. up, . . | 43 ft. 5 in. | Height of tree, . . . . . | 50 ft. |
| ,, 5 ft. up, . . | 43 ft. 6 in. | ,, stem, . . . . | 9 to 10 ft. |
| ,, 7 ft. up, . . | 43 ft. | Girth of largest limb, . . | 8 ft. |
| ,, 8 ft. up, . . | 42 ft. 3 in. | | |

The measurements show that the tree springs from the ground without buttresses. The stem, instead of dividing into two or three great limbs, gives off eight branches of moderate size in a circle at a nearly uniform level 9 feet above ground. What may be called the roof of the stem has measured 6 feet by 4 feet 6 inches within the circle of limbs, but it has mostly rotted away, showing the stem to be a hollow shell, although without a lateral break. The peculiar form of the tree is no doubt due to pollarding, a practice so common in ancient times, to provide fodder for cattle, that an old writer complains that scarcely a fine tree in England had escaped it.* It is interesting to note

* I am informed by Mr. Oakeley that in this very dry spring, from a want of fodder, the farmers in his district had recourse to pollarding to feed their cattle.

that, apparently because buttresses were not required in a pollard, they were not produced. This tree stands conspicuously alone in a gently sloping field, and no other oak in the Forest of Dean at all approaches it in size.

COWTHORPE, WETHERBY, YORKSHIRE.—If in addition to girth other points are considered, the oak at this place may lay a strong claim to the sovereignty, a claim, indeed, which was admitted by Mr. Marsham (Op. cit. 1780), who states that "the largest oak in England is one near Wetherby," and by Hunter in his edition (1776) of Evelyn's Sylva. Referring to an oak in Sheffield Park, he says, "Neither this nor any of the oaks mentioned by Mr. Evelyn bear any proportion to one now growing at Cowthorpe. The dimensions are almost incredible." He then gives them, as shown in my table, concluding his description thus: "The foliage is extremely thin, so that the anatomy of the ancient branches may be distinctly seen in the height of summer. When compared to this, all other trees are but children of the forest."

Strutt (1822) says that Hunter's description "so nearly answers to the present state that the tree does not appear to have suffered material deprivation since." Yet his drawing, compared with Hunter's, shows an evident diminution in height and branches. A photograph of 1859, sent me by the Rev. J. J. D. Dent, Hunsingore, shows perhaps a further diminution in height, but so great a revival of the foliage that it no longer deserved the reproach of "showing the anatomy of the ancient branches"; and this improvement continued in 1887, when I saw the tree. The stem, the condition of which is not described by the earlier observers, I found to be a hollow shell, to which access is gained by a considerable gap, which, however, does not interfere with the accuracy of measurement. My notes unfortunately were lost, but Mr. Dent has kindly supplied the loss by careful measurements taken in 1889.

Measurements of Oak at Cowthorpe.

| | 1776. — Dr. Hunter. | Before 1780. — Mr. Marsham. | 1889. — Rev. J. Dent. |
|---|---|---|---|
| Girth at the ground, . . | 78 ft. | ... | 54 ft. 6 in. |
| ,, 1 ft. up, . . . | ... | ... | 49 ft. 6 in. |
| ,, 2 ft. up, . . . | ... | ... | 47 ft. |
| ,, 3 ft. up, . . . | 48 ft. | ... | 44 ft. 10 in. |
| ,, 4 ft. up, . . . | ... | 40 ft. 6 in. | 42 ft. |
| ,, 5 ft. up, . . . | ... | 36 ft. 6 in. | ... |
| ,, 5 ft. 4 in. up, . . | ... | ... | 37 ft. 5 in. |
| ,, 6 ft. up, . . . | ... | 32 ft. 1 in. | ... |
| ,, 6 ft. 6 in. up, . . | ... | ... | 35 ft. 9 in. |
| Height of tree, . . . . | 85 ft. | ... | ... |
| Length of longest branch, . | 48 ft. | ... | 36 ft. |

The table illustrates the difficulty of arriving at the truth as to the size of old trees. No one who has seen this tree can believe that by any process of loss its girth at the ground can have diminished between 1776 and 1889 by 24 feet, or even by 3 feet at 3 feet above ground. But Mr. Dent's measurements were taken expressly for me with every care, and I have no doubt are substantially correct. It is possible, indeed, that in measuring such an irregular surface, where the slightest shifting of the tape makes a great difference, he may have missed the narrowest point, and unless we suppose growth to have taken place in the decaying tree since Mr. Marsham's measurements, the date of which is uncertain, this must be the case. My recollection is that I got one measurement as low as 34 feet.

In further illustration of the unreliability of earlier statements, Strutt, speaking of this very tree, remarks, "In girth, indeed, it is inferior to the magnificent remains of the oak in Salcey Forest." But, on turning to his account of it, we find the dimensions, as taken in 1794, to be 46 feet 10 inches at the bottom, and 24 feet 7 inches at 3 feet up. Now Strutt accepts Hunter's 78 feet and 48 feet at the corresponding positions in the Cowthorpe oak as correct, and yet calls it inferior to the Salcey Forest tree!

Oaks above 20 feet in girth must be numerous in England. To take a single locality, in a series of measurements of oaks at or near Moccas Park, Herefordshire* (comprising forty-eight above 15 feet in girth at 5 feet up), there are no less than eleven in the park, and in other parts of the country there are eighteen more, all girthing 20 feet or upwards. These measurements were taken by "a commissioner" for the Club, and they are confirmed by an unsigned list among my father's papers, in which, although the results do not strictly agree, they are near enough to show the substantial accuracy of both. Even 30 feet is not an extremely rare girth for the English oak, as, in addition to the Cowthorpe, Newland, and three of the Moccas Park trees, I have found records of the following:—

IN HEREFORDSHIRE (Trans. Woolhope Club, 1870), all at 5 feet up—The Rosemaund Oak, 34 feet; Brampton Brian Park Oak, 30 feet; Croft Oak, 34 feet; Nonupton Oak, 33 feet (at 4½ feet), 50 feet at the ground, destroyed by fire, 1851; Cowarne Court Oak, 37 feet 8 inches, owing partly to a protuberance, rapidly narrows; Newbury Oak, 31 feet, destroyed.

OAK IN HOLT FOREST, Bentley, 34 feet at 7 feet, a large excrescence at 5 and 6 feet making measurement there unfair (R. Marsham, 1759).

FAIRTOP OAK, Epping Forest, 31 feet 9 inches at 5 feet (R. Marsham, 1754).

EARL OF THANET'S OAK, Whinfield Park, Westmoreland, 31 feet 9 inches at 5 feet (R. Marsham, 1765).

THE SELBORNE OAK, described by Gilbert White as girthing 34 feet at 7 feet, with a stem of 16 feet, containing 1000 cubic feet of timber.

THE QUEEN ELIZABETH OAK, Huntingfield, Suffolk, 34 feet at 5 feet (Strutt).

Not far short of these comes MAGOG, Yardly, 54 feet 4 inches at the roots, and 31 feet 3 inches at 3 feet up (Strutt); and a fine solitary oak in a field near Bristol which I found to girth 28 feet at 5 feet up.

* Trans. of the Woolhope Club, 1870.

## 1. Rate of Girth-Increase in Oaks of known Age.

(*a*) Oak at Stratton, Norfolk, planted in 1720 by Mr. Marsham.

| Date. | Girth. Ft. | Girth. In. | Period. Years. | Increase. In. | Rate. In. | |
|---|---|---|---|---|---|---|
| 1742 | 2 | 11¾ | 22 | 36 | 1·63 at 5 ft. | Mr. Marsham. |
| 1778 | 7 | 9 | 36 | 57 | 1·58 do. | do. |

"Perhaps the growth was helped by digging a large circle round it in several winters, and in other years having that circle covered with greasy pond mud." He also washed the stem frequently in dry seasons.

(*b*) Oak at same place, known from a Deed to have been planted in 1580.

| Date. | Girth. Ft. | Girth. In. | Period. Years. | Increase. In. | Rate. In. | |
|---|---|---|---|---|---|---|
| 1760 | 15 | 2¾ | 180 | 182¾ | 1·01 at 5 ft. | Mr. Marsham. |
| 1778 | 16 | 3½ | 18 | 12¾ | 0·70 do. | do. |

(*c*) English oaks measured in 1889 by Mr. Collins, Trentham, Staffordshire. Age accurately known from records on pillars of the dates of planting, and tested by counting the rings on many felled specimens.

| Situation. | Number of Trees. | Age. | Girth at 5 ft. Average. | Girth at 5 ft. Largest. | †Av. Annual Increase. Of all. | †Av. Annual Increase. Of Largest. | Height. Average. | Height. Annual average. |
|---|---|---|---|---|---|---|---|---|
| | | Yrs. | In. | In. | | | Ft. | In. |
| *Trentham, . | 111 | 71 | 49·75 | 74 | 0·76 | 1·13 | 58 | 8·17 |
| Windsor, . . | 30 | 69 | 50·25 | 62 | 0·80 | 0·98 | 60 | 8·70 |
| Sherwood, . | 10 | 75 | 49 | 53 | 0·70 | 0·76 | 65 | 8·66 |
| Weston, . . | 10 | 74 | 58·75 | 67 | 0·84 | 0·98 | 66 | 8·78 |
| Chillington, . | 10 | 84 | 57·75 | 93 | 0·74 | 1·19 | 66 | 7·85 |

* Includes all in Ashgreen Plantation.
† Deducting six years for growth up to 5 feet.

(*d*) "Many oaks at Cammo, Midlothian, planted 150 years ago, and age proved by counting rings in felled trees, vary from 9 to 10 feet in girth, giving a rate of from 0·72 to 0·80, and for the largest (11 feet girth) of 0·86. Rate of the latter confirmed by two years' measurement, showing 0·75 still."—Sir R. C., 1880.

(e) Age ascertained from the annual rings (Mr. Collins, Trentham).

| Girth at 5 ft. | | No. of Rings. | Average Annual Increase. |
|---|---|---|---|
| No. 1, . . . . | 7 ft. 3½ in. | 86 | 1·01 in. |
| No. 2, . . . . | 11 ft. 10 in. | 192 | 0·74 in. |

(f) Oak at Baslow, Cheltenham, thrown down by a flood, 1879. Rings counted by Mr. E. M. Wrench, surgeon, and information furnished by him to Sir R. Christison.

| Girth 3 ft. up. | | No. of Rings. | Average Annual Increase. |
|---|---|---|---|
| Without the Bark. | With the Bark. | | |
| 17 ft. 8 in. | 18 ft. 3 in. | 479 | 0·46 in. |

(g) Oak at Cammo, Midlothian. Rings counted by Sir R. Christison, at 2 feet above ground.

| | Average Annual Incr. | |
|---|---|---|
| First 40 years, . . | 1·50 in. | After this the tree almost ceased to grow for 30 years before being cut down. |
| Next 80 years, . . | 0·82 in. | |
| For 120 years, . . | 1·00 in. | |

2. Rate from Girth Measurements in Trees of unknown Age.

(a) Young oaks in Edinburgh Arboretum, measured by me, 1890–92.

| No. | Average Girth, 1892. | 1889–1892. Average Annual Increase. | | Average of Three, 1890. |
|---|---|---|---|---|
| | | Of Three. | Of Best. | |
| Three | 10·26 in. | 0·84 | 1·06 | 0·98 |

(b) Oaks, Dalswinton, Dumfriesshire, originally marked and measured by Sir R. Christison and Mr. J. M. Leny of

Dalswinton, and latterly by Mr. W. M. Leny and myself, at various dates from 1836 to April 1893, at from 3 to 4 feet up. They have all (April 1893) been failing for some time, and are now shabby looking. I have only given their increase till failure evidently began, at various dates. Their average girth is now, at 3 to 4 feet, 12 feet 8 inches; and at 5 to 6 feet, 11 feet 7 inches.

| | Term of Years. | Girth at First. | Girth at Last. | Increase. | Annual Rate. |
|---|---|---|---|---|---|
| | | Ft. In. | Ft. In. | Ins. | In. |
| No. 1, . . | 51 | 8 2 | 12 0·5 | 45·5 | 0·90 |
| No. 2, . . | 36 | 9 6 | 12 0 | 30 | 0·83 |
| No. 3, . . | 37 | 10 5½ | 13 0 | 30·5 | 0·82 |
| Averages, | 41 | 9 4 | 12 4 | 36 | 0·85 |

(*c*) Oak at Craigiehall, West Lothian, measured by me for ten years.

Girth, 1887, 10 ft., 7·25 in. Average increase for ten years previously, 0·68 in. at 5 ft. up.

(*d*) Oaks at Polloc, Renfrewshire, for sixty-eight years ending 1880 (Mr. Hutchison's Table).

| | Girth. | | Increase. | Annual Rate. |
|---|---|---|---|---|
| | 1812. | 1880. | | |
| | Ft. In. | Ft. In. | In. | In. |
| No. 1, . . . . . | 6 8 | 10 1 | 41 | 0·60 |
| No. 2, . . . . . | 7 6 | 11 6 | 48 | 0·70 |
| No. 3, . . . . . | 7 9 | 11 9 | 48 | 0·70 |
| No. 4, . . . . . | 8 9 | 12 4½ | 43½ | 0·64 |
| Averages, . | 7 8 | 11 5 | 45 | 0·66 |

(*e*) Oak at Methven Castle, Perthshire (Colonel Smythe).

| Date. | Girth. | Increase. | No. of Years. | Annual Rate. |
|---|---|---|---|---|
| | Ft. In. | In. | | In. |
| 1795 | 14 6 | ... | ... | ... |
| 1811 | 16 0 | 18 | 16 | 1·12 |
| 1879 | 19 7 | 43 | 68 | 0·63 |
| 1892 | 20 1 | 6 | 13 | 0·45 |
| 1795 to 1892 | ... | 67 | 97 | 0·69 |

(*f*) Oak near, and north of, Bewick's Oak, West Felton, Salop (Mr. John Dovaston, in a letter to Sir R. Christison).

| Girth. | | | Rate. | |
|---|---|---|---|---|
| 1811. | 1836. | 1879. | 1st Period, 15 years. | 2nd Period, 44 years. |
| Ft. In. | Ft. In. | Ft. In. | In. | In. |
| 2 9 | 4 8·5 | 7 $7\frac{1}{2}$ | 1·56 | 0·80 |

(*g*) Herne's oak, Windsor, 26 feet in girth when blown down. On a block, 5 inches thick, of exterior decayed wood, there were 142 rings; on the inner inch, $21\frac{1}{2}$; on the outer inch, 44 (Sir R. Christison).

## 3. Estimation of Age in Ancient Oaks.

We may form an approximate estimate of age in oaks of very considerable size, but available data in the case of the great giants are so defective, and the difficulty of estimating the period when they may have been "standing still" in a state of decay is so great, that in them estimation is little better than guess-work. Let us make the attempt, however, on the Cowthorpe tree.

The oldest oak on my list, with a well-ascertained age, is the Baslow tree (1 *f*), which had 479 rings at a height of 3 feet, and allowing 6 years for growth to that height, must have been 485 years old. Its girth was 18 feet 3 in., and consequently its rate for the whole period was 0·46. Now the Cowthorpe oak is almost twice that girth, and if we allow its rate to have been 0·46 till it was 18 feet in girth, and take half that rate for the last 18 feet, its age, without any allowance for "standing still" in the period of decay, comes out at about 1450 years. But the Baslow tree was slow of growth, as one radius increased at only half the rate of the other, and because some of my trees yield a much higher rate up to a considerable size. Thus rates of 1·50 up to 40 years of age; of 1·13 up to 71; of 1·19 up to 84; of 1 up to 86; of 0·86 up to 150; of 0·92 for 39 years in a tree 11 feet

3 in. in girth; lastly, of 0·69 for 97 years in a tree 20 feet 1 in. in girth, are recorded.

Taking the most favourable figures, we may construct the following scheme for a tree 20 feet 1 inch in girth, like the Methven oak (2 *e*).

| | Increase in Girth. In. | | In. | | | In. | | Years. |
|---|---|---|---|---|---|---|---|---|
| From | 0 | to | 93 | at annual rate of | | 1·10 | gives | 84 |
| ,, | 93 | to | 135 | ,, | | 0·92 | ,, | 46 |
| ,, | 135 | to | 192 | ,, | | 0·76 | ,, | 75 |
| ,, | 192 | to | 241 | ,, | | 0·61 | ,, | 80 |
| | | Total, | 241 | | Average, | 0·84 | Total, | 285 |

Thus we get 285 years as the *possible* age of an oak 20 feet in girth, which has grown at the greatest rate that our tolerably reliable data supply, or 0·80. The period might indeed be considerably reduced if we accepted the rate of the Methven oak, between the girth of 14 feet 6 in. and 16 feet, as correct. Frequent measurements of this tree, although at irregular intervals (of which I have given only a summary in the table), have been recorded for the past 97 years, and although there are no means of checking their accuracy, and 1·12 at the size mentioned seems an extraordinary rate, yet the form of the stem is such that a considerable shifting of the point of measurement would apparently not cause serious error, over a long period of time. Accepting the rate of 1·12, and without making any allowance for the rate having been greater previous to the tree attaining 14 feet 6 in. in girth, the age of this 20 feet oak would be about two and a half centuries, but allowing for a greater rate in its earlier life it would not be much above two centuries. But at the size of the Methven tree the Cowthorpe oak had still 15 feet 8 in. to grow, and supposing the rate during this latter period reduced to half that which brought the tree in our scheme to 20 feet, or 0·40, and adding upwards of a century, during which decay is known to have been going on, the age of the Cowthorpe tree would be 855 years. It could not well be less, except on the supposition either that such a giant does grow throughout more quickly than at the quickest rate ascertained for smaller trees, or that the rate, instead of gradually diminishing, continues unimpaired till a very advanced age. But the age may be a great deal more if the rate after all has only been an average one, and if the period of decay has been longer than is recorded, and if during that period there has been little or no growth. That the age might well be a great deal more is shown by the very slow rate of the Herne's oak (2 *g*) towards the end of its career, ascertained to have been only about 0·20 for the last 142 years, and 0·13 for the last 44 years of growth; and this in a tree only 26 instead of 36 feet in girth. Here it may be noticed that by De Candolle's method the inner inch of the last five would make Herne's oak 1013, but the outer one 2077, years of age. All this proves, I think, the impossibility of forming even a rough estimate of the age of such a veteran as the Cowthorpe oak, without far more precise and extensive data than we at present possess. But we may go so far as to say that it is *possibly* not much more than eight centuries old.

## II. The Beech (*Fagus sylvatica*).

The beech flourishes better in most parts of Scotland than any other deciduous tree. It seems somewhat surprising, then, that in Mr. Hutchison's list only three are to be found as much as 20 feet in girth at 5 feet from the ground, and of these but one, the short-stemmed Eccles tree, reaches 20 feet at its narrowest part. Even at the lesser girths of 19 to 20 feet he records not one, and between 16 and 19 feet, but fourteen. On the other hand, splendid beeches, between 10 and 14 feet in girth, are so numerous in Scottish avenues and plantations as to lend much probability to Mr. Hutchison's belief that the older generations of the species were rarely allowed to survive to a great age, and that a newer generation, planted most extensively about the beginning of the eighteenth century, are now coming to great perfection, but have not yet had time to yield a crop of giants.

Scottish beeches above 17 feet in girth, at 5 feet from the ground (Mr. Hutchison's Table of 232 Scottish Beeches, Trans. H. and Agr. Soc. Scot., xiii., 1881).

| | Girth. | | Height of Bole. | Height of Tree. | Spread of Branches. |
|---|---|---|---|---|---|
| | Ft. | In. | Ft. | Ft. | Ft. |
| Kinnaird, Forfar, . . . . | 17 | 3 | 18 | 75 | ... |
| Cramond House, Midlothian, | 17 | 5 | ... | 85 | . |
| Yester, East Lothian, . . | 17 | 6 | 19 | 70 | ... |
| Dunkeld, Perth, . . . | 17 | 6 | 11 | 82 | 130 |
| Drummond Castle, Perth, . | 17 | 8 | 10 | 77 | ... |
| Dalmeny, West Lothian, . | 18 | 0* | 6 | ... | ... |
| Ardkinglass, Argyll, . . | 18 | 9½ | ... | 92 | 108 |
| Eccles, Dumfries, . . . | 20 | 3 | 4† | 65 | 100 |
| Belton, East Lothian, . . | 20 | 4 | 31 | 63 | ... |
| Newbattle, Midlothian, . . | 21 | 2 | 17 | 95 | 130† |
| **Highest Beeches.** | | | | | |
| ‡Methven, Perth, . . . . | 16 | 3 | ... | 120 | 110 |
| Milne-Graden, Berwick, . | 13 | 7 | ... | 122 | ... |

* At narrowest, Sir R. C., 1874. † Sir R. C., 1878. ‡ Col. Smythe, 1893.

Number above 15 feet in girth at 5 feet from the ground.

| | | |
|---|---|---|
| Between | 15 and 16 feet, | 15 |
| ,, | 16 and 17 ,, | 8 |
| ,, | 17 and 18 ,, | 5 |
| ,, | 18 and 19 ,, | 1 |
| ,, | 19 and 20 ,, | 0 |
| | 20 and upwards, | 3 |
| | Total above 15 feet, | 32 |
| Number recorded between 90 and 100 feet in height, | | 34 |
| ,, | above 100 feet in height, | 22 |

The lofty beeches recorded by Mr. Hutchison are also of remarkable girth. At Arniston, Midlothian, and no doubt in many other places, beeches of considerable girth, and 100 feet high, are numerous. At Cramond Bridge, in the Craigiehall grounds, there is a grove which thirteen years ago numbered sixty, all about 100 feet high, and several above it, but girthing only between 6 and 9 feet.

Although the giant beeches are inferior in girth to the giant oaks in Scotland, yet their general superiority is shown by their greater height and the wider span of the branches.

(*a*) NEWBATTLE BEECH, MIDLOTHIAN.—If we take into consideration height, spread of foliage, vigorous growth, and grandeur of aspect, as well as girth, the Newbattle beech, besides being the king of Scottish deciduous trees, is probably one of the grandest beeches in the United Kingdom. It stands in the well-sheltered haugh of the River Esk behind Newbattle Abbey. The stem rises from the ground by several strong buttresses, but at about 4½ feet up it already forms a cylindrical bole, which an encircling tape touches pretty nearly all round. The bole, after ascending with a beautiful but not deeply marked spiral curve, divides into a larger and smaller limb, the fork being about 17 feet above ground. At a further height of 5 or 6 feet the larger limb bifurcates, and finally subdivides into the mass of branches and twigs which rise to a height of about 100 feet. The ramification consists of two divisions, the upper forming the great head of foliage, while the lower consists of about a dozen branches, which, springing from a height of about 25 feet, arch downwards, reach the ground from 20 to 30 feet from the trunk, and form around it a natural arbour, about 60 feet in diameter. Some of these branches break up into a number of small ones, which trail along the ground for some distance, and finally turn upwards at the outer margin of the tree; but four or five others, comparatively slender, reach the ground without branching, and after rooting give origin to a number of veritable young trees much thicker than their parent limbs.

Thus I found, in autumn 1892, that a parent branch measured 24·60 inches in girth, and that the thickened trailing portion, rooted in the ground, gave off four young trees, two of which girthed respectively 51·10 and 43·10 inches, the other two being about 40 and 23 inches.

On the 3rd November 1892 I took careful measurements of the trunk, aided by Mr. F. R. Coles and Mr. M'Hattie, head gardener at Newbattle Abbey, with the following results:—

| | Ft. | In. | | Ft. | In. |
|---|---|---|---|---|---|
| Girth at the ground, . . | 43 | 8 | Girth about 5 ft. up, . . | 20 | 3·6 |
| ,, about 1 ft. up, . . | 37 | 0 | ,, ,, 6 ft. up, . . | 19 | 6·9 |
| ,, ,, 2½ ft. up, . | 27 | 8 | ,, ,, 6½ ft. up, . | 19 | 1·5 |
| ,, ,, 3 ft. up, . . | 25 | 9·6 | ,, ,, 7 ft. up, . . | 18 | 5·3 |
| ,, ,, 4 ft. up, . . | 23 | 1·6 | ,, ,, 7½ ft. up, . | 18 | 7 |
| ,, ,, 4½ ft. up, . | 21 | 11·6 | | | |

| | |
|---|---|
| Circumference of the foliage (taken 1889), . . | 400 feet. |
| Average diameter of foliage ,, . . | 130 ,, |
| Longest horizontal branch ,, . . | 72 ,, |

The seven upper girths were taken with a 24 feet Chesterman steel tape, the base from which their position was fixed being a line marked with white paint at 6 feet 6 inches. The four lower girths, taken with an ordinary 66 feet tape, are less reliable, as they encounter the sloping base. The measurement at the ground was taken by a tape laid on the roots close to the rise of the base. The circumference of the foliage was got by measuring along the ground with a tape under the extremities of the branches, but disregarding those that projected overhead decidedly beyond the mass. The result may be somewhat unduly increased by including the foliage of the secondary trees, which cannot be separated from the general mass. The tree is perfectly sound and healthy, making long annual shoots, and the foliage in summer is so dense as to completely conceal the stem and branches except at a small opening on one side.

(*b*) Eccles Beech, Dumfriesshire. — Mr. Hutchison quotes the girths in 1869 as 26 feet at 2 feet; 20 feet at 4 feet; 25 feet at 7 feet; 17 feet at 16 feet; with a spread of branches of 100 feet, and a height of 65 feet. Sir R. Christison some years later says the trunk is only 4 feet high, and that at the sharply defined narrowest point, 2 feet up, the girth is 21 feet. He describes it as little inferior to the Newbattle beech, except in height and in the length of the trunk.

(*c*) Belton Beech, East Lothian, in 1863, girthed 19 feet 4 inches at 6 feet; 17 feet 8 inches at 9½ feet: and in 1880, 32 feet 8 inches at 1 foot; 20 feet 4 inches at 5 feet, with a 31 feet bole and a height of 63 feet, "a very magnificent specimen."—Mr. Hutchison.

(*d*) Methven Castle Beech, Perthshire, deserves notice for its general size and great height, although the girth at 5 feet is not so much as in the others. Colonel Smythe has furnished the following measurements:—

| | Ft. | In. |
|---|---|---|
| Girth at the ground, . . | 37 | 0 |
| ,, 1 ft. up, . . . | 26 | 0 |
| ,, 3 ft. up, . . . | 18 | 9 |
| ,, 5 ft. up, . . . | 16 | 3 |
| ,, 6 ft. up, . . . | 15 | 10 |
| ,, 7 ft. up, . . . | 15 | 7 |

| | Ft. |
|---|---|
| Diameter of foliage, . . . | 110 |
| Longest horizontal branch, . | 57 |
| Bole, . . . . . . . . . | 18 to 20 |
| Height, about . . . . . | 120 |

(*e*) KNOLE BEECH, KENT.—This celebrated tree girthed 24 feet at 3 feet; 27 feet at 10 feet; height, 105 feet; extent of boughs, 123 feet; solid timber, 498 feet.—Strutt, 1822.

(*f*) ROLLE BEECH, DEVON.—A gigantic tree, girthing 30 feet 7 inches at 3 feet; 25 feet 3 inches at 5 feet; height, 94 feet: branch-spread, 86 feet; cubic contents, 988 feet.—J. Barrie, forester, 1889.

1. RATES OF GIRTH-INCREASE IN BEECHES OF KNOWN AGE.

(*a*) Seven beeches at Stratton, Norfolk, grown from seed. Measured by Mr. Marsham, 1776. Five years taken from age (35) to allow for growth to 5 feet in calculating the rate.

| | Age. | Girth at 5 ft. | Rate for 30 years. | Increase in 1776. |
|---|---|---|---|---|
| | | Ft. In. | | |
| No. 1, . . . . | 35 | 3 9·1 | 1·50 | 1·50 |
| No. 2, . . . . | 35 | 3 9·7 | 1·52 | 2·50* |
| Five others of same age, . . | | ... | ... | 1·50 |

* This extraordinary growth he believed to be due to washing the stems three to five times a week in the spring, first with a stiff shoe-brush, afterwards with coarse flannel. The others were not washed.—Philosoph. Trans., 1777, p. 12.

(*b*) Beech at Bargaly, Kirkcudbrightshire, planted 1697 (Dr. Walker, 1780).

| | Period. | Increase at 4 ft. | Rate. | Height. |
|---|---|---|---|---|
| | Years. | Inches. | Inch. | Feet. |
| 1697 to 1780, . | 83 | 96 | 1·15 | 80 |

(*c*) Two in Edinburgh Botanical Garden, planted 1821 when 5 or 6 years old. Measured, at 5 feet up, from 1878 to 1892 annually by Sir R. and D. Christison.

| | No. 1. | | | No. 2. | | |
|---|---|---|---|---|---|---|
| | Period. | Increase. | Rate. | Period. | Increase. | Rate. |
| | Yrs. | In. | In. | Yrs. | In. | In. |
| 1821 to 1877, . | 57 | 72 | 1·25 | 57 | 60 | 1·05 |
| 1878 to 1892, . | 14 | 14 | 1·00 | 14 | 14 | 1·00 |
| Average, | 71 | 86 | 1·21 | 71 | 74 | 1·04 |

(*d*) Two tall beeches, 100 feet high, with long boles and small heads of foliage, in a grove at Craigiehall, Cramond. Age ascertained in 1878 by counting the rings in felled specimens, by Sir R. Christison. Subsequent measurements by him and by D. Christison. Five years deducted from their age for growth to 5 feet.

| | No. 1. | | | No. 2. | | |
|---|---|---|---|---|---|---|
| | Period. | Increase. | Rate. | Period. | Increase. | Rate. |
| | Yrs. | In. | In. | Yrs. | In. | In. |
| 1758 to 1878, . | 120 | 61·75 | 0·51 | 120 | 71·85 | 0·59 |
| 1878 to 1888, . | 10 | 4·90 | 0·49 | 10 | 6·40 | 0·64 |
| Average, . | 130 | 66·65 | 0·51 | 130 | 78·25 | 0·60 |

(*e*) Beech at Cramond House, Midlothian, 100 feet high, 16 feet in girth at 5 feet up. Age ascertained by counting the rings on a fallen limb, 10 feet 2 inches in girth at 3 feet from its axilla, which was 33 feet above ground, and adding 40 years for growth up to that height.—Sir R. Christison, 1878.

Age, between 200 and 215 years. Rate, at least, 0·91.

(*f*) Beech at Craigiehall, 15 feet 9 inches in girth at 5 feet up where narrowest (16 feet, at least, allowing for loss from a gap). Rings counted by Sir R. Christison, 1878.

Age, 130 years. Rate, 1·53 inch.

(*g*) From Mr. Hutchison's Table.

| Situation. | Date. | Age. | Girth at | | Rate at | |
|---|---|---|---|---|---|---|
| | | | 1 Ft. | 5 Ft. | 1 Ft. | 5 Ft. |
| | | Yrs. | Ft. In. | Ft. In. | In. | In. |
| Binning, East Lothian, . | 1878 | 173 | 20 3 | 13 9 | 1·40 | 0·95 |
| Craighall, Perth, . . . | 1879 | 129 | 16 0 | 13 10 | 1·49 | 1·28 |

## 2. RATES FROM GIRTH MEASUREMENT IN TREES OF UNKNOWN AGE.

### (a) From Mr. Hutchison's Table.

| | Last Observation. | Period. | Girth. | | Increase. | Annual Rate. |
|---|---|---|---|---|---|---|
| | | Yrs. | Ft. | In. | In. | |
| Polloc, Renfrew, | 1879 | 16 | 13 | 4 | 26 | 1·62 at 5 ft. up |
| Do. do. | ,, | ,, | 14 | 8 | 24 | 1·50 ,, |
| Shawholm, do. | ,, | ,, | 13 | 5 | 23 | 1·44 ,, |
| Leslie, Fife, | ,, | 51 | 16 | 8 | 67 | 1·01 at 3 ft. up |
| Tullibody, Perth, | ... | 9 | 16 | 6 | 25·5 | 2·83 at 1 ft. up |

(b) Beech at Dalswinton, Dumfries, first measured by Mr. Leny and Sir R. Christison in 1857. Although its rate has decreased, the tree is now (April 1893) in splendid condition, and perfectly healthy. Girth at 6 feet, 13 feet 6½ inches.

| | Girth at 3½ feet. | | Number of Years. | Rate. |
|---|---|---|---|---|
| | Ft. | In. | | In. |
| 1857 | 11 | 11 | ... | ... |
| 1875 | 13 | 2½ | 18 | 0·86 |
| 1887 | 13 | 11¾ | 12 | 0·77 |
| 1892 | 14 | 2¾ | 5 | 0·60 |
| | | | 35 | 0·80 |

(c) Young and middle-aged beeches at various localities, at 5 feet up.

| SITUATION. | Date. | Period. | Girth. | | Increase. | Rate. | OBSERVER. |
|---|---|---|---|---|---|---|---|
| | | Yrs. | Ft. | In. | In. | In. | |
| Edinburgh Arboretum, | 1892 | 4 | 1 | 2 | 4·90 | 1·25 | D. Christison |
| Do. do. | ,, | 4 | 1 | 3 | 5·25 | 1·31 | do. |
| Manor House, Clifton, | 1890 | 3 | 6 | 4 | .. | 0·95 | Dr. Beddoe |
| Annat Lodge, Perth, | 1889 | 1 | 7 | 1 | .. | 1·05 | Dr. Buchanan White |
| Chantry, Bradford-on-Avon, | 1892 | 1 | 7 | 11 | .. | 1·20 | Dr. Beddoe |
| Do. do. | ,, | 1 | 19 | 8 | .. | 1·25 | do. |
| Annat Lodge, Perth, | 1889 | 1 | 10 | 7 | .. | 0·70 | Dr. Buchanan White |
| Craigiehall, W. Lothian, | 1887 | 10 | 11 | 11 | .. | 0·81 | D. Christison |

(d) Rate of the great Newbattle beech for fifteen years ending November 1892, at a marked line 6½ feet above ground. Original measurement by Sir R. Christison; subsequent ones by me. Given in feet, inches, and tenths of an inch.

| Girth Nov. 1892. | Increase. | | | | | | | Annual Rate. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1880 to 1885. | 1886 to 1888. | 1889. | 1890. | 1891. | 1892. | Total. | First 6 years. | Next 3 years. | Next 4 years. | 13 years. |
| Ft. In. 19 1·5 | In. 2·60 | In. 1·35 | 0·30 | 0·30 | 0·45 | 0·50 | 5·50 | 0·43 | 0·45 | 0·39 | 0·42 |

### 3. Estimation of Age in Ancient Beeches.

The data yield a greater range than in the oaks. In Mr. Hutchison's cases we do not know whether the measurements were taken at a marked line. On the whole, however, the figures are confirmed by the results in the other tables.

*Estimation of Age of the Newbattle Beech.*—Taking the ascertained rate of 0·40 inch for the last 14 years, at a girth of 19 feet, and supposing, according to De Candolle's theory, that the rate had always been nearly the same except in early youth, we get about 550 for the age; but how fallacious this would be is actually proved by measurements taken above a century ago, as will presently appear. Reverting, therefore, to the mode of estimation already explained, let us first take the data which show the most rapid growth. These we find in the large beech at Craigiehall (1 *f*). Fortunately for us, though unluckily for the tree, a violent storm tore away one of the large limbs, producing a gap 4 feet wide in the 9 feet long stem, right down to the pith. In 1879 Sir R. Christison describes the tree as 70 feet high, luxuriant in foliage, with branches extending 50 feet from the trunk to north, south, and west, and only deficient to the east on account of the gap. In this gap he was able to count the rings, at a height of about 6½ feet, throughout the whole radius of 32½ inches, except the inner five, which were decayed, and six more, beginning at a foot from the centre, in which the rings were too indistinct to be counted. It is easy to make allowance for these, however, and dividing the radius, in the diagram drawn up by Sir Robert, into spaces of

$2\frac{1}{2}$ inches, we get the following number of rings in each space:—

| Spaces. | No. of Rings. | Spaces. | No. of Rings. | Spaces. | No. of Rings. | Spaces. | No. of Rings. | Spaces. | No. of Rings. |
|---|---|---|---|---|---|---|---|---|---|
| Inner | 12 | 4th | 7 | 7th | 7 | 10th | 9 | Outer | 14 |
| 2nd | 8 | 5th | 7 | 8th | 7 | 11th | 8 | Additional | 2 |
| 3rd | 8 | 6th | 8 | 9th | 7 | 12th | 12 | | |
| | | | | | | | | Total, | 116 |

Adding the liberal allowance of 14 years for growth up to $6\frac{1}{2}$ feet, we got 130 years for the age of the tree. Its girth was 15 feet 9 inches, but must have been considerably more before the gap was made. Taking it, however, at only 16 feet, and allowing but 5 years for growth up to 5 feet, we establish the fact that a beech *may* attain 16 feet in girth at the narrowest part of the stem within 130 years, thus growing throughout at the annual average rate of 1·53 at the very least. The figures also show that the rate did not fall off till the tree was about 15 feet in girth, and Sir Robert ascertained by annual girth-measurement that at the end of its career, and in spite of the terrible injury, the tree was still growing at the rate of fully an inch annually. This result is so far confirmed by Mr. Marsham's two beeches (1 *a*), which grew at the rate of 1·50 for 35 years.

Valuable assistance in estimating the age of the Newbattle beech is obtained from Prof. Walker's measurements in 1789. He describes "the large beech at Newbattle Abbey, standing on the lawn behind the house," as vigorous and healthy, with an immense head, a span of branches of 89 feet, and a girth of 17 feet at 4 feet up. It is now 23 feet 1 inch at the same height, showing a growth of 6 feet in a century, or at the average annual rate of 0·72 inch. But from what we know of its present form, the stem must have had much the same girth, at 6 feet 6 inches, a century ago, as the Craigiehall stem had at the same height. Thus we get 130 for the *possible* age of the Newbattle beech in 1789, and adding the 103 years to 1892, 233 for its *possible* present age.

Admitting that the rate of the Craigiehall tree is quite extraordinary, and making an estimate from our more moderate data, it is evident that when 12 feet in girth the tree might easily have been 154 years old. Now the rate for the last 13 years is known to be 0·40 inch, and that of a 12 feet tree being known to be 0·80 inch, if we take 0·50, or half an inch, for the average rate between 12 and 19 feet—a very moderate estimate, allowing for the gradual diminution of the rate with age—the age comes out as about 320.

Again, Sir Robert Christison ascertained the age of the splendid beech at Cramond (1 *c*) to be between 200 and 215, with a girth of 16 feet at 5 feet: allow the Newbattle tree to have attained the same size at the same age—it is now 20 feet at that height; take the ascertained recent rate of 0·40 at 6 feet 6 inches as having lasted during the whole time the tree took to grow from 16 to 20 feet in girth at 5 feet, and we get 120 to add to, say, 210, or 330 in all. But the rate must be greater where the tree girths 20 feet than where it is only 19 feet, and it must in all probability be greater in proportion as we recede from the present time. Hence, by this computation, the tree cannot be much, if at all, above three centuries old. Altogether, we may conclude that the age is not likely to exceed 320 years, and may *possibly* not be above 250.

The rate of two of the secondary trees springing from one of the rooted branches of the giant I ascertained for four years, as follows:—

| | Girth. | Increase. | | | | Average Rate. |
|---|---|---|---|---|---|---|
| | April 1889. | 1889. | 1890. | 1891. | 1892. | |
| Parent branch, . . | 24·70 | 0·00 | 0·00 | 0·00 | 0·00 | 0·00 |
| Young tree No. 1, . | 48·00 | 0·60 | 0·45 | 0·60 | 0·55 | 0·52 |
| Do. No. 2, . | 38·85 | 0·65 | 0·90 | 1·00 | 1·50 | 1·01 |

It thus appears that the young trees are growing vigorously, while their parent branch has ceased to grow. The numerous young trees, of which these two are but examples, must therefore be attracting much of the nourishment that ought to go to the parent tree, and it is to be feared that as the youths grow up they may gradually starve and kill the parent. It is a serious question, therefore, whether they should not be removed, bearing in mind the risk there might be of exposing the giant more freely to the assaults of the wind, a danger which could probably be avoided by removing the secondary trees gradually.

### III. THE SPANISH CHESTNUT (*Castanea vesca*).

According to Mr. Hutchison's tables the Spanish chestnut comes next to the oak in productiveness of large trees in Scotland, at least as far as girth measurement goes. It is necessary, however, to deduct two from the eighteen which figure in his list as above 17 feet in girth at 5 feet, because they measure less than 17 feet lower down, and in four others the same fault may be suspected, although the data are insufficient to prove it. I have placed these six, therefore, in a separate list, and have added to the first list two others which are entitled to a place in it.

Spanish chestnuts, 17 feet in girth and upwards at 5 feet up, or at the probable narrowest point. Chiefly from Mr. Hutchison's Table of 116 Scottish specimens (Trans. H. and Agr. Soc. Scot., 1879).

| | Girth. | | Height of Bole. | Height of Tree. | Spread of Branches. |
|---|---|---|---|---|---|
| | Ft. | In. | Ft. | Ft. | Ft. |
| Newbattle, Midlothian, . . | 17 | 0 | ... | 80 | ... |
| Lochryan, Wigtown, . . | 17 | 2 | 10 | 60 | ... |
| Gask, Perth, . . . . . | 17 | 2 | ... | 35 | ... |
| Newbattle, Midlothian, . | 17 | 10 | ... | 75 | ... |
| Ardkinglass, Argyll, . . | 17 | 11 | ... | 35 | 42 |
| Duntarvy, West Lothian, . | 18* | 0 | ... | 85 | ... |
| Castle-Menzies, Perth, . . | 19 | 2 | ... | 60 | ... |
| Inveraray, Argyll, . . | 19 | 4 | ... | 85 | ... |
| Ardgartan, Argyll, . . | 20 | 8 | 25 | 90 | .. |
| Bemersyde, Roxburgh, . . | 21 | 6 | ... | 50 | ... |
| Camnethan, Lanark, . . | 22 | 0 | 10 | 70 | ... |
| *Not in Mr. Hutchison's List.* | | | | | |
| Castle-Leod, Ross, . . | 19 | 6 | ... | ... | ... |
| Keir, Perth, . . . . . | 20 | 0 | ... | ... | ... |
| *Highest in Mr. Hutchison's List.* | | | | | |
| Marchmont, Berwick, . . | 14 | 6 | 32 | 102 | ... |
| *Greatest Branch-Spread.* | | | | | |
| Ardkinglass, Argyll, . . | 15 | 9 | ... | 90 | 72 |
| Tillicoultry, Clackmannan, . | 16 | 0 | ... | 75 | 72 |

Number exceeding 15 feet in girth at 5 feet.

| | | |
|---|---|---|
| 15 to 16 feet, . . | 9 | Probably all these would be retained as above 15 feet at the *narrowest* girth, but several would be reduced from the higher to the lower ranks. |
| 16 ,, 17 ,, . . . . | 11 | |
| 17 ,, 18 ,, . . . . | 8 | |
| 18 ,, 19 ,, . . . . | 3 | |
| 19 ,, 20 ,, . . . . | 5 | |
| Above 20 ,, . . . . | 3 | |
| Above 15 feet, | 39 | |
| Above 20 feet in girth at 1 foot, . . . . . . | | 21 |

Except the Marchmont tree none exceed 90 feet in height, and only four reach it.

The trees, 17 feet in girth and upwards at 5 feet, excluded from the table are:—

| | Ft. | In. | |
|---|---|---|---|
| Taymouth, Perth, . . | 17 | 5 | Only 14 ft. 6 in. at 3 ft. in 1862. |
| Kirkmichael, Ayr, . . | 17 | 0 | Only 15 ft. 6 in. at 6 ft. in 1862. |
| Kirkconnel, Dumfries, . | 18 | 7 | Only 10 ft. at 1 ft.; surely some mistake here. |
| Menteith, Stirling, . . | 18 | 6 | Only 16 ft. at 3 ft. |
| Dunipace, Stirling, . . | 19 | 6 | Bole only 6 ft. |
| Murthly, Perth, . . | 17 | 7 | Bole not given, and no other details. |

Scottish Chestnuts. — 1. Ardgarten Chestnut. — Probably this was the finest and most promising Spanish chestnut in Scotland until a few years ago. In 1867 Sir Robert Christison described it as having a tall, beautiful trunk, without humps, 20 feet in girth at 5 feet up. Unfortunately, a storm in 1875 broke it over, and reduced its height from 100 to 70 feet. He found, nevertheless, in 1877 that the girth had increased 8 inches since 1867, and that the foliage was still dense and healthy. In 1879, Mr. James Gordon, gardener at Luss, found the girth at 7 feet up to be 19 feet 10½ inches.

2. Keir Chestnut.—Sir Robert described this in 1878 as venerable and staghorned, with scanty foliage and many rugged humps. At 4 feet up, where most free from these, it girthed 20 feet.

3. Edmonstone Chestnut.—Probably the largest near Edinburgh. Sir Robert found it to be 16 feet 10 inches in girth 5 feet up in 1879.

4. Finavon Chestnut, Forfarshire.—One of the largest deciduous trees in Scotland, of which we have a well-

authenticated record. It was solemnly measured in 1744 before two justices of the peace, with the following results:—

| | Ft. | In. |
|---|---|---|
| Girth of trunk 6 inches up, | 42 | $8\frac{1}{2}$ |
| ,, ,, at narrowest, | 30 | 7 |
| ,, top of trunk, where grains branch, | 35 | 9 |
| ,, largest grain, | 23 | 9 |
| ,, smallest grain, | 13 | $2\frac{3}{4}$ |

These dimensions are well borne out by a print of 1750, a copy of which was sent to Sir Robert by Mr. Hutchison. The tree was in a state of decay when measured, but its remains were not cut down till about 35 years ago.

5. KINFAUNS CHESTNUT.—Another veteran of the past, cut down in 1760. Girth at 4 feet up, 22 feet 6 inches (Dr. Walker).

ENGLISH CHESTNUTS.—1. TORTWORTH CHESTNUT, GLOUCESTERSHIRE.—Even the Finavon giant seems dwarfed by this wonderful tree, of which the following measurements have been published:—

(*a*) Girth at 6 feet up, 51 feet 6 inches, stem not hollow, but the boughs few and small (Bradley's Phil. Acct. of Works of Nature, 1739).

(*b*) Girth at 6 feet up, 46 feet 6 inches in 1759 (Mr. R. Marsham).

(*c*) In 1776 girthed 50 feet at 6 feet, and one of its limbs $28\frac{1}{2}$ feet at 5 feet from the stem (Strutt's Sylva Brit., 1822).

(*d*) In 1877 it still survived as a ruin, with a hollow trunk, throwing out shoots to a height of 40 feet. When carefully measured for Mr. Hutchison, the girth at 1 foot was 45 feet 9 inches, and at 5 feet, 47 feet 9 inches.

2. In LORD PETRE'S PARK, Writtle, Essex, a chestnut 42 feet 5 inches in girth at $3\frac{1}{2}$ feet, the narrowest part; 46 feet 1 inch at 5 feet; 49 feet $5\frac{7}{8}$ inch at 6 feet.—Mr. R. Marsham, 1755.

3. Largest of "THREE SISTERS," BACHYMBYD, NORTH WALES (Mr. Cornwallis West of Ruthin Castle, 1878). Girth at one foot, 36 feet 6 inches; at 5 feet, 34 feet 6 inches; at 7 feet, 35 feet 4 inches. Height about 70 feet.

4. COBHAM PARK CHESTNUT.—35 feet 2 inches at the ground, 29 feet at 3 feet, 33 feet at 12 feet, and 40 feet at the division into limbs.—Strutt's Sylva Brit., 1822.

5. CROFT, HEREFORD.—25 feet 6 inches at 5 feet up.—Trans. Woolhope Club, 1870.

## Rates of Girth-Increase.

1. Six Spanish chestnuts, Kirkconnel, Dumfries, planted in 1748 (from family records; Mr. Maxwell Witham to Mr. Hutchison, 1878).

| | Date of Measurement. | Girth at 1 Ft. | Girth at 5 Ft. | Rate at 1 Ft. | Rate at 5 Ft. | Period of Years. |
|---|---|---|---|---|---|---|
| | | Ft. In. | Ft. In. | In. | In. | |
| Average of six, . . | 1878 | 16 6 | 12 3 | 1·52 | 1·14 | 130 |
| The largest, . . | 1878 | 21 0 | 16 0 | 1·93 | 1·47 | 130 |

2. Two planted at Rosebank, Midlothian, 1729, girthed 5 feet 4 inches in 1761. Rate for thirty-two years, 2 inches. One at Lochnell, Argyllshire, thirty-six years old, girthed 5 feet. Rate 1·66 inch. All at 4 feet up (Dr. Walker).

3. Young or middle-aged trees, from girth measurements at 5 feet up.

| Situation. | Date. | Period. | Girth. | Rate. | Authority. |
|---|---|---|---|---|---|
| | | Yrs. | Ft. In. | In. | |
| Dunkeld, Perth, . | 1889 | 1 | 0 7 | 1·12 | Mr. Fairgrieve |
| Annat Lodge, Perth, | ,, | 1 | 4 1 | 1·45 | Dr. Buchanan White |
| Edin. Bot. Garden, . | 1892 | 15 | 7 0 | 0·90 | D. Christison |
| Annat Lodge, Perth, | 1889 | 1 | 8 9 | 0·90 | Dr. Buchanan White |

4. One at Dalswinton, Dumfries, first measured 1836, by Mr. J. M. Leny and Sir R. Christison, at 5 feet. In April 1893 it looks very shabby, and has probably long been failing, as the decreasing rate also testifies.

| Girth, 1836, . Ft. 9 In. 6 | Period. | Girth. | Rate. |
|---|---|---|---|
| | Years. | Ft. In. | Inch. |
| 1836 to 1875, . . | 39 | 11 9 | 0·70 |
| 1875 to 1887, . . | 12 | 12 4 | 0·58 |
| 1887 to 1892, . . | 5 | 12 6¾ | 0·55 |

5. Two at Castle-Menzies, Perth. First measured by

Sir R. Christison, 1879; re-measured by Sir R. Menzies, 1892, at 5 feet up.

| | Period. | Girth, 1892. | Rate. |
|---|---|---|---|
| | Years. | Ft. In. | |
| No. 1, . . . . | 13 | 14 0 | 1·00 |
| No. 2, . . . . | 13 | 14 8 | 1·23 |

6. Old chestnuts at 5 feet up.

| Situation. | Girth. | Period. | Rate. | Authority. |
|---|---|---|---|---|
| | Ft. In. | Yrs. | | |
| Polloc, Renfrew, . . | 15 6 | 41 | 1·07 | Mr. Hutchison's Table |
| Dumbarney, Perth, . | 16 0 | 16 | 1·50 | do. do. |
| Ardgarten, Dumbarton, | 20 8 | 10 | 0·60 | Sir R. Christison, 1879 |
| Hevingham, Norfolk, . | 14 8½ | 168 | 1·04 | Mr. R. Marsham, 1780 |

From the above data the Spanish chestnut appears to be a quick grower, even when of very considerable size. The age of the Kirkconnel trees seems perfectly well ascertained from family records, and if we construct a scheme for the age of the deceased Finavon giant, 30 feet in girth at the narrowest, founded on the rate of the most vigorous of these, and on that of the Ardgarten tree, supposing the rate of the Finavon tree after passing the size of the Ardgarten one to be reduced to one-half of that of the latter, we get the following:—

| Size. | Rate. | No. of Years. |
|---|---|---|
| 0 to 192 inches | 1·47 | 130 |
| 192 to 240 ,, | 1·00 | 48 |
| 240 to 248 ,, | 0·60 | 10 |
| Possible least age of Ardgarten tree, | | 188 |
| 248 to 368 inches | 0·30 | 400 |
| Possible age of Finavon tree, . . | | 588 |

This estimate, however, is founded on the theory that a very large tree, 30 feet in girth, would begin to grow slowly at the same size as that at which a tree never exceeding 20 feet in girth began to grow slowly. But is it not more likely that the greater tree, like the lesser one, would not slacken in its rate till within a few feet of attaining its final girth? In that case about four centuries, or even less, seems not at all an impossible period for a Spanish chestnut, 30 feet in girth, to attain its full dimensions.

The history of the Finavon tree, confirmed by that of the Tortworth giant, proves that the species is slow to decay. The drawing of 1750 shows that even then the great majority of the branches were leafless, and ten years later Dr. Walker describes only "a great part of the trunk and several branches" as remaining. Nevertheless it was not till 1858, a century later, that it was pronounced dead and was cut down. The whole period of decay cannot have been much less than two centuries.

The Dalswinton chestnut (No. 4) is an example of what I have noticed in trees of various species, that a considerable increase in girth may continue after serious signs of failure in the branches.

## IV. The Ash (*Fraxinus excelsior*).

Scottish ashes above 18 feet in girth at 5 feet from the ground. Chiefly from Mr. Hutchison's Table of 108 Scottish ashes (Trans. H. and Agr. Soc. Scot. xii., 1880).

| Situation. | Girth. | | Height of Bole. | Height of Tree. | Spread of Branches. |
|---|---|---|---|---|---|
| | Ft. | In. | Ft. | Ft. | Ft. |
| Kinnaird, Forfar, . . . | 18 | 3 | 50 | 70 | ... |
| Ochtertyre, Perth, . . | 18 | 3 | 40 | 85 | ... |
| Darnaway, Moray, . . | 18 | 5 | 10 | 60 | ... |
| Do. do. . . | 18 | 8 | 13 | 50 | ... |
| Yair, Selkirk, . . . | 19 | 9 | ... | 115 | ... |
| *Cawdor Castle, Nairn, . . | 20 | 8 | ... | 50 | 84 |
| Highest Ashes. | | | | | |
| Cockburnspath, Berwick, . | 11 | 6 | 18 | 103 | ... |
| Gilmerton, Midlothian, . | 9 | 0 | 36 | 108 | ... |
| Brahan Castle, Ross, . . | 12 | 8* | 17 | 110 | ... |
| Scone, Perth, . . . . | 11 | 2 | 40 | 115 | ... |
| Milne-Graden, Berwick, . | 12 | 2 | 55 | 121 | ... |
| Mount Stuart, Bute, . . | 9 | 6 | 36 | 134 | ... |

* Mr. Charles Clark, forester (Conifer Conf. Statistics, 1891).

Number 100 feet high and upwards, . . 10
From 90 to 100 feet, . . . . . . 13

Number above 15 feet in girth at 5 feet up.

| | |
|---|---|
| 15 to 16 feet, | 5 |
| 16 ,, 17 ,, | 2 |
| 17 ,, 18 ,, | 1 |
| 18 ,, 19 ,, | 4 |
| 19 ,, 20 ,, | 1 |
| Above 20 ,, | 1 |
| Total, | 14 |
| Above 20 feet in girth at 1 foot up, | 16 |

The Yair tree, perhaps the largest thriving ash in Scotland, is difficult to measure, as the ground on which it stands is fully 4 feet higher on the one side than the other. On the 21st June 1893, measuring from the lower side, I found the girth to be 21 feet 6 inches at 5 feet up, 18 feet 2 inches at 6 feet, and 17 feet 10 inches at 8 feet. The circumference of the foliage, which was somewhat thin but healthy, was nearly 300 feet.

The number of remarkable ashes in a flourishing condition is not great, but there is good evidence that the species has produced in the past several trees of the largest size of which we have any record in Scotland. Besides two, which are equalled in the present day,—one at Carnock, Stirlingshire, recorded by Strutt in 1825 as being 31 feet in girth at the ground, 19 feet 3 inches at 5 feet, and 21 feet 6 inches at 9 feet; the other on Inch Merrin, Loch Lomond, recorded by Dr. Walker in 1784, as 21 feet 8 inches at 4 feet,—Dr. Walker mentions three that greatly exceeded these dimensions, (1) a second specimen on Inch Merrin, 28 feet 5 inches at 5 feet; (2) the celebrated ash at Kilmalie, Inverness-shire, burnt to the ground by the soldiery in 1746, the circuit of which was still traceable in the same year, the remains being from several inches to a foot high all round, measuring 58 feet, with cross diameters of 21 and 17 feet, and described by one who remembered it before its destruction as dividing into three great arms at a height of 8 feet; (3) the great ash at Bonhill Place, Dumbartonshire, vestiges of which still remain, described by Dr. Walker in 1784 as girthing 34 feet 1 inch at 4 feet, 21 feet 3 inches at 8 feet, and 22 feet 9 inches at 12 feet, where it divided into three arms (not original, but the result of pollarding), 12, 11, and 10 feet in girth; a room in the trunk was 9 feet 1 inch in diameter, and eighteen people could sit on a hexagonal bench round a table in the middle. Another great ash was blown down at Bonhill Churchyard in 1845. The circle round the base was 63 feet; girth at 3 feet, 26 feet 6 inches; branch spread, 100 feet; height, 113 feet.

My own recollection of another ruined ash at Dalswinton, Dumfries, seen in my youth, is that it was the largest stump of a tree I have ever seen in Scotland. Unfortunately no record of its size has been kept, but Mr. W. M. Leny, the proprietor, writing in 1875, says his recollection was that the last measurement was 39 feet.

But the most satisfactory example is at Logierait, Perthshire, as, although much ruined, enough remains to prove the accuracy of the measurements given in the Statistical Account of Scotland in 1845, when it was still comparatively flourishing. The girth was then 53½ feet at the ground, 40 feet at 3 feet, 22 feet at 11 feet; and the height, 60 feet. The upper part had been carried away, the trunk was hollow, but "the profusion of foliage attracted the eye at a distance to its enormous proportions." The Rev. Mr. Andrew Meldrum, minister of the parish, has supplied me with a drawing, measurements, and description, from which it appears that only half the circumference of the trunk remains, and its height is reduced to 15 feet. The semi-circumference measures 29 feet, and its base-line 18 feet, at the ground. At 3 feet the diameter is 13 feet; at 6 feet, 9 feet; and at 11 feet, 7 feet 6 inches. The tree when complete, therefore, could hardly have girthed less than 30 feet at 5 feet up, and it must have been one of the largest trees in Scotland of which we have a reliable record.

Too late for insertion in the proper place, I have received measurements, taken expressly for me, of the *Capon Oak*, near Jedburgh, one of the very largest oaks in Scotland,—"it covers an area of between 80 and 90 feet diameter. The gnarled stem girths 39 feet near the ground, 23 feet at 4 feet up, the narrowest point, and after giving off a large limb forks at 6 feet up, one limb girthing 10 feet 9 inches, and the other 16 feet 4 inches, a little above the fork" (Mr. T. Caverhill, factor to Lord Lothian).

## RATE OF GIRTH-INCREASE.

Rate of Girth-Increase from measurements 5 feet up.

| SITUATION. | Last Observation. | Girth. | Period. | Rate. | Authority. |
|---|---|---|---|---|---|
| | | Ft. In. | Yrs. | | |
| Edin. Arboretum, . | 1892 | 0 10·30 | 5 | 0·91 | D. Christison |
| Do. do. | 1892 | 1 1·60 | 1 | 1·35 | do. |
| Craigiehall, W. Lothian, | 1890 | 12 | 13 | 0·37 | do. |
| Biel, E. Lothian, . | 1879 | 13 2 | 67 | 0·30 | Mr. Hutchison's Table |
| Dalswinton, Dumfries, | 1887 | 13 3 | 30 | 0·58 | D. Christison |
| From measurements 4 feet up. | | | | | |
| Lord Methuen's Ash, Methven, Perth, . | 1891 | 6 | 28 | 0·64 | Col. Smythe |
| Col. Robert's Ash, do. | 1892 | 7 2 | 29 | 0·69 | do. |
| St. George's Ash, do. | 1892 | 5 3 | 29 | 0·69 | do. |
| Rate from known age of tree, at 3 feet up. | | | | | |
| Colonel Robert's Ash, Methven, Perth, . | 1883 | 7 | 83 | 1·01 | do. |
| St. George's Ash, do. | 1845 | 2 9 | 40 | 0·83 | do. |

At uncertain height, West Felton, Salop, 1880. (Mr. J. Dovaston.)

| Date. | Period. | Girth. | Increase. | Rate. |
|---|---|---|---|---|
| | Years. | Ft. In. | | |
| 1880 . . . . | 69 | 12 7 | 72 | 1·04 |

From known age, at 4 feet up.

| SITUATION. | Last Observation. | Girth. | Period. | Rate. | Authority. |
|---|---|---|---|---|---|
| | | Ft. In. | Yrs. | | |
| Kames, Bute, . . . | 1771 | 10 10 | 80 | 1·62 | Dr. Walker |
| Mellerstain, Berwick, | 1795 | 8 1 | 80 | 1·21 | do. |
| Rate by counting Rings in a fallen tree, at 3 feet. | | | | | |
| Rothesay, Bute, . . | ... | 17 5 | 220 | 0·95 | do. |

The rates yield in general rather low results, although a few are higher than in the oak. The very slow rate of the Craigiehall ash, 12 feet in girth, is accounted for by obvious injury from the great frosts of 1879, as in 1878 it increased 0·70, and never more than 0·45 thereafter, generally much less. Dr. Walker describes an ash at the ferry over the Tay, near the Church of Logierait, well known in the country as "the Ash Tree of the Boat of Logierait," which in July 1770 was a healthy, well-shaped tree, 16 feet in girth at 4 feet up, and about 70 feet high. It is difficult to see how this can be any other than the tree of which the stump still remains, and which we have shown must have been at least 30 feet in girth at 5 feet up, and was, therefore, considerably more at 4 feet. This would give a rate for about seventy-five years of something between $2\frac{1}{2}$ and 3 inches, which seems incredible, unless trees of gigantic size have the power of developing, with great rapidity, the conical swelling which is required to support their increasing weight.

### V. The Sycamore (*Acer pseudoplatanus*).

This species, a favourite in Scotland from its beauty and power of standing our strong winds, seems but rarely to have reached a gigantic size, as Mr. Hutchison's table contains only one 20 feet in girth at 5 feet up.

Scottish sycamores above 17 feet in girth at 5 feet from the ground. From Mr. Hutchison's Table of 153 Scottish sycamores (Trans. H. and Agr. Soc. Scot. xii., 1880).

| Situation. | Girth. | | Height of Bole. | Height of Tree. | |
|---|---|---|---|---|---|
| | Ft. | In. | Ft. | Ft. | In. |
| Castle-Menzies, Perth, . . . . | 17 | 8 | 15 | 90 | 3 |
| Newbattle, Midlothian, . . . . | 18 | 3 | 12 | (?) | |
| Castle-Menzies, Perth, . . . . | 18 | 4 | 35 | 104 | 0 |
| Birnam, Perth, . . . . . | 18 | 11 | 10 | 75 | 0 |
| Newbattle, Midlothian, . . . . | 19 | 8 | (?) | (?) | |
| Tyninghame, East Lothian, . . | 20 | 10 | 37 | 80 | 0 |
| Trees of substantial girth which are 100 feet or more in height. | | | | | |
| Castle-Menzies, Perth, . . . . | 13 | 6 | 28 | 100 | 0 |
| Broxmouth, East Lothian, . . | 15 | 2 | 50 | 100 | 0 |
| Beil, East Lothian, . . . . . | 12 | 7 | 50 | 100 | 0 |
| Braehead, Midlothian, . . . . | 12 | 7 | 14 | 101 | 0 |

Number between 90 and 100 feet in height, 11
,, 100 feet or upwards, . . . . 6
Greatest spread of branches (eighteen given), 90 ft.

Number above 15 feet in girth at 5 feet.

| | |
|---|---|
| 15 to 16 feet . . . . . . . . . | 8 |
| 16 ,, 17 ,, . . . . . . . . | 3 |
| 17 ,, 18 ,, . . . . . . . . . | 3 |
| 18 ,, 19 ,, . . . . . . . . | 4 |
| 19 ,, 20 ,, . . . . . . . . . | 1 |
| Above 20 ,, . . . . . . . . . | 1 |
| Total, . . . | 20 |

Between 20 and 30 feet at 1 foot, . 9
Above 30 feet at 1 foot, . . . . . 1

SCOTTISH SYCAMORES. — NEWBATTLE SYCAMORE.—There is a larger sycamore here than any recorded above, although it is in a very ruinous condition. On 3rd November 1892, I measured it carefully with the assistance of Mr. F. Rhenius Coles. It has a short "bumpy" stem, 34 feet in girth, where it springs, without buttresses, from the ground. A little higher it is 30 feet. It then suddenly narrows to 21 feet 9 inches at 4 feet, but rises again to a considerable height with little or no diminution. The narrowest I could get, where also most free from bumps, was 21 feet 4 inches at 6 feet 8 inches up. This is apparently the tree described by Dr. Walker in 1789 as still sound, but with an aspect of great antiquity, measuring 24 feet 4 inches at 2½ feet, and 18 feet 7 inches at 4 feet.

KIPPENROSS SYCAMORE.—Mr. Hutchison mentions this as long reputed to be "the largest tree in Scotland," and said to be 22 feet 6 inches in girth at 5 feet up in 1798. It was snapped across by a gale, a few feet from the ground, not many years ago. Probably it is the same tree as that described by Sir R. Christison in 1880. A plate on the trunk certifies its girth at the narrowest point to have been 19 feet 6 inches, and he found it still to measure 18 feet 6 inches at 5 feet up, notwithstanding an evident loss of substance.

CASTLE-MENZIES SYCAMORE.—Sir Robert Menzies has sent me, December 1892, the following girths of his finest specimen:—At 1 foot, 28 feet 4 inches; at 3 feet, 22 feet 9 inches; at 5 feet, 19 feet 2 inches.

ENGLISH SYCAMORES.—Perhaps the species was, formerly at least, not such a favourite in England as in Scotland, as Mr. Strutt seems to have been struck with the beauty of the Scottish specimens. His only English example, at Cobham Park, was 26 feet in girth at the ground, and 94 feet high.

### RATE OF GIRTH-INCREASE.

The mature sycamore does not lend itself well to accurate girth measurement, as the bark is not only very rough, but is apt to scale off. As far as my data go, however, this species seems to be of slow growth in girth, although Mr. Hutchison thinks it grows quickly in height. The lower measurements—at 3 feet and 1 foot—indeed yield better results, possibly indicative of rapid growth in the conoid base, but measurements there are little reliable, unless the position has been carefully marked.

Rate of Sycamores of various Ages.

| Situation. | Last Observation. | Girth. | | Period. | Rate. | Authority. |
|---|---|---|---|---|---|---|
| At 5 feet up. | | | | | | |
| No. | | Ft. | In. | Years. | In. | |
| 1. Edin. Arboretum, . | 1892 | 1 | 3 | 6 | 1·14 | D' Christison |
| 2. Do. do. | ,, | 1 | 4 | 6 | 1·19 | do. |
| 3. Edin. Bot. Garden, . | ,, | 5 | 3 | 14 | 0·35 | do. |
| 4. Craigiehall, Midloth'n, | 1890 | 10 | 10 | 13 | 0·44 | do. |
| 5.*Edin. Arboretum, . | 1892 | 11 | 3 | 15 | 0·26 | do. |
| 6. Lochwood, Dumfries, | 1879 | 13 | 4 | 106 | 0·52 | R. Hutchison |
| At 4 feet up. | | | | | | |
| 7. Redhall, Midlothian, | 1879 | 10 | 2 | 81 | 0·30 | do. |
| 8. Do. do. | ,, | 11 | 9 | 81 | 0·36 | do. |
| At 3 feet up. | | | | | | |
| 9. Birnam, Perth, . . | 1879 | 19 | | 16 | 0·56 | do. |
| 10. Rossdhu, Dumbarton, | ,, | 17 | | 83 | 0·50 | do. |
| 11. Houston, Renfrew, . | ,, | 16 | 10 | 16 | 1·00 | do. |
| At 1 foot up. | | | | | | |
| 12. Rossdhu, Dumbarton, | 1879 | 22 | | 16 | 0·75 | do. |

* Largest sycamore in the Arboretum. Shows symptoms of decay.

Aged trees at Castle-Menzies, taken at 5 feet by Sir Robert Christison in 1879, and by Sir R. Menzies in 1892.

| | Date. | Girth. | | Period. | Rate. |
|---|---|---|---|---|---|
| | | Ft. | In. | Years. | |
| No. 1, . . | 1892 | 12 | 5 | 13 | 0·30 |
| No. 2, . . | ,, | 14 | 0 | ,, | 0·30 |
| No. 3, . . | ,, | 15 | 3 | ,, | 0·79 |
| No. 4, . . | ,, | 16 | 4½ | ,, | 0·15 |
| No. 5, . . | ,, | 18 | 9 | ,, | 0·46 |

Another at Castle-Menzies, at several points, 1892.

| | Girth. | | Increase. 13 years. | Rate. |
|---|---|---|---|---|
| | Ft. | In. | In. | |
| At 2 feet, . . | 28 | 4 | 4 | 0·30 |
| ,, 3 feet, . . | 22 | 9 | 9 | 0·69 |
| ,, 5 feet, . . | 19 | 2 | 10 | 0·77 |

*Acer campestris.*

Probably the largest in Scotland, in 1770, at Inveraray, was 7 feet 1 inch in girth at 4 feet.—Dr. Walker.

The rate of a young tree, 14 inches in girth, in the Edinburgh Arboretum in 1892 was 1·60 inch. — D. Christison.

## VI. THE LIME (*Tilia europæa*).

The lime, as Mr. Hutchison remarks, is rarely grown in Scotland except as an ornamental tree, particularly for avenues. There appears to be no record of any remarkable lime which has disappeared.

Scottish limes above 17 feet in girth at 5 feet up. Chiefly from Mr. Hutchison's Table of 69 Scottish limes (Trans. H. and Agr. Soc. Scot., 1883).

| SITUATION. | Girth. | | Height of Bole. | Height of Tree. | Spread of Branches. |
|---|---|---|---|---|---|
| | Ft. | In. | Ft. | Ft. | Ft. |
| Ingliston, Midlothian, . . | 17 | 0 | 20 | 83 | ... |
| *Monzie Castle, Perth, . . | 17 | 10 | ... | ... | ... |
| Kinnaird, Forfar, . . . | 18 | 1 | 6 | 62 | ... |
| Ferniehirst, Roxburgh, . . | 18 | 3 | ... | ... | ... |
| Kinloch, Meigle, Perth, . | 19 | 2 | ... | 73 | 90 |
| Ancrum House, Roxburgh, . | 20 | 0‡ | 12 | ... | ... |
| Kirkmichael, Dumbarton, . . | 23 | 1† | 25 | 80 | 100 |
| Highest Limes. | | | | | |
| Blairdrummond, Perth, . . | 14 | 9 | 6 | 98 | ... |
| Newton-Don, Roxburgh, . | 11 | 10 | ... | 104 | ... |

* Mr. G. Morgan, wood merchant, Crieff, April 1893.
† At 3 feet, no other girth given.
‡ At 5 feet, the narrowest.—Sir R. C., about 1877.
§ By Atkinson's Hypsometer, but I think the height is greater.—D. C., 1893.

Number above 15 feet in girth.

| | |
|---|---|
| 15 to 16 feet, | 4 |
| 16 ,, 17 ,, | 0 |
| 17 ,, 18 ,, | 2 |
| 18 ,, 19 ,, | 2 |
| 19 ,, 20 ,, or upwards, | 3 |
| Total, | 11 |
| Above 20 feet in girth at 1 foot, | 9 |

The Kirkmichael tree I have included because, with its girth of 23 feet 1 inch at 3 feet, and a bole of 25 feet, it cannot fail to be above 17 feet at 5 feet, and may easily be above 20 feet. This tree, with its greater height and wider spread, may surely dispute the premiership which Mr. Hutchison gives to the Kinloch specimen, particularly as the latter is only 21 feet 2 inches at 1 foot, while the former is 23 feet 1 inch at 3 feet.

## Rates of Girth-Increase.

| Situation. | Last Observation. | Girth. | | Period. | Rate. | Authority. |
|---|---|---|---|---|---|---|
| From measurements at 5 feet up. | | | | | | |
| | | Ft. | In. | Years. | | |
| 1. Edin. Arboretum, | 1892 | 0 | 11·5 | 6 | 0·73* | D. Christison |
| 2 Do. do. | ,, | 0 | 11·0 | 6 | 0·56* | do. |
| 3. Do. do. | ,, | 1 | 3·0 | 1 | 1·35 | do. |
| 4. Clifton, Gloucester, | 1890 | 5 | 3·0 | 3 | 1·25 | Dr. Beddoe |
| 5. Polloc, Renfrew, | 1881 | 11 | 3·0 | 23 | 0·91 | Mr. Hutchison's Tables |
| From known age of Tree, at 5 feet. | | | | | | |
| Kenmure, Kirkcudt., | 1883 | 10 | 11·0 | 183 | 0·71 | Mr. Hutchison's Tables |
| Do. do. | ,, | 12 | 1·0 | 183 | 0·79 | do. |
| Kinnaird, Forfar, | ,, | 12 | 8·0 | 200 | 0·76 | do. |
| Do. do. | ,, | 18 | 1·0 | 200 | 1·08 | do. |

* In poor sandy soil.

## VII. The Elm (*Ulmus campestris* and *U. montana*).

Large elms in Scotland are of the *Wych* species, the biggest, *U. campestris*, at Eglinton girthing only 12 feet 4 inches at 5 feet (Hutchison); whereas the great elms of England are nearly all of the latter species.

Scottish elms above 17 feet in girth, at 5 feet up, from

Mr. Hutchison's Table of 105 Scottish elms. (Trans. H. and Agr. Soc. Scot. xv., 1883, p. 84).

| SITUATION. | Girth. | Height of Bole. | Height of Tree. | Spread of Branches. |
|---|---|---|---|---|
| | Ft. In. | Ft. | Ft. | Ft. |
| Newbattle, Midlothian, | 17 11 | ... | ... | ... |
| Carronhall, Stirling, | 18 2 | ... | 85 | ... |
| Kinfauns, Perth, | 19 3 | 7 (?) | 92 | ... |
| | Highest. | | | |
| Biel, East Lothian, | 12 11 | 12 | 102 | ... |
| | Remarkable spread. | | | |
| Strontian, Argyll, | 15 2 | (?) | 63 | 120 |

| | |
|---|---|
| Number between 90 and 96 feet high, | 16 |
| 100 and upwards, | 1 |

Number above 15 feet in girth.

| | |
|---|---|
| From 15 to 16 feet, | 4 |
| .. 16 to 17 .. | 3 |
| .. 17 to 18 .. | 0 |
| .. 18 to 19 .. | 1 |
| .. 19 to 20 .. | 1 |
| Above 15 feet, | 9 |
| Number above 20 feet at 1 foot, | 9 |

NEWBATTLE ELM.—This lofty, though failing, elm stands close to the great beech. In November 1892 I found it at 5 feet 6 inches, apparently the narrowest part, to be 17 feet 9 inches; and at 4 feet, 18 feet 1 inch. The head of foliage is still considerable, and is about 180 feet in circumference.

ENGLISH ELMS. — 1. MOOR COURT, HEREFORD.—"The finest in the country," 18 feet 10 inches at 5 feet up.—Trans. Woolhope Club, 1870.

2. SILVER HALL, ISLEWORTH, THAMES.—Two stems spring from a base, 13 feet 7 inches in diameter, close to the ground, indicating a girth of about 40 feet. At 3 feet the largest limb is 20 feet 4 inches in girth, and at 30 feet, 14 feet 4 inches; at 3 feet, the smallest limb is 14 feet 6 inches in girth.

3. HEVINGHAM PARK, NORFOLK.—At 4 feet, 29 feet 6 inches, in 1779.—Mr. Marsham.

4. BRADLEY, SUFFOLK.—At 5 feet, 26 feet 3 inches, in 1754.—Mr. R. Marsham.

5. Crawley, Sussex.—61 feet in girth at the ground, 35 feet in girth 2 feet up inside the hollow stem.—Strutt's Sylva, 1822.

6. Sprotborough Hall, Yorkshire.—*U. montana*, 18 feet 2 inches at 4 feet up, the narrowest of a 15 feet stem; branch-spread, 148 feet; height about 85 feet.—Mr. Malcolm Dunn, 1891.

Rate of Girth-Increase.

From measurements at 5 feet up.

| Situation. | Last Observation. | Girth. | Period. | Rate | Authority. |
|---|---|---|---|---|---|
| | | Ft. In. | Years. | | |
| Edin. Arboretum, . | 1892 | 1 8·85 | 5 | 1·62 | D. Christison |
| Do. do. | 1891 | 1 4·45 | 4 | 1·44 | do. |
| Bradley Ch., Suffolk, | 1767 | 26 3·00 | 13 | 0·73 | Mr. R. Marsham |
| Polloc, Renfrew, . | 1881 | 14 8·00 | 69 | 0·66 | Mr. Hutchison's Table |

From measurements at 4 feet up.

| Situation. | Date of Observation. | Girth. | Period. | Increase | Rate. | Authority. |
|---|---|---|---|---|---|---|
| | | Ft. In. | Years. | In. | | |
| Newbattle Abbey, | 1789 | 10 4 | ... | ... | ... | Dr. Walker |
| The same tree, . | 1892 | 18 1 | 103 | 93 | 0·90 | D. Christison |

Rate from known age of tree at 5 feet up.

| Situation. | Last Observation. | Girth. | Period | Rate. | Authority. |
|---|---|---|---|---|---|
| | | Ft. In. | Years. | | |
| Sorn, Ayrshire, . | 1881 | 11 4 | 156 | 0·87 | Mr. Hutchison's Table |
| The same tree for same period at 1 foot, . . | | | | 0·93 | ... |

VIII. The Horse Chestnut (*Æsculus hippocastanum*).

Great trees seem to be rarer in this than in any other of the deciduous forest species in Scotland. There are but three in Mr. Hutchison's table above 15 feet in girth at 5 feet from the ground; and although one reaches 19 feet, this may be not quite at the narrowest part, as the bole is only 8 feet high. The species seems not to have been introduced in Britain till about 1620, and may not yet have had time to produce giants.

Scottish horse chestnuts above 17 feet in girth at 5 feet up. From Mr. Hutchison's Table of 68 Scottish horse chestnuts (Trans. H. and Agr. Soc. Scot. xvi., 1884, p. 192).

| SITUATION. | Girth. | | Height of Bole. | | Height of Tree. | Spread of Branches. |
|---|---|---|---|---|---|---|
| | Ft. | In. | Ft. | In. | Ft. | Ft. |
| Eglinton Castle, Ayr, | 17 | 9 | 5 | 0 | 56 | 70 |
| Moncrieffe, Perth, | 19 | 0 | 8 | 0 | 80 | ... |
| Highest. | | | | | | |
| Invercauld, Aberdeen, | 8 | 7 | 6 | 6 | 110 | 55 |
| Only three attain 90 feet or upwards. | | | | | | |
| Greatest branch spread. | | | | | | |
| Newbattle, Midlothian, | 13 | 0 | 15 | 0 | 75 | 103 |

Number 15 feet in girth and upwards.

| | |
|---|---|
| 15 to 16 feet, | 0 |
| 16 ,, 17 ,, | 1 |
| 17 ,, 18 ,, | 1 |
| 18 ,, 19 ,, | 0 |
| 19 and upwards, | 1 |
| Above 15, | 3 |
| Above 20 at 1 foot up, | 2 |

## RATE OF GIRTH-INCREASE.

From measurements at 5 feet up.

| SITUATION. | Last Observation. | Girth. | Period. | Rate. | Authority. |
|---|---|---|---|---|---|
| | | Ft. In. | Years. | | |
| 1. Edin. Arboretum, | 1892 | 1 1·25 | 5 | 1·15 | D. Christison |
| 2. Do. do. | ,, | 1 2·15 | 1 | 1·35 | Do. |
| 3. Do. do. | ,, | 0 11·10 | 1 | 1·15 | Do. |
| 1. Annat Lodge, Perth, | 1889 | 3 3·00 | 1 | 1·05 | Dr. Buchanan White |
| From measurements at 4 feet up. | | | | | |
| Polloc, Renfrew, | 1883 | 15 6·00 | 47 | 1·37 | Mr Hutchison's Table |

Rate from known age of the Tree, at 5 feet.

| SITUATION. | Last Observation. | Girth. | Age. | Rate. | Authority. |
|---|---|---|---|---|---|
| | | Ft. In. | Years. | | |
| Yester, Haddington, | 1883 | 8 6 | 90 | 1·13 | Mr. Hutchison's Table |
| At 4 feet. | | | | | |
| Bargaly, Kirkc'dbright | 1780 | 6 10 | 83 | 1·00 | Dr. Walker |

From the scanty data I have to offer, the horse chestnut appears to be rather a quick grower, even at a considerable age.

## IX. The Walnut (*Juglans regia*).

The walnut cannot be said to make itself much at home in Scotland, where it rarely, if ever, ripens its seed, but a few have been known to attain fair proportions, and the tree at Stobhall, 21 feet 2 inches in girth, 70 feet high, and with a branch spread of 99 feet, must be exceptionally fine.

Scottish walnuts above 15 feet in girth, at 5 feet, chiefly from Hutchison's Table of 40 Scottish walnuts. (Trans. H. and Agr. Soc. Scot. xvi., 1884, p. 196.)

| Situation. | Girth. | | Bole. | Height. | Spread of Branches. | Authority and Remarks. |
|---|---|---|---|---|---|---|
| | Ft. | In. | Ft. | Ft. | Ft. | |
| Cawdor Castle, Nairn, . | 15 | 6 | .. | 60 | 69 | Mr. C. Clark, forester, 1891 |
| Biel, East Lothian . . | 16 | 1 | .. | 65 | .. | Dead in 1883 |
| Castle-Huntly, Perth, . | 16 | 2 | 7 | 65 | .. | |
| Ballinshoe Castle, Forfar, | 15 | 7 | .. | 52 | .. | |
| Edmonstone, Midlothian, | 15 | 11 | .. | .. | .. | At 1 ft. 3 in., the narrowest. Sir R. C., 1879 |
| Stobhall, Perth, . . | 21 | 2 | 12 | 70 | 99 | .. |
| Highest. | | | | | | |
| Milne-Graden, Berwick, . | 13 | 9 | 25 | 80 | .. | .. |
| Only two others reach 80 feet in height. | | | | | | |

Two walnuts, reputed to be the finest in Scotland, were blown down in 1882, at Otterstone, Fife. One is stated, in the information given to Mr. Hutchison, to have been 16 feet in girth at 12 feet, and the other 18 feet at 20 feet, but perhaps measurements taken at such unusual heights were intended to make the most of the girths, and were at the swelling below the great limbs, because I am informed by Mr. John Taylor, cabinetmaker, Edinburgh, who bought one of them, that its stem, 12 feet in length, averaged 4 feet 6 inches in diameter, giving a girth of about 14 feet. Mr. Taylor also tells me that, although the wood of Scottish walnuts is almost always soft and of little value for cabinetmaking, in this instance it was equal to the best Italian quality, and proved to be worth between £300 and £400 for veneering.

Walnut at Whitehall, Shrewsbury.—At 4 feet, 15 feet 7½ inches; spread of branches, 120 feet.—Journal of Forestry, v., 384.

HAWKSTONE PARK, SHROPSHIRE.—1000 feet above the sea; 22 feet in girth at 1 foot; 16 feet 6 inches at 5 feet; 99 feet high; circumference of foliage, 279 feet. —Mr. Hutchison.

Rate of girth-increase in walnut trees:—

| Situation. | Last Observation. | Girth. | Period. | Rate. | Authority. |
|---|---|---|---|---|---|
| Rate in Trees of known age, at 4 feet up. | | | | | |
| | | Ft. In. | Years. | In. | |
| Lochnell, Argyll, . . | 1771 | 3 3 | 36 | 1·08 | Dr. Walker |
| Kames, Bute, . . . | ,, | 6 1 | 70 | 1·04 | do. |
| Kinross House, Kinross, | 1796 | 9 6 | 112 | 1·01 | do. |
| At 5 feet up. | | | | | |
| Logiealmond, Perth, . . | ... | 8 1 | 110* | 0·88 | do. |
| Rate from girth measurements at 5 feet up. | | | | | |
| Gordon Castle, Banff, . | 1883 | 13 4 | 45 | 1·02 | Mr. Hutchison |
| Bradford, Wilts, . . | 1892 | 8 4 | 1 | 0·70 | Dr. Beddoe |

* Ascertained by counting rings in companions blown down.

The remaining deciduous species being less important, and my information concerning them being comparatively slight, I shall do little more than record the collected data.

## X. THE POPLAR (*Populus*, species often not recorded).

| Situation. | Girth at 1 Foot. | Girth at 3 Feet. | Girth at 4 Feet | Girth at 5 Feet. | Authority. |
|---|---|---|---|---|---|
| | Ft. In. | Ft. In. | Ft. In. | Ft. In. | |
| Castle-Menzies, Perth, . . | .. | .. | .. | 11 6 | Sir R. Menzies, 1892. |
| Holyrood Park, Edinburgh, | .. | .. | .. | 11 10 | Sir R. Christison, 1878. |
| Bank of Tweed, Gattonside House, Melrose | 14 6 | 13 0 | 12 9 | 12 4 | D. C., 1892. Bole, 50 ft; Height, 100 ft. |
| Alloa House, Clackmannan, | .. | .. | 13 6 | .. | Dr. Walker, 1792. |
| *Kelso, Roxburgh, . . . | .. | .. | 13 8 | 13 2 | D. Christison, 1892. |
| Scone, Perth, . . . | 18 4 | 15 7 | .. | 14 9 | A. M'Kinnon, 1893. |
| Brahan Castle, Ross, . . | 17 4 | 15 4 | .. | 15 0 | Mr. W. H. Gunn, forester, 1889. |
| Methven Castle, Perth, . | .. | 16 9 | 16 4 | 16 1 | Colonel Smythe, 1892. |
| Dunerub Park, Perth, . . | 19 0 | .. | .. | 17 0† | Hon. B. Rollo, 1893. |

* One of a group of a dozen, 80 to 100 feet high, at the junction of the Teviot and Tweed; two others girth 10 feet 10 inches and 10 feet 2 inches at 5 feet up.
† At 6 feet; a limb, 8 feet in girth, given off 18 inches from ground, prevents measurement at 5 feet. Height, 70 feet; branch spread, 100 feet.

Poplars grow to a great size in the English Midlands. Mr. Malcolm Dunn saw a black Italian poplar cut down in 1863 at Eardiston, Worcestershire, of which the quarter girth, 6 feet up, was 5 feet 3 inches. The lower cut of 12 feet contained 250 cubic feet of sound but coarse timber. Above that it branched. The tree as it stood sold for £10.

Rate of *P. nigra*, 16 feet 9 inches in girth, at 3 feet up, Methven, Perth, from records (Col. Smythe).

| | Period. | Increase. | Rate. | Remarks. |
|---|---|---|---|---|
| | Years. | In. | In. | |
| 1776 to 1812, . . | 36 | 81 | 2·25 | It may be remarked that the rate at 5 feet could not be much less than at 3 feet, as the stem was only 8 inches less at 5 feet than at 3 feet. |
| 1812 ,, 1825, . . | 13 | 31 | 2·38 | |
| 1825 ,, 1839, . . | 14 | 32 | 2·28 | |
| 1839 ,, 1849, . . | 10 | 15 | 1·50 | |
| 1849 ,, 1892, . . | 43 | 42 | 0·90 | |
| | 116 | 201 | 1·73 | |

Nisbet, Berwickshire—Lombardy poplar, 60 ft. high; 6 ft. 1 in. in girth at 4 ft.; 26 years old; rate, 2·80 (Dr. Walker, 1795).
Craiglockhart, Edinburgh—Balsam poplar, 50 ft. high; 4 ft. in girth at 4 ft.; 27 years old; rate, 1·77 (Dr. Walker, 1795).
Annat Lodge, Perth—*P. balsamifera*, 4 ft. 5 in. in girth, rate 0·70; *P. fastigiata*, 7 in. in girth, rate 1·40; *P. alba*, 1 ft. in girth, rate 2·50, all at 5 ft. up, and for one year (Dr. Buchanan White).

## XI. The Oriental Plane (*Platanus orientalis*).

As this species thrives well in the smoke of London, attempts have been made to introduce it in the Edinburgh gardens, but with little success. It grows fairly well for a time, but seems unable to withstand our strong winds. Last century, as we are told in Dr. Walker's essays, the oriental plane was introduced with some success in Rothesay. Lord Bute planted one at Mount Stuart in 1738, which in 1786 was 6 feet 10 inches in girth, giving an annual rate of 1·70 inch. Another at Kaimes was 60 feet high, with a clear stem of 15 feet, 4 feet 1 inch in girth. Dr. Walker also mentions one at Loudon Castle, 4 feet 5 inches in girth. All these girths are at 4 feet from the ground. I have not found any notices of oriental planes in Scotland at the present day.

LEE COURT, BLACKHEATH, KENT.—Girth of an oriental plane at 6 feet, 14 feet 8 inches. Height 60 feet (Strutt's Sylva Brit., 1822).

RILSTON PARK, YORKSHIRE.—The following dimensions furnished me by the Rev. J. J. D. Dent:—

| Position. | Girth. Ft. | Girth. In. | Position. | Girth. Ft. | Girth. In. |
|---|---|---|---|---|---|
| At the ground, . . | 18 | 0 | At 3½ feet, . . . | 14 | 0 |
| ,, 1 foot, . . . | 16 | 4 | ,, 4 feet, . . . | 13 | 7 |
| ,, 2 feet, . . . | 15 | 7 | ,, 6 feet, . . . | 14 | 0 |
| Girth of an arm, . . | 8 | 6 | Length of an arm, . | 34 | 0 |

The rate of a *Platanus* at the Chantry, Bradford-on-Avon, Wilts, 7 feet 10 inches in girth at 5 feet up, for two years, was 1·50 inch (Dr. Beddoe, 1892).

## XII. THE BIRCH (*Betula alba*).

Professor Walker, 1790, quotes from the Stat. Hist. that "many birches in Darnaway Forest girthed 9 feet," and that a birch at Ballogie, Aberdeen, was judged to be 100 feet high.

"A large grove at Balmacniel, Perthshire, 4 to 5 feet in girth at 5 feet up, and 50 to 70 feet high" (Sir R. Christison, 1879).

| Birches at "The Bog," Pityaulisk House, Strathspey. | Girth at The Root. Ft. | Girth at The Root. In. | Girth at 5 Feet up. Ft. | Girth at 5 Feet up. In. | Remarks. |
|---|---|---|---|---|---|
| No. 1, . . . . | 8 | 2 | 6 | 8 | Of good girth for 30 feet |
| No. 2, . . . . | 6 | 10 | 6 | 10 | Stem, 12 ft. Height, 60 ft. |
| No. 3, . . . . | 7 | 7 | 7 | 3 | About 50 feet high |
| No. 4, . . . . | ... | | 7 | 10 | (A. Clarke, forester, 1890) |

From the above it does not appear that the birch often attains a great magnitude. Nevertheless, I have measured one at Newton Don, Roxburgh, girthing 13 feet ½ an inch at the narrowest part of the short stem, which forks at 30 inches above ground, one limb girthing 9 feet 2 inches, the other 7 feet 4½ inches at 5 feet up; height 80 feet; branch spread 70 feet (Sept. 1893).

In England, two at Moccas Park, Hereford, girth 10 feet 1 inch and 9 feet 2 inches at 5 feet up (Trans. Woolhope Club, 1870); and one at Holwood, Kent, 12 feet 2 inches at 3 feet, and 12 feet 1 inch at 5 feet; stem short; the three limbs, 4 feet from the fork, girthed 5 feet 8 inches, 4 feet 1 inch, and 3 feet 7 inches; height, 62 feet; branch spread 57 feet (Mr. A. D. Webster, 1889).

In Ireland, one at Powerscourt, Wicklow, blown down 1868, girthed 12 feet 8 inches at 3 feet up, the narrowest; height, 75 feet (Mr. M. Dunn).

Rates from girth measurements at 5 feet up (D. Christison).

| SITUATION. | Last Observation. | Girth. | Period. | Increase. | Rate. |
|---|---|---|---|---|---|
| | | Ft. In. | Years. | In. | In. |
| Craigiehall, West Lothian, | 1890 | 6 1 | 11 | 4·80 | 0·43 |
| Edinburgh Arboretum, . | 1892 | 2 2·65 | 6 | 5·80 | 0·96 |
| Do. do. | ,, | 1 3·90 | 6 | 6·60 | 1·10 |
| Do. do. | ,, | 1 3 | 1 | 1·75 | 1·75 |

## XIII. THE WILLOW (*Salix*).

I have not seen any account of a large Scottish willow. A decaying short-stemmed one in the Edinburgh Botanic Garden measures 17 feet at the ground and at 1 foot above it, and 18 feet at 2 feet, where the branches are given off. The species grow to a great size in the English Midlands, but I have met with few records of the girths of great English willows.

HAVERSHOLME PRIORY.—Girth at 1 foot, 27 feet 4 inches; 4 feet, 20 feet 5 inches; 7 feet, 28 feet. Height, 40 feet.

ABBOTS WILLOW, BURY St. EDMUNDS.—Girth, 18 feet 6 inches, probably at narrowest; two limbs 15 feet and 12 feet. Height, 75 feet (Strutt).

Rates—1 and 3, Edinburgh Botanical Garden; 2, Annat Lodge, Perth.

| | Last Observation. | | Period. | Increase. | Rate. | Authority. |
|---|---|---|---|---|---|---|
| No. | | Ft. In. | Years. | In. | In. | |
| 1. Salix, Sp., . | 1892 | 0 8·45 | 3 | 5·85 | 1·95 at 5 ft. | D. Christison |
| 2. S. Smithiana, | 1889 | 2 7·30 | 1 | 3·05 | 3·05 at 5 ft. | Dr. Buchanan White |
| 3. S. alba, . . | 1798 | 9 4 | 33 | 112·00 | 3·39 at 4 ft. | Dr. Walker |

## XIV. THE ALDER (*Alnus glutinosa*).

"I had in 1760 a headed alder in my park at Hevingham, Norfolk, 16 feet 2½ inches in girth at 4 feet up" (Mr. R. Marsham).

Mr. Edwin Lees gives a drawing of a monstrous hollow alder near Strawley, Worcester, 45 feet in girth at the base, the neck being 2 feet up, where from the drawing it must be 30 feet at least (Journal of Forestry, vi., p. 4). May this not be more than one tree?

Rate of girth-increase at 5 feet of an alder, Edinburgh Arboretum (D. Christison).

| Last Observation. | Girth. | | Period. | Rate. |
|---|---|---|---|---|
| | Ft. | In. | Years. | Inch. |
| 1889 | 1 | 0·35 | 3 | 0·95 |

## XV. The Australian Gum Tree (*Eucalyptus*).

Several species planted in the Isle of Arran by the Rev. D. Landsborough, Kilmarnock (information furnished by him). Girths at 5 feet up. In calculating the rates I have made allowance where necessary for growth to 5 feet. All the trees were sown or planted, and the measurements taken, in spring.

| | | Girth. | Height. | | Annual Rate. | | |
|---|---|---|---|---|---|---|---|
| | | | | | Girth. | Height. | |
| | | In. | Ft. | In. | In. | Ft. | In. |
| *E. alpina. | Planted . 1884 | ... | 2 | 0 | ... | ... | |
| | Dimensions 1892 | 8 | 13 | 1½ | 1·33 | 1 | 4 |
| E. globulus. | Sown . 1874 | ... | ... | | ... | ... | |
| | Dimensions 1887 | 24½ | ... | | 2·4 | ... | |
| | Do. 1892 | 37 | ... | | 2·6 | ... | |
| E. pauciflora. | Planted . 1880 | ... | A few inches. | | ... | ... | |
| | Dimensions 1887 | 9½ | 21 | 0 | 1·9 | 3 | 0 |
| | Do. 1892 | 23 | 31 | 7 | 2·7 | 2 | 1 |
| E. viminalis. | Sown . 1871 | ... | ... | | ... | ... | |
| | Dimensions 1887 | 14½ | 28 | 0 | 1·2 | 1 | 9 |
| | Do. 1892 | 25 | 43 | 9 | 2·1 | 3 | 1 |
| E. urnigera. | Planted . 1887 | ... | 3 | 0 | ... | .. | |
| | Dimensions 1892 | 6 | 16 | 0 | 1·5 | 2 | 9 |

* Has grown three times as rapidly as two of the same species in Melbourne Botanic Garden.

Eucalyptus, Sp.? Whittinghame, East Lothian (Mr. J. Garrett, head gardener). From seed about 1845. In 1861, when 40 feet high, injured by frost and cut over at 9 feet up. Stump apparently dead for nearly two years, but in 1863 it budded at the base and made a fresh start. Stem at 3 feet up divides into four branches.

Girths, April 1893 (branches taken at 5 feet above ground).

| | Ft. | In. | | Ft. | In. |
|---|---|---|---|---|---|
| Trunk at 2 feet, . . | 11 | 10 | Branch No. 3, . . | 4 | 9 |
| Do. 3 feet, . . | 12 | 2 | Do. No. 4, . . | 3 | 8 |
| Branch No. 1, . . | 6 | 7 | Height, . . . | 62 | 0 |
| Do. No. 2, . . | 4 | 10 | | | |

The upward growth has been at the annual rate of about 2 feet for thirty years; and the girth-rate at 2 feet, probably the narrowest part, about 3¼ inches for forty-three years, a deduction of four years being made for growth to 2 feet, and for two years of inactivity, from 1861 to 1863.

## XVI. Other Deciduous Species.

| | | Girth. | |
|---|---|---|---|
| | | Ft. In. | |
| Carpinus Betula, . | Bargaly, Kirkcudbright | 6 2 at 4 ft. | Dr. Walker, 1780 |
| Do. | Writtle, Essex | 12 0 ,, 5 ,, | Mr. R. Marsham, 1764 |
| Cratægus Oxyacantha | Loch Leven, Kinross | 6 4 ,, 5 ,, | Dr. Walker, 1796 |
| * Do. | Castle-Huntly | 6 10 ,, 3 ,, | do. do. |
| * Do. | Scone, Perth | 9 0 ,, 4 ,, | do. do. |
| † Do. | Hethel Ch., Norfolk | 9 1½ ,, 4 ,, | Mr. R. Marsham, 1755 |
| ‡ Do. | Holwood, Kent | 14 6 ,, 3 ,, | Mr. Webster, 1889 |
| Cytisus Laburnum, . | Greenlaw, Edinburgh | 4 6 ,, 4 ,, | Dr. Walker, 1763 |
| Prunus Padus, . . | Drumlanrig, Dumfries | 8 0 ,, 4 ,, | do. do. |
| § Prunus (Geen), . . | Holm, Kirkcudbright | 5 6 ,, 4 ,, | do. do. |
| Do. (White Heart Cherry) | Kames, Bute | 5 10 ,, 4 ,, | do. do. |
| Pyrus communis, . | Melrose | 8 10 ,, 4 ,, | do. 1795 |
| Do. | do. | 8 0 ,, 4 ,, | Mr. Curle, 1893 |
| Do. | do. | 8 0 ,, 2 ,, | do. do. |
| Do. | Restalrig, Edinburgh | 12 0 Stem 2½ ft. | Dr. Walker, 1799 |
| ‖ Pyrus malus, . . | Jedburgh | 7 2 at 3 ft. | do. 1763 |
| Robinia pseudac, . | Newland, Gloucester | 11 0 ,, 5 ,, | D. Christison, 1893 |
| ¶ Do. | Hollydale, Kent | 14 10 ,, 3 ,, | Mr. Webster, 1889 |

* From the Stat. Account. † One arm extended 21 feet.
‡ Divides at 3 feet into six limbs, 4 feet 2 inches, 4 feet, 5 feet 8 inches, 2 feet 8 inches, 4 feet 4 inches, and 3 feet 5 inches in girth. Height, 42 feet; Branch spread, 63 feet.
§ Height, 50 feet; Branch spread, 33 feet. ‖ Branch spread, 40 feet.
¶ Height, 78 feet; Branch spread, 54 feet.

Quercus Cerris—Cramond House, Midlothian, 12 feet 8 inches at 5 feet (narrowest point)—(Sir R. C., 1878).

Quercus rubra—Newton Don, Berwick, 8 feet 3½ inches at 3 feet (narrowest point). Circumference of foliage, 220 feet; longest branch, 41 feet (D. Christison, 1893).

| | | Last Observation. | Girth. | Period. | Rate at 5 Feet. | |
|---|---|---|---|---|---|---|
| | | | In. | Yrs. | Ins. | |
| Amygdalus communis | Bradford-on-Avon | 1892 | 20 | 1 | 0·90 | Dr. Beddoe |
| Carpinus Betula | Edin. Arboretum | ,, | 12 | 6 | 0·79 | D. Christison |
| Cratægus Oxyacantha | do. | ,, | 16 | 5 | 1·15 | do. |
| Do. | Edin. Botanical Gar. | ,, | 46 | 15 | 0·55 | do. |
| Cytisus Laburnum | Edin. Arboretum | ,, | 11 | 6 | 0·80 | do. |
| Mespilus germanica, | Bradford-on-Avon | ,, | 14 | 1 | 0·85 | Dr. Beddoe |
| Morus nigra, | Clifton, Bristol | 1891 | 9 | 4 | 0·90 | do. |
| Prunus Padus, | Drumlanrig, Dumf. | 1773 | 96 | 70 | 1·37 | Dr. Walker |
| Do. | Edin. Arboretum | 1892 | 13 | 5 | 1·28 | D. Christison |
| Do. | do. | ,, | 14 | 1 | 2·00 | do. |
| Pyrus Aucuparia, | do. | ,, | 15 | 5 | 0·94 | do. |
| Do. communis, | do. | ,, | 12 | 1 | 0·95 | do. |
| Do. do. | Clifton, Bristol | 1891 | 24 | 2 | 0·87 | Dr. Beddoe |
| Quercus Cerris, | Edin. Botanical Gar. | 1892 | 50 | 15 | 0·56 | D. Christison. |
| Do. do. | do. | ,, | 64 | 6 | 0·60 | do. |
| Do. do. | Craigiehall, W. Loth. | 1890 | 82 | 11 | 0·89 | do. |
| Do. conferta, | Edin. Botanical Gar. | 1892 | 34 | 13 | 1·54 | do. |
| Do. do. | do. | ,, | 38 | 13 | 1·68 | do. |
| Do. do. | do. | ,, | 47 | 15 | 1·54 | do. |
| Do. rubra, | do. | ,, | 9 | 3 | 1·06 | do. |

## B. NON-CONIFEROUS EVERGREENS.

### I. The Holly (*Ilex aquifolium*).

Many hollies branch near the ground, when measurement at 5 ft. is impracticable. But some have an appreciable bole, and enter the class of smaller forest trees. Only nine in Mr. Hutchison's list attain 45 ft. in height, the highest being 52 ft.; and only three attain 10 ft. in girth at their narrowest, the biggest being 12 ft. 6 in. But a holly at Clochfaen, Llanidloes, N. Wales, girths 30 ft. above the roots; two of its sixteen main branches, which spring from near the ground, girth 11 ft. 7 in. and 8 ft. 2 in.; height, 43 ft.; branch spread, 54 ft. Another holly in the same valley girths 17 ft. 6 in. at the ground (Col. G. H. Lloyd-Verney, 1893).

Hollies above 7 ft. in girth. From Mr. Hutchison's Table of 89 Scottish hollies (Trans. H. and Agr. Soc. of Scot., 1892).

Hollies with short boles.

| Situation. | Bole. | Girth at 1 Foot. | | Height. |
|---|---|---|---|---|
| | Feet. | Ft. | In. | Feet. |
| Darnaway, Moray, | 3 | 9 | 0 | 40 |
| Do. do. | 3 | 8 | 8 | 30 |
| Do. do. | 2 | 10 | 4 | 38 |
| Do. do. | 3 | 7 | 10 | 35 |
| Do. do. | 3 | 12 | 6 | 30 |
| Do. do. | 3 | 10 | 8 | 35 |

Hollies with comparatively long boles.

| Situation. | Bole. | | Girth at 1 Foot. | | Girth at 3 Feet. | | Girth at 5 Feet. | | Height. |
|---|---|---|---|---|---|---|---|---|---|
| | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. | Feet. |
| Skibo, Sutherland, | 7 | 9 | 7 | 3 | 6 | 8 | ... | | 28 |
| Do. do. | 8 | 0 | 7 | 0 | 6 | 6 | ... | | 42 |
| Kinloch, Meigle, Perth, | 15 | 0 | 7 | 2 | .. | | 7 | 3 | 40 |
| Gordon Castle, Moray, | 7 | 0 | ... | | 8 | 5 | 7 | 7 | 33 |
| Darnaway, Moray, | 15 | 0 | 9 | 9 | ... | | 9 | 4 | 42 |
| Glenkill, Arran, | 14 | 0 | ... | | 8 | 3 | ... | | 50 |
| Do. do. | 18 | 0 | 11 | 2 | 9 | 2 | 8 | 1 | 33 |
| Hollydale, Kent (A. D. Webster), | ... | | ... | | 9 | 4 | 9 | 2 | ... |

## Rate of Girth-Increase.

The only apparently reliable rate of girth-increase in the holly that I can find is given below. If the reputed age of other trees in Mr. Hutchison's list were reliable, they would yield a much slower rate, but the one I give is the only instance in which the date of planting is positively stated.

| Situation. | Length of Bole. | Girth at 5 feet. | | Age. | Rate. |
|---|---|---|---|---|---|
| | Feet. | Ft. | In. | Years. | Inch. |
| Brahan, Ross, | 12 | 6 | 10 | 112 | 0·74 |

## II. The Evergreen Oak (*Quercus Ilex*).

One at Castle-Kennedy, Wigtownshire, girths 15 feet at 1 foot; 14 feet at 3 feet; 15 feet at 5 feet; is 48 feet high, and the circumference of foliage is 186 feet (Mr. W. Cruden, gardener, 1893).

Another at Burghill, Hereford, girthed 9 feet 10 inches at 5 feet, was 50 feet high, and had a branch spread of 63 feet (Trans. Woolhope Club, 1870).

Rate of an evergreen oak, Edinburgh Botanical Garden, injured by severe winter of 1878,—46·60 inches in girth in 1892; also of a very young one, Edinburgh Arboretum, 8 inches in girth 15 inches up.

| | Period. | Increase. | Rate. |
|---|---|---|---|
| | Years. | Inches. | |
| 1879 to 1889, } old tree | 11 | 3·40 | 0·31 |
| 1889 to 1892, } old tree | 3 | 1·70 | 0·56 |
| 1887 to 1892, young tree | 6 | 3·70 | 0·62 |

## III. The Box (*Buxus sempervirens*).

Dimensions of box trees on Inchmahome, Lake of Menteith (Mr. R. Hutchison, 1887).

| | Girth at Ground. | | At 1 foot. | | Height. | |
|---|---|---|---|---|---|---|
| | Ft. | In. | Ft. | In. | Ft. | In. |
| Largest, . . . . | 2 | 8 | 3 | 3 | 20 | 6 |
| Other two, . . . | 1 | 3 | ... | | 22 | 0 |

## C. CONIFERÆ.

### 1. Native or Long-Introduced.

#### i. The Scots Fir (*Pinus sylvestris*).

I have been able to hear of but few existing native firs of remarkable size in Scotland. Indeed, the general impression as to the dimensions attainable by the species may be expressed by the bold assertion, made a few years ago, that a Scots fir blown down at Lawers, measuring only 13 feet 9 inches in girth, was the largest in the world! Nevertheless, besides three trees of slightly greater girth,—one of 14 feet 7 inches, "Magog," at Guisachan; another of 14 feet in Duthil Forest; the third, "Peter Porter," 13 feet 10·5 inches (Sir R. Christison, 1880), at Abernethy,—there are two which exceed the Lawers tree by several feet, one at Glenfeshie, 15 feet 8 inches at 5 feet, the other at

Abernethy, no less than 1500 feet above the sea, 16 feet 6 inches at 3 feet, the narrowest point. That other giants do not exist is no doubt due to the almost total destruction of the primeval Highland forests about a century ago, when they were leased to English companies for shipbuilding or manufacturing purposes. Certain it is that even greater dimensions were attained by at least one tree in Glenmore, a plank from which is preserved at Fochabers. By examination of this plank Sir Robert Christison proved (Trans. Ed. Bot. Soc., 1878, p. 229) that the tree from which it came must have been at least 19, and probably was 20 feet in girth at 6½ feet up. Mr. Clark, the forester, has informed me that the girth at its root, which existed in 1890, was 28 feet, and at a "middle cut," which still lay on the ground, was nearly 12 feet. Another tree in Glenmore Forest, possibly rivalling this, was blown down in 1868, which yielded a plank "certainly over 5 feet 6 inches in width."

This species is not remarkable for height in the Highland forests. A tree at Castle-Grant, blown down in 1868, called "The King" from its superior height, measured 93 feet, but it was only 6 feet in girth at the root. Only one other Highland tree in my table reaches 90 feet, and the next highest is only 70 feet. Probably the three magnificent trees at Arniston (see the Table) are unequalled in Scotland for combined height and girth. They rival neighbouring beeches, some of which were blown down, and measured on the ground considerably above 100 ft. Mr. J. S. Blackett, C.E., measured one 7½ feet in girth, at Bessborough, Co. Kilkenny, as it lay on the ground, which was 97 feet long. —Mr. J. Horn Stevenson to Sir R. Christison, 1879.

In the plantations of North Germany the Scots fir is made to grow to a great height. According to Schwappach (Wachstum normaler Kiefernbestande, Berlin, 1889), at 140 years of age, 137 trees on an English acre should average 106 feet in height, with a girth about 4½ feet at breast height.—A. C. Forbes, in Trans. Roy. Scot. Arb. Soc., vol. xiii., p. 2.

Scots firs above 10 feet in girth at 5 feet up, unless otherwise stated.

| LOCALITY. | Girth. | Bole. | Height. | Authorities and Remarks. |
|---|---|---|---|---|
| | Ft. In. | Ft. | Ft. | |
| Cammo, Midlothian, | 10 2 | 28 | 71 | Branch spread, 65 feet (Sir R. Christison, 1879). |
| Hopetoun, W. Lothian, | 10 4 | .. | 83 | Mr. T. Smith, gardener, 1893. |
| Dunmore, Stirling, | 10 3 | .. | 67 | |
| Murthly, Perth, | 10 7 | .. | .. | Largest on estate, 1879. |
| Rossdhu, Dumbarton, | 11 0 | .. | 65 | Conifer Conf. Statistics, 1891. |
| Bowhill, Selkirk, | 11 0 | 25 | 55 | 13 feet 6 inches at ground; circumf. of foliage, 190 feet (D. C., 1893). |
| Dalswinton, Dumfries, | †11 3 | 4 | .. | |
| Taymouth Castle, Perth, | 11 6 | .. | .. | Sir R. Christison, 1878. |
| Brodie, Nairn, | ‡13 0 | .. | 60 | |
| Castle-Huntly, Perth, | §13 6 | .. | .. | |
| Lawers, Perth, | 13 6 | .. | .. | Journ. of Forestry, vi., 638. |
| Guisachan, Inverness, | ‖14 7 | .. | .. | |
| Moccas Park, Hereford, | 10 11 | .. | .. | Largest in Park (Trans. Woolhope Club, 1870). |
| *In the Forests of Strathspey, Inverness.* | | | | |
| Loch an Eilan, | 10 7 | .. | 45 | Mr. J. Christison, 1890. |
| The Slughan, Glenmore, | 10 11 | .. | 45 | do. do. |
| Carr Bridge, | 11 7 | .. | .. | do. do. |
| The Slughan, Glenmore, | 11 9½ | 10 | 50 | do. do. |
| Gorge near Loch Morlich, | 12 0 | .. | 45 | do. do. |
| Do. do. | 12 1 | 27 | .. | 14 feet 2 inches at ground (Mr. Clarke, forester, 1890). |
| Loch an Eilan, | 12 3 | 50 | 70 | Branch spread, 60 ft. (J. C., 1890) |
| Ord Bain, Loch an Eilan, | 13 1 | .. | 50 | J. Christison, 1890. |
| Abernethy, | 13 10·5 | .. | .. | "Peter Porter" (Sir R. C., 1880) |
| Sleuich, do. | 16 6 | 10 | 52 | At 3 ft., 16 ft. 6 in., also at the ground, 18 ft. at 4 ft., 18 ft. 5 in. at 5 ft. (Mr. J. G. Thomson, wood manager, May 1893) |
| Lethendry Hill, Duthill For., | 10 0 | 21 | 65 | Great head of foliage (Mr. Mackinnon, forester, 1890). |
| Do. do. | 10 2 | .. | .. | 120 cubic feet of timber do. |
| Do. do. | 10 9 | 10 | .. | Three limbs at 10 feet do. |
| Do. do. | 10 9 | 24 | .. | Massive spreading top do. |
| Do. do. | 11 5 | 40 | .. | do. do. |
| Do. do. | 12 6 | 6 | .. | Divides into two at 6 feet do. |
| Do. do. | 14 0 | 10 | 90 | Divides into two at 10 feet do. |
| Glenfeshie Lodge, Kingussie, | 15 8 | 10 | 60 | 20 feet at the ground (Mr. James Bell, gardener, 1892). |
| Castle-Grant, | 10 5 | .. | .. | Mr. Stuart, forester, May 1893. |
| Do. | 10 6 | .. | .. | do. do. |
| Do. | 10 6 | .. | .. | do. do. |
| Do. | 10 10 | .. | .. | do. do. |
| *Scots firs remarkable for height.* | | | | |
| Castle-Grant, Strathspey, | 6 0 | .. | 93 | "The King," blown down 1868 (Mr. J. G. Thomson). |
| Arniston, Midlothian, | 9 11 | 50 | 110 | Stand well apart, have fine symmetrical boles and good heads. Height measured by two methods (Mr. Cook, factor, and D. Christison, June 1893). |
| Do. do. | 9 8 | 50 | .. | |
| Do. do. | 8 3 | 50 | .. | |

* At 17 feet up; 11 feet 3 inches at ground. "Perhaps the largest in South Scotland" (Strutt, 1825).

† At 3 feet, the narrowest; foliage abundant and healthy (April 1893, D. Christison).

‡ At 4 feet; branch spread, 85 feet (Journ. of Forestry, 1892).

§ At 3 feet; 19 feet at ground; "probably the largest planted fir in the country" (Dr. Walker, 1796).

‖ At 6 feet; 16 feet at ground; 14 feet 9 inches at 3 feet; 15 feet 3 inches at 9 feet; 16 feet 8 inches at 12 feet; 17 feet at 15 feet. Cubic contents of the 15 feet, 210 feet (Mr. Harvie Brown, Annals of Scot. Nat. Hist., 1892).

RATES OF GIRTH-INCREASE.

(*a*) Ascertained by counting rings (Sir R. Christison).

| LOCALITY. | Girth. | | Age. | Rate. | Remarks. |
|---|---|---|---|---|---|
| | Ft. | In. | Yrs. | | |
| Glenmore Forest, | 19 | 0 | 272 | 0·84 at 6 ft. 6 in. | Plank at Fochabers. |
| Morayshire, . . | 8 | 8 | 166 | 0·68 at 3 ft. | Section of stem. |

(*b*) Rate in a grove at Rothiemurchus, estimated by counting rings in a felled tree, the others, which are standing and which girth from 8 to 12 feet, believed to be of the same age (Rev. Mr. M'Dougall).

| | Date. | Girth at 5 feet. | Age. | Rate. |
|---|---|---|---|---|
| | Year. | Feet. | Years. | Inches. |
| Smallest tree, . . . . | 1890 | 8 | 150 | 0·64 |
| Largest, . . . . . | ,, | 12 | ,, | 0·96 |
| Average, . . . . | ,, | 10 | ,, | 0·80 |

(*c*) Ascertained by girth measurements at $2\frac{1}{2}$ ft., the narrowest (Sir R. Christison, Mr. W. M. Leny, and D. Christison).

| LOCALITY. | Date. | Girth. | | Period. | Rate. |
|---|---|---|---|---|---|
| | Year. | Ft. | In. | Years. | Inches. |
| Dalswinton, Dumfries, . | 1855 | 9 | 1 | ... | ... |
| Do. do. . | 1875 | 10 | 8 | 20 | 0·95 |
| Do. do. . | 1892 | 11 | 3 | 17 | 0·41 |

Although the rate, on the whole, is apparently decreasing in the last period of seventeen years, it rose to 0·80 in the final five years, and the tree is in splendid condition.

(*d*) Five young trees planted at Dalswinton in precisely the same circumstances as the larches (see under Larch), varied in girth at 5 feet from $11\frac{9}{10}$ inches to $12\frac{7}{10}$ inches in April 1893, and their rate for eight years was between 1·52 and 1·58.

(*e*) Ascertained in trees of known age (Conifer Conf. Statistics, 1891).

| LOCALITY. | Height. | Age. | Girth. | | Rate. |
|---|---|---|---|---|---|
| | Feet. | Years. | Ft. | In. | Inch. |
| Hewell Grange, Worcester, . | 90 | 75 | 9 | 6 | 1·52 |
| Curraghmore, Waterford, . | 90 | 120 | 6 | 6 | 0·65 |
| Scone, Perth, . . . | 48 | 41 | 3 | 8 | 1·02 |

(*f*) Many in the Posso plantation, Tweeddale, planted 1740, girthed 4 feet at 4 feet up, in 1767; rate, 1·77 for twenty-seven years. A Scots fir at Bargaly, Kirkcudbright, eighty-three years old, girthed 9 feet 3 inches at 4 feet; rate, 1·33, and was 90 feet high (Dr. Walker).

The possible rate of girth-increase in Scots firs of great size in the primeval forests is established by the fortunate preservation of the plank at Fochabers, by counting the rings on which Sir R. Christison clearly proved that a tree measuring probably 20, but certainly 19 feet in girth 6½ feet above ground, may attain that vast bulk in 272 years, or at the rate of 0·84 inch annually. He also found that although the rate varied in different decades, it was not much, if at all, less towards the end than at the beginning of the tree's career. This he attributed to the unusual height of the conoid base, but it is not likely that this influence could be great so high as 6½ feet, and possibly equality of the rings throughout life may be a true characteristic of this and other species in exceptionally vigorous specimens.

The Dalswinton tree (*c*) confirms Sir R. Christison's observation of the variation in rate in different decades in the Fochabers plank, as it grew very slowly from 1875 to 1888, and much more quickly from 1888 to 1893. The great rate of the Hewell Grange tree (*e*), 1·52, is confirmed by Dr. Walker's examples (*f*), and the five young Dalswinton ones (*d*).

## II. THE YEW (*Taxus baccata*).

The general rule of measuring at 5 feet from the ground is inapplicable to this species, because of its various habits of growth. Some aged yews are buttressed like other large trees, but this is exceptional. Others are cylindrical from the ground, and change but little in girth till the branches are given off; in most of this class the stem is short, but in rare instances, unknown I believe in Scotland, it is long, like that of a pine tree. But frequently, in aged yews, the stem is narrowest at the ground, and swells rapidly to the offshoot of the branches, only a few feet from the ground. Hence, for comparison by a single measurement, it is necessary to choose the narrowest point, although to give any true idea of size it is necessary to give several particulars.

Scottish Yews.—A catalogue of existing Scottish yews serves but to show their great inferiority to the celebrated Fortingall tree, reputed to be 54 feet in girth, of which mere fragments remain. The largest recorded survivor—at Craigends, Renfrew—is only 21 feet in girth, and probably no other exceeds 14½ feet at the narrowest point. Very few attain a great height. A yew at Bute stands clearly at the head with 64 feet, and only two others exceed 50 feet.

Yews above 13 feet in girth, probably at the narrowest part of the stem. From Mr. Hutchison's Table of 107 Scottish yews (Trans. Roy. Scot. Arb. Soc., 1890).

| Locality. | Girth at | | | | Bole. | | Branch Spread. |
|---|---|---|---|---|---|---|---|
| | 1 Foot. | | 3 Feet. | | | | |
| | Ft. | In. | Ft. | In. | Ft. | In. | Feet. |
| Pitmedden, Aberdeen, . | 13 | 9 | 13 | 0 | ... | | 45 |
| Loudoun Castle, Ayr, . | 13 | 8 | 13 | 10 | 6 | 0 | 74 |
| Pitmedden, Aberdeen, . | 14 | 6 | 14 | 0 | ... | | 51 |
| Lawers, Perth, . . | 14 | 4 | ... | | none | | 60 |
| Parkhill, Perth, . . | 14 | 5 | 15 | 0 | 7 | 0 | ... |
| Ormiston, East Lothian, | 13 | 10 | 15 | 0 | 10 | 0 | 72 |
| Craigends, Renfrew, . | 21 | 0 | ... | | 1 | 6 | 80 |
| Rossdhu, Dumbarton, . | 13 | 3 | 12 | 8 | ... | | ... |
| Inch Lonaig, do. . | ... | | 13 | 0 | 10 | 0 | ... |

A remarkably fine thriving yew at Arngomery, Kippen, Stirling, measured by Mr. Malcolm Dunn, 1893, was 16 feet 2 inches in girth at the ground; 13 feet at 1 foot; 11 feet 1 inch at 5 feet; 11 feet 8 inches at 7 feet; circumference of branches, 220 feet; height, 38 feet. Height of clean stem, 8 feet; of bole, 15 feet.

A decaying yew on Glenmorriston Estate, four miles east of Fort-Augustus, roughly measured by Mr. Ewan Cameron, Glenlea, was 14 ft. in girth at 2 ft. up, and 80 paces in circumference of foliage (D. Brown Anderson, W.S., 1893).

English Yews.—If Evelyn is to be trusted, the largest-girthed British yew, or tree of any kind, of which we have any record, existed in his day, 1665, at Brabourne, Kent, as a ruin with a trunk 60 feet in girth. Not a vestige of it remains.

Four of the largest existing yews in England were measured expressly for Sir R. Christison, and I therefore give the results in full:—

| Situation. | Girth. | Ft. | In. | Measurer. |
|---|---|---|---|---|
| Darleydale, Derbyshire, . | At the ground, | 32 | 0 | Mr. Smith, Nurseryman, of the Dale. |
| | .. 4 feet up, . | 34 | 6 | |
| Ankerwyke, Buckingham, | .. the ground, | 25 | 0 | Mr. Troy, Gardener to Mr. Anderson, Ankerwyke Ho. |
| | .. 3 feet up, . | 30 | 5 | |
| | .. 7 feet up, . | 35 | 0 | |
| Gresford, Wrexham, . | .. the ground, | 22 | 4 | Mr. Francis Manisty, Surgeon. |
| | .. 2 feet up, . | 24 | 9 | |
| | .. 4 ft. 5 in. up, | 28 | 2 | |
| | .. 5 ft. 4 in. up, | 30 | 5 | |
| Yewdale, Westmoreland, | .. 3 ft. (narr'w'st) | 26 | 2 | Bole 25 feet, J. Christison. |

Fountains Abbey Yew.—Burton, quoted by Strutt, describes a remarkable group of seven yews "growing on the declivity of the hill on the south side of the Abbey, all standing except the largest, which was blown down about the middle of last century. The trunk of one of them is 26 feet 6 inches in girth at 3 feet from the ground, and they stand so near each other as to form a cover almost equal to a thatched roof." Strutt then describes the wanton destruction going on in 1822, but his plate (No. XXI.) shows five still standing within a few yards of each other.

Only one now exists, and the stem is a mere shell, a third part of which at the bottom has decayed away, so that the tree would collapse but for artificial props. The head of foliage, however, is large and luxuriant. It is not the largest of the seven mentioned by Burton, as according to measurements made by the Rev. Mr. Bittleston of South Stainley in 1880, it was only 18 feet 6 inches in girth at 3 feet 6 inches up, instead of 26 feet. At 7 feet up, where there is an evident great expansion to the branches, it was 25 feet 3 inches.

This tree is interesting in its decay, because it serves to clear away doubts, which have very naturally arisen from the present condition of the remains of the Fortingall yew, as to their ever having been parts of one and the same tree. I found in 1887 in the Fountains Abbey yew that the wood springing from the earth was reduced to a slender pillar in the centre, and a larger mass attached to the shell on one side. Nine-tenths of the circumference was a mere shell, a few inches thick, of which only two-thirds touched the ground; and it was evident that a little further decay would produce a ground plan very like that of the Fortingall remains (see Plate XII., Trans. Bot. Soc. Edin., vol. xiii.), and quite as difficult to reconcile with the supposition of original unity of the detached fragments.

Yews in Portbury Churchyard, near Bristol.—These are two fine examples of the rare variety, with tall stems, which at a distance resemble the Scots fir. About twenty years ago I found the one to be 15 and the other 17 feet in girth at 5 feet up.

## Rates—Trees of known Age.

(*a*) West Felton, Shropshire.

| Observation. | Period. | Increase. | Rate. | Observers. |
|---|---|---|---|---|
| | Years. | In. | In. | |
| 1836 | 70 | 61 | 0·87 | Mr. Bowman. |
| 1878 | 42 | 33 | 0·78 | Mr. Dovaston. |
| | 112 | 94 | 0·84 | |

(*b*) Dalkeith, Midlothian, at 5 feet up.

| | | | | |
|---|---|---|---|---|
| 1891 | 150 | 116 | 0·77 | Mr. Malcolm Dunn. |

(*c*) Average of eighteen yews at Gresford Churchyard, Wrexham, 120 years old (Parish Records, Bowman); girth, 5 feet 3 inches; rate, 0·52.

(*d*) Two yews, Edin. Bot. Garden (Dr. Christison).

| | Last Observation. | Period. | Girth. | Increase. | Rate. |
|---|---|---|---|---|---|
| | | Years. | Ft. In. | In. | |
| No. 1, . . | 1892 | 15 | 6 2·70 | 7·10 | 0·47 |
| No. 2, . . | ,, | 14 | 3 8·10 | 6·60 | 0·47 |

(e) Yew at Ormiston, East Lothian (1834, Sir T. Dick Lauder; 1879, Professor Balfour).

| Date. | Girth at Ground. Ft. | Ground. In. | 3 Feet. Ft. | 3 Feet. In. | 4 Feet. Ft. | 4 Feet. In. | 5 Feet. Ft. | 5 Feet. In. |
|---|---|---|---|---|---|---|---|---|
| 1834, | 12 | 9·00 | 13 | 6·00 | 14 | 9·00 | 17 | 8·00 |
| 1879, | 13 | 10·00 | 15 | 0·00 | 16 | 10·00 | 19 | 8·00 |
| Increase, 45 years, | 1 | 1·00 | 1 | 6·00 | 2 | 1·00 | 2 | 0·00 |
| Rate, | 0 | 0·28 | 0 | 0·40 | 0 | 0·55 | 0 | 0·53 |

Dr. Walker gives the girth at 4 feet as 10 feet 3 inches in 1762, making an increase to 1879 of 75 inches, and a rate of 0·74 for 117 years.

The estimation of the age of gigantic yews presents peculiar difficulties. No opportunity of counting their rings throughout can be expected, as not only is their little chance of such veterans being cut down, but the chance is equally small of finding the mass of the interior preserved from decay. To ascertain their present rate by girth measurement, at least within a moderate period of years, is scarcely possible, from the extreme irregularity of the surface, particularly at the usual narrowest point, near the ground. We are reduced, therefore, to such information as can be got from young trees, supplemented by borings at the surface of aged specimens. From the few reliable data collected by Sir R. Christison, he drew up the following scale of probable age for a yew 22 feet in girth.

| Age. | Rate. In. | Girth. In. |
|---|---|---|
| To 100 years, | About 0·50 | 54 |
| ,, 200 ,, | ,, 0·40 | 96 |
| ,, 500 ,, | ,, 0·24 | 168 |
| ,, 1000 ,, | ,, 0·19 | 264 |

This estimate, however, is founded on the supposition that the giants grow only at the average ascertained rate in early life, and fall off gradually from an early period to the very slow rate, ascertained by Mr. Bowman's borings, of from 140 to 180 years for the last 18 inches of girth-increase in two yews 22 and 27 feet in girth. But two elements of doubt remain. I have shown, in the first place, that the giants of other species probably grow at a quite exceptionally rapid rate, and that this is possible in the yew also is indicated by the exceptional rate of 0·84 for the first 112 years of life in one recorded by Mr. Bowman. Secondly, from Sir R. Christison's own observations on the large Craigiehall beech and the Fochabers Scots fir, it is plain that the falling off in rate, which in average trees begins before they have attained a large size, in trees destined to be great may be put off till they have assumed almost gigantic proportions. Hence, it is quite possible that Sir R. Christison's estimate of 1000 years for a tree 22 feet in girth may be several centuries in excess of the truth. The question might be solved by using the modern instruments which extract cylinders to a considerable depth, whereas Mr. Bowman's primitive borer only probed to a depth of a few inches.

Sir Robert's estimate of 3000 years for the age of the Fortingall yew may in a corresponding way be liable to great reduction.

Finally, it may be a question whether gigantic stems like these may not be compound — formed by the coalescence of two or more which were originally separate.

### III. The Cedar (*Cedrus Libani*).

As the cedar somewhat resembles the yew in the varieties of form in the stem, I have given the girth at several points, so as to give a better idea of the true size of the specimens recorded.

Scottish cedars above 17 feet in girth at different heights, from Mr. Hutchison's Table of 58 Scottish cedars (Trans. H. and Ag. Soc. Scot., 1890).

| Locality. | Girth at 1 Foot. | Girth at 3 Feet. | Girth at 5 Feet. | Bole. | Height. | Branch Spread. | Cubic Feet. |
|---|---|---|---|---|---|---|---|
| | Ft. In. | Ft. In. | Ft. In. | Ft. In. | Feet. | Feet. | |
| Gray House, Forfar, . . | .. | 17 0 | .. | 19 6 | 55 | .. | 323 |
| Biel, East Lothian, . . | 17 4 | .. | 18 10 | 10 0 | 83 | .. | .. |
| Beaufort Castle, Inverness, | 19 9 | .. | 21 0 | 4 6 | 80 | 70 | .. |
| Prestonhall, Midlothian, . | 21 0 | .. | 20 2 | 28 0 | 60 | 90 | .. |
| *Hopetoun, West Lothian, . | .. | .. | 23 0 | 33 0 | 88 | .. | .. |

* Blown or cut down in a dying state lately.

60 to 70 feet in height, . . . . . 14
70 ,, 80 ,, . . . . . 4
80 ,, 88 ,, . . . . . 5

It is remarkable that in Mr. Hutchison's list there are no cedars between 15 and 17 feet, so that the next largest to the five in my selection is at least 2 feet less than the least of them. He has missed, however, a very fine healthy tree at Arniston, Midlothian, which in 1893 I found to be 16 ft. 8 in. in girth at 5 feet, about the narrowest part of a symmetrical ten-foot stem.

The finest cedar in England in Loudoun's time was at Syon. He gives the height as 92 feet, the girth at 3 feet up as 24 feet, and the diameter of the branch spread as 117 feet. The tallest, 108 feet, appears to be at Strathfieldsaye, but its girth is only 9 feet.

RATES FROM TREES OF KNOWN AGE.

| SITUATION. | Age | Girth in 1888 at | | | Rate at | | | Authority. |
|---|---|---|---|---|---|---|---|---|
| | | 1 Ft. | 3 Ft. | 5 Ft. | 1 Ft. | 3 Ft. | 5 Ft. | |
| | Yrs. | Ft. In. | Ft. In. | Ft. In. | In. | In. | In. | |
| Biel, East Lothian, . | 181 | 17 4 | .. | 18 10 | 1·15 | .. | 1·26 | Mr. Hutchison's List |
| Dalkeith, Midlothian, | 110 | .. | .. | 13 2 | .. | .. | 1·43 | Mr. Mal. Dunn, 1891 |
| Brahan, Ross, . . | 80 | 9 1 | 8 3 | 7 10 | 1·36 | 1·23 | 1·17 | Mr. Hutchison's List |
| Do. do. . . | 150 | 12 6 | 11 9 | 11 7 | 1·50 | 0·93 | 0·92 | do. |
| Tarbat, Ross, . . | 62 | .. | 7 2 | .. | .. | 1·39 | .. | do. |
| Beaufort, Inverness, . | 150 | 19 9 | .. | .. | 1·58 | .. | .. | do. |
| Rossie Priory, Perth, . | 100 | .. | .. | 8 11 | .. | .. | 1·07 | do. |
| Do. do. . | ,, | .. | .. | 8 2 | .. | .. | 0·98 | do. |
| Do. do. . | ,, | .. | .. | 8 3½ | .. | .. | 0·99 | do. |
| Dryburgh, Berwick, . | ,, | 10 4 | 9 7 | 9 3 | 1·24 | 1·15 | 1·11 | do. |
| Drummond Cas., Perth, | 63 | .. | . | 7 9 | .. | .. | 1·47 | do. |
| Do. do. | ,, | .. | . | 8 2 | .. | .. | 1·55 | do. |

Great cedar formerly at Hopetoun, West Lothian, 23 feet girth at 5 feet.

| Date. | Period. | Growth. | Rate. |
|---|---|---|---|
| | Years. | Inches. | Inch. |
| 1740 to 1801, . . | 61 | 120 | 2·00 |
| 1802 to 1841, . . | 40 | 78 | 1·95 |
| 1842 to 1884, . . | 43 | 78 | 1·81 |
| | 144 | 276 | 1·91 |

English cedar, West Felton, Salop (Mr. J. Dovaston).

| Date. | Period. | Increase. | Rate. |
|---|---|---|---|
| | Years. | Inches. | Inch. |
| 1773 to 1836, . . | 63 | 99 | 1·58 |
| 1836 to 1880, . . | 44 | 54 | 1·21 |
| | 107 | 153 | 1·43 |

English and Irish cedars (Conifer Conf. Statistics, 1891).

| Locality. | Height. | Age. | Girth. | Rate. |
|---|---|---|---|---|
| | Feet. | Years. | Ft. In. | |
| Bretby Park, Derby, | 82 | 215 | 16 2 | 0·90 at 5 feet |
| Hewell Grange, Worcester, | 50 | 100 | 16 0 | 1·92 ,, |
| Howick Hall, Northumberland, | 51 | 70 | 12 0 | 2·05 at 2 feet |
| Revesby Abbey, Lincoln, | 45 | 43 | 9 6 | 2·65 at 5 feet |
| Woodstock, Kilkenny, | 78 | 66 | 9 2 | 1·27 ,, |
| Average of 140, Dropmore, Bucks, | 65 | 80 | 7 6 | 1·12 at 3 feet |
| Largest at do. do. | 104 | 100 | 13 9 | 1·73 ,, |

Rate from Girth Measurements.

| Locality. | Last Observation. | Girth at 5 Feet. | | Period. | Rate. |
|---|---|---|---|---|---|
| | | Ft. | In. | Years. | Inch. |
| Abercairney, Perth, | 1888 | 8 | 11 | 28 | 1·85 |
| Annat Lodge, Perth, | 1889 | 11 | 8 | 1 | 1·60 |

Cedrus atlantica.

Rate in Trees of known Age.

| Locality. | Age. | Height. | Girth at 5 Feet. | | Rate. | Authorities and Remarks. |
|---|---|---|---|---|---|---|
| | Yrs. | Ft. | Ft. | In. | In. | |
| Biel, Haddington, | 181 | 80 | 14 | 5 | 0·95 | At 5 ft. (Mr. Hutchison's List). |
| Dropmore, Bucks, | 49 | 64 | 5 | 10 | 1·42 | At 3 ft. (Mr. Herrin, gardener, 1891). |

Tree 4 feet in girth at 5 feet up, Botanic Garden, Edinburgh (D. Christison).

| | Period. | Increase. | Rate. |
|---|---|---|---|
| | Years. | In. | In. |
| 1878 to 1887, | 10 | 14·95 | 1·50 |
| 1888 to 1892, | 5 | 6·20 | 1·24 |
| Average, | 15 | 21·15 | 1·41 |

Cedrus deodara, Dropmore, Bucks (Mr. Ch. Herrin, gardener, 1891).

| | Age. | Height. | Girth. | | Rate. | Remarks. |
|---|---|---|---|---|---|---|
| | Yrs. | Ft. | Ft. | In. | In. | |
| No. 1, | 51 | 72 | 9 | 9 | 2·30 | At 3 feet up. |
| ,, 2, | 51 | 67 | 8 | 3 | 1·94 | do. |
| ,, 3, lightning-struck, | 50 | ... | 12 | 3 | 2·94 | Near the ground. |

It is evident that the cedar of Lebanon, and its near relatives the Atlantic cedar and deodar, are quick growers, in favourable circumstances, in this country. There can be little doubt that the great cedar at Hopetoun, which attained 23 feet in girth, increased at the rate of nearly 2 inches annually throughout its life, and although this is probably exceptional, yet there are authentic instances of a similar or even greater rate in cedars of considerable size. The deodars at Dropmore attained the considerable rates, at 3 ft. up, of 1·94 and 2·30 for fifty years.

### iv. The Silver Fir (*Abies pectinata*).

The silver fir has grown to a greater girth and height than any other pine in Scotland, where Mr. Hutchison states it was introduced about 1600. It appears to have been known in England, however, prior to 1548.

Silver firs above 17 feet in girth at 5 feet up. Chiefly from Mr. Hutchison's Table of 147 Scottish silver firs (Trans. H. and Agr. Soc. Scot., xviii., 1885, p. 240).

| Locality. | Girth at | | | Bole. | Height. |
|---|---|---|---|---|---|
| | 5 Feet. | 3 Feet. | 1 Foot. | | |
| | Ft. In. | Ft. In. | Ft. In. | Ft. | Ft. |
| Drummond Castle, Perth, | 17 5 | ... | 22 10 | 32 | 106 |
| Castle-Menzies, Perth, . | 17 7 | 18 3 | 20 2 | 22 | 120 |
| *Rossdhu, Dumbarton, . | 17 9 | ... | ... | ... | 110 |
| Drummond Castle, Perth, | 18 2 | ... | 23 9 | 28 | 105 |
| Roseneath, Dumbarton, . | 21 8 | 22 8 | 28 0 | 90 | 125 |
| Do. do. . | 22 0 | 23 4 | 28 10 | 90 | 130 |
| Tree with greatest branch spread (65 feet). | | | | | |
| Drumlanrig, Dumfries, . | 13 8 | ... | 20 6 | 59 | 96 |

* Mr. F. Macpherson, gardener, Conifer Conference Statistics, 1891.

There is a remarkable group of twenty-two silver firs near Inverawe, Argyll. Of eleven still standing, one is 17 feet in girth, another 15 feet 9 inches, another 14 feet 5 inches, and four more are above 12 feet. Of the fallen trees, one is 16 feet 1 inch, another 15 feet 4 inches, and three others are above 12 feet in girth, all at 5 feet above the highest part of the ground (Dr. Allan Macnaughton, 1893).

Number above 15 feet in girth at 5 feet up.

| | |
|---|---|
| 15 to 16 feet, | 7 |
| 16 ,, 17 ,, | 4 |
| 17 ,, 18 ,, | 4 |
| 18 ,, 19 ,, | 1 |
| 19 ,, 20 ,, | 0 |
| Above 20 ,, | 2 |
| Above 15 feet, | 18 |

| | |
|---|---|
| Number 100 feet high, | 10 |
| ,, 100 to 109 feet high, | 20 |
| ,, 110 ,, 119 ,, | 18 |
| ,, 120 ,, 129 ,, | 9 |
| ,, 130 feet high, | 2 |
| 100 feet high and upwards, | 59 |

A few other remarkable silver firs.

| Locality. | Girth at 5 Feet. | Authorities and Remarks. |
|---|---|---|
| | Ft. In | |
| Lynedoch, Perth, | 13 8 | 104 feet high (Mr. L. Bayne, forester, Conifer Conf. Stat., 1891). |
| Castle-Menzies, Perth, | 14 6 | Sir Robert Menzies, 1892. |
| Arniston, Midlothian, | 14 0 | About 100 ft. high (D. Christison, 1893). |
| Dunkeld, Perth, | 14 6 | 110 feet high (Sir R. Christison, 1879). |
| Do. do. | ... | 120 feet high do. |

## (a) Rate of Girth-increase in Trees of known Age, at 5 Feet.

| Locality. | Date of Observation. | Girth. Ft. | Girth. In. | Age. Years. | Rate. In. | Authority. |
|---|---|---|---|---|---|---|
| Craighall, Perth, | 1884 | 10 | 3 | 89 | 1·38 | Mr. Hutchison's List. |
| Drumlanrig, Dumfries, | ,, | 11 | 1 | 70 | 1·90 | Do. |
| Do. do. | ,, | 11 | 10 | 70 | 2·03 | Do. |
| Rossdhu, Dumbarton, | 1891 | 17 | 9 | 108 | 1·93 | Mr. F. Macpherson, gardener. |
| Dalwick, Peebles, | 1826 | 11 | 6 | 91 | 1·51 | Sir T. Dick Lauder. |
| Gray, Forfar, | .. | 11 | 3 | 140 | 0·96 | Mr. Hutchison's List. |
| Drummond Castle, Perth, | 1884 | 14 | 5 | 196 | 0·87 | Do. |
| Do. do. | ,, | 16 | 0 | 196 | 0·96 | Do. |
| Do. do. | ,, | 17 | 5 | 196 | 1·06 | Do. |
| Do. do. | ,, | 18 | 2 | 196 | 1·11 | Do. |

## (b) Rate in Trees of known Age, at 4 Feet.

| | | | | | | |
|---|---|---|---|---|---|---|
| Lochnell, Argyll, | 1771 | 6 | 3 | 36 | 2·08 | Dr. Walker. |
| Do. do. | ,, | 6 | 6 | 36 | 2·16 | Do. |
| Bargaly, Kirkcudbright, | 1780 | 8 | 0 | 83 | 1·15 | Do. |
| Polkemmet, W. Lothian, | 1799 | 10 | 0 | 94 | 1·27 | Do. |
| Drumlanrig, Dumfries, | 1773 | 12 | 0 | 83 | 1·73 | Do. |

(c) RATE, ASCERTAINED BY GIRTH MEASUREMENT, AT 5 FEET (Mr. Hutchison's Tables).

| Locality. | Date. | Girth. | | Period. | Rate. |
|---|---|---|---|---|---|
| | | Ft. | In. | Years. | Inch. |
| Roseneath, Dumbarton, . | 1882 | 21 | 8 | 65 | 1·12 |
| Do. do. . | ,, | 22 | 0 | 65 | 1·07 |

(d) A tree at Dalswinton, Dumfries, 8 feet 6 inches in girth in 1860; rate for previous five years, 1·50 inch (Sir R. Christison).

(e) RATE OF ROSENEATH TREES, SUPPOSING 1600 TO BE THE DATE OF PLANTING.

| Dates. | Increase in Inches "Eve." | Increase in Inches "Adam" | Period. Years. | Rate "Eve." | Rate "Adam" |
|---|---|---|---|---|---|
| At 1 Foot. | | | | | |
| 1600 to 1817, . . | 236 | 238 | 217 | 1·08 | 1·09 |
| 1818 ,, 1833, . . | 28 | 51 | 16 | 2·18 | 3·18 |
| 1834 ,, 1882, . . | 72 | 57 | 49 | 1·47 | 1·16 |
| | 336 | 346 | 282 | 1·19 | 1·22 |
| At 3 Feet. | | | | | |
| 1600 to 1817, . . | 210 | 215 | 217 | 0·96 | 0·99 |
| 1818 ,, 1833, . . | 10 | 10 | 16 | 0·62 | 0·62 |
| 1834 ,, 1882, . . | 52 | 55 | 49 | 1·06 | 1·12 |
| | 272 | 280 | 282 | 0·96 | 1·00 |
| At 5 Feet. | | | | | |
| 1600 to 1817, . . | 187 | 194 | 217 | 0·86 | 0·89 |
| 1818 ,, 1833, . . | 24 | 24 | 16 | 1·50 | 1·50 |
| 1834 ,, 1882, . . | 49 | 46 | 49 | 1·00 | 0·94 |
| | 260 | 264 | 282 | 0·92 | 0·93 |

The considerable number of rates given in the tables, although they may not all be strictly reliable, nevertheless agree in showing that this species both grows more quickly and attains a greater size than the native fir. If the measurements of the celebrated trees at Roseneath, given in Mr. Hutchison's table, are to be relied on, increase in girth must be going on about as rapidly at the present enormous bulk of the trees as it is likely to have done at any previous period, except in very early life. And if it be true that the species was only introduced in Scotland about the year 1600, then these trees must be a little under three centuries old, and they must have increased nearly at the rate of an inch a year (0·92 and 0·93), at 5 feet above ground, over that long period. The measurements, quoted by Mr. Hutchison, at three points in 1817, 1832, and 1882, yield results which, on the whole, agree so well with each other as to inspire considerable confidence in their accuracy. The only exception is the remarkably rapid rate, at one foot up, between 1817 and 1832, both in "Adam" and "Eve," but particularly the former. This may have been due to a sudden expansion in the conoid base, which I have been led to believe, in the present investigation, is apt to take place in very large trees of various species, and which is occasionally confirmed by the rings in tree-sections; or it may be an error of observation, as at 1 foot up the slightest shifting in position of the tape may give very different results. Strutt (Sylva Brit., 1826) gives 268 inches at 1 foot and 209 at 5 feet as the girths of one of these trees. Comparing these with the figures for 1817 in the table, and supposing Strutt's figures to date from 1825 for "Adam," the larger of the two, we get 3·75 for the rate at 1 foot, and 1·87 at 5 feet, for the eight years 1817 to 1825, which agree wonderfully well with the corresponding rates of 3·18 and 1·50 from 1818 to 1833 in the table.

## V. The Spruce Fir (*Abies excelsa*).

Notices of large spruce firs are not nearly so numerous as of the silver fir, although the two species were introduced about the same date. I have only two to offer, both taken from the Conifer Conference Statistics of 1891.

| Situation. | Girth at 5 feet. | | Height. | Authority. |
|---|---|---|---|---|
| | Ft. | In. | Feet. | |
| Studley Royal, York, | 12 | 6 | 132 | Mr. John Clark, gardener. |
| Lynedoch, Perth, . | 10 | 0 | 106¼ | Mr. L. Bayne, forester. |

The rate of two young trees girthing $10\frac{2}{10}$ inches and $11\frac{5}{10}$ inches at 5 feet, at Dalswinton, Dumfries, grown under the same conditions as the larches and Scots fir (which see), for eight years, was 1·27 and 1·43, somewhat under that of the Scots fir, and greatly below that of the larches (D. Christison, Ap. 1893).

## VI. THE LARCH (*Larix europæa*).

This species was introduced in Scotland by the Duke of Athole in 1727, although it was known in England prior to 1629. Perhaps the period is not yet long enough to establish the size which the species may attain, but one of the original trees at Dunkeld is now (April 1893) 15 feet 1 inch in girth at 5 feet up, although it has probably been growing very slowly for some years back; and another, at Monzie Castle, Perth, is no less than 16 feet 1 inch at the same height. The larch apparently attains, in Scotland, a greater height than the Scots fir, as a rule.

Table of remarkable Scottish larches.

| SITUATION. | Girth at 5 feet up. Ft. | In. | Remarks and Authorities. |
|---|---|---|---|
| Annandale, Dumfries, | 9 | 5 | Largest on estate (James White, forester). |
| Arniston, Midlothian, | 9 | 8 | Bole, 60 ft.; height above 100 ft. (D. C., June 1893). |
| Murthly, Perth, . . | 9 | 8 | Largest on estate (D. F. Mackenzie, forester). |
| Dunkeld, Perth, . . | 10 | 0 | 115 ft. high (Sir R. Christison, 1879). |
| Dalswinton, Dumfries, | 10 | 3½ | Evidently failing (April 1893, D. Christison) |
| Hopetoun, W. Lothian, | 10 | 4 | 78 ft. high (Mr. J. Smith, gardener, 1893). |
| Brahan Castle, Ross, . | 10 | 9 | 13 ft. 8 in. at 1 ft.; 11 ft. 6 in. at 3 ft.; 95 ft. high; spread, 38 ft. (W. F. Gunn, 1885). |
| Keir, Perth, . . . | 11 | 3 | Sir R. Christison, 1879. |
| Arniston, Midlothian, | 11 | 5 | Bole, 50 ft.; height, above 100 ft. (D. C., 1893). |
| Duns Castle, Berwick, | 12 | 1 | 15 ft. at 1 ft. (D. Christison, 1893). |
| Monzie Castle, Perth, | 12 | 3 | About 95 ft high (George Morgan, wood merchant, Crieff, April 1893). |
| Glamis, Forfar, . . | 12 | 5 | 21 ft. 8 in. at ground; 11 ft. 10 in. below the fork, 12 ft. up; 107 ft. high; blown down 1879 (Rev. Dr. Stevenson, Glamis). |
| Westquarter, Falkirk, | 12 | 7 | 18 ft. at ground; 16 ft. at 1 ft.; 14 ft. 2 in. at 2 ft.; 13 ft. 3 in. at 3 ft.; 12 ft. 8 in. at 4 ft. (Mr. Livingston to Sir Wyville Thomson, Nov. 1878). |
| Dalwick, Peebles, . | 13 | 8½ | At narrowest of a short stem; 17 ft. 9 in. at 1 ft. 6 in. (D. Christison, 1873). |
| Do. . | 13 | 7 | At narrowest; 19 ft. 6 in. above the roots; a ruin (D. Christison, 1873). |
| Dunkeld, Perth, . . | 13 | 11 | Sir R. Christison, 1879. |
| Do.[1] . | 15 | 1 | Height, 102 ft. 4 in. (P. W. Fairgrieve, gardener, April 1893). |
| Monzie Castle, Perth, . | 16 | 1 | 100 ft. high (George Morgan, wood merchant, Crieff, April 1893). |

[1] General dimensions of this veteran furnished by Mr. Fairgrieve—

| | Ft. | In. | | Ft. | In. |
|---|---|---|---|---|---|
| Girth at 3 feet, . . . . | 17 | 2 | Girth at 68 feet, . . . . | 6 | 1 |
| ,, 5 feet, . . . . | 15 | 1 | Height, . . . . . | 102 | 4 |
| ,, 17 feet, . . . . | 12 | 10½ | Cubic feet with bark, . . | 648 | 0 |
| ,, 51 feet, . . . . | 8 | 8 | ,, without bark, . | 532 | 0 |

Rates of larches in several localities (Dr. Walker).

| Situation. | Last Observation. | Period. | Girth at 4 Feet. | | Rates. | | Height. |
|---|---|---|---|---|---|---|---|
| | | | | | If from Seed. | If young Trees. | |
| | Years. | Years. | Ft. | In. | Inches. | Inches. | Feet. |
| Leadhills, 1600 feet above sea, . | 1773 | 33 | 2 | 3 | 1·00 | 0·82 | 40 |
| Polkemmet, West Lothian, . . | 1799 | 39 | 5 | 2 | 1·71 | 1·59 | .. |
| Dunkeld, several, . . . | 1770 | 28 | 5 | 5 | 2·95 | 2·35 | 60 |
| *Moffat, . . . . . . . | 1785 | 12 | 2 | 3 | 2·25 | .. | 28 |

* From seed; sixteen years old; four years deducted for growth to 4 feet.

Largest of the first two larches planted in Scotland, Dunkeld, 1727; four years added to this date for growth in a greenhouse to 4 feet.

| Date. | Period. | Increase. | Rate. | Authority. |
|---|---|---|---|---|
| | Years. | Inches. | Inches. | |
| 1731 to 1770, . | 39 | 50 | 1·28 at 4 feet. | Dr. Walker. |
| 1731 to 1878, . | 147 | 177 | 1·20 at 5 feet. | Sir R. Christison. |
| 1878 to 1892, . | 14 | 4 | 0·28 do. | Mr. Fairgrieve. |

Monzie larch, supposing it to be the same age.

| | | | | |
|---|---|---|---|---|
| 1731 to 1892, . | 161 | 193 | 1·20 at 5 feet. | Mr. Geo. Morgan. |

Four young larches at Dalswinton, Dumfries, planted when 3 feet high, spring 1884, in ground "stubbed" for removal of roots, thus trenched 3 or 4 feet deep. One year allowed for growth to 5 feet (D. Christison, April 1893). Also four old ones at the same place, not thriving latterly (Sir R. Christison, various dates).

| Four Young Larches. | Girth at 5 Feet. | Rate for Eight Years. |
|---|---|---|
| | Inches. | Inches. |
| No. 1, . . . . | 17·25 | 2·15 |
| No. 2, . . . . | 16·30 | 2·00 |
| No. 3, . . . . | 17·60 | 2·20 |
| No. 4, . . . . | 18·00 | 2·25 |

Four Old Larches.

| | Last Observation. | Period. | Girth at 5 Feet. | | Rate. |
|---|---|---|---|---|---|
| | | Years. | Ft. | In. | Inch. |
| No. 1, | 1875 | 39 | 9 | 3⅓ | 0·73 |
| No. 2, | 1860 | 21 | 8 | 10½ | 1·20 |
| No. 3, | ,, | 24 | 8 | 4 | 0·70 |
| No. 4, | 1875 | 21 | 10 | 1 | 0·76 |
| Do. | 1892 | 17 | 10 | 3½ | 0·15 |

Larch blown down at Glamis, Forfarshire, 1879. Rings counted at 2 feet 4 inches up, above the basic swelling, by the Rev. Dr. Stevenson and Sir R. Christison.

| Height. | Girth at 2 ft. 4 in. | Age. | Rate. |
|---|---|---|---|
| Feet. | Ft. In. | Years. | Inch. |
| 105 | 12 10 | 108 | 1·42 |

Larch at Hewell Grange, Worcester (Conifer Conference Statistics, 1891).

| Height. | Age. | Girth at 5 Feet. | Rate. |
|---|---|---|---|
| Feet. | Years. | Feet. | Inch. |
| 80 | 75 | 11 | 1·75 |

Young larch, Edinburgh Arboretum (D. Christison).

| Last Observation. | Girth. | Period. | Rate. | Best Year. |
|---|---|---|---|---|
| | Inches. | Years. | Inches. | Inches. |
| 1892 | 11·35 | 6 | 1·23 | 1·75 |

The indubitable rate of above 2 inches in young larches at Dalswinton, and of about 1¼ inch for the long period of 160 years in the Dunkeld and Monzie trees, confirms the accuracy of other large results, and proves that the species is a quick grower under favourable circumstances. The four planted in "stubbed" ground at Dalswinton grew more than twice as fast as others close to them planted in undisturbed ground.

## 2. Coniferæ of Recent Introduction.

The valuable paper contributed to the Conifer Conference of 1891 by Mr. Malcolm Dunn, with tables giving the dimensions of a vast number of the recently introduced Coniferæ, from information furnished to him by practical men in all parts of the United Kingdom, is almost the sole source of the details in the concluding division of my subject. The mass of information contained in these tables is, I believe, unrivalled for extent and accuracy. It might have sufficed to select only the best example of each species, in order to show the size which each has been able to reach in Scotland under the most favourable circumstances, but it seemed more advisable to take two or three of the best in each species, as there was a risk that single examples might be supposed to be altogether exceptional; of course none of these recently introduced species have had time to prove what they can do in the way of producing giants in this country, and our chief interest lies in showing the extraordinary rate at which many of them have grown. I have, therefore, added to my selected examples from Mr. Dunn's tables a calculation of the rate of their girth-increase; and here we are on surer ground than when dealing with long-established species, because, knowing with certainty the date of their introduction, we are at least sure that the existing examples cannot exceed a certain age. In some cases, indeed, Mr. Dunn's informants have themselves planted the trees of which they treat, and in many others the date of planting has been accurately recorded. There is a difficulty in interpreting the "Date of Planting" in the tables, as it may mean either planting of a seed or of a young tree of unknown size. But, I believe, in the vast majority of cases, a seedling 18 inches or 2 feet high is implied. To avoid exaggeration, however, my calculations are all based on the supposition that the trees when planted had reached 5 feet; the height at which all the measurements in Mr. Dunn's tables were taken.

I. Dimensions of recently introduced Conifers, almost all selected from information collected by Mr. Malcolm Dunn for the Conifer Conference (Jour. Hortic. Society, 1891); with the rate of their girth-increase.

ABIES.

| Introduced. | Species. | Situation. | Height. | Age. | Girth at 5 Ft. | Rate. |
|---|---|---|---|---|---|---|
| | | | Ft. In. | Yrs. | Ft. In. | In. |
| 1851 | Albertiana, | Cairnies, Perth, | 63 0 | 30 | 6 9 | 2·70 |
| ,, | Do. | Castle-Menzies, Perth, | 72 0 | 38 | 5 9 | 2·00 |
| ,, | Do. | Dolphinton, Lanark, | 55 0 | 27* | 3 6 | 1·70 |
| 1824 | cephalonica, | Cluny Castle, Aberdeen, | .. | 20* | 4 9 | 3·35 |
| ,, | Do. | Whittinghame, East Lothian, | 55 0 | 45 | 8 0 | 2·13 |
| ,, | Do. | Castle-Kennedy, Wigtown, | 42 0 | 42 | 7 0 | 2·00 |
| 1851 | concolor, | Brahan, Ross, | 40 0 | 30 | 7 0 | 2·80 |
| ,, | Do. | Cairnies, Perth, | 55 0 | 30 | 6 0 | 2·40 |
| 1827 | Douglasii | Keir, Perth, | 45 0 | 42 | 11 6 | 3·28 |
| ,, | (Pseudotsuga | Dunrobin, Sutherland, | 58 0 | 40 | 10 10 | 3·25 |
| ,, | Douglasii), | Dunkeld, Perth, | 94 0 | 45 | 12 0 | 3·20 |
| ,, | Do. | Murthly Castle, Perth, | 76 0 | 45 | 11 9 | 3·13 |
| ,, | Do. | Lynedoch, Perth, | 91 9 | 57 | 12 0 | 2·52 |
| ,, | Do. | do. do. | 72 0 | 57 | 11 2 | 2·35 |
| ,, | Do. | Haddo, Aberdeen, | 73 0 | 40 | 8 1 | 2·42 |
| ,, | Do. | Buchanan Castle, Stirling, | 85 0 | † | 12 0 | 2·40 |
| ,, | Do. | Dolphinton, Lanark, | 62 0 | 41* | 7 6 | 2·31 |
| ,, | Do. | Jardine Hall, Dumfries, | 67 0 | 63 | 10 6 | 2·10 |
| 1831 | grandis, | Altyre, Moray, | 60 0 | 22 | 7 0 | 3·81 |
| ,, | Do. | Conan, Ross, | 52 0 | 18 | 5 0 | 3·33 |
| ,, | Do. | Dolphinton, Lanark, | 68 0 | 20* | 5 5 | 3·61 |
| ,, | Do. | Inveraray, Argyll, | 45 0 | 27 | 7 1 | 3·14 |
| ,, | Do. | Drumlanrig, Dumfries, | 49 0 | 20 | 4 9 | 2·85 |
| 1851 | magnifica, | Durris, Kincardine, | 45 0 | † | 4 2 | 1·42 |
| ,, | Do. | Cairnies, Perth, | 50 0 | 30 | 3 6 | 1·40 |
| 1831 | Menziesii | Drumlanrig, Dumfries, | 49 0 | 22 | 7 9 | 4·22 |
| ,, | (Piceasitchensis) | Buchanan Castle, Stirling, | 65 0 | 35 | 9 0 | 3·08 |
| ,, | Do. | Keillour, Perth, | 95 0 | 57* | 13 9 | 3·00 |
| ,, | Do. | Castle-Menzies, Perth, | 96 6 | 46 | 11 0 | 2·87 |
| ,, | Do. | Scone, Perth, | 71 0 | 39 | 8 5 | 2·59 |
| 1818 | Morinda, | Castle-Kennedy, Wigtown, | 50 0 | 40 | 4 10 | 1·45 |
| ,, | Do. | Hopetoun, West Lothian, | 76 0 | 70‡ | 8 0 | 1·47 |
| 1831 | nobilis, | Brahan Castle, Ross, | 55 0 | 35 | 7 9 | 2·65 |
| ,, | Do. | Haddo House, Aberdeen, | 64 0 | 35 | 6 6 | 2·22 |
| ,, | Do. | Castle-Kennedy, Wigtown, | 50 0 | 40 | 7 0 | 2·20 |
| ,, | Do. | Coul, Ross, | 77 6 | 60‡ | 7 10 | 1·70 |
| 1843 | Nordmanniana, | Buchanan Castle, Stirling, | 50 0 | 35 | 7 2 | 2·45 |
| ,, | Do. | Altyre, Moray, | 45 0 | 22 | 4 6 | 2·45 |
| .. | Do. | Poltalloch, Argyll, | 70 0 | † | 6 0 | 1·90 |
| | | **ARAUCARIA.** | | | | |
| 1796 | imbricata, | Dupplin, Perth, | 54 0 | 32 | 5 6 | 2·06 |
| ,, | Do. | Poltalloch, Argyll, | 55 6 | 35 | 6 0 | 2·65 |
| ,, | Do. | Kilmaron, Fife, | 32 0 | 22 | 3 5 | 1·86 |
| ,, | Do. | Torloisk, Mull, | 39 0 | 40 | 6 2 | 1·85 |
| ,, | Do. | Duns Castle, Berwick, | .. | .. | 6 3 | .. |
| ,, | Do. | Buchanan Castle, Stirling, | 43 0 | 35 | 5 4 | 1·82 |
| ,, | Do. | Duart, Mull, | 34 6 | 60(?) | 6 11 | .. |
| ,, | Do. | §Cairnsmore, Kirkcudbright, | .. | 25 | 5 2 | 2·48 |
| ,, | Do. | ‖Cardoness, | 41 6 | .. | 6 6 | .. |
| | | **CEDRUS.** | | | | |
| 1841 | atlantica, | Rossie Priory, Perth, | 42 0 | 45 | 7 9 | 2·06 |
| ,, | Do. | Hopetoun, West Lothian, | 59 0 | 45 | 6 8 | 1·77 |
| ,, | Do. | Gordon Castle, Moray, | 18 0 | 18 | 3 6 | 2·33 |
| 1831 | deodara, | Whittinghame, East Lothian, | 44 0 | 45 | 8 0 | 2·13 |
| ,, | Do. | Gordon Castle, Moray, | 42 0 | 40 | 6 9 | 2·02 |
| ,, | Do. | Dupplin Castle, Perth, | 49 0 | 32 | 5 4 | 2·00 |
| ,, | Do. | Kilmaron, Fife, | 37 0 | 33 | 5 4 | 1·92 |
| ,, | Do. | Rossie Priory, Perth, | 70 0 | (?) | 5 9 | (?) |
| | | **CRYPTOMERIA.** | | | | |
| 1841 | japonica, | Keir, Perth, | 42 6 | 40 | 9 8 | 2·90 |
| ,, | Do. | Methven, Perth, | 30 0 | 35¶ | 5 5 | 1·97 |
| ,, | Do. | Whittinghame, East Lothian, | 30 0 | 30 | 4 5 | 1·76 |

* Two or three years deducted from age given here, to allow for growth to 5 feet, in calculating the rate.

† Age taken from date of introduction of the species, and five years deducted for growth to 5 feet in height.

‡ Five years deducted from age given here, as tree was grown from seed.

§ From measurements in 1880, by Lord Currichill, at 3 feet 6 inches.

‖ Mr. James Thomson, gardener; girth at ground, 12 feet; 1893.

¶ Two years deducted from age given, for growth to 5 feet.

SEQUOIA GIGANTEA.

| Introduced. | Situation. | Height. | | Age. | Girth at 5 feet. | | Rate. |
|---|---|---|---|---|---|---|---|
| | | Ft. | In. | Yrs. | Ft. | In. | In. |
| 1850 to 1853 | Castle-Menzies, Perth, | 52 | 0 | 35 | 13 | 9 | 5·00 |
| ,, | Munches, Kirkcudbright, | 40 | 0 | 25 | 9 | 4 | 4·48 |
| ,, | Methven, Perth, | 61 | 0 | 25 | 7 | 5 | 3·80 |
| ,, | Rossdhu, Dumbarton, | 65 | 0 | * | 11 | 0 | 3·66 |
| ,, | Dupplin, Perth, | 55 | 0 | 28 | 8 | 6 | 3·64 |
| ,, | Keir, Perth, | 52 | 0 | 28 | 8 | 6 | 3·64 |
| ,, | Castle-Leod, Ross, | 61 | 0 | * | 10 | 3 | 3·42 |
| ,, | Altyre, Moray, | 50 | 0 | 25 | 7 | 3 | 3·40 |
| ,, | Castle-Kennedy, Wigtown, | 33 | 0 | 30 | 8 | 6 | 3·40 |
| ,, | Kilmaron Castle, Fife, | 51 | 0 | 26 | 7 | 4 | 3·38 |
| ,, | Drumlanrig, Dumfries, | 47 | 0 | 26 | 7 | 0 | 3·23 |
| ,, | Murthly Castle, Perth, | 66 | 3 | 35 | 9 | 3 | 3·17 |
| ,, | Gordon Castle, Moray, | 52 | 0 | 30 | 7 | 9 | 3·10 |
| | TAXODIUM SEMPERVIRENS. | | | | | | |
| 1846 | Murthly Castle, Perth, | 45 | 0 | 35 | 8 | 10 | 3·02 |
| ,, | Dupplin, Perth, | 60 | 0 | 32 | 7 | 9 | 2·90 |
| ,, | Kilmaron, Fife, | 45 | 9 | 26 | 5 | 9 | 2·65 |
| ,, | Cultoquhey, Perth, | 45 | 0 | 31 | 6 | 6 | 2·20 |
| ,, | Castle-Kennedy, Wigtown, | 34 | 0 | 35 | 5 | 10 | 2·00 |
| | THUYA GIGANTEA. | | | | | | |
| 1850 to 1853 | Keir, Perth, | 47 | 0 | 28 | 5 | 4 | 2·28 |
| ,, | Duart, Argyll, | 46 | 0 | 30 | 5 | 4 | 2·13 |
| ,, | Buchanan Castle, Stirling, | 28 | 0 | 25 | 4 | 4 | 2·04 |
| ,, | Riccarton, Midlothian, | 41 | 0 | 28 | 4 | 3 | 1·82 |
| ,, | Gordon Castle, Moray, | 48 | 0 | 30 | 4 | 9 | 1·90 |
| ,, | Dupplin Castle, Perth, | 50 | 0 | 30 | 4 | 8 | 1·86 |

* Age taken from date of introduction of species, and five years deducted for growth to 5 feet, in calculating rate.

CUPRESSUS.

| Introduced. | Species. | Situation. | Height. | | Age. | Girth at 5 Ft. | | Rate. |
|---|---|---|---|---|---|---|---|---|
| | | | Ft. | In. | Yrs. | Ft. | In. | In. |
| 1854 | Lawsoniana, | Torloisk, Mull, | 34 | 6 | 35 | 8 | 6 | * |
| ,, | Do. | Methven, Perth, | 45 | 0 | 33 | 5 | 4 | 2·06 |
| ,, | Do. | Dupplin, Perth, | 55 | 0 | 32 | 4 | 3 | † |
| 1838 | macrocarpa, | Castle-Kennedy, Wigtown, | 55 | 0 | 35 | 8 | 8 | 2·97 |
| | | PINUS. | | | | | | |
| 1835 | austriaca, | Murthly Castle, Perth, | 30 | 0 | 25 | 5 | 7 | 2·68 |
| ,, | Do. | Altyre, Moray, | 35 | 0 | 22 | 4 | 8 | 2·53 |
| ,, | Do. | Whittinghame, East Lothian, | 51 | 0 | 45 | 6 | 9 | 1·80 |
| ,, | Do. | Castle-Kennedy, Wigtown, | 45 | 0 | 42 | 6 | 6 | 1·73 |
| 1827 | Cembra, | Abercairney, Perth, | 55 | 0 | 30 | 7 | 0 | 2·80 |
| ,, | Do. | Munches, Kirkcudbright, | 40 | 0 | 25 | 4 | 3 | 2·04 |
| ,, | excelsa, | do. do. | 60 | 0 | 30 | 6 | 1 | 2·43 |
| ,, | Do. | Brahan Castle, Ross, | 30 | 0 | 23 | 3 | 9 | 1·95 |
| ,, | Do. | Abercairney, Perth, | 42 | 0 | 30 | 5 | 0 | 2·00 |
| 1833 | insignis, | Keir, Perth, | 54 | 0 | 40 | 9 | 4 | 2·80 |
| ,, | Do. | Castle-Kennedy, Wigtown, | 52 | 0 | 42 | 7 | 9 | 2·21 |
| ,, | Do. | Bute, | 57 | 0 | 34 | 4 | 11 | 1·73 |
| 1852 | Jeffreyi, | Fordell, Fife, | 50 | 0 | 35 | 3 | 6 | 1·20 |
| 1827 | Lambertiana, | Poltalloch, Argyll, | 45 | 0 | ‡ | 9 | 0 | 1·83 |
| 1831 | monticola, | Scone, Perth, | 71 | 0 | 39 | 5 | 11 | 1·82 |
| 1705 | strobus, | Logiealmond, Perth, | 90 | 0 | (?) | 7 | 6 | .. |
| 1825 | pinaster, | Haddo, Aberdeen, | 43 | 0 | 40 | 6 | 0 | 1·80 |
| 1834 | pyrenaica, | Keir, Perth, | 35 | 0 | 40 | 5 | 4 | 1·60 |
| 1759 | Laricio, | Altyre, Moray, | 49 | 0 | 22 | 3 | 10 | 2·09 |
| ,, | Do. | Keir, Perth, | 51 | 0 | 36 | 5 | 10 | 1·94 |
| ,, | Do. | Hopetoun, West Lothian, | 71 | 0 | 70 | 7 | 3 | 1·24 |
| ,, | Do. | Riccarton, Midlothian, | 69 | 0 | (?) | 7 | 7½ | (?) |
| 1827 | ponderosa, | Scone, Perth, | 50 | 0 | 31 | 6 | 8½ | 2·58 |
| ,, | Do. | Kilmaron, Fife, | 40 | 0 | 26 | 4 | 4 | 2·0 |
| ,, | Do. | Dupplin, Perth, | 29 | 0 | 28 | 3 | 5 | 1·46 |
| ,, | Do. | Whittinghame, East Lothian, | 50 | 0 | 45 | 4 | 6 | 1·20 |

* 2·90 inches at 1 foot. † 1·60 or 1·88 inches.

‡ Age from date of introduction of species, and five years deducted for growth to 5 ft.

II. Girth at 5 feet up of some of the finest conifers at Castle-Kennedy, Wigtownshire (Mr. William Cruden, gardener, December 1891).

| | Ft. | In. | | Ft. | In. |
|---|---|---|---|---|---|
| Abies nobilis, . . . | 6 | 7 | Cryptomeria japonica, . | 4 | 8 |
| Do. . . . | 7 | 0 | Sequoia gigantea, . . | 9 | 0 |
| Do. . . . | 7 | 1 | Taxodium sempervirens, . | 6 | 1 |
| Araucaria imbricata, . | 5 | 7 | | | |
| Do. . . | 5 | 10 | | | |

III. Dimensions and rate of girth-increase of the best conifers of all the species at Dolphinton and Methven, selected from the Conifer Conference Statistics, 1891, because their age is known with exceptional precision.

Mr. Ord Mackenzie has kept a regular record of the planting and progress of his conifers at Dolphinton. They were planted when about 18 inches high, and I have added two years to the date of planting for their growth to 5 feet. The Methven trees were raised from seed, or cuttings, or planted as seedlings 2 feet high. I have added only two years to the date of planting for all for growth to 5 feet.

Conifers at Dolphinton, Lanarkshire (Mr. J. Ord Mackenzie), 1891. Age estimated from the height of 5 feet, the position of girth measurement.

| SPECIES. | Height. | Branch Spread. | Age. | Girth. | | Rate. |
|---|---|---|---|---|---|---|
| | Feet. | Feet. | Years. | Ft. | In. | Inches. |
| Abies grandis, . . | 68 | 32 | 18 | 5 | 5 | 3·61 |
| ,, orientalis, . . | 32 | 15 | 13 | 2 | 9 | 2·53 |
| .. Menziesii, . . | 60 | 30 | 28 | 5 | 6 | 2·35 |
| .. Douglasii, . . | 62 | 36 | 39 | 7 | 6 | 2·31 |
| .. magnifica, . . | 28 | 11 | 13 | 2 | 4 | 2·30 |
| .. nobilis, . . | 57 | 26 | 28 | 4 | 9 | 2·03 |
| .. cephalonica, . | 37 | 17 | 16 | 2 | 7 | 1·93 |
| .. lasiocarpa, . . | 40 | 19 | 28 | 4 | 0 | 1·71 |
| .. Albertiana, . . | 55 | 28 | 25 | 3 | 6 | 1·70 |
| .. Nordmanniana, . | 50 | 18 | 28 | 3 | 10 | 1·64 |
| Araucaria imbricata, . | 28 | 17 | 38 | 2 | 5 | 0·76 |
| Cupressus Lawsoniana, . | 29 | 15 | 26 | 2 | 4 | 1·07 |
| Sequoia gigantea, . . | 32 | 15 | 23 | 5 | 6 | 2·87 |
| Pinus Laricio, . . | 36 | 15 | 33 | 3 | 6 | 1·27 |
| Thuya Lobii, . . . | 41 | 15 | 16 | 2 | 4 | 1·75 |

Conifers at Methven, Perth (Col. Smythe), 1891. Age estimated as at Dolphinton.

| Species. | Height. | Branch Spread. | Age. | Girth. | Rate. |
|---|---|---|---|---|---|
| | Feet. | Feet. | Years. | Ft. In. | Inches. |
| Abies Douglasii, | 65 | 33 | 31 | 6 10 | 2·64 |
| ,, Albertiana, | 58 | 27 | 21 | 4 7 | 2·62 |
| ,, grandis | 35 | 12 | 19 | 4 0 | 2·52 |
| ,, magnifica, | 25 | 9 | 11 | 2 2 | 2·36 |
| ,, nobilis, | 35 | 12 | 19 | 2 7 | 1·63 |
| ,, Nordmanniana, | 35 | 15 | 20 | 2 5 | 1·45 |
| ,, Pattoniana, | 25 | 10 | 32 | 2 2 | 0·81 |
| ,, Hookeriana, | 15 | 13 | 31 | 1 1 | 0·40 |
| Araucaria imbricata, | 35 | 16 | 33 | 4 3 | 1·54 |
| Cedrus atlantica, | 20 | 10 | 33 | 3 0 | 1·09 |
| ,, deodara, | 30 | 10 | 23 | 2 8 | 1·38 |
| Cryptomeria japonica, | 30 | 12 | 33 | 5 5 | 1·97 |
| Cupressus Lawsoniana, | 45 | 15 | 31 | 5 4 | 2·06 |
| Libocedrus decurrens, | 25 | 8 | 28 | 3 5 | 1·46 |
| Thuyopsis borealis, | 37 | 12 | 31 | 3 4 | 1·29 |
| Sequoia gigantea, | 61 | 16 | 23 | 7 5 | 3·80 |

The following well-authenticated facts are given as illustrating various interesting points in the history of recently introduced conifers :—

I. Dimensions and rate of increase for the last twelve years of three large araucarias at Duns Castle, Berwickshire (Mr. Peter Loney, land steward, Marchmont House), last measurement, 14th September 1892.

| | Height. | Girth at | | Period. | Increase at | | Rate at | |
|---|---|---|---|---|---|---|---|---|
| | | 1 Foot. | 5 Feet. | | 1 Foot. | 5 Feet. | 1 Foot. | 5 Feet. |
| | Ft. In. | Ft. In. | Ft. In. | Yrs. | In. | In. | In. | In. |
| No. 1, | 46 1 | 8 10 | 6 3 | 12 | 22 | 15 | 1·83 | 1·25 |
| No. 2, | 43 3 | 7 3 | 5 10 | 12 | 18 | 12 | 1·50 | 1·00 |
| No. 3, | 40 6 | 4 10 | 4 0 | 12 | 16 | 11 | 1·33 | 0·92 |

This table shows that three araucarias, averaging 5 feet in girth 5 feet up, were growing at an annual rate of 1 inch; that of the largest, upwards of 6 feet in girth, being $1\frac{1}{4}$ inch. The circumference of the foliage of this magnificent tree, thickly clothed to the ground, is 105 ft. (D. Christison, 1893).

II. Average rate of an araucaria, 27 feet high, and 24 inches in girth, at Stravithie House, Fifeshire, for twenty years, at 5 feet up, 1·20 inch (Dr. Cleghorn, 1891).

III. Annual girth-increase of largest *Ab. Douglasii*, Dolphinton.

| 1876 | '77 | '78 | '79 | '80 | '81 | '82 | '83 | '84 | '85 | '86 | '87 | '88 | '89 | '90 | '91 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. |
| $3\frac{3}{4}$ | 4 | $2\frac{1}{2}$ | 2 | $\frac{8}{10}$ | $2\frac{2}{10}$ | $4\frac{1}{2}$ | $3\frac{1}{2}$ | 1 | 3 | $2\frac{1}{4}$ | $3\frac{1}{4}$ | $2\frac{1}{2}$ | $\frac{1}{2}$ | $2\frac{1}{4}$ | $2\frac{1}{4}$ |

This table illustrates the extraordinary variation in the rate of girth-increase from year to year of an *Abies Douglasii*, from careful measurements taken by Mr. John Ord Mackenzie of Dolphinton. A considerable annual variation is characteristic of all trees, as I have shown at length in a Paper on the Increase of Girth in Trees (Trans. Bot. Soc. Ed., 1888), but comes out more strikingly in a tree of extraordinarily rapid growth, such as this, than in my ordinary examples. It is curious and worthy of further investigation that this variation would not be suspected from looking at sections of stems, as the width of neighbouring rings seems in general tolerably uniform.

IV. Progressive rate of *Abies Douglasii* at Jardine Hall, Dumfries. (Conifer Conference Statistics, 1891).

| Date. | Height. | Girth at | | | | | | | | Diameter of Branches. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Base. | | 1 Foot. | | 3 Feet. | | 5 Feet. | | |
| | Ft. | Ft. | In. | Ft. | In. | Ft. | In. | Ft. | In. | Feet. |
| 1828 | 2 | ... | | ... | | ... | | ... | | ... |
| 1842 | 25 | ... | | 2 | 9 | ... | | ... | | ... |
| 1845 | ... | ... | | 3 | 8 | ... | | ... | | ... |
| 1875 | ... | ... | | 11 | 0 | ... | | 8 | 6 | ... |
| 1880 | ... | ... | | 12 | 0 | 10 | 3 | ... | | 55 |
| 1884 | ... | 15 | 6 | 12 | 7 | 11 | 0 | 10 | 0 | 60 |
| 1887 | 70 | 16 | 0 | ... | | 11 | 0 | 10 | 0 | 62 |

Loudon gives the height as 13 feet 2 inches in 1837.

The top is much injured and broken by a colony of rooks which have met there for thirty years (W. H. Maxwell of Munches).

V. Additional instances of great size and rapid growth (Conifer Conference Statistics, 1891).

*Abies nobilis*, Golden Grove, Caermarthen.

| Height. | Age. | Girth at 5 Feet. | | Rate. |
|---|---|---|---|---|
| Feet. | Years. | Ft. | In. | Inches. |
| 48 | 22 | 5 | 11 | 4·61 |

As this tree was raised from seed, four years have been deducted from its age of twenty-two years, in calculating the rate of girth-increase at 5 feet up.

*Abies Douglasii*, Dropmore, Bucks.

| Height. | Branch Spread. | Age. | Girth at 5 Feet. | Rate. |
|---|---|---|---|---|
| Feet. 120 | Feet. 64 | Years. 60 | Ft. In. 11 4 | Inches. 2·26 |

The rate given is supposing the tree planted at five years old. This tree is remarkable for having the greatest recorded height of any Douglas fir in Great Britain.

*Abies Douglasii*, Dunkeld, Perth.

| Height. | Girth at | | | | | | Age. | Rate at 5 Feet. |
|---|---|---|---|---|---|---|---|---|
| | 1 Foot. | 3 Feet. | 5 Feet. | 8 Feet. | 40 Feet. | 75 Feet. | | |
| Feet. 94 | Ft. In. 14 6 | Ft. In. 12 6 | Ft. In. 12 0 | Ft. In. 9 10 | Ft. In. 5 9 | Ft. In. 1 6 | Years. 45 | Inches. 3·20 |

The rate given is supposing the tree planted at five years old.

VI. *Abies Douglasii*, Duncrub Park, Perth (Hon. Bernard Rollo, 1893).

| Height. | Girth at | | | | Branch Spread. | | Age. | Rate at 5 Feet. |
|---|---|---|---|---|---|---|---|---|
| | 1 Foot. | 3 Feet. | 5 Feet. | 7 Feet. | N. to S. | E. to W. | | |
| Feet. 72 | Ft. In. 14 8 | Ft. In. 11 10 | Ft. In. 12 5 | Ft. In. 11 9 | Ft. In. 76 0 | Ft. In. 77 8 | Years. 57 | Inches. 2·71 |

Height lessened by the top being broken in 1881. A healthy new top now formed.

VII. Rapid upward growth (Conif. Conf. Stat. 1891).

| Species. | Locality. | Period. | Annual Rate. | |
|---|---|---|---|---|
| | | Years. | Ft. | In. |
| Abies Douglasii, | Dropmore, Bucks, . . | 60 | 2 | 0 |
| Do. | Dunkeld, Perth, . . . | 45 | 2 | 1 |
| Abies grandis, | Dolphinton, Lanark, . . | 4 | 4 | 0 |
| Do. | do. (same tree), | 20 | 3 | 3 |
| Do. (No. 1) | Riccarton, Midlothian, . . | 12 | 4 | 5 |
| Do. (No. 2) | do. . . | 5 | 4 | 3 |
| Do. | Conan, Ross, . . . . | 18 | 2 | 7 |
| Do. | Altyre, Moray, . . . . | 22 | 2 | 6 |
| Abies Menziesii, | Drumlanrig, Dumfries, . . | 22 | 2 | 0 |
| Do. | Castle-Menzies, Perth, . . | 46 | 2 | 0 |
| Sequoia gigantea, | Methven Castle, Perth, . | 25 | 2 | 4 |

Although the Conifer Conference Statistics prove beyond doubt the occasional very rapid growth of many species of new conifers in this country in early youth, yet their capacity to grow to a great size is in general still unascertained. Indeed, it is the common belief among practical foresters that most of the species cease to flourish before they attain even a moderate size, and this seems borne out by the condition of the celebrated Pinetum at Castle-Kennedy, Wigtownshire, which some years ago was perhaps the most beautiful and promising collection in Britain, but which, on revisiting it last year, I was sorry to find apparently in a declining state. Even the Douglas fir, although promising well, has not yet established its position as a profitable tree. But whatever the commercial value of these conifers may turn out to be, they will always be prized for ornamental purposes.

## HISTORIC TREES.

THE BOSCOBEL OAK.—One of the necessary but thankless occasional duties of science is to dispel pleasing illusions. This duty generally falls most heavily on the archæologist, or historian, but the forester cannot altogether escape it. It may be asked, why disturb alluring beliefs, although they may be false? To this, science replies that they ought to be contradicted because they are false, and because there is no knowing how far-reaching the consequences of falsehoods may be.

It is chiefly the oak, among trees, that has been associated with heroic names or historic deeds, and perhaps none has acquired so universal fame and credit as the Boscobel Oak, reputed to have concealed King Charles II. after the battle of Worcester in 1651. An inscription placed against the present tree by Miss Evans in 1875 certifies: "This tree, under the blessing of Almighty God, had the honour of sheltering from his foes King Charles II." But Mr. Robert F. Collins (Trans. N. Staffordshire Field Club, 1890) shows that this tree, being only 11 feet 10 inches in girth, could not have been the pollard oak of nearly two and a half centuries ago, and that a previous inscription in 1817 testified that "the present tree sprung, it is said, from the above tree" (meaning the Royal tree). It also referred to previous inscriptions, from which it is plain that the original tree disappeared soon after 1787. Indeed, Dr. Stukely informs us that in 1713 "the tree was in the middle almost cut away by people who came to see it."

WALLACE OAKS.—Two oaks have been associated with the name of the Scottish hero. The ELLERSLIE OAK.—According to the legend, "Sir William Wallace and 300 of his men hid themselves among its branches from the English" (Semple's continuation of Crawford's History of Renfrewshire, 1783). But its trunk is described as being "about 12 feet in circumference," an altogether trifling girth for a tree reputed to be then five centuries old. Strutt, 1826, gives the girth as 13 feet 2 inches. The TORWOOD WALLACE OAK was estimated by Dr. Walker in 1775 to have been 22 feet in girth at 4 feet up, but only one longitudinal half of the trunk remained, and it has long entirely disappeared.

HISTORIC HAWTHORNS.—A thorn is credited with having witnessed the death of Lord Maxwell at the battle of Dryfe Sands, and several have been associated with Mary Queen of Scots, but it is scarcely possible that any hawthorn could exist for 300 years, as the species rarely exceeds a very moderate size, and my observations show that it grows at a fair average rate.

REPORT ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, during JULY, AUGUST, SEPTEMBER, and OCTOBER 1892. By ROBERT LINDSAY, Curator of the Garden.

JULY.

The weather of July was, for the most part, cool and unsettled, with heavy falls of rain, and with one or two gales of much severity for the time of year. The lowest night temperature was 40°, which occurred on the 10th of the month, and the highest 54°, on the 31st. The lowest day temperature was 55°, on the 12th, and the highest 79°, on the 31st. The growth of trees and shrubs during the month was fairly good. Most herbaceous plants flowered very well, and roses were very fine towards the end of the month.

On the rock-garden 237 species and well-marked varieties came into flower, as against 252 for the corresponding month last year. A few of the more interesting were:—*Convolvulus lineatus, Cyananthus lobatus, Dianthus cinnabarinus, Epilobium Fleischerii, E. obcordatum, Erythræa diffusa, Eriogonum aureum, Gentiana septemfida cordifolia, Gillenia trifoliata, Kniphofia caulescens, Linaria origanifolia, Meconopsis Wallichii, Primula Poissonii, Saxifraga diversifolia, S. fimbriata, Silene Elizabethæ.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during July 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 47° | 61° | 66° | 17th | 46 | 52 | 69 |
| 2nd | 49 | 58 | 71 | 18th | 48 | 55 | 66 |
| 3rd | 53 | 59 | 69 | 19th | 47 | 52 | 63 |
| 4th | 45 | 59 | 65 | 20th | 43 | 53 | 65 |
| 5th | 50 | 63 | 66 | 21st | 47 | 53 | 65 |
| 6th | 45 | 53 | 69 | 22nd | 52 | 61 | 69 |
| 7th | 54 | 59 | 65 | 23rd | 44 | 62 | 76 |
| 8th | 49 | 57 | 61 | 24th | 45 | 66 | 74 |
| 9th | 47 | 57 | 69 | 25th | 45 | 54 | 67 |
| 10th | 40 | 60 | 72 | 26th | 46 | 52 | 69 |
| 11th | 48 | 52 | 60 | 27th | 40 | 55 | 66 |
| 12th | 49 | 51 | 55 | 28th | 50 | 65 | 68 |
| 13th | 49 | 55 | 63 | 29th | 48 | 51 | 65 |
| 14th | 51 | 53 | 67 | 30th | 48 | 59 | 77 |
| 15th | 47 | 55 | 63 | 31st | 54 | 61 | 79 |
| 16th | 45 | 55 | 67 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of July 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 30·020 | 67·7 | 49·7 | 59·6 | 54·7 | W. | Cum. | 9 | W. | 0·000 |
| 2 | 29·927 | 62·0 | 46·9 | 56·9 | 54·4 | Var. | Cum. | 10 | S. | 0·045 |
| 3 | 29·622 | 64·5 | 56·9 | 58·9 | 57·3 | Calm. | Cum. | 10 | S.W. | 0·270 |
| 4 | 29·645 | 63·8 | 52·0 | 52·2 | 51·2 | W. | Cum. | 10 | W. | 0·090 |
| 5 | 29·486 | 64·0 | 51·9 | 61·8 | 56·2 | W.S.W. | Cum. | 6 | W.S.W. | 0·020 |
| 6 | 29·593 | 64·7 | 47·9 | 55·1 | 51·3 | W. | {Cir.Cum.<br>Cum. | 7<br>1 | W. | 0·125 |
| 7 | 29·108 | 64·8 | 52·8 | 58·3 | 55·1 | W.S.W. | Cum. | 10 | W.S.W. | 0·020 |
| 8 | 29·480 | 61·5 | 49·0 | 58·4 | 52·9 | W. | {Cir.<br>Cum. | 3<br>2 | W. | 0·005 |
| 9 | 29·820 | 63·0 | 49·9 | 57·1 | 53·1 | W. | Cum. | 10 | W. | 0·005 |
| 10 | 29·949 | 64·0 | 43·6 | 57·9 | 53·6 | N.E. | {Cir.<br>Cum. | 2<br>1 | N.E. | 0·000 |
| 11 | 29·965 | 66·0 | 49·1 | 51·1 | 50·5 | E.N.E. | St. | 10 | E.N.E. | 0·000 |
| 12 | 29·794 | 58·8 | 49·4 | 50 7 | 49·0 | E.N.E. | Nim. | 10 | E.N.E. | 0·020 |
| 13 | 29·682 | 54·2 | 47·9 | 54·2 | 51·1 | N.E. | Cum. | 5 | N.E. | 0·000 |
| 14 | 29·869 | 57·9 | 48·3 | 50·5 | 48·1 | E. | Cum. | 10 | E. | 0·000 |
| 15 | 29·945 | 58·0 | 49·8 | 52·5 | 49·1 | E. | Cum. | 10 | E. | 0·000 |
| 16 | 29·893 | 58·0 | 49·0 | 55·4 | 50·0 | N.E. | Cum. | 5 | N.E. | 0·000 |
| 17 | 29·862 | 61·2 | 48 9 | 51·9 | 47·2 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 18 | 29·839 | 59·7 | 44·7 | 53·8 | 50·2 | N.W. | Cum. | 5 | N.W. | 0·310 |
| 19 | 29·421 | 59·0 | 49·9 | 53·1 | 52·8 | W.S.W. | Nim. | 10 | W.S.W. | 0·070 |
| 20 | 30·059 | 61·5 | 48·7 | 53·2 | 50·2 | N.N.E. | Cum. | 10 | N.N.E. | 0·000 |
| 21 | 30·123 | 59 8 | 41·6 | 59·8 | 55·3 | W. | Cir. | 4 | N. | 0·000 |
| 22 | 30·136 | 69·5 | 55·0 | 61·3 | 56·8 | W. | Cum. | 9 | W. | 0·000 |
| 23 | 30·197 | 66·2 | 49·0 | 61·7 | 56·1 | N.W. | Cir. | 3 | N.W. | 0·000 |
| 24 | 30·276 | 68·0 | 47·9 | 61·7 | 57·3 | E. | ... | 0 | ... | 0·000 |
| 25 | 30·243 | 68·8 | 49·8 | 52·9 | 52·3 | E. | Cum. | 10 | E. | 0·000 |
| 26 | 30·236 | 59·9 | 51·0 | 56·1 | 54·0 | E. | Cum. | 10 | E. | 0·000 |
| 27 | 30·290 | 63·8 | 43·4 | 54·6 | 52·7 | E. | Cum. | 10 | E. | 0·000 |
| 28 | 30·272 | 60·0 | 52·9 | 59·1 | 53·4 | E. | Cum. | 1 | E. | 0·000 |
| 29 | 30·248 | 63·0 | 50·8 | 52·2 | 51·1 | E. | Cum. | 10 | E. | 0·000 |
| 30 | 30·158 | 58·2 | 50·9 | 54·8 | 53·4 | W. | Cum. | 10 | W. | 0·010 |
| 31 | 29·889 | 70·0 | 53·9 | 61·0 | 58·8 | W. | Cum. | 10 | W. | 0·000 |

Barometer.—Highest Reading, on the 27th, = 30·290. Lowest Reading, on the 7th, = 29·108. Difference, or Monthly Range, = 1·182. Mean = 29·905.

S. R. Thermometers.—Highest Reading, on the 31st, = 70°·0. Lowest Reading, on the 21st, = 41°·6. Difference, or Monthly Range, = 28°·4. Mean of all the Highest = 62°·6. Mean of all the Lowest = 49°·4. Difference, or Mean Daily Range, = 13°·2. Mean Temperature of Month = 56°·0.

Hygrometer.—Mean of Dry Bulb = 56°·0. Mean of Wet Bulb = 52°·9.

Rainfall.—Number of Days on which Rain fell = 12. Amount of Fall, in inches, = 0·990.

A. D. RICHARDSON,
*Observer.*

## AUGUST.

August was a most inclement month. No really warm days occurred, and altogether the month was a most unfavourable one. The lowest night temperature was 35°, which occurred on the 10th of the month, and the highest 58°, on the 14th. The lowest day temperature was 51°, on the 8th, and the highest 74°, on the 13th.

On the rock-garden 103 species and varieties came into flower, as against 84 during last August. Amongst the most conspicuous or interesting were:—*Campanula isophylla alba*, *C. Waldsteiniana*, *Castanea chrysophylla*, *Coreopsis grandiflora*, *Chelone barbata*, *Dianthus Atkinsonii*, *D. glauca*, *Gentiana asclepiadea*, *G. asclepiadea alba*, *G. ornata*, *G. tibetica*, *G. arvernensis*, *Lobelia cardinalis*, *Monarda Kalmiana*, *Olearia Haastii*, *Papaver pyrenaicum*, *Scabiosa fumariæfolia*, *Senecio speciosus*, *Spiræa Bumalda*, *Symphiandra Hoffmanii*, *Veronica longifolia subsessilis*, *V. lycopodioides*, *Viola cornuta* × *tricolor*.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during August 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 56° | 64° | 66° | 17th | 47° | 53° | 59° |
| 2nd | 48 | 54 | 70 | 18th | 48 | 55 | 59 |
| 3rd | 50 | 58 | 70 | 19th | 47 | 59 | 69 |
| 4th | 39 | 59 | 69 | 20th | 37 | 57 | 69 |
| 5th | 47 | 55 | 70 | 21st | 54 | 64 | 70 |
| 6th | 46 | 57 | 68 | 22nd | 56 | 66 | 73 |
| 7th | 44 | 60 | 72 | 23rd | 50 | 63 | 74 |
| 8th | 46 | 50 | 51 | 24th | 49 | 57 | 68 |
| 9th | 46 | 50 | 51 | 25th | 52 | 57 | 70 |
| 10th | 35 | 62 | 69 | 26th | 47 | 57 | 68 |
| 11th | 44 | 52 | 70 | 27th | 46 | 58 | 67 |
| 12th | 50 | 60 | 73 | 28th | 43 | 61 | 65 |
| 13th | 54 | 59 | 74 | 29th | 37 | 54 | 68 |
| 14th | 58 | 64 | 70 | 30th | 45 | 55 | 69 |
| 15th | 50 | 63 | 69 | 31st | 51 | 54 | 57 |
| 16th | 47 | 54 | 68 | | | | |

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of August 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·839 | 71·4 | 56·0 | 63·5 | 59·1 | N.W. | Cum. | 9 | N. | 0·030 |
| 2 | 30·050 | 63·9 | 49·9 | 54·0 | 51·4 | S.E. | Cum. | 10 | S.E. | 0·000 |
| 3 | 29·907 | 63·8 | 53·1 | 59·8 | 54·2 | W.S.W. | ... | 0 | ... | 0·050 |
| 4 | 29·963 | 68·0 | 41·0 | 57·3 | 50·3 | N.W. | { Cir. / Cum. | 2 / 3 } | N.W. | 0·000 |
| 5 | 29·797 | 64·8 | 51·0 | 56·1 | 53·1 | S.W. | Cum. | 10 | S.W. | 0·075 |
| 6 | 29·570 | 67·1 | 49·7 | 60·2 | 54·3 | W. | Cum. | 3 | W. | 0·000 |
| 7 | 29·839 | 65·7 | 45·7 | 61·4 | 54·0 | N.W. | Cir. | 1 | N.W. | 0·680 |
| 8 | 29·734 | 65·7 | 50·1 | 50·8 | 50·1 | E. | Nim. | 10 | E. | 0·420 |
| 9 | 29·977 | 53·7 | 47·0 | 53·0 | 47·2 | N. | Cum. | 8 | N.E. | 0·000 |
| 10 | 30·127 | 58·9 | 39·8 | 58·5 | 53·1 | W. | ... | 0 | ... | 0·070 |
| 11 | 29·927 | 66·4 | 47·0 | 57·3 | 55·8 | W. | Cum. | 10 | W. | 0·045 |
| 12 | 29·840 | 65·8 | 53·1 | 60 4 | 57·9 | S.W. | Cum. | 10 | S.W. | 0·045 |
| 13 | 29·393 | 68·0 | 58·1 | 60·3 | 58·3 | S.W. | Nim. | 10 | S.W. | 0·400 |
| 14 | 29·391 | 69·6 | 53·6 | 64·2 | 59·0 | S.W. | Cir. | 5 | S.W. | 0·475 |
| 15 | 29·467 | 67·8 | 52·9 | 61·0 | 55·4 | W. | Cum. | 1 | W. | 0·000 |
| 16 | 29·868 | 65·6 | 50·4 | 62·8 | 57·2 | W.S.W. | Cum. | 8 | W.S.W. | 0·100 |
| 17 | 29·821 | 65·6 | 50·6 | 59·3 | 57·3 | W. | Cum. | 4 | W. | 0·030 |
| 18 | 29·818 | 64·6 | 51·0 | 54·9 | 53·3 | S.S.E. | Nim. | 10 | S.S.E. | 0·200 |
| 19 | 29·627 | 57·0 | 51·6 | 56·9 | 55·5 | Calm. | Cum. | 10 | N.W. | 0·000 |
| 20 | 29·871 | 64·0 | 42·2 | 60·1 | 56·1 | W. | ... | 0 | ... | 0·010 |
| 21 | 29·866 | 68·8 | 58·8 | 66·5 | 62·9 | S.W. | Cir. | 8 | S.W. | 0·000 |
| 22 | 29·888 | 70 8 | 61·2 | 67·7 | 62·7 | S.W. | Cir. St. | 6 | S.W. | 0·000 |
| 23 | 29·729 | 72·5 | 52·9 | 62·2 | 59·2 | S. | ... | 0 | ... | 0·060 |
| 24 | 29·672 | 67·3 | 55·3 | 57·1 | 57·0 | N.E. | Cum. | 10 | N.E. | 0·005 |
| 25 | 29·578 | 61·4 | 53·5 | 59·6 | 55·4 | S.W. | Cir. | 4 | S. | 0·000 |
| 26 | 29·710 | 67·7 | 50·0 | 59·4 | 53·1 | W. | Cum. | 2 | W. | 0·190 |
| 27 | 29·408 | 64·5 | 48·1 | 57·4 | 53·1 | W.S.W. | ... | 0 | ... | 0·000 |
| 28 | 29·391 | 64·0 | 47·8 | 59·5 | 53·4 | W.N.W. | ... | 0 | ... | 0·020 |
| 29 | 29·631 | 64·8 | 38·3 | 52·2 | 47·2 | N.E | Cir. | 2 | S.W. | 0·810 |
| 30 | 29·264 | 56·9 | 48·5 | 57·2 | 56·9 | Calm. | Cum. | 10 | S.W. | 0·650 |
| 31 | 29·202 | 60·6 | 53·7 | 55·3 | 55·2 | N. | Nim. | 10 | N. | 0·280 |

Barometer.—Highest Reading, on the 10th, = 30·127. Lowest Reading, on the 31st, = 29·202. Difference, or Monthly Range, = 0·925. Mean = 29·716.

S. R. Thermometers.—Highest Reading, on the 23rd, = 72°·5. Lowest Reading, on the 29th, = 38°·3. Difference, or Monthly Range, = 34°·2. Mean of all the Highest = 65°·1. Mean of all the Lowest = 50°·4. Difference, or Mean Daily Range, = 14°·7. Mean Temperature of Month = 57°·7.

Hygrometer.—Mean of Dry Bulb 58°·9. Mean of Wet Bulb = 55°·1.

Rainfall.—Number of Days on which Rain fell 21. Amount of Fall, in inches = 4·645.

A. D. RICHARDSON,
*Observer.*

## SEPTEMBER.

The month of September was cool and unsettled throughout. No frost occurred, but the average temperature was very low. The greatest deficiency of heat occurred during the day. There was an entire absence of anything in the shape of warm weather. The lowest night temperature was 35°, which occurred on the 30th of the month, and the highest 55°, on the 13th. The lowest day temperature was 52°, on the 28th, and the highest 69°, on the 6th.

Most herbaceous plants flowered very well this month, particularly species of *Aster, Rudbeckia, Pyrethrum,* and other compositæ. *Colchicum, Kniphofia,* and *Crocus* were also fine. Roses flowered fairly well in September. Autumn tints began to show on *Pavia flava* about the middle of the month, and towards the close the golden-yellow leaves were most beautiful and effective.

On the rock-garden 45 plants came into flower, as against 41 for the corresponding month last year, amongst which were the following:—*Colchicum speciosum maximum, C. striatum, Carlina subcaulescens, Centaurea alpina, Coreopsis verticillata, Crocus annulatus, C. medius, C. nudiflorus, Delphinium nudicaule aurantiacum, Gentiana alba, Gladiolus Saundersii, Hypericum patulum, Kniphofia nobilis, Liatris elegans, Lilium auratum macranthum, Montbretia* ("Star of Fire"), *Potentilla formosa, Senecio pulcher, Teucrium flavum.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during September 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 43° | 54° | 61° | 16th | 47° | 51° | 61° |
| 2nd | 41 | 57 | 59 | 17th | 42 | 53 | 63 |
| 3rd | 40 | 47 | 60 | 18th | 50 | 51 | 62 |
| 4th | 40 | 50 | 68 | 19th | 46 | 51 | 64 |
| 5th | 37 | 52 | 67 | 20th | 47 | 50 | 55 |
| 6th | 50 | 58 | 69 | 21st | 45 | 52 | 58 |
| 7th | 40 | 52 | 60 | 22nd | 36 | 48 | 58 |
| 8th | 36 | 53 | 65 | 23rd | 43 | 47 | 60 |
| 9th | 40 | 55 | 66 | 24th | 42 | 52 | 58 |
| 10th | 45 | 58 | 69 | 25th | 46 | 57 | 63 |
| 11th | 47 | 58 | 68 | 26th | 44 | 52 | 64 |
| 12th | 48 | 56 | 64 | 27th | 38 | 55 | 60 |
| 13th | 55 | 61 | 67 | 28th | 39 | 45 | 52 |
| 14th | 41 | 53 | 63 | 29th | 37 | 42 | 54 |
| 15th | 48 | 54 | 65 | 30th | 35 | 42 | 55 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of September 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·439 | 56·8 | 46·2 | 55·0 | 52·3 | S.W. | Cum. | 10 | S.W. | 0·120 |
| 2 | 29·196 | 58·2 | 44·4 | 55·7 | 52·4 | W. | Cum. | 8 | W. | 0·105 |
| 3 | 29·399 | 58·8 | 43·8 | 50·2 | 46·7 | W. | Cum. | 10 | N.W. | 0·000 |
| 4 | 30·045 | 56·8 | 41·1 | 52·3 | 47·7 | N.W. | Cum. | 1 | N.W. | 0·000 |
| 5 | 30·130 | 59·8 | 39·8 | 53·5 | 50·1 | S.W. | Cir. | 4 | W. | 0·005 |
| 6 | 30·047 | 61·3 | 52·4 | 58·7 | 56·0 | S.W. | Cir. | 7 | S.W. | 0·005 |
| 7 | 29·780 | 62·8 | 46·0 | 55·1 | 53·1 | S.W. | Cum. | 10 | S.W. | 0·045 |
| 8 | 29·983 | 57·0 | 38·5 | 54·3 | 51·2 | W. | ... | 0 | ... | 0·000 |
| 9 | 29·714 | 60·8 | 44·4 | 55·9 | 53·4 | S.W. | Cum. | 8 | S.W. | 0·000 |
| 10 | 29·739 | 62·9 | 48·9 | 57·9 | 54·0 | S.W. | Cum. | 1 | N.W. | 0·000 |
| 11 | 29·682 | 63·9 | 44·9 | 57·0 | 52·4 | W.S.W. | Cum. | 7 | W. | 0·020 |
| 12 | 29·678 | 60·7 | 48·2 | 55·3 | 53·6 | W. | Cum. | 9 | S.W. | 0·005 |
| 13 | 29·291 | 62·0 | 55·3 | 61·6 | 58·7 | S.W. | Cum. | 2 | S.W. | 0·000 |
| 14 | 29·804 | 65·1 | 42·2 | 53·6 | 50·8 | S.W. | Cum. | 9 | S.W. | 0·012 |
| 15 | 29·623 | 59·2 | 52·4 | 56·2 | 53·1 | S.S.W. | Cum. | 9 | S.W. | 0·000 |
| 16 | 29·300 | 60·7 | 52·2 | 55·3 | 50·5 | S.S.W. | Cir. Cum. | 3 | S.S.W. | 0·000 |
| 17 | 29·851 | 58·0 | 40·1 | 51·5 | 46·8 | W.S.W. | Cum. | 2 | N.W. | 0·007 |
| 18 | 29·635 | 57·3 | 50·8 | 54·9 | 52·0 | S.W. | Nim. | 6 | W. | 0·103 |
| 19 | 29·507 | 59·5 | 51·5 | 58·3 | 55·9 | W. | Cum. | 2 | W. | 0·054 |
| 20 | 29·936 | 62·4 | 47·0 | 48·4 | 46·5 | E. | Nim. | 10 | E. | 0·000 |
| 21 | 30·099 | 53·2 | 46·9 | 48·9 | 44·3 | E.N.E. | Cum. | 9 | E. | 0·000 |
| 22 | 30·176 | 53·2 | 40·1 | 49·8 | 45·8 | E.N.E. | Cum. | 8 | E. | 0·000 |
| 23 | 29·957 | 56·1 | 47·9 | 49·5 | 48·8 | E. | ... | 0 | ... | 0·198 |
| 24 | 29·474 | 57·5 | 45·3 | 51·7 | 48·2 | W.S.W. | Cum. | 3 | W. | 0·005 |
| 25 | 29·322 | 56·8 | 48·0 | 56·7 | 53·3 | W.S.W. | Cum. | 5 | S.W. | 0·080 |
| 26 | 29·690 | 61·6 | 46·0 | 54·1 | 50·7 | S.W. | Cum. | 6 | S.W. | 0·085 |
| 27 | 29·141 | 61·4 | 53·7 | 57·0 | 55·1 | S.W. | Nim. | 10 | S.W. | 0·180 |
| 28 | 29·475 | 57·6 | 40·8 | 47·8 | 44·2 | S.W. | ... | 0 | ... | 0·030 |
| 29 | 29·231 | 53·6 | 41·4 | 49·4 | 46·1 | W.S.W. | Cum. | 10 | W.S.W. | 0·020 |
| 30 | 29·237 | 52·5 | 38·2 | 44·8 | 43·1 | S. | Cir. | 5 | S. | 0·010 |

Barometer.—Highest Reading, on the 22nd, = 30·176. Lowest Reading, on the 27th, = 29·141. Difference, or Monthly Range, = 1·035. Mean = 29·653.

S. R. Thermometers.—Highest Reading, on the 14th, = 65°·1. Lowest Reading, on the 30th, = 38°·2. Difference, or Monthly Range, = 26°·9 Mean of all the Highest = 58°·9. Mean of all the Lowest = 45°·9. Difference, or Mean Daily Range, = 13°·0. Mean Temperature of Month = 52°·4.

Hygrometer.—Mean of Dry Bulb = 53°·7. Mean of Wet Bulb = 50°·6.

Rainfall.—Number of Days on which Rain fell = 19. Amount of Fall, in inches, = 1·089.

A. D. RICHARDSON, } *Observers.*
A. ANDERSON, }

## OCTOBER.

The month was very cold, with much frost and rain. The first frost this season was on the 2nd, when the glass registered 32°. The thermometer was at or below the freezing point on nine occasions, indicating collectively 44° of frost for the month. The lowest readings were on the 18th, 26°; 19th, 28°; 24th, 23°; 25th, 19°; 26th, 20°. The lowest day reading was 44° on the 25th, and the highest 62° on the 2nd. Leaves of deciduous trees and shrubs began to fall early in the month. Autumn tints were most conspicuous on species of Oak, Maple, *Cornus*, *Azalea*, *Pyrus*, and *Berberis*. The brown tint on varieties of *Biota* is also very distinct and interesting. Fruit is most abundant on trees of *Pyrus latifolia*, Holly Cotoneaster, and *Pernettya*. Flowering herbaceous plants continued to bloom till the frost of the 25th. Large masses of *Polygonum vacciniifolium* on the rock-garden were completely destroyed at the same date.

On the rock-garden 15 species came into flower during October, as against 13 for October 1891. Amongst those were:—*Aster longifolius*, *Crocus asturicus*, *C. Salzmannii*, *Helleborus albicans*, *Hypericum nepalense*, *Parochætus communis*, *Rudbeckia Newmannii*, *Sedum spectabile*, *Statice minuta*. The total which have flowered since 1st January is 1208. During the same period last year 1210 flowered.

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during October 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 34° | 40° | 45° | 17th | 35 | 43 | 50 |
| 2nd | 32 | 42 | 62 | 18th | 26 | 35 | 51 |
| 3rd | 37 | 45 | 51 | 19th | 28 | 40 | 51 |
| 4th | 42 | 45 | 55 | 20th | 37 | 39 | 51 |
| 5th | 39 | 43 | 51 | 21st | 34 | 36 | 46 |
| 6th | 36 | 47 | 61 | 22nd | 32 | 38 | 47 |
| 7th | 41 | 44 | 52 | 23rd | 32 | 40 | 45 |
| 8th | 39 | 41 | 53 | 24th | 23 | 38 | 46 |
| 9th | 36 | 50 | 56 | 25th | 19 | 25 | 44 |
| 10th | 38 | 45 | 52 | 26th | 20 | 27 | 45 |
| 11th | 33 | 45 | 56 | 27th | 32 | 39 | 52 |
| 12th | 33 | 41 | 54 | 28th | 45 | 54 | 61 |
| 13th | 44 | 46 | 55 | 29th | 46 | 51 | 60 |
| 14th | 43 | 50 | 54 | 30th | 37 | 44 | 54 |
| 15th | 44 | 46 | 55 | 31st | 34 | 38 | 50 |
| 16th | 34 | 42 | 48 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of October 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·266 | 50·5 | 37·5 | 42·0 | 41·8 | Calm. | Cir. | 5 | S.W. | 0·420 |
| 2 | 29·366 | 50·0 | 36·0 | 45·0 | 44·8 | S. | Nim. | 10 | E. | 0·120 |
| 3 | 29·614 | 50·1 | 38·0 | 48·6 | 47·8 | N.E. | Nim. | 10 | N.E. | 0·945 |
| 4 | 29·550 | 50·9 | 46·0 | 46·4 | 46·1 | Calm. | Nim. | 10 | E. | 0·300 |
| 5 | 29·242 | 52·5 | 43·0 | 44·8 | 44·8 | Calm. | Nim. | 10 | N.E. | 0·280 |
| 6 | 29·142 | 49·8 | 44·5 | 49·8 | 46·1 | S.W. | Cum. | 9 | S.W. | 0·030 |
| 7 | 29·110 | 56·7 | 43·8 | 45·8 | 44·4 | S.W. | Cir. St. | 10 | N. | 0·100 |
| 8 | 29·318 | 50·7 | 41·0 | 41·9 | 39·7 | W. | Cir. St. | 10 | N.W. | 0·175 |
| 9 | 28·764 | 50·8 | 40·6 | 45·8 | 44·0 | W. | { Cir. / Cum. | 2 / 3 } | W. | 0·070 |
| 10 | 29·532 | 51·0 | 40·0 | 45·0 | 42·5 | N.W. | Cum. | 4 | N. | 0·010 |
| 11 | 29·964 | 49·8 | 34·1 | 42·9 | 42·0 | S.W. | Nim. | 10 | N. | 0·005 |
| 12 | 30·115 | 51·8 | 35·2 | 41·9 | 40·0 | W. | Cum. | 5 | N. | 0·005 |
| 13 | 30·096 | 48·8 | 41·0 | 47·9 | 44·8 | N.E. | Cum. | 10 | N.E. | 0·250 |
| 14 | 30·063 | 50·8 | 46·8 | 50·1 | 48·0 | E.N.E. | Cum. | 5 | E.N.E. | 0·020 |
| 15 | 29·992 | 51·9 | 45·8 | 46·8 | 44·7 | E.N.E. | Cum. | 10 | E.N.E. | 0·025 |
| 16 | 29·896 | 47·0 | 38·0 | 42·9 | 40·0 | N.N.E. | Cum. | 9 | N.N.E. | 0·005 |
| 17 | 30·067 | 47·1 | 36·8 | 40·7 | 37·9 | N.N.W. | Cir. St. | 8 | N. | 0·000 |
| 18 | 30·273 | 45·1 | 29·2 | 35·1 | 34·0 | W. | ... | 0 | ... | 0·000 |
| 19 | 30·120 | 49·3 | 29·0 | 47·3 | 41·6 | W. | Cir. | 6 | N.W. | 0·000 |
| 20 | 29·966 | 49·8 | 39·0 | 41·8 | 40·4 | N.W. | Cum. | 10 | N.W. | 0·230 |
| 21 | 29·606 | 47·0 | 37·9 | 39·4 | 39·0 | N. | Cum. | 10 | N. | 0·000 |
| 22 | 29·588 | 43·9 | 34·1 | 39·2 | 36·1 | N.W. | Cir. St. | 10 | N.W. | 0·000 |
| 23 | 29·442 | 43·8 | 33·9 | 40·3 | 36·2 | N.W. | Cir. | 1 | N. | 0·030 |
| 24 | 29·691 | 44·1 | 35·2 | 37·4 | 35·4 | N.W. | Cir. | 8 | N.W. | 0·000 |
| 25 | 29·805 | 43·0 | 23·0 | 27·7 | 26·7 | W. | ... | 0 | ... | 0·000 |
| 26 | 29·924 | 39·9 | 23·7 | 28·4 | 27·9 | N.W. | ... | 0 | ... | 0·140 |
| 27 | 29·282 | 42·9 | 27·7 | 42·7 | 41·5 | S. | Cum. | 10 | S. | 0·155 |
| 28 | 28·941 | 53·3 | 41·8 | 53·4 | 51·6 | S.W. | Cum. | 2 | S.W. | 0·055 |
| 29 | 28·941 | 58·0 | 48·6 | 52·2 | 51·1 | S. | Cum. | 10 | S. | 0·070 |
| 30 | 29·486 | 56·9 | 38·6 | 42·1 | 40·2 | S.S.W. | ... | 0 | ... | 0·010 |
| 31 | 29·593 | 49·5 | 35·9 | 38·2 | 38·0 | S.W. | ... | 0 | ... | 0·000 |

Barometer.—Highest Reading, on the 18th, = 30·273. Lowest Reading, on the 9th, = 28·764. Difference, or Monthly Range, = 1·509. Mean = 29·637.

S. R. Thermometers.—Highest Reading, on the 29th, = 58°·0. Lowest Reading, on the 25th, = 23°·0. Difference, or Monthly Range, = 35°·0. Mean of all the Highest = 49°·2. Mean of all the Lowest = 37°·3. Difference, or Mean Daily Range, = 12°·1. Mean Temperature of Month = 43°·2.

Hygrometer.—Mean of Dry Bulb = 43°·0. Mean of Wet Bulb = 41°·3.

Rainfall.—Number of Days on which Rain fell = 23. Amount of Fall, in inches, = 3·450.

A. D. RICHARDSON,
*Observer.*

## SUPPLEMENTARY NOTES ON THE MARINE ALGAE OF THE ORKNEY ISLANDS. By GEORGE WM. TRAILL.

(With Zincograph.)

(Read at the Meeting of the Society on February 11, 1892.)

While on a few weeks' visit to South Ronaldsay, in Orkney, last summer, seeing that the Marine Algae of the island had been comparatively little studied, I devoted my attention to the subject in the hope of being successful in finding new species to add to the Orkney list.

The island is seven and a half miles long, by about three in average breadth, and is deeply intersected with bays.

A coast of this extent might be thought likely to yield fair results; but, from my having been unable to dredge, and having thus had to confine myself almost exclusively to the littoral Algae, the results are unfortunately not so good as I might otherwise have been able to show.

I found above 115 species. These being, as a rule, very similar to the littoral Algae enumerated in my Orkney list, I shall mention only those which are of special interest, including several not hitherto recorded.

*Calothrix pulvinata* (Mert.), Ag.—At the west of St. Margaret's Hope, near "The Needle"; chiefly on the sides of grassy tufts covered by the sea at high tides only. Now first recorded as an Orkney species.

*Calothrix scopulorum* (Web. and Mohr.), Ag.—At Kirkness in abundance, on smooth, flat rocks near high-water mark. Now first recorded as an Orkney species.

*Prasiola stipitata*, Suhr.—Occurs sparingly at the east of Harrabrough Head, on rocks and large stones in shaded places exposed to the north, at about the high-water mark of neap tides. The only other Orkney locality recorded is Scapa Bay, where I found it in 1887, but it is scarce there also.

*Bryopsis plumosa* (Huds.), Ag.—At Kirkness, very fine in pools at about half-tide level; also at the east of Harrabrough Head, but not so large.

*Vaucheria sphaerospora*, Nordst.; *f. genuina*, Nordst.; *f. dioica*, Nordst.—At the Oyce of Quindry; at the west side of St. Margaret's Hope; near Howe Taing, Hoxa, etc.; usually on the muddy sides of grassy tufts near high-water mark.

*Dictyosiphon hippuroides* (Lyngb.), Kütz, forma *fragilis* (Harv.), Kjellm. In Kjellman, "The Algae of the Arctic Sea," page 268.—At St. Peter's Point, on an exposed open coast, growing on the rock in pools at about half-tide level, in characteristic specimens from six to ten inches high, with zöosporangia. I forwarded one of the specimens to Professor Kjellman, of Upsala, and am indebted to him for kindly identifying the plant. This is now first recorded as a British form. (See Illustration previous page.)

*Stictyosiphon tortilis* (Rupr.), Rke.—At Roeberry Taing in considerable abundance in sandy pools at about half-tide level. This species has only once before been found in Orkney, namely, one specimen at Holm, East Mainland, by Mr. J. W. Cursiter.

*Callithamnion arbuscula* (Dillw.), Lyngb. — In great abundance, and of large size on flat rocks near low-water mark, east of Harrabrough Head, at a place where there is generally considerable surf. These are by far the finest Orkney specimens I have seen.

*Catenella Opuntia* (Good. and Wood.), Grev.—In dark crevices near high-water mark, at the east of Harrabrough Head, sometimes in very fine specimens.

*Rhodymenia palmata* (Linn.), Grev., forma *sarniensis* (Mert.) Grev.; also var. B. *tenuissima*, Turn.—In Kjellman "The Algae of the Arctic Sea, page 148. In Turn. Hist. Fuc. 1, page 96.—This form and variety occur on the shores of St. Margaret's Hope, and at similar sheltered places around the coast of the island, in large, bushy tufts, and sometimes in immense quantities. The typical form seldom, if ever, accompanies them. The variety, B. *tenuissima*, for the identification of which I am indebted to Prof. Kjellman, is now first recorded as having been found in Orkney.

*Corallina mediterranea*, Aresch.—At Kirkness in pools at about half-tide level, rare. I am indebted to Mr. Batters for kindly identifying the plant. It is now first recorded as an Orkney species.

*Callithamnion byssoides*, Arn.—Found many years ago by Mr. Pollexfen in Kirkwall Bay, epiphytic on *Desmarestia aculeata.* Determined by Harvey.

*Phyllophora Brodiæ* (Turn.), J. Ag., forma *angustissima*, C. Ag.—This form occurs in the Loch of Stenness.

## MEETING OF THE SOCIETY,

Thursday, December 8, 1892.

Dr. DAVID CHRISTISON, President, in the Chair.

Rev. GEORGE GUNN, M.A., T. CUTHBERT DAY, and R. STEWART, S.S.C., were elected Resident Fellows of the Society.

Dr. KARL GOEBEL, Professor of Botany in the University and Director of the Botanic Garden, Munich, and GRAF H. ZU SOLMS LAUBACH, Professor of Botany in the University and Director of the Botanic Garden, Strassburg, were, on the recommendation of the Council, chosen Foreign Honorary Fellows of the Society.

The death of JAMES LILBURNE, R.N., M.D., Fellow of the Society, was announced.

Presents to the Library at the Royal Botanic Garden were announced.

The CURATOR exhibited a seedling, *Eichhornia* (*Pontederia*) *crassipes*, from the Royal Botanic Garden, showing the linear first-formed submerged leaves and the later aerial leaves.

Professor BAYLEY BALFOUR exhibited a young carpel of *Cycas Rumiriana* from a plant in flower in the Royal Botanic Garden.

Mr. CAMPBELL sent for exhibition specimens of *Genista fragrans*, *Escallonia macrantha*, some species of *Veronica*, and of *Tritoma*, and of *Passiflora*, all in flower in open air in his garden at Ledaig, Argyllshire.

The PRESIDENT exhibited a seed of *Ipomœa tuberosa* found on the shore of Uist. He read a note by the late Sir Robert Christison in which mention was made of three other species of tropical fruits also found in Uist, and which had been sent him by Dr. Macdonald, of Lochmaddy. These were *Entada gigantea*, *Dolichos vulgaris*, and *Guilandina Bonduc*, all West Indian fruits carried by the Gulf Stream and stranded on the Outer Hebrides. In a letter sent to Dr. Christison with the seed, Dr. Stewart of Ardgour mentioned that the natives of Uist call this seed "Airne Moire," (Virgin) Mary's kidney, on account of the colour and the presence of a roughly marked cross on one of the surfaces. It was referred to by Martin in 1692 under the name of "Molluscan bean," while Pennant calls it "Jamaica bean."

The following Papers were read:—

## EXCURSION OF THE SCOTTISH ALPINE BOTANICAL CLUB TO KILLIN, IN JULY 1892. By CHARLES STUART, M.D.

On Monday, 18th July 1892, the following members of the Club—W. B. Boyd, President; Rev. David Paul, Rev. W. W. Peyton, P. Neill Fraser, George H. Potts, Captain F. M. Norman, and Dr. Charles Stuart—left Edinburgh for Killin. They travelled in a reserved carriage, by the Caledonian Railway, and reached Killin about 7 P.M., where they were comfortably accommodated at Maisie's Hotel. They were accompanied by Rev. George Gunn and Mr. Milne.

Tuesday, 19th July.—This day, unfortunately, was very wet and stormy, the mist was down to the hotel doors, and mountain climbing was out of the question. A lull having taken place about eleven o'clock, Mackintoshes were donned, and a start was made for a walk up the Lochay as far as Tirai. Furious blasts of wind from the north blew sheets of rain in our faces, so that matters were far from comfortable at first. Between showers we botanized on both sides of the road. On the meadows sloping down to the river Lochay, *Orchis maculata*, L., var. *alba*; *Habenaria conopsea*, Benth.; *H. bifolia*, Br.; *H. chlorantha*, Bab., were abundant. On the old wall bordering the road many good mosses were gathered of a sub-alpine type. A raid was made up the steep banks of the Finlarig woods, where some good forms of *Nephrodium Oreopteris*, Desv., were obtained by Mr. Fraser.

Wednesday, 20th July.—The excursion to-day was to Meall-nan-Tarmachan. Driving four miles to where the road to Glen Lyon branches off from the Kenmore road, a walk of five miles brought us to Lochan-na-Lairige, which is situated on the watershed. It is surrounded by high mountains, but, on the west side, a range of promising-looking ledges, covered at this season with greenery and alpine flowers, appeared to give us hope of something good. The Minister of Killin and the Supervisor of Excise joined our party, and were agreeable companions on the hill. At the Loch the party divided so as to give the range of rocks a thorough inspection, but to reach the plateau most of the members had to come to the south side and ascend by a very steep watercourse, as the rocks farther round could not be climbed with safety. *Woodsia hyperborea*, Br., is said to grow on the higher ledges, but this plant was certainly not obtained by any of us. However, plenty of *Asplenium viride*, Huds., and *Aspidium Lonchitis*, Sw., were growing in the rock crevices; while *Hieracia*, Mountain Saxifrages, *Cochlearia alpina*, Wats., all in full flower, fringed the rocks, and made a very steep ascent more interesting than it otherwise would have been. It certainly was a work of time to attain the plateau, but it was much easier to ascend than to descend. On attaining the level a grand view was obtained of Schiehallion, Ben Lawers, Beinn Ghlas,—even to the Lomonds in Fife, with Benarty, and the more distant Pentlands and Moorfoots. The air was clear and the weather pleasant. We now found ourselves among bogs, rocks, and streamlets, with a line of precipices running in a southerly direction, the cone of Meall-nan-Tarmachan towering like a castle above us. Several of our men went to the summit, where Hooker states *Andreæa nivalis* is to be found. The summit of Ben Nevis would be a more certain station. The line of rocks previously alluded to looked very promising, being moist, the soil micaceous schist. This region is so accessible that many eminent botanists and competent rock-climbers have scoured every inch of these ledges. So much depends on the particular season at which the locality is visited, that there is always a chance of picking up some new form or rare plant. Perhaps the best flowering plant which was gathered here was a lovely rose-pink form of *Veronica saxatilis,* L., with a deep ring of crimson round the base of the corolla. The plants grew in most inaccessible situations, and in no great abundance. With the assistance of our Killin companions we succeeded in gathering a few specimens which have grown freely on the rock border here. The plant seen growing in the moss (*Trichostomum lanuginosum*), and in full flower in its own native home was a singularly beautiful object. On the ledges were also gathered *Juncus castaneus,* L.; *J. biglumis,* L.; *Carex pulla,* Good.; *C. pallescens,* L.; *Veronica saxatilis,* L.; *Draba incana,* L.; *D. rupestris,* Br.; *Cerastium alpinum,* L.; *C. latifolium,* Sm.; *Potentilla Sibbaldia,* L.; *Thalictrum alpinum,* L.; *Potentilla salisburgensis,* Hænke, a very pretty plant with the brown spots at the base of the corolla. Other mountain forms of *Potentilla; Salix herbacea,* L.; *S. reticulata,* L.; *Trollius europæus,* L.; *Cochlearia alpina,* Wats., were curiously associated in this elevated region with *Viola lutea,* Huds., var. *amœna,* the petals of a bright blue colour. *Armeria vulgaris,* Willd.; and *Oxyria digyna,* Hill, also grew close together. *Saxifraga nivalis,* L., was sticking closely to the rock faces in full flower and in great abundance; while, in moist situations, *S. stellaris,* L.; *S. hypnoides,* L.; *S. aizoides,* L., flourished, fringing the rocks and showing its rose corollas. *S. oppositifolia,* L., hung in festoons from the rocks. *Lycopodium Selago,* L.; *L. alpinum,* L.; and *Selaginella selaginoides,* Gray, were observed in plenty. On the ledges, *Carex atrata,* L.; *C. capillaris,* L.; *C. pulla,* Good., were gathered in fine specimens. Mosses were in abundance, and the following were obtained:—*Splachnum mnioides, Conostomum boreale, Hypnum trifarium, Leskea rufescens, Andreæa alpina, Bryum Zierii,* and several other varieties, were gathered. The gentian station, where *Gentiana nivalis,* L., was plentiful at one time, was examined without result, but the season was too early for its flowering, and without the colour the plant is not easily found. Killin was reached after a long walk in time for a late dinner.

Thursday, 21st July.—The excursion to-day was to Creag-na-Caillich. The morning was dry and pleasant, and favourable for a mountain excursion. After passing Bridge of Lochay, the path by the side of the burn which comes from above was taken, in the fine old Finlarig woods, the last remains of the old Caledonian Forest. We followed the path till the heathery moors were reached. The inclination of the ground is very steep, there being many rocky interruptions, the path being in many places close to the edge, with the stream a hundred feet below, and requires careful walking—not just the place to come down in the dark. The open moor being reached, a long walk to the left has to be accomplished before the first series of rocks on Creag-na-Caillich are attained. We must confess that these rocks are rather disappointing to the botanist. So many persons go to them for the purpose of collecting, that very few rare plants are to be got there. We may mention here that, in passing Bridge of Lochay, a party of twenty ladies and gentlemen residing there, all of the botanical order, were holding a council of war in front of the hotel as to the locality they intended to visit that day. There need be no wonder that the rarer plants are scarce. However, by working up the corrie good ground still exists. It was only on the more elevated ledges near the head of the corrie that the undermentioned plants were found:—*Dryas octopetala*, L.; *Salix herbacea*, L.; *S. reticulata*, L.; *Silene acaulis*, L., var. *aurea*, and the ordinary form; *Veronica saxatilis*, L.; *Viola amœna*, very bright blue specimens; *Draba incana, L.*; *D. rupestris*, Br.; *Saxifraga nivalis*, L.; *Antennaria dioica*, Br.; very fine specimens of *Carex atrata*, L.; *C. rupestris*, All. (found by Mr. Boyd), and *C. pulla*, Good., were gathered; *Alisma ranunculoides*, L.; *Sagina Linnæi*, Presl.; etc. Among mosses, *Hypnum trifarium; H. scorpioides; Encalypta rhabdocarpa*, Schw.; *Conostomum boreale; Andreæa alpina; Grimmia spiralis*, H. et J.; and *Bryum Zierii*, Dicks., were among the best obtained. Several of our members went to the summit, which was quite clear of mist, and returned from the other side of the mountain to Killin.

Friday, 22nd July.—To-day the party divided. One division, consisting of Dr. Stuart, Captain Norman, and

Mr. Milne, set out to go to Cam Chreag, but, on reaching the place on the Kenmore road from which the ascent is usually made, a ferocious West Highland bull disputed our passage, and in consequence we lost "tracks," and "got off the line." Perhaps it was as well, as we have often been at Cam Chreag before, but never in the corrie of Ben Cruban, a mountain situated midway between Creag-na-Caillich and Meall-nan-Tarmachan. We had a most toilsome ascent to the rocks, which were not reached till after one o'clock. The hard walking of the previous days had, we suppose, told on our powers of locomotion in some degree. However, after a rest, a scramble among the ledges was undertaken, which were found to be well furnished with all the ordinary alpine plants. Although these rocks are not so extensive as those at Cam Chreag or Creag-na-Caillich, there is a far greater profusion of the alpines. One rock-face on the left side of the corrie, with a rough cleft in it from near the summit of the mountain, was about the most attractive rock garden we have seen for some time. Here flourished *Salix reticulata*, L.; *S. herbacea*, L.; *Dryas octopetala*, L.; *Veronica saxatilis*, L.; *Silene acaulis*, L., var. *aurea*, and the ordinary form in sheets of bloom, a beautiful sight at any time; *Saxifraga nivalis*, L., in great abundance and in fine flower; *S. aizoides*, L.; *S. hypnoides*, L.; *S. stellaris*, L., and *S. oppositifolia*, L., all in bright bloom. Several specimens of *Juncus biglumis*, L., were observed and left. *Draba rupestris*, Br., and *D. incana*, L., in both flower and fruit; *Cochlearia alpina*, Wats., *Cerastium alpinum*, L., and *C. latifolium*, Sm.; *Aspidium Lonchitis*, Sw.; *Asplenium viride*, Huds.; *Polypodium alpestre*, Hoppe, were more plentiful than in any other station. Many seedling forms of these and other ferns growing in the cracks of these rocks were very interesting to look at, but difficult to identify. Several Hieracia growing higher up in the cliffs were as yet not in flower. Although the walk to Ben Cruban is a very toilsome one from the boggy nature of the ground, the mountain is worthy of more careful exploration than we were able to give it with the time we had at command. The plants are mostly together, and easily collected.

The other division of the party, consisting of Messrs. Boyd, Paul, and Gunn, set out on a visit to Ben Lawers. Driving up to the Lawers Inn, they followed thence the old peat road to Lochan a' Chait. Leaving Mr. Boyd there to botanize on the rocks by which it is bounded, the others made their way to the summit, returning by the same route to pick up their companion. Many of the well-known plants characteristic of the hill were found, such as *Potentilla salisburgensis*, Hænke; *Saxifraga nivalis*, L.; *S. cernua*, L.; *Erigeron alpinum*, L.; *Myosotis alpestris*, Schmidt; *Carex pulla*, Good.; *Lycopodium alpinum*, var. *decipiens* (found by Mr. Boyd growing rather plentifully about 200 feet above Lochan a' Chait). Quantities of *Potamogeton prolongus*, Wulf., were found on the margin of the lake, cast up by the waves. But a more interesting plant than any of these—*Carex ustulata*, Wahl.—was found by Mr. Paul on one of the slopes of the hill that descend towards the loch. It was said to have been found in Scotland for the first time by Mr. George Don in 1810, on Ben Lawers, but its occurrence as a British plant had become generally discredited until it was rediscovered, as members of the Society know, in July 1885, by Mr. Brebner of Dundee, in the corrie of Ben Heasgarnich. It was again found in the same spot in considerable abundance in the following year, and was afterwards found in the neighbourhood by Mr. A. H. Evans. But the discovery of it this year gives more exact confirmation of Mr. Don's accuracy and trustworthiness, as showing that it still grows on the same hill on which he declared he found it. The best specimen gathered was sent to the Botanic Garden, and there seen by Prof. Blytt, of Christiania, who pronounced it to be, "without doubt," *Carex ustulata*.

Saturday, 23rd July.—The party left Killin this morning, at 7.15 A.M., and travelled *via* Stirling to Edinburgh, where the party separated for their respective homes, all greatly delighted with the excursion and sorry that it had come to an end.

ON LIGHTNING-STRUCK TREES AT METHVEN CASTLE. By Prof. BAYLEY BALFOUR.

On Temperature and Vegetation in the Royal Botanic Garden, Edinburgh, during the month of November 1892. By Robert Lindsay, Curator of the Garden.

The past month of November was dull and gloomy, but somewhat mild for the season. Storms of wind and rain were less frequent than usual, and no snow fell during the month. The thermometer was at or below the freezing point on twelve mornings, indicating collectively 41° of frost for the month. The lowest readings were on the 1st, 27°; 2nd, 27°; 17th, 26°; 18th, 27°; 19th, 26°. The lowest day temperature was 39°, on the 16th, and the highest 57°, on the 11th. Very few plants are in flower, out-door vegetation being now almost dormant. Fruit has disappeared rapidly from most trees and shrubs, with the exception of holly, on which a good supply of berries still remain. On the rock-garden only two plants came into flower during the month, viz., *Helleborus altifolius* and *Gynerium argenteum*.

Readings of exposed Thermometer at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during November 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 27° | 34° | 45° | 16th | 30° | 33° | 39° |
| 2nd | 27 | 32 | 44 | 17th | 26 | 29 | 42 |
| 3rd | 36 | 47 | 53 | 18th | 27 | 29 | 41 |
| 4th | 39 | 50 | 52 | 19th | 26 | 35 | 45 |
| 5th | 45 | 48 | 53 | 20th | 34 | 42 | 48 |
| 6th | 33 | 39 | 53 | 21st | 40 | 42 | 44 |
| 7th | 29 | 31 | 48 | 22nd | 36 | 38 | 46 |
| 8th | 35 | 46 | 53 | 23rd | 38 | 39 | 44 |
| 9th | 45 | 50 | 54 | 24th | 29 | 35 | 45 |
| 10th | 29 | 36 | 51 | 25th | 33 | 37 | 44 |
| 11th | 36 | 47 | 57 | 26th | 32 | 44 | 46 |
| 12th | 35 | 43 | 51 | 27th | 32 | 46 | 53 |
| 13th | 43 | 45 | 50 | 28th | 43 | 49 | 53 |
| 14th | 42 | 45 | 51 | 29th | 35 | 36 | 45 |
| 15th | 42 | 49 | 52 | 30th | 28 | 30 | 40 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of November 1892.

Distance from Sea, 1 Mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount. | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·790 | 45·9 | 30·0 | 33·6 | 33·2 | Calm. | Cir. | 5 | W. | 0·000 |
| 2 | 29·636 | 41·3 | 30·7 | 33·4 | 32·7 | E. | ... | 0 | ... | 0·060 |
| 3 | 29·296 | 46·1 | 32·6 | 46·4 | 44·4 | S.W. | Cir. | 2 | W. | 0·010 |
| 4 | 29·422 | 51·0 | 42·0 | 50·1 | 48·5 | S. | Nim. | 10 | S. | 0·010 |
| 5 | 29·472 | 55·5 | 47·2 | 50·9 | 48·1 | S. | Cum. | 1 | S. | 0·000 |
| 6 | 29·730 | 55·5 | 36·2 | 41·3 | 41·0 | W. | Cum. | 10 | W. | 0·000 |
| 7 | 30·052 | 47·4 | 31·6 | 32·7 | 32·7 | W. | ... | 0 | ... | 0·110 |
| 8 | 29·923 | 47·5 | 31·9 | 47·7 | 46·8 | S.W. | Nim. | 10 | S.W. | 0·030 |
| 9 | 29·813 | 51·9 | 47·0 | 51·2 | 49·0 | S.W. | Cir. St. | 10 | S.W. | 0·050 |
| 10 | 29·960 | 52·9 | 31·8 | 35·1 | 35·0 | W. | Cir. | 4 | W. | 0·000 |
| 11 | 29·921 | 48·0 | 34·6 | 48·2 | 46·5 | S.S.W. | Cum. | 10 | S.S.W. | 0·000 |
| 12 | 29·850 | 54·6 | 38·1 | 44·7 | 43·0 | W. | Cum. | 8 | S.W. | 0·060 |
| 13 | 29·561 | 49·0 | 44·0 | 47·3 | 47·0 | S. | Nim. | 10 | S. | 0·010 |
| 14 | 29·556 | 47·8 | 40·0 | 43·8 | 41·8 | S.E. | Nim. | 10 | S. | 0·170 |
| 15 | 29·436 | 55·5 | 43·0 | 48·8 | 47·9 | W. | Cum. | 10 | W. | 0·000 |
| 16 | 29·728 | 50·7 | 32·8 | 34·8 | 34·9 | W. | Cir. | 6 | S.W. | 0·000 |
| 17 | 29·920 | 42·8 | 28·9 | 30·2 | 30·0 | Calm. | Cir. | 4 | S.W. | 0·000 |
| 18 | 29·791 | 41·0 | 29·3 | 30·8 | 30·8 | W. | Fog | 10 | ... | 0·000 |
| 19 | 29·608 | 40·2 | 29·5 | 36·2 | 34·0 | E. | Cir. Cum. | 5 | S. | 0·040 |
| 20 | 29·895 | 42·6 | 35·7 | 42·7 | 41·0 | S.E. | Cum. | 10 | S.E. | 0·030 |
| 21 | 30·268 | 47·0 | 42·0 | 42·9 | 42·7 | S.E. | Nim. | 10 | S.E. | 0·000 |
| 22 | 30·345 | 44·1 | 39·4 | 40·1 | 39·0 | S.E. | Cir | 3 | N.W. | 0·000 |
| 23 | 30·260 | 44·9 | 39·9 | 40·6 | 38·0 | S.E. | Cum. | 9 | S.E. | 0·000 |
| 24 | 30·105 | 40·8 | 31·1 | 36·7 | 35·2 | Var. | Cum. | 10 | W. | 0·000 |
| 25 | 30·149 | 39·5 | 36·0 | 38·7 | 37·1 | S.E. | Cir. | 5 | S.E. | 0·230 |
| 26 | 29·807 | 45·3 | 35·5 | 45·2 | 44·7 | S.W. | Nim. | 10 | S.W. | 0·240 |
| 27 | 30·086 | 46·6 | 35·8 | 46·6 | 45·7 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 28 | 30·000 | 51·8 | 46·1 | 50·0 | 47·3 | W. | Cum. | 5 | W. | 0·140 |
| 29 | 29·694 | 52·8 | 37·1 | 37·7 | 36·3 | S.W. | ... | 6 | ... | 0·170 |
| 30 | 29·855 | 41·9 | 30·5 | 32·0 | 30·6 | W.N.W. | ... | 0 | ... | 0·110 |

Barometer.—Highest Reading, on the 22nd, = 30·345. Lowest Reading, on the 4th, = 29·422. Difference, or Monthly Range, = 0·923. Mean = 29·831.

S. R. Thermometers.—Highest Readings, on the 5th, 6th, and 15th, = 55°·5 Lowest Reading, on the 17th, = 28°·9. Difference, or Monthly Range, = 26°·6 Mean of all the Highest = 47°·4. Mean of all the Lowest 36°·3. Difference, or Mean Daily Range, = 11°·1. Mean Temperature of Month = 41°·8.

Hygrometer.—Mean of Dry Bulb = 41°·3. Mean of Wet Bulb = 40°·2.

Rainfall.—Number of Days on which Rain, or Snow, fell = 16. Amount of Fall in inches, = 1·470. First Fall of Snow for season on night of 30th.

A. D. RICHARDSON,
*Observer.*

# MEETING OF THE SOCIETY,

Thursday, January 12, 1893.

Dr. DAVID CHRISTISON, President, in the Chair.

Professor JOHN STRUTHERS, M.D., LL.D., was elected Resident Fellow of the Society.

Presents to the Library at the Royal Botanic Garden were announced.

In accordance with notice duly given, Dr. WILLIAM CRAIG brought forward his proposal for the amendment of the Laws of the Society with the purpose of admitting Ladies to full Membership of the Society on the same terms as Gentlemen. He moved as follows:—

That Article 3, Chapter I. of the Laws of the Society be repealed, and the following article substituted therefor:—

"3. The Society shall be open to Ladies and Gentlemen, and shall consist of Honorary, Resident, Non-Resident, Foreign, and Corresponding Members, who shall have the privilege of denominating themselves Fellows of the Society; of Lady Members elected under the Rule, Chapter IV., Section VI. hereof; and of Associates elected under the Rule, Chapter IV., Section V. hereof."

That the following words be added to the Rule, Chapter IV., Section V., relating to Associates, viz.:—"are not entitled to receive copies of the Transactions, and have no interest in the property of the Society."

That the following words be added to the Rule, Chapter IV., Section VI., relating to Lady Members, viz.:—"or may be elected and continue a Member on payment annually of a Subscription of 10s.; but Lady Members, elected under this rule, shall not be entitled to receive copies of the Transactions, shall have no voice in the management of the Society, nor any interest in the property thereof."

Mr. WILLIAM MURRAY seconded the motion, which was unanimously adopted by the Society.

The CURATOR exhibited from the Royal Botanic Garden a plant of the aroid *Nephthytis liberica,* introduced in 1881 from Liberia, by Mr. Bull; a plant of the "caraguata ue" of the natives of Paraguay, a bromeliad, grown from

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seed brought by Mr. Graham Kerr, naturalist with the Pilcomayo Expedition; and a twig of *Thuya orientalis*, showing russet brown tints in winter which in summer are replaced by a golden hue.

Dr. JOHN WILSON sent for exhibition fruits of *Celastrus scandens*, the bitter-sweet of America, brought from Minnesota by Mr. J. Orr.

Professor BAYLEY BALFOUR exhibited a branch of *Abies nobilis*, sent by Sir James Gibson Craig, of Riccarton, showing tubercular growth of the cortex; also a set of cultures of microphyta, prepared by Dr. Krahl, of Prag, in a form said to be permanent and in which they could be shown in a museum.

Dr. CHRISTISON exhibited a photograph of a tree said to be the largest in Victoria, and measuring 57 feet in girth and about 450 in height; also a panel about 3 feet square, veneered on both faces with walnut of high quality, obtained from a large tree grown at Otterstone, Fife. The tree was 15 feet in girth, and was supposed to be 300 years old. Dr. Christison presented the panel to the Museum of the Royal Botanic Garden as an example of the best walnut wood ever grown in Scotland.

The following Communications were read:—

DESCRIPTIONS OF PLANTS COLLECTED DURING THE PILCOMAYO EXPEDITION. By J. GRAHAM KERR.

NOTE ON THE ROOTS OF PLANTS GROWN IN TUBS IN THE ROYAL BOTANIC GARDEN. By Professor BAYLEY BALFOUR.

ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, EDINBURGH, during the month of DECEMBER 1892. By ROBERT LINDSAY, Curator of the Garden.

The weather of the past month was of an exceedingly wintry character. Frost was registered on twenty-three mornings, indicating collectively 192° of frost for the month. So much frost has not been registered at the garden for December since 1879. During the corresponding month of 1891, frost was registered on eighteen mornings, the total amount being 83° only. The lowest readings of the thermometer for the last month occurred on the 3rd, 16°; 4th, 16°; 25th, 15°; 26th, 12°; 27th, 13°. The lowest day temperature was 24°, which occurred on the 25th of the month, and the highest 56°, on the 18th.

On the rock-garden only one plant came into flower, namely, *Primula inflata.* A special feature is the deep russet-brown tints of the foliage of the varieties of *Thuya orientalis,* which on the south side of the plants is much more pronounced than on the north, giving them a very curious appearance. During summer the brown tints disappear, and assume a golden colour. The total number of species and well-marked varieties which have flowered on the rock-garden during the year 1892 amounts to 1211, as against 1216 for 1891. The largest number came into bloom during the month of June. A record has been kept, showing the date when each plant was first observed in flower. The number of species which came into flower each month was as follows:—January, 7; February, 31; March, 39; April, 119; May, 282; June, 330; July, 237; August, 103; September, 45; October, 15; November, 2; December, 1:—total, 1211.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during December 1892.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 29° | 32° | 35° | 17th | 37° | 39° | 42 |
| 2nd | 16 | 17 | 35 | 18th | 45 | 49 | 56 |
| 3rd | 16 | 33 | 43 | 19th | 42 | 41 | 46 |
| 4th | 25 | 26 | 36 | 20th | 35 | 36 | 41 |
| 5th | 22 | 23 | 39 | 21st | 35 | 37 | 42 |
| 6th | 22 | 34 | 40 | 22nd | 36 | 39 | 41 |
| 7th | 27 | 29 | 35 | 23rd | 27 | 28 | 38 |
| 8th | 23 | 29 | 36 | 24th | 24 | 26 | 38 |
| 9th | 27 | 29 | 34 | 25th | 15 | 18 | 24 |
| 10th | 27 | 30 | 41 | 26th | 12 | 19 | 29 |
| 11th | 32 | 34 | 43 | 27th | 13 | 19 | 42 |
| 12th | 31 | 34 | 40 | 28th | 24 | 26 | 40 |
| 13th | 27 | 32 | 45 | 29th | 26 | 38 | 42 |
| 14th | 26 | 41 | 45 | 30th | 24 | 25 | 36 |
| 15th | 36 | 41 | 46 | 31st | 19 | 30 | 35 |
| 16th | 35 | 37 | 49 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of December 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 a.m.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·718 | 36·8 | 31·4 | 33·2 | 33·0 | S.E. | Nim. | 10 | S.E. | 0·080 |
| 2 | 30·065 | 34·8 | 18·2 | 19·7 | 19·0 | W. | ... | 0 | ... | 0·080 |
| 3 | 29·370 | 34·0 | 18·8 | 34·1 | 34·1 | Var. | Nim. | 10 | W.S.W. | 0·010 |
| 4 | 29·374 | 39·9 | 25·9 | 26·7 | 25·8 | W. | ... | 0 | ... | 0·000 |
| 5 | 29·511 | 30·9 | 24·1 | 25·1 | 23·6 | W. | ... | 0 | ... | 0·000 |
| 6 | 29·610 | 35·4 | 24·2 | 35·8 | 34·1 | W. | Cum. | 8 | N.N.W. | 0·160 |
| 7 | 30·095 | 38·8 | 31·0 | 32·1 | 31·9 | N.E. | Cum. | 8 | N.E | 0·000 |
| 8 | 30·113 | 32·9 | 27·0 | 29·8 | 29·0 | S.W. | Cum. | 2 | N.W. | 0·240 |
| 9 | 29·819 | 35·0 | 29·1 | 31·6 | 29·8 | N.N.W. | ... | 0 | ... | 0·000 |
| 10 | 29·784 | 33·0 | 24·2 | 33·2 | 33·1 | S.W. | St. | 10 | S.W. | 0·120 |
| 11 | 29·070 | 42·1 | 32·6 | 37·1 | 36·4 | S.W. | Cum. | 10 | S.W. | 0·010 |
| 12 | 29·252 | 40·2 | 36·2 | 36·8 | 35·1 | W. | Cir. | 5 | W. | 0·000 |
| 13 | 29·771 | 38·6 | 29·9 | 34·3 | 31·1 | W. | Cir. | 1 | N.W. | 0·100 |
| 14 | 29·611 | 43·9 | 28·6 | 43·2 | 45·1 | S.W. | Nim. | 10 | S.W. | 0·070 |
| 15 | 29·696 | 44·6 | 38·3 | 43·0 | 42·0 | W. | Cum. | 10 | W. | 0·000 |
| 16 | 30·025 | 45·2 | 36·0 | 37·7 | 37·7 | W. | Cir. St. | 10 | W. | 0·060 |
| 17 | 29·836 | 51·0 | 36·9 | 46·0 | 44·2 | S.W. | ... | 0 | ... | 0·020 |
| 18 | 29·749 | 53·6 | 45·8 | 48·1 | 45·4 | W. | ... | 0 | ... | 0·000 |
| 19 | 29·907 | 48·7 | 44·0 | 45·7 | 45·0 | W. | Nim. | 10 | W. | 0·160 |
| 20 | 29·988 | 46·7 | 37·7 | 38·2 | 38·0 | E. | Nim. | 10 | E. | 0·001 |
| 21 | 29·974 | 40·2 | 37·4 | 39·2 | 39·1 | Calm | Cum. | 10 | S.E. | 0·001 |
| 22 | 29·959 | 41·1 | 38·0 | 40·1 | 39·1 | Calm. | Cum. | 10 | N.E. | 0·000 |
| 23 | 30·059 | 41·9 | 30·1 | 30·8 | 29·8 | E. | Fog. | 10 | ... | 0·000 |
| 24 | 29·941 | 36·9 | 27·0 | 28·0 | 27·0 | S.E. | ... | 0 | ... | 0·000 |
| 25 | 29·871 | 30·8 | 18·2 | 20·8 | 19·7 | W. | Fog. | 10 | ... | 0·000 |
| 26 | 30·046 | 23·5 | 15·1 | 19·2 | 19·1 | W. | ... | 0 | ... | 0·000 |
| 27 | 30·146 | 28·1 | 18·8 | 21·2 | 21·1 | W. | ... | 0 | ... | 0·000 |
| 28 | 30·106 | 31·9 | 20·4 | 29·9 | 29·8 | W. | ... | 0 | ... | 0·000 |
| 29 | 29·788 | 39·5 | 29·0 | 39·7 | 38·8 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 30 | 29·704 | 40·8 | 28·6 | 29·3 | 28·6 | W. | ... | 0 | ... | 0·000 |
| 31 | 29·847 | 33·3 | 21·9 | 30·0 | 29·0 | Var. | Nim. | 10 | S. | 0·010 |

Barometer.—Highest Reading, on the 27th, = 30·146. Lowest Reading, on the 11th, = 29·070. Difference, or Monthly Range, = 1·076. Mean = 29·800.

S. R. Thermometers.—Highest Reading, on the 18th, = 53°·6. Lowest Reading, on the 26th, = 15°·1. Difference, or Monthly Range, = 38°·5. Mean of all the Highest = 38°·5. Mean of all the Lowest = 29°·2. Difference, or Mean Daily Range, = 9°·3. Mean Temperature of Month = 33°·8.

Hygrometer.—Mean of Dry Bulb = 33°·5. Mean of Wet Bulb = 32°·7.

Rainfall.—Number of Days on which Rain, or Snow, fell = 15. Amount of Fall, in inches, = 1·122.

A. D. RICHARDSON,
*Observer.*

Abstract of Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during 1892.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-level, 71·5 feet. Hour of Observation, 9 A.M.

| Months. | Barometer, corrected and reduced to 32°. (Inches.) | | | | | | Thermometers, protected, 4 feet above grass. | | | | | | | | | | | | Rain, etc. (Inches.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Self-Registering Thermometers. | | | | | | | | | | Hygrometer. | | | | | |
| | Highest. | | Lowest. | | Range | Mean. | Highest. | | Lowest. | | Range | Mean of all the Highest. | Mean of all the Lowest. | Mean Daily Range. | Mean Temperature. | Mean of Dry Bulb. | Mean of Wet Bulb. | No. of Days on which Rain, etc., fell | Amount. | Greatest Fall in 24 Hours. | |
| | Date. | Reading. | Date. | Reading. | | | Date. | Reading. | Date. | Reading. | | | | | | | | | | Date. | Amount |
| January, . . | 25 | 30·218 | 6 | 29·056 | 1·162 | 29·656 | 30 | 54·5 | 8 | 23·0 | 31·5 | 40·6 | 30·8 | 9·8 | 35·7 | 35·5 | 34·0 | 19 | 0·937 | 18 | 0·225 |
| February, . . | 13 | 30·533 | 2 | 28·765 | 1·769 | 29·669 | 13 | 51·4 | 19 | 8·4 | 43·0 | 42·0 | 31·9 | 10·1 | 36·9 | 36·0 | 34·8 | 24 | 1·891 | 14 | 0·545 |
| March, . . | 22 | 30·520 | 13 | 29·322 | 1·198 | 29·967 | 19 | 60·6 | 28 | 19·2 | 41·4 | 43·5 | 31·2 | 12·3 | 37·4 | 36·9 | 34·5 | 11 | 1·175 | 26 | 0·390 |
| April, . . | 1 | 30·375 | 27 | 29·399 | 0·976 | 29·935 | 3 | 66·8 | 17 | 24·2 | 42·6 | 51·8 | 34·9 | 16·9 | 43·4 | 43·9 | 40·3 | 13 | 1·055 | 27 | 0·380 |
| May, . . . | 12 | 30·390 | 16 | 29·267 | 1·123 | 29·842 | 31 | 68·8 | 2 | 31·8 | 37·0 | 58·2 | 42·6 | 15·6 | 50·4 | 51·7 | 48·2 | 20 | 2·795 | 22 | 0·500 |
| June, . . . | 8 | 30·288 | 2 | 29·372 | 0·916 | 29·850 | 10 | 80·6 | 13 | 36·8 | 43·8 | 62·2 | 46·4 | 15·8 | 54·3 | 55·2 | 51·2 | 20 | 2·900 | 19 | 0·465 |
| July, . . . | 27 | 30·290 | 7 | 29·108 | 1·182 | 29·905 | 31 | 70·0 | 21 | 41·6 | 28·4 | 62·6 | 49·4 | 13·2 | 56·0 | 56·0 | 52·9 | 12 | 0·990 | 18 | 0·310 |
| August, . . | 10 | 30·127 | 31 | 29·202 | 0·925 | 29·716 | 23 | 72·5 | 10 | 39·8 | 32·7 | 65·1 | 50·4 | 14·7 | 57·7 | 58·9 | 55·1 | 21 | 4·645 | 29 | 0·810 |
| September, . | 22 | 30·176 | 27 | 29·141 | 0·816 | 29·653 | 14 | 65·1 | 30 | 38·2 | 26·9 | 58·9 | 45·9 | 13·0 | 52·4 | 53·7 | 50·6 | 19 | 1·089 | 23 | 0·198 |
| October, . . | 18 | 30·273 | 9 | 28·764 | 1·509 | 29·637 | 29 | 58·0 | 25 | 23·0 | 35·0 | 49·2 | 37·3 | 11·9 | 43·2 | 43·0 | 41·3 | 23 | 3·450 | 3 | 0·945 |
| November, . | 22 | 30·345 | 4 | 29·422 | 0·923 | 29·831 | 5, 6, 15 | 55·5 | 17 | 28·9 | 26·6 | 47·4 | 36·3 | 11·1 | 41·8 | 41·3 | 40·2 | 16 | 1·470 | 26 | 0·240 |
| December, . . | 27 | 30·146 | 11 | 29·070 | 1·076 | 29·800 | 18 | 53·6 | 26 | 15·1 | 38·5 | 38·5 | 29·2 | 9·3 | 33·8 | 33·5 | 32·7 | 15 | 1·122 | 8 | 0·240 |
| For Year, . . | Feb. 13 | 30·533 | Oct. 18 | 28·764 | 1·769 | 29·788 | June 10 | 80·6 | Feb. 19 | 8·4 | 72·2 | 51·7 | 38·8 | 12·8 | 45·2 | 45·5 | 43·0 | 213 | 23·519 | Oct. 3 | 0·945 |

NOTE.—Owing to an error in the graduation of the measuring glass used during 1891, the Total Rainfall for that year was understated in the Abstract by 1·430 inch. The correction to be applied is + 0·060 inch per inch of fall.

A. D. RICHARDSON, } *Observers.*
A. ANDERSON, }

# MEETING OF THE SOCIETY,

Thursday, February 9, 1893.

Dr. David Christison, President, in the Chair.

Dr. Leo Errera, Professor of Botany in the University, Brussels, and Dr. Fr. Schmitz, Professor of Botany in the University and Director of the Botanic Garden, Greifswald, were, on the recommendation of the Council, chosen Corresponding Fellows of the Society.

Presents to the Library at the Royal Botanic Garden were announced, amongst these being a number of papers relating to the foundation of the Society, given by Commander A. F. Balfour, R.N.

The Treasurer submitted the following Statement of Accounts for the Session 1891–92 :—

Receipts.

| | £ | s. | d. |
|---|---|---|---|
| Annual Subscriptions, 1891–92, 71 at 15s., | £53 | 5 | 0 |
| Do. do., 1890–91, 2 at do. | 1 | 10 | 0 |
| Compositions for Life Membership, | 12 | 12 | 0 |
| Transactions, etc., sold, | 6 | 19 | 1½ |
| Diplomas, Fees, | 0 | 14 | 5 |
| Interest received, | 1 | 7 | 6 |
| Subscriptions to Illustration Fund, | 11 | 1 | 0 |
| Receipts, | £87 | 9 | 0½ |
| Balance of Payments, | 33 | 12 | 0 |
| | £121 | 1 | 0½ |

Payments.

| | £ | s. | d. |
|---|---|---|---|
| Printing Transactions, £63, 6s. 7d.; Billets, etc., £7, 19s. 4d., | £71 | 5 | 11 |
| Lithographing and Engraving, | 13 | 14 | 6 |
| Assistant Secretary's Salary, | 15 | 0 | 0 |
| Diploma Boxes, and Stamping Diplomas, | 1 | 2 | 3 |
| Rooms for Meetings, and Tea, | 6 | 19 | 8 |
| Commission paid to Collector, | 1 | 7 | 9 |
| Postages, Carriages, etc., | 11 | 3 | 10½ |
| Sundries, | 0 | 7 | 1 |
| Payments, | £121 | 1 | 0½ |

Issued November 1893.

State of Funds.

| | | |
|---|---|---|
| Amount of Funds at close of Session 1890–91, . . | | £69 14 2 |
| Decrease during Session 1891–92, . . . . . . | | 33 12 0 |
| Amount of Funds at close of Session 1891–92, . . | | £36 2 2 |
| Being:—Sum on Current Account with Union Bank of Scotland, . . | £36 1 7 | |
| Balance in hands of Treasurer, . . | 0 0 7 | |
| | | 36 2 2 |

Edinburgh, 31*st January* 1893.—Certified as a correct Abstract of the Treasurer's Accounts, which have been audited by me, compared with the Vouchers, and found correct.

Rob. C. Millar, C.A., *Auditor.*

The Treasurer intimated the receipt since last meeting of the following subscriptions to the Illustration Fund:—

| | |
|---|---|
| Dr. Christison, . . . . | £2 2 0 |
| William Sanderson, Esq., . . | 1 1 0 |
| Dr. Cleghorn, . . . . . | 1 0 0 |
| John Clayton, Esq., *per* Dr. Christison, . . . | 0 10 6 |

The attention of Members of the Society was directed by Dr. William Craig to the following appeal on behalf of the Illustration Fund which the Council had issued:—

THE ILLUSTRATION FUND.

This important Fund was commenced eighteen years ago, and the total contributions have amounted to £178, 4s. 6d.

During the same period the Society has spent on Illustrations £198, 19s. 1d., being £20, 14s. 7d. more than the sums received.

The above statement brings down the state of the Illustration Fund only to the beginning of the present Session.

From these figures it is evident that the *Transactions* could not have been illustrated as they have been but for the existence of this Fund.

The Council would therefore respectfully appeal to the Members of the Society to contribute to this Fund, so that in the future, as in the past, the papers published in the *Transactions* may be illustrated in a manner worthy of the Papers and of the Society.

The Curator exhibited plants of *Saxifraga Burseriana*, *S. Burseriana multiflora*, *S. imbricata*, *Crocus chrysantha*, *Iris stylosa;* and twigs of *Garrya elliptica*, *Hamamelis japonica*, and *Jasminum nudiflorum* in flower, from the Royal Botanic Garden.

Mr. LINDSAY exhibited twigs of *Ulmus campestris* showing remarkable development of cork, sent by Mrs. Astell, of Dorchester; also a branch of *Pinus sylvestris* from Blair-Athole, showing an excess in number of cones, sent by Mr. J. G. Thomson, 71 South Clerk Street.

Dr. WILLIAM CRAIG exhibited a print of *Ipomœa tuberosa* found on the shore of South Ireland, and sent by Mr. Beemish of Cork.

Professor BAYLEY BALFOUR exhibited a portion of a stem of laburnum which, being rotted in the centre, had given passage to an ivy stem entering through some aperture, and the ivy stem now filled the pith cavity of the laburnum. The specimen was sent by Mr. T. M. Callendar, Inverard.

The following Papers were read:—

NOTES ON THE MORPHOLOGY OF SOME BRITISH LEGUMINOSÆ. By JAMES A. TERRAS, B.Sc.

I have in the following notes given a summary of some general points of Morphology exhibited by the British Leguminosæ, and have subsequently referred particularly to the morphology of *Ulex europæus*. The known facts regarding the morphology of our British plants is so widely scattered, mostly in foreign literature, that the sweeping together of what is known, along with the communication of fresh facts, will, it is hoped, be of interest to those who are interested in our native flora. In later communications I shall hope to deal with other species of the family.

SEED.—The seeds of the British species of Leguminosæ are usually of moderate size, varying from about 1 mm. to 5 or 6 mm. in length, their breadth, measured across the cotyledons and radicle at their widest part, is somewhat less, while their thickness may be similar to their breadth, but is generally somewhat smaller, and may in many cases be taken as half of the height or thereabout. As regards colour, all gradations of tint between pale yellow and a deep reddish purple black may be observed.

The embryo is curved; the cotyledons, closely applied to one another by their upper surfaces, enclose between them the minute rudiments of the plumule; while the radicle, curving backwards, runs for a greater or less distance along their edges, either parallel to these or projecting slightly outwards so as to form an angle with the median plane of the cotyledons.

The seed is borne at the free end of a short funicle, and when ripe, is set free in such a way that the funicle is left behind attached to the placenta. The separation between the seed and the funicle takes place by two distinct methods; either all the funicular tissue is detached from the seed, and this is by far the commoner mode, or a definite part of the funicle is left attached to it in the form of a false aril. In the former case a scar, generally of a different colour from the rest of the seed-coat, is left on that part of the seed to which the funicle was attached.

This scar, which is called by Nobbe (v.) the hilum, is often a mere point, usually somewhat sunk in the seed-coat, and lying in the hollow between the cotyledons and the apex of the radicle. It is, however, often elongated, taking a somewhat elliptical form and extending more or less round the end of the cotyledonary part of the seed—*i.e.*, over the apex of the cotyledons. Moreover, it not unfrequently becomes a mere linear mark extending along the edge of the cotyledons towards that part of the seed which corresponds to their base. In the unripe seed it is covered by a similarly shaped mass of parenchymatous tissue, formed as an outgrowth from the apex of the funicle and more or less triangular in transverse section.

The free part of the funicle does not, however, arise from the middle of this outgrowth, but is in most cases united to it at no great distance from the end next the micropyle. A vascular bundle runs up the funicle and along the outer edge of this parenchymatous tissue, till it reaches the end of the scar remote from the radicle, and there enters the seed.

In the case of these seeds which possess a false aril, the tissue at the apex of the funicle forms a short, thick mass, covering a small, elliptical, rather deeply sunk scar. The outer layers of this funicular tissue are composed of moderately thickened cells, which grow out on each side of the funicle, so as to form two lateral fan-shaped structures, which diverge from one another in the direction of the radicle, but generally fuse at the end next the cotyledons. In this way the funicle appears to spring from the central part of the tissue at its apex between two divergent plates of somewhat thickened cells.

This central tissue, of which the free part of the funicle is a continuation, is composed of very thin-walled cells, which, when the seed is ripe, give way along the plane at which the two lateral wings are given off, leaving the seed attached to its funicle by the bundle alone, or together with a small remanent of thin-walled tissue on one side.—Comp. Bachmann (I.). When the bundle breaks, which happens as soon as the seed is dry enough, the seed is set free, and the lateral wing-like expansions adhere to it forming the false aril.

Round the edge of the seed at a little distance from that end of the hilum at which the vascular bundle from the funicle enters the seed-coat, we find a not very distinct wart-like protuberance on the surface. This is described and figured by Schleiden and Vogel (VI.) as the "Chalaza," that is to say, the point at which the vascular bundle enters the nucellus. Sempolowski (VII.) follows Schleiden in calling this region the "Chalaza." But Mattirolo and Buscalioni (IV.), who describe here a pair of protuberances placed one on each side of the middle line, apply to these the name "tubercoli Gemini," and seem, as far as can be determined from an abstract of their work, which appeared in the *Botanische Centralblat*, and on which I am dependent for my information, not having yet seen the original paper, to deny that this region corresponds to the Chalaza, stating, what is certainly a fact, that the vascular bundle does not enter the seed-coat at this point. As I have not yet seen my way to study the development of these seeds, I am unable at present to state whether the funicular bundle enters the nucellus at a point corresponding to these tubercules or not.

As regards the tubercules themselves, they are easily recognisable in the majority of seeds, and appear to the unaided vision as a slight elevation of a somewhat darker colour than the rest of the seed-coat; the double character of this elevation is easily made out by means of a hand lens, the two tubercules being somewhat darker in colour than the median line which divides them.

GERMINATION.—As soon as the seed is placed in damp soil, it commences to swell, owing to the absorption of water in considerable quantities, through the whole surface of the seed-coat, but specially through the hilum. The time required for complete saturation varies in different species, and also in different individuals of the same species, though, in the latter case, the great majority of the seeds contained in any one sample will become saturated in about the same time.

Detmer (III.) found that out of 1000 seeds of *Trifolium pratense* placed in water, 919 were completely saturated in one day, while at the end of ten days only 25 more were fully swollen, and after 156 days 30 seeds in one experiment and 10 in another remained still unaffected. According to the observations of Bruying (II.), a still larger percentage of the seeds remain hard in the case of *Ulex europæus*. In this plant only 4·7 per cent. had germinated after six days, while at the end of fourteen days 30·2 per cent. showed signs of growth, leaving a very large percentage of "hard" seeds.

Various methods, having for their object the obtaining of a higher germination percentage, were tried by this author—the seeds were treated with sulphuric acid of various strengths, with solutions of soda, etc., but the best results were obtained by mechanical abrasion of the seed coat by means of sharp sand; seed so treated gave a germination percentage of 30·2 after six days, and of 63·5 after fourteen days.

As soon as sufficient water has been absorbed growth commences in the embryo, and this, aided by the swelling of the inner layers immediately around the embryo, "Schleim endosperm," causes the rupture of the hard outer wall. As the radicle is the part in which growth first appears, it is usually in its neighbourhood that the seed-coat splits, and in most cases the split, commencing near the tip of the radicle, extends transversely on each side of it, passing round the sides of the seed.

In the majority of cases the radicle grows vertically downwards, branching slightly if at all, and generally reaches a considerable length, often several inches, before any further changes take place in the other organs of the embryo, and this is especially the case in those species which have hypogeal cotyledons. If, however, the cotyledons are to be epigeal, these are soon drawn out of the seed-coat by the elongation of the hypocotyl. In the seed this part of the axis, lying between the cotyledonary node and the radicle, is very short, but when elongation is about to take place in it intercalary growth is set up; and since, on account of the curved nature of the embryo, neither extremity can be moved, both the root and the apex of the cotyledonary part being pressed firmly against the soil in a downward direction, the hypocotyl is forced by its own elongation to assume the position and form of an inverted U, one limb of which, that attached to the radicle, is longer than the other. As it increases in length the curved part of the U approaches the surface of the soil, and not unfrequently appears above it.

Very soon, however, it commences to straighten itself out, and in the earlier stages of this process generally forms a sickle-like bend on that part of the longer limb where it is just passing over into the curve of the U, this bend being directed away from the cotyledons and so formed as to gain sufficient leverage to remove these from the seed-coat and raise them, edge first, through the soil.

As soon as the straightening of the hypocotyl is completed, the cotyledons, which till now have been closely applied to one another by their upper faces, and have not unfrequently retained on their apices the remains of the seed-coat as a small brown cap, separate from one another and become horizontally expanded at no great distance above the ground.

They are always green, and not unfrequently provided with a small petiole, the base of which expands into a sheathing vagina half surrounding the axis and uniting in many cases with that of the opposite cotyledon to form a short tube inclosing and protecting the plumular bud.

The cotyledonary lamina is generally entire, more or less broadly elliptical, though in *Hippocrepis* almost strapshaped, fleshy, and not unfrequently asymmetrical about its median line, being in these cases markedly concave near the base on one lateral margin, while the opposite one is as markedly convex at the same point. This want of symmetry, though very distinct in most of the species of *Medicago* and in *Onobrychis,* is not by any means of constant occurrence, and seems to be determined in great part, if not entirely, by the form of the seed, which, in its turn, may well depend on the exigencies of carpel formation.

In those genera where the cotyledons are hypogeal the first part to appear above ground is the plumule. This structure lies, in the seed, between the two cotyledons, but as germination proceeds it is drawn out from this position, on the one hand by the elongation of its own lower internodes, and on the other by the growth of the cotyledonary petioles, whereby the cotyledons are removed to a greater distance from the axis than before. As the young bud leaves the seed the apex is found in most cases to be more or less closely bent down towards the base, so that here again the two parts form an inverted U. In some cases the bend joining the two limbs is very sharp, and the two parts of the plumule are consequently very closely applied to one another. As the plumule increases in length, this bend, though gradually becoming opener, does not straighten out, and neither does any elongation take place in the apical part till the apex itself is raised quite clear of the surface by the elongation of the basal part, so that the delicate plumular bud is protected from injury, being drawn through the soil backwards by the elongation of what is practically the first plumular internode, the first leaf being generally borne somewhere near the bend.

The first plumular leaf arises typically in a plane placed at right angles to that of the two cotyledons, and in those genera which have these hypogeal it is placed on the side of the axis opposite to that on which the seed lies. It is generally, but not by any means always, simpler in character than are the adult foliage leaves, being frequently composed of but one leaflet if the older leaves have three, or of three if the older ones have a multifoliolate pinnate arrangement, though even in these latter, as in *Onobrychis,* it is not unfrequently unifoliolate.

In most cases the adult form is not reached till a considerable number, often four or five leaves of an intermediate nature, have appeared; and in some cases, where the adult form is highly specialised, as in *Ulex*, several distinct series of leaf-forms arise in succession before the permanent condition is attained.

Those genera, such as *Vicia* and *Lathyrus*, which have hypogeal cotyledons almost always have the first leaf at least, and often the first two or three, reduced to mere scale-like organs, representing apparently the vaginæ of normal leaves, since three teeth are always discernable, and all gradations may be observed between the lateral teeth and the stipules of the adult leaves, while the median tooth passes over gradually, but not so distinctly, into the petiole of the higher form.

In genera with epigeal cotyledons the first leaf has, in many cases, a rather large lamina, which, borne on a long, slender, nearly vertical petiole, projects upwards above surrounding objects, and thus secures both light and air. The petiole is generally provided with a sheathing vagina, the margins of which are continued upwards into a pair of delicate stipules, which are, however, not of exactly the same shape, and not perhaps so highly specialised as those attached to the adult form of leaf.

Where the first leaf arises on an undeveloped first internode within a tubular sheath formed by the union of the cotyledonary vaginæ, it not unfrequently happens that the thickening of the plumular bud, consequent on its formation, splits the sheath along a line corresponding to the median plane of the leaf, and the two cotyledons, which lay at first opposite each other in a plane at right angles to that containing the first leaf, are forced to converge towards one another on the side opposite that from which the first leaf springs. This, however, cannot occur if the first internode be even slightly elongated, so as to raise the first node above the vaginal sheath.

STEM. — The aerial stem in most of the British Leguminosæ is annual, dying down in autumn to the level of the ground, and being replaced in spring, if the plant persists for more than one year, by a larger or smaller number of lateral branches, which arise from the subterranean part of the stem.

These lateral branches are, in many species, employed not only to reproduce the aerial part of the plant, with its leaves and flowers; but, having their origin below the soil, they may, instead of becoming aerial, remain subterranean, and running through the ground to greater or less distances from the parent, may give rise to new plants, which will ultimately become free by their death, and decay.

It is in this way, rather than by seeding, that the large circular patches of such sand-loving plants as *Astragalus hypoglottis, Ononis arvensis, Lotus corniculatus, and Lathyrus tuberosus,* which may be seen on almost any of our links during summer, are formed. The parent plant, generally situated near the centre of the group, is provided with a long tap-root often penetrating several feet into the soft sandy soil, and is generally connected till very late in life by means of the stout cord-like subterranean branches with the daughter-plants of the next generation, each of which has a similar but shorter tap-root, in this case of course adventitious, and is connected by a similar series of cords with a smaller circle of still younger plants, each with a small slender tap-root of its own, formed apparently from one of the nodes of the underground branch on which it is borne.

Branching.—The branching of the aerial part of the primary stem, as well as that of the aerial parts of the branches just described, depends in many cases to a considerable extent on the formation of, so called, accessory, or as Wydler (viii.) prefers to name them, serial buds which arise singly or in vertical median rows, the number in each being dependent on the strength of the plant. These rows are intercalated between the normal branch and the leaf in the axil of which it arises, the members of each row appear successively in descending series, so that the highest below the normal branch is the first to show itself and is always the strongest. The members of a row, though appearing at first vertically above one another, soon show a zigzag arrangement, which is initiated by the highest of the series deviating either to right or to left of the vertical line, while the next lower bud assumes a position alternating with it, the third being under the first, the fourth below the second, and so on throughout the series. The direction of the deviation from the vertical of the highest serial bud depends, as Wydler remarks, on the direction of the primary phyllotactic spiral: if this is to the right, then the deviation is to the right; if left, to the left.

The subterranean branches are produced singly or in similar series in the axils of either the cotyledons or the first plumular leaves, but remain quiescent during the first summer of the plant's existence, and only develope to any great extent in the spring of the following year. Some of them are consequently normal axillary buds arising in the axils of the cotyledons or first leaves, while others are, so called, accessory buds.

M. Russell states, with a good deal of reason, that these accessory buds are not adventitious structures, but are successive branches arising from one another, the highest serial bud being a branch of the normal axillary bud, while the second is a branch of the first, and so on throughout the series; the leaves, in the axils of which the various branches arise, remaining undeveloped, as do also the internodes between them.

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I. Ulex europæus.

Seed.—The seed is ellipsoidal, and more or less laterally compressed as regards the cotyledonary part, while the radicle runs along the edges of the cotyledons for almost their whole length either closely applied to them or projecting to a greater or less extent, especially at the lower end. In colour the seed is dark greenish brown with a slightly yellow tint, and its surface is smooth and shining.

The hilum is small, elliptical, and situated in the hollow between the apex of the radicle and that of the cotyledons. It is, however, almost entirely concealed by the aril, which is of a bright yellow colour, narrowly horse-shoe-like in shape, and so placed that the open end lies just immediately below the apex of the radicle.

According to my measurements the average size of the seeds is 2·5 mm. long × 2 mm. broad × 1·5 mm. thick, while Harz (iii.) mentions 3 mm. × 2·5 mm. × 1·8 mm. for the corresponding dimensions, so that the relations existing between these three dimensions appear to be fairly constant, the seeds observed by Harz being merely somewhat larger than those which I was able to obtain.

Cotyledons.—The cotyledons are epigeal, and generally lie expanded horizontally at no great distance above the surface of the soil. They are small, thick, bluntly elliptical, quite symmetrical about their median plane, and nearly twice as long as broad. They vary in length and breadth between rather wide limits, but the approximate size of full grown cotyledons may be expressed by the numbers 7–9 mm. long × 4–5 mm. broad. Sir J. Lubbock (v.) mentions 8 mm. to 1·1 cm. × 4–6 mm. as the approximate size, while Buchenau gives 8 mm. × 5 mm. The upper surface is smooth, somewhat shining and dark green, while the under side is distinctly paler in colour. They are quite sessile, being attached to the axis by a sheathing base, which is, however, much narrower than the lamina, and does not unite laterally with the corresponding part of the opposite cotyledon to form a closed tube surrounding the plumule, though both sheaths are nearly vertical and their edges are in contact on each side of the bud but not united. The fold, due to this sheathing base, gives to the narrow part of the cotyledonary lamina near it the appearance of being concave on its upper, and convex on its under surface, and is besides continued up into the body of the cotyledon, as it bends outwards to assume the horizontal position, and is there represented by a shallow median groove on the upper surface corresponding to a somewhat more distinct ridge below.

HYPOCOTYL.—The hypocotyl, on which the cotyledons are raised above the ground, is short, slender, and terete, of a pale green colour on the shaded side, but frequently tinted with red on the face turned towards the sun. Under normal conditions it reaches a length, according to Sir J. Lubbock, of 5 mm. or 1 cm.; but, if grown in a shaded situation or among grass, it may become much longer, frequently attaining a height of from 2 to 2½ or 3 cm.

ROOT.—The end of the radicle in most cases grows vertically downwards, branching slightly, and forming a strong tap root. The lateral rootlets are given off in four rows, arranged in two double rows, one vertically below each cotyledon, and corresponding to one extremity of the diarch xylem strand, which lies in the plane of the cotyledons. The members of each double row diverge from one another at an angle of about 20°, while the angular distance between the two double rows is about 160°. The root of *Ulex* thus agrees, in this respect, with that of the other Genisteæ, and falls into Van Tieghem's binary division of roots.

Tubercules are formed on both main and lateral roots very early indeed in the life of the plant, but they seldom attain any large size.

PLUMULE.—The first few internodes of the plumular bud are, in the majority of cases, but slightly developed, with the consequence that the leaves springing from the corresponding nodes are crowded together immediately above the cotyledons. The first plumular leaf lies in a plane at right angles to that occupied by the cotyledons, and the second leaf is placed almost opposite the first, but slightly higher up. The angular divergence of $\frac{1}{2}$, indicated by the opposite position of the first pair of plumular leaves, passes over at the third or fourth leaf into one of $\frac{1}{3}$, which, after a very few turns, is converted into a divergence of $\frac{2}{5}$, and this finally becomes $\frac{3}{8}$ in the adult plant.

Many variations, however, occur; not unfrequently the $\frac{2}{5}$ spiral is omitted, and the $\frac{3}{8}$ follows directly on the $\frac{1}{3}$ arrangement.

The first one or two plumular leaves are, in typical seedlings, provided with a simple spathulate or elliptical lamina without a terminal spine, supported on a somewhat elongated petiole-like structure (flattened vertically from above downwards), which passes gradually over into the lamina at its apex, while its base expands into a small sheath without stipules. These leaves are seldom expanded in a flat and horizontal manner, but the lateral margins generally curve upwards, so as to make the upper surface take the form of a more or less narrow longitudinal groove, which is continued down the upper face of the flat petiole to the sheathing base.

The upper surface is generally glabrous, like that of the cotyledons, but the lower is, on the other hand, covered with long white hairs, as are also the edges. The second or third leaf, according as the first one or two are simple, is generally provided with a small lateral leaflet, placed on one side of the main leaf, at or near the junction of the lamina with the petiole. This lateral leaflet exactly reproduces the lamina of the terminal part, but is much smaller in size, and the whole does not differ from those already described, except by the presence of this lateral appendage. After the appearance of one or two of these transition forms, the leaf, generally the fifth, sixth, or seventh, is found to have an additional lateral leaflet placed on the opposite side, so that it is now a tripartite leaf, all the segments being of nearly the same size.

The leaflets are now quite covered with long soft hairs, even on the upper surface, which had hitherto remained smooth, and the hairs on the leaf margins are especially long.

A considerable number of leaves are of this tripartite form, and usually it extends as far as the tenth, twelfth, or even thirteenth leaf, the leaflets becoming gradually narrower in the higher leaves. Thereafter the lateral lobes begin to diminish in size, and finally one disappears leaving a long, linear, median part, the lamina of which is but slightly broader than the petiole, and terminates in a short soft spine, together with a small, almost linear, lateral lobe on one side.

This lateral structure disappears in the succeeding one or two leaves, and a long, narrow, linear leaf is left which gradually narrows until no expansion at all remains and the leaf is represented by its midrib alone, terminating in a hard sharp spine when the adult spine leaf form is reached.

Variations from this type are of very frequent occurrence, and of these, perhaps, the most common is the entire absence of the simple leaves intercalated between the cotyledons and the tripartite leaves, these last following in this case directly on the cotyledons without the appearance of any transition forms. About fifty per cent. of the seedlings which I have examined show no trace of simple leaves between the cotyledons and the trifoliate leaves, but in other respects closely resemble the type, while the remaining fifty per cent. are typical.

A form, however, in which all the leaves appear to be spathulate is mentioned by Sir John Lubbock (v., p. 410). The same author describes another seedling in which the first two are "linear-oblong," the second pair are provided with one lateral leaflet each, the fifth leaf is spathulate, the sixth "trifoliolate," and the eighth and ninth each provided with a lateral leaflet, while the succeeding leaves are spathulate. In both these cases there has clearly been an increase in the number of the spathulate simple leaves at the expense of the trifoliolate form, but in both simple leaves follow directly on cotyledons.

In another plant described by the same author, the first six leaves were trifoliolate, the remainder up to the eleventh being simple, while in other two specimens described by him other modes of arrangement of the three kinds of leaves occur, such as the intercalation of a spathulate leaf between two bifoliate leaves, or between the zone of tripartite leaves following directly on the cotyledons and the succeeding bipartite leaves.

Hildebrand (iv.), while describing and figuring the successive leaf-forms of what I regard as the typical case, mentions that in some seedlings the first simple leaves are altogether omitted, the tripartite leaves following directly on the cotyledons. Winkler (vi.), on the other hand, inclines to the view that this occurs in the majority of cases, and is in fact typical, he having only observed one specimen in which the tripartite leaves were preceded by simple structures. This difference, however, he explains by the remark that, while he conducted his observations on cultivated plants, those described by Hildebrand were wild.

Buchenau (I.), who seems to have employed wild plants in his researches, states that the first stem leaves are generally tripartite and very seldom simple.

Branching.—No branches are formed during the first year in the axils of either the cotyledons or the first few plumular leaves, but the higher trifoliate leaves, and all leaf organs higher up the axis, bear in their axils spine-branches. These are the only branches which appear during the first year, but in the spring of the second year the cotyledons and lower leaves give rise to axillary branches of another kind which are not spine-structures, but are, on the other hand, indefinite as regards their growth. At the same time similar, but in this case accessory, indefinite branches arise higher up the stem between the spine-branches and the leaves from the axils of which they spring.

After the commencement of the second year, therefore, a plant of *Ulex* exhibits two distinct kinds of branches, viz.:—the spine-branches, which are all axillary structures arising in the axiles of the spine-leaves; and the indefinite branches, of which the lower three or four are axillary in the axils of the cotyledons and lower leaves, while the higher are accessory, arising immediately below the axillary spine-branches, *i.e.* between them and their axillant leaves.

Leaf Arrangement.—The arrangement of the leaves is not the same on both these branch systems, and the leaves themselves also differ in their form and texture at least in the early stages of both. The first leaf organs borne on the spine-branches are two lateral prophylls, which take the form of spine-leaves placed opposite each other. The third leaf is placed in the median plane posteriorly, and is, according to Wydler (VIII.), the first leaf of a $\frac{1}{3}$ emprosthrodromous spiral of which he has observed three cycles, the second alternating with the first, while the third is placed directly over it, though in some cases this third cycle is absent and is replaced by a $\frac{3}{8}$ spiral.

In other specimens he finds the $\frac{1}{3}$ spiral entirely absent, while the $\frac{3}{8}$ follows immediately on the two prophylls.

Each of the leaves borne on a spine-branch, the two prophylls included, bears in its axil a spine-branch with at least two prophyllate spine-leaves and frequently one or more higher leaves occupying positions similar to those assumed by the leaves on the first spine-branch.

The indefinite branches which arise as accessory structures below the spine-branches, or as axillary branches in the axils of the cotyledons and lower leaves, but which do not appear in either position till the beginning of the second year, bear, like the spine-branches, two lateral prophylls which are, however, not spine-leaves in this case but scale-leaves somewhat triangular in outline, very small, and borne close to the base of the branch. These are followed by two leaves placed almost above the prophylls, but in both cases rather nearer the axillant leaf. With the next, *i.e.* the third leaf, a $\frac{1}{3}$ left to right spiral commences, and it is so placed that the second leaf of the spiral, *i.e.* the fourth leaf on the branch after the prophylls, lies in the plane of the axillant leaf.

This $\frac{1}{3}$ spiral passes over gradually into a $\frac{3}{8}$ spiral in such a way that the sixth leaf, or thereabouts, of the $\frac{1}{3}$ spiral is placed posteriorly in the median plane, and is also the first leaf of the permanent $\frac{3}{8}$ spiral of the branch. The earlier leaves of these branches, unlike those of the spine-branches, are soft, more or less scale-like structures, but these are gradually replaced by spine-leaves as their distance from the base of the branch increases.

These spine-leaves, but not the earlier soft leaves of an indefinite branch, bear spine-branches in their axils, and in this, as well as the character of their leaves, these branches repeat to a certain extent the characteristics of the main stem.

Not unfrequently these so-called indefinite branches terminate abruptly in a spine, but even so, are in most cases much longer than the axillary spine-branches, though not so long as other indefinite branches which continue to grow for at least one entire season. The spine-branches, which arise on the main stem in the first season, and on the indefinite branches, which take origin below them, in the second season, bear, as has been mentioned above, spine-branches; but these, like the primary spine-branches of which they are branches, bear, in the season following that in which they appear, accessory branches arising immediately below them, and similar in character to the indefinite branches above described as terminating in a spine.

According to Delbrouck (II.), the spine-branches of *Ulex* persist in the cultivated state of the plant, while those of *Prunus*, etc., disappear; and he draws the conclusion that the spines of *Ulex* are specially evolved organs of the plant, while those of *Prunus* are due to degeneration of branches which, under more favourable nutritive conditions, continue to grow in length.

As long as either the main stem or its branches remain green and bear leaves the surface is marked by eight longitudinal grooves, which run alternately with eight ridges along the stem, the latter terminating one at the base of each leaf, while a new ridge commences above the median plane of the same leaf and runs up the stem through eight internodes, the spiral being a $\frac{3}{8}$ one, till it reaches the under side of the base of the ninth leaf. All these ridges are covered with long soft hairs, both on their backs and along, at least, the upper part of their sloping sides.

In the autumn following that of the season in which any given branch is produced, the ridges, along with all the chlorophyll-containing tissue, are cut off by means of a phellogen formation, which takes place in the deeper layers of the branch. The outer parts, though dead, still adhere to the stem for some considerable time, but ultimately fall away, leaving it brown and covered with loose, thin scales of cork.

The spines borne on the apices of spine-branches or at the extremities of accessory branches are generally roughly triangular in section, and are always green; but no phellogen formation takes place here, and the whole spine ultimately dies, but in most cases adheres to the stem in a dry state for a considerable period after all trace of life has disappeared.

The flowers are borne at the extremities of short peduncles, each of which is provided with a pair of very small lateral prophylls, and arises in the axil of a spine-leaf. These spinescent bract-leaves are, in most cases, the spine-leaves borne on spine-branches near the apex of the shoot, but may be the higher spine-leaves of the shoot itself, in which case the flowers replace the spine-branches of the first generation on that branch, while in the former case they replace the secondary spine-branches.

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## REPORT ON THE BOTANY OF THE MOFFAT DISTRICT FOR 1892. By J. THORBURN JOHNSTONE.

Owing to circumstances I was unable to devote much time to botanical pursuits last year, and in consequence I have not many plants to record for the year.

*Subularia aquatica*, L., Aug. 7. Loch Skene.

*Melilotus arvensis*, Willd., = *officinalis*, Desv., Aug. 27. Casual plant in own garden.

*Trifolium arvense*, L., Aug. 5. Barnhill sandpit, per J. M'Andrew.

*Ornithopus perpusillus*, L., June 19. Dumfries Road at Lochhouse Tower.

*Æthusa Cynapium*, L., July 27. Wamphray.

*Meum Athamanticum*, Jacq., June 25. Pastures on Whitecoomb, elevation 1750 feet.

*Hieracium umbellatum*, L., Sept. 4. Alton Mote.

In the "Journal of Botany" for July and September 1892, the following Hieracia are given by Messrs. E. F.

and W. Linton for Dumfriesshire, having stations at Spoon Burn, Correferron, Blacks Hope, etc.:—

*Hieracium rubicundum*, F. L. H. n. sp.
*Hieracium murorum*, var. *sarcophyllum*, Stenstr.
*Hieracium duriceps*, F. L. H.
*Bromus commutatus*, Schrad., Aug. 8. Holm fields.

I have also to note the following plants as occurring at Crawford and Abington, Lanarkshire:—

*Draba muralis*, L., May 14. Roadside at Abington.

*Vicia sylvatica*, July 19. Roadside bank between Camp Water and Medlock.

*Hieracium gothicum*, July 19. Roadside bank between Camp Water and Medlock.

*Veronica hederæfolia*, June 21. Waste ground at Abington.

ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, EDINBURGH, during the month of JANUARY 1893. By ROBERT LINDSAY, Curator of the Garden.

During the early part of January, severe frost prevailed. A change set in on the 15th of the month, after which the temperature rose gradually, with but slight interruption, till the close of the month, when fairly mild and genial weather prevailed. Falls of snow occurred frequently during the first half of the month. The thermometer was at or below freezing point on eighteen mornings, indicating collectively 100° of frost for the month, as against 136° for the corresponding month last year. The lowest reading was registered on the morning of the 6th, when the glass went down to 9°, or 23° of frost, the lowest point reached this winter, so far. No other very low readings were registered during the month, the lowest being on the 3rd, 24°; 5th, 22°; 7th, 22°; 12th, 23°. The lowest day temperature was 32° on the 2nd and 5th, and the highest 55° on the 31st of the month. Of the forty selected plants whose dates of flowering are annually recorded to the Society, the following came into flower, viz.:—*Dondia Epipactis* on January 16th; *Eranthis hyemalis*, January 25th; *Galanthus plicatus*, January 28th; *G. nivalis*, January 30th. At the same date last year one only had flowered.

On the rock-garden 13 plants came into flower, as against 7 last January, viz:—*Andromeda floribunda*, *Colchicum crociflorum*, *Erica herbacea alba*, *Hepatica angulosa*, *H. triloba*, vars., *Helleborus purpurasceus*, var., *H. torquatus*, *Primula variabilis*, *Saxifraga Burseriana*, *Synthiris reniformis*, and three of the selected plants just mentioned.

Among hardy shrubs, the most conspicuous in blossom are *Jasminum nudiflorum*, *Garrya elliptica*, *Hamamelis japonica*, and the autumn-flowering variety of *Daphne Mezereum*. The russet-brown tints of *Biota orientalis*, which were so prominent a feature last month, have already undergone a change. The foliage is now almost green. The transitions are taking place much earlier than usual.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during January 1893.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 28° | 32° | 36° | 17th | 32° | 35° | 45° |
| 2nd | 25 | 28 | 32 | 18th | 37 | 40 | 49 |
| 3rd | 24 | 29 | 35 | 19th | 37 | 41 | 46 |
| 4th | 25 | 28 | 33 | 20th | 33 | 44 | 52 |
| 5th | 22 | 23 | 32 | 21st | 31 | 37 | 43 |
| 6th | 9 | 22 | 34 | 22nd | 33 | 44 | 52 |
| 7th | 22 | 32 | 37 | 23rd | 37 | 46 | 51 |
| 8th | 30 | 37 | 41 | 24th | 42 | 44 | 52 |
| 9th | 32 | 33 | 40 | 25th | 35 | 37 | 47 |
| 10th | 32 | 35 | 40 | 26th | 31 | 43 | 45 |
| 11th | 27 | 28 | 38 | 27th | 34 | 38 | 46 |
| 12th | 23 | 28 | 39 | 28th | 33 | 36 | 45 |
| 13th | 27 | 28 | 36 | 29th | 37 | 39 | 55 |
| 14th | 28 | 29 | 36 | 30th | 34 | 40 | 54 |
| 15th | 28 | 33 | 39 | 31st | 40 | 42 | 55 |
| 16th | 36 | 37 | 46 | | | | |

[Table

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of January 1893.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. Max. | Min. | Hygrometer. Dry. | Wet. | Direction of Wind. | Clouds. Kind. | Amount | Direction. | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | ° | ° | | | | | |
| 1 | 30·001 | 35·9 | 29·1 | 31·8 | 38·0 | E. | Cum. | 8 | E. | 0·010 |
| 2 | 30·062 | 32·5 | 28·0 | 30·0 | 25·9 | N.E. | Cum. | 10 | N.E. | 0·010 |
| 3 | 30·023 | 33·1 | 27·2 | 32·3 | 31·8 | N.E. | Nim. | 10 | N.E. | 0·020 |
| 4 | 30·297 | 33·6 | 28·0 | 30·8 | 30·8 | S.E. | Nim. | 10 | S.E. | 0·065 |
| 5 | 30·305 | 31·6 | 24·8 | 25·0 | 24·7 | Calm. | Cum. | 10 | N.W. | 0·020 |
| 6 | 30·130 | 25·7 | 9·9 | 24·8 | 24·2 | Calm. | Nim. | 10 | ... | 0·010 |
| 7 | 29·991 | 33·2 | 23·8 | 33·7 | 32·0 | E.S.E. | Cum. | 10 | E.S.E. | 0·080 |
| 8 | 29·877 | 36·7 | 32·2 | 36·9 | 35·2 | E.N.E. | Nim. | 10 | E.N.E. | 0·005 |
| 9 | 29·841 | 38·1 | 35·9 | 36·1 | 35·0 | E. | Cum. | 6 | E. | 0·010 |
| 10 | 30·110 | 38·7 | 35·2 | 37·8 | 36·0 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 11 | 30·383 | 38·9 | 31·0 | 31·2 | 30·4 | W. | ... | 0 | ... | 0·000 |
| 12 | 30·221 | 34·9 | 26·0 | 30·5 | 30·0 | W. | ... | 0 | ... | 0·000 |
| 13 | 29·942 | 37·1 | 29·9 | 37·4 | 36·1 | N.W. | ... | 0 | ... | 0·010 |
| 14 | 29·664 | 39·9 | 30·3 | 31·6 | 30·8 | N.W. | Nim. | 10 | N. | 0·010 |
| 15 | 30·168 | 35·1 | 29·0 | 33·0 | 31·2 | N.W. | Cum. | 8 | N.W. | 0·075 |
| 16 | 29·623 | 38·6 | 32·0 | 38·7 | 38·2 | W. | Cir. St. | 10 | N.W. | 0·120 |
| 17 | 29·723 | 44·1 | 34·0 | 37·0 | 36·7 | N.W. | Cir. St. | 10 | N. | 0·005 |
| 18 | 29·909 | 44·5 | 36·1 | 44·8 | 42·5 | W. | Cir. | 3 | N.W. | 0·000 |
| 19 | 30·079 | 48·6 | 41·2 | 43·8 | 42·4 | S.W. | { Cir.<br>{ Cum. | 6<br>2 | W. }<br>S.W. } | 0·030 |
| 20 | 30·024 | 47·8 | 36·1 | 37·1 | 35·6 | W. | Cir. | 3 | N.W. | 0·000 |
| 21 | 30·205 | 40·0 | 33·7 | 37·1 | 35·0 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 22 | 30·102 | 43·9 | 33·6 | 44·1 | 43·1 | W. | Cir. St. | 10 | N.W. | 0·000 |
| 23 | 29·857 | 49·0 | 44·7 | 49·1 | 47·2 | W. | Cir. St. | 10 | N. | 0·000 |
| 24 | 29·681 | 50·0 | 45·0 | 45·2 | 43·0 | W. | Cir. Cum. | 2 | W. | 0·000 |
| 25 | 29·858 | 50·8 | 39·0 | 39·6 | 37·9 | W. | ... | 0 | ... | 0·025 |
| 26 | 29·225 | 46·0 | 34·9 | 45·1 | 43 0 | S.W. | Cir. | 4 | S.W. | 0·015 |
| 27 | 29·768 | 46·0 | 37·1 | 40·1 | 39·2 | W. | Cum. | 6 | W. | 0·000 |
| 28 | 29·496 | 44·1 | 35·0 | 38·5 | 35·0 | S. | Cum. | 10 | S. | 0·010 |
| 29 | 29·186 | 44·7 | 37·7 | 42·2 | 41·2 | S. | Cum. | 10 | S. | 0·035 |
| 30 | 29·623 | 49·9 | 39·0 | 46·4 | 44·6 | S.W. | Cir. St. | 6 | S.W. | 0·080 |
| 31 | 29·390 | 52·6 | 43·7 | 44·4 | 42·4 | S.S.W. | Cum. | 4 | S.S.W. | 0·075 |

Barometer.—Highest Observed, on the 11th, = 30·383 inches. Lowest Observed, on the 29th, = 29·186 inches. Difference, or Monthly Range, = 1·197 inch. Mean = 29·896 inches.

S. R. Thermometers.—Highest Observed, on the 31st, = 52°·6. Lowest Observed, on the 6th, = 9°·9. Difference, or Monthly Range, = 42°·7. Mean of all the Highest = 40°·8. Mean of all the Lowest = 33°·0. Difference, or Mean Daily Range, = 7°·8. Mean Temperature of Month = 36°·9.

Hygrometer.—Mean of Dry Bulb = 37°·3. Mean of Wet Bulb = 36°·1.

Rainfall.—Number of Days on which Rain fell = 21. Amount of Fall = 0·720 inch. Greatest Fall in 24 hours, on the 16th, = 0·120 inch.

A. D. RICHARDSON,
*Observer.*

## MEETING OF THE SOCIETY.

Thursday, March 9, 1893.

Dr. David Christison, President, in the Chair.

Lady Christison was elected Resident Fellow of the Society.

William Henry Wilkinson was elected Non-Resident Fellow of the Society.

Presents to the Library at the Royal Botanic Garden were announced; amongst them being a set of the "So Moku Zusetzu," a valuable illustrated work of the Botany of Japan, presented by A. Coxon, Esq., 8 William Street, London; and the "Yoduko So Yoku Dyusetzu" and the "So Moku Seifu," presented by the Director of Kew Gardens.

The Curator exhibited plants of *Rhododendron racemosum*, *Anigozanthus brevifolius*, and *Saxifraga Burserian Boydii* in flower, from the Royal Botanic Garden; also a branch in bloom of *Rhododendron dahuricum*, var. *atrovirens*.

The Rev. David Landsborough sent for exhibition cut specimens of species of *Eucalyptus* grown in the island of Arran, including *E. pauciflora* and *E. alpina*, both with ripe fruit; also a flowering branch of *Cordyline australis* from a plant grown in similar circumstances in Arran.

The following papers were read:—

Orobanche cruenta, Bertoloni, in Scotland. By Arthur Bennett.

Some years ago an old member of the London Botanical Society gave me a collection of plants that he had no use for; they were such as he had at various times received

Issued November 1893.

through the Society. Among them was an *Orobanche* named *O. elatior*, and labelled from the neighbourhood of Oban, Argyllshire. At the time I did not possess, nor had I gathered, *O. elatior*. When, some years after, I saw the plant growing plentifully in Surrey, and dried a good series in various stages, I saw the Oban plant was not *O. elatior*, and then contented myself with writing on the sheet, "Certainly not *O. elatior*."

A year or so after this, I gathered a good series of *O. caryopyllacea* in Kent, among them a very curious fern, which, unfortunately, I did not notice when fresh. However, last year, my friend, Mr. Miller, sent me from the Channel Isles a series of orobanches, which, unfortunately, were gathered too late to dissect with any satisfaction, though I saw there was one, at least, unrecorded from the Isles, viz., *O. rubra*, Sm., and another which is doubtless new to Britain. This caused me to dissect all my specimens, and on coming to the Oban one, I saw it could not be referred to any known British species. Comparison with descriptions in books, and the Kew and British Museum Herbaria, showed it to be *O. cruenta*, Bert. This plant, judging by the specimens seen, and its synonymy, is a very variable plant. Whether there are any more specimens extant in British herbaria I cannot say, but I could find none such in the British Herbarium at South Kensington, but I hope to look through Borrer's and Watson's collections this spring.

It will be very desirable that the species should be sought for in Argyllshire this summer, before one gives a description of the plant, etc. It will be well to say that it grows on *Genista tinctoria, Hippocrepis comosa, Lotus corniculatus, Lathyrus pratensis, Hedera helix, Anthyllis vulneraria, Ononis arvensis, Onobrychis sativa*, etc. The flowers are generally yellowish towards the base, then purple, and of a blood-red towards the throat.

I send this note in the hope that some will search for it, as I have already asked the local botanists to do.

A Notice of Mr. R. Marsham, of Stratton, Norfolkshire, a Scientific Investigator of Forestry of Last Century. By Dr. David Christison, President.

In all ages, and probably in every science, there have been investigators who were in advance of their time. Many such are well-known to fame, but there are others who, either from an excess of modesty, or from a want of appreciation of the value of their work, or for some other reason, have taken no efficient steps to make known their observations, which, consequently, either have been imperfectly preserved or have been altogether lost to science. Such seems to have been the case with the subject of this brief notice, to whom my attention was drawn by the following accident.

In the posthumous volume of Essays by Dr. John Walker, Professor of Natural History in Edinburgh University during the latter part of last century, reference is made to the dimensions of the great oak at Cowethorp given by Mr. Beevor in "Bath Memoirs, 1780." In the hope of finding measurements of other trees, at this early period, by Mr. Beevor, I looked up the reference, but with much difficulty, as Professor Walker, alarmed apparently by the formidable length of the title, "Letters and Papers on Agriculture, Planting, etc. Selected from the Correspondence Books of the Bath Society for the encouragement of Agriculture, Arts, Manufactures, and Commerce. Bath, 1780," had contracted it in his reference so as to make it almost unrecognisable. Having searched the catalogues of the Edinburgh libraries in vain, it occurred to me that the proper place to hunt for "Bath Memoirs" was in Bath, and by the kindness of Mr. Dymond, the distinguished archæologist, Curator of the Bath Library, the hunt was at last successful. On turning up the passage the necessity for verifying quotations was exemplified, as it turned out that Mr. Beevor was not the measurer of the Cowethrop Oak at all, nor apparently of any other tree, but had merely forwarded to the Editor the measurements of Mr. Marsham. Thus I lost Mr. Beevor but found Mr. Marsham, a Norfolk squire, who, in the middle of last century, a period when the manners of his class are depicted to us as generally so rude and rough, had apparently been engaged in the study of forestry for forty or fifty years. Most unfortunately, however, the records, which we cannot doubt that he must have kept, were never published, and all that we know of his work is contained in the letter already mentioned, and in another to the Bishop of Bath and Wells, in the Philosophical Transactions for 1777, Vol. 67, p. 12.

In the former letter, besides the measurements of the Cowethorp tree, Mr. Marsham gives the results of experiments upon an oak planted by himself in 1720. The size at that time he did not remember, but in the autumn of 1742 it was 2 feet $11\frac{3}{4}$ inches in girth at about breast-height, and in 1778 it had increased to 7 feet 9 inches. The annual rate, therefore, for the whole period was 1·60 inch, and for the last thirty-six years 1·58 inch. This is a very high rate for an oak, but he explains that it may have been due to special causes:—"It was taken from very poor land to a tolerable light soil, and stands single; and perhaps the growth was helped by digging a large circle round it in several winters, and in other years having that circle covered with greasy pond-mud. In some seasons I washed the stem; and the advantage of washing I experienced in 1775, greatly to my satisfaction."

He then refers for a full account of his washing experiments to his letter to the Bishop of Bath and Wells. In this letter, however, there is nothing about the oak, but he gives the following account, which I have abridged, of experiments on a beech:—"Putting in practice Dr. Hale's advice (as to washing) and Evelyn's (as to rubbing), in spring 1776, as soon as the buds began to swell, I washed my tree from the ground to the beginning of the head, viz., 13 to 14 feet in height; first with water and a stiff shoe-brush, till the tree was quite clean, then with coarse flannel, three, four, or five times a week, during the dry time of spring and the fore part of summer, but after the rains I seldom washed." He then gives the comparative girth-increase of the washed and of an unwashed beech for the season. Both trees were sown in 1741, and transplanted to a grove in 1749. The washed tree was the largest till 1767, after which its rival gained upon it, so that in 1776, when the experiment was made, the two were almost identical in size, but, to make the result quite reliable, he chose as the tree to be washed the one which was the least thriving of the two at the time. He also took the increase of five other beeches of the same age for further comparison, and here follow the results:—

| Tree. | Girth, 1776. | Increase, 1776. |
|---|---|---|
| | Ft. In. | Inches. |
| Unwashed Beech, . . . . | 3 $7\frac{9}{10}$ | 1·20 |
| Washed Beech, . . . . | 3 $7\frac{2}{10}$ | 2·50 |
| Average of five, unwashed, . | ... | 1·50 |

The increase in the washed tree is so remarkable as to cast some doubt on the accuracy of the observation, particularly as the actual increase must have exceeded $2\frac{1}{2}$ inches, because there must have been a certain diminution in the girth from the scrubbing. Yet it is hardly possible to doubt the accuracy of an investigator who was evidently so careful in his methods.

From the few hints furnished by his two letters we can see that the Norfolk squire anticipated modern methods by more than a century, in advocating 5 feet as the proper height for taking the girth of a tree, in taking girth-measurements to the fineness of a tenth of an inch, and in making experiments on manuring the soil and washing the stems in stimulating the growth of trees.

Experiments on the effects of manuring upon tree growth, although advocated fifteen years ago by Sir Robert Christison, so far as I am aware, have not yet been carried out in a scientific way, by comparing the girth-increase of manured and unmanured trees, and by trying different manures. A great field for experiment here lies open, requiring no higher qualifications than patience and accuracy, which might afford an agreeable change to the shooting, fishing, and hunting which are still, as in the time of our Norfolk squire, the too exclusive occupations of our country gentry. As to the scrubbing and washing of the stems of trees I do not know that any experiments have been made since those of Mr. Marsham, but the very remarkable results which he appears to have got certainly encourage further trial in our own day. It does not quite appear whether he attributed any virtue to the moistening of the bark as well as to the cleansing of it, but when we consider the long exposure of our trees with their tender young buds to the parching east winds of spring, it is reasonable to conclude that frequent drenching of the bark at that season might be very beneficial, not only to the functions of the bark, but by the general supply of moisture to the tree. In his trees obstruction to the functions of the bark could only arise from lichen or other vegetable growths; but in our town trees the deposit from smoke is perhaps more prejudicial to health, and is certainly more unsightly, and although it would be impracticable to scrub the whole bark-surface of large trees, it might be found beneficial, and it certainly would be an improvement to appearance, if the stems at least could be cleaned from the incrustation of soot which now disfigures them. Should such experiments be made, and prove of utility, it ought not to be forgotten that the credit of being among the first to initiate them was due to Mr. R. Marsham, of Stratton, more than a century ago.

ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, EDINBURGH, during the month of FEBRUARY 1893. By ROBERT LINDSAY, Curator of the Garden.

During February the thermometer was at or below the freezing point on eleven occasions, indicating collectively 64° of frost for the month, as against 114° for the corresponding month last year. The lowest readings occurred on the 13th, 23°; 24th, 22°; 25th, 20°; 26th, 26°; 28th, 21°. The lowest day temperature was 39°, on the 24th, and the highest 58°, on the 19th. A good deal of snow fell during the last week of the month. Up till the 23rd, fine mild weather prevailed, and spring-flowering plants came rapidly into blossom. The hybrid *Rhododendron præcox* had all its flowers destroyed by frost on the 25th, while one of its parents, *R. dahuricum*, is quite uninjured, and is flowering more profusely this season than has been observed for some years.

Of the forty spring-flowering plants whose dates of flowering are annually recorded, the following 15 came into flower:—*Rhododendron atrovirens*, on February 4th; *Tussilago fragrans*, 6th; *Leucojum vernum*, 6th; *Corylus Avellana*, 8th; *Crocus susianus*, 8th; *Bulbocodium vernum*, 10th; *Scilla præcox*, 10th; *Crocus vernus*, 14th; *Scilla siberica*, 14th; *Rhododendron Nobleanum*, 14th; *Symplocarpus fœtidus*, 14th; *Tussilago alba*, 18th; *T. nivea*, 18th; *Daphne Mezereum*, 19th; *Nordmannia cordifolia*, 20th.

On the rock-garden 40 species and varieties came into flower during the month, as against 31 during February 1892, the most interesting being *Chionodoxa sardensis*, *Daphne Blagayana*, *Galanthus Imperati*, *Hyacinthus azureus*, *Leucojum carpaticum*, *Narcissus minimus*, *Polygala chamæbuxus*, *Primula denticulata*, *Ranunculus anemonoides*, *Rhododendron præcox*, *Saxifraga imbricata*, *S. oppositifolia*, *S. pyrenaica superba*, etc. Several half-hardy plants have sustained severe injury by frost, chiefly during the previous month. The worst affected are *Eucalyptus coccifera*, *Edwardsia microphylla*, *Cordyline australis*, *Genista aspalathoides*, *Polygonum vacciniifolium*, *Veronica Andersonii*. *V. angustifolia*, *V. parviflora*, *V. chathamica*, and *Erica australis*.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during February 1893.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 34° | 37° | 45° | 15th | 37 | 39 | 48 |
| 2nd | 34 | 37 | 51 | 16th | 39 | 41 | 49 |
| 3rd | 35 | 40 | 52 | 17th | 32 | 40 | 52 |
| 4th | 39 | 45 | 50 | 18th | 37 | 51 | 54 |
| 5th | 36 | 42 | 46 | 19th | 40 | 44 | 58 |
| 6th | 30 | 41 | 43 | 20th | 42 | 43 | 48 |
| 7th | 37 | 41 | 52 | 21st | 33 | 36 | 41 |
| 8th | 37 | 45 | 48 | 22nd | 35 | 36 | 39 |
| 9th | 35 | 43 | 51 | 23rd | 30 | 32 | 41 |
| 10th | 33 | 40 | 49 | 24th | 22 | 25 | 39 |
| 11th | 36 | 40 | 41 | 25th | 20 | 30 | 40 |
| 12th | 31 | 36 | 49 | 26th | 26 | 33 | 41 |
| 13th | 23 | 25 | 41 | 27th | 29 | 36 | 42 |
| 14th | 24 | 38 | 51 | 28th | 21 | 36 | 42 |

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of February 1893.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·618 | 46·8 | 36·2 | 37·8 | 37·0 | W. | Cir. St. | 10 | W. | 0·035 |
| 2 | 29·577 | 43·6 | 36·1 | 38·6 | 37·7 | W. | ... | 0 | ... | 0·030 |
| 3 | 29·980 | 44·1 | 37·2 | 42·2 | 42·0 | W. | Cum. | 8 | W. | 0·000 |
| 4 | 30·102 | 49·8 | 41·9 | 45·9 | 43·0 | S.W. | Cum. | 8 | S. | 0·000 |
| 5 | 30·168 | 48·1 | 38·3 | 42·2 | 39·8 | S.W. | Cir. | 2 | S.W. | 0·000 |
| 6 | 30·080 | 45·9 | 33·0 | 42·5 | 40·4 | S.W. | Cum. | 10 | S.W. | 0·025 |
| 7 | 29·709 | 48·9 | 42·1 | 43·9 | 41·9 | W. | ... | 0 | ... | 0·070 |
| 8 | 29·418 | 48·3 | 38·5 | 40·0 | 37·8 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 9 | 29·424 | 44·8 | 36·8 | 44·8 | 43·1 | S.W. | Cum. | 10 | S.W. | 0·440 |
| 10 | 28·821 | 47·8 | 36·5 | 39·2 | 38·5 | W. | Cir. | 1 | W. | 0·060 |
| 11 | 29·099 | 49·0 | 38·6 | 40·9 | 38·1 | W. | Cir. | 1 | W. | 0·040 |
| 12 | 29·499 | 44·3 | 33·3 | 33·9 | 31·6 | N.W. | Cir. | 3 | N.W. | 0·005 |
| 13 | 29·486 | 39·7 | 27·0 | 28·2 | 28·2 | N. | Cir. | 2 | N. | 0·380 |
| 14 | 28·839 | 40·1 | 27·9 | 40·6 | 40·1 | E. | Nim. | 10 | S. | 0·165 |
| 15 | 29·419 | 49·8 | 35·7 | 38·0 | 35·2 | S.W. | ... | 0 | ... | 0·015 |
| 16 | 29·222 | 46·8 | 37·3 | 41·6 | 40·9 | S.S.E. | Cum. | 10 | S.S.E. | 0·075 |
| 17 | 29·610 | 46·8 | 33·9 | 37·5 | 36·0 | S.W. | ... | 0 | ... | 0·080 |
| 18 | 29·524 | 51·0 | 36·8 | 51·2 | 49·5 | W.S.W. | Cum. | 10 | W.S.W. | 0·005 |
| 19 | 29·569 | 53·8 | 43·2 | 44·0 | 43·8 | Calm. | Cum. | 10 | S.W. | 0·010 |
| 20 | 29·228 | 53·9 | 42·5 | 43·1 | 41·8 | S. | Cir. St. | 10 | S | 0·000 |
| 21 | 28·842 | 51·0 | 37·0 | 33·6 | 32·6 | E. | Cum. | 10 | N.E. | 0·190 |
| 22 | 29·273 | 41·0 | 37·6 | 37·9 | 35·6 | N.E. | Cum. | 10 | N.E. | 0·020 |
| 23 | 29·416 | 37·9 | 32·1 | 33·8 | 32·0 | E. | Cum. | 10 | E. | 0·000 |
| 24 | 29·300 | 38·4 | 26·8 | 29·2 | 27·9 | W. | Cum. | 6 | N.E. | 0·000 |
| 25 | 29·192 | 38·5 | 25·0 | 28·3 | 28·0 | S.W. | ... | 0 | ... | 0·005 |
| 26 | 29·084 | 37·9 | 27·6 | 35·1 | 32·8 | E. | Cir. St. | 10 | E. | 0·730 |
| 27 | 28·826 | 35·0 | 31·8 | 34·7 | 32·0 | W. | Cir. | 4 | W. | 0·000 |
| 28 | 29·442 | 39·9 | 25·5 | 35·3 | 32·1 | S.W. | Cir. | 8 | W. | 0·045 |

Barometer.—Highest Observed, on the 5th, = 30·168 inches. Lowest Observed, on the 27th, = 28·826 inches. Difference, or Monthly Range, = 1·342 inch. Mean = 29·420 inches.

S. R. Thermometers.—Highest Observed, on the 20th, = 53°·9. Lowest Observed, on the 25th, = 25°·0. Difference, or Monthly Range, = 28°·9. Mean of all the Highest = 45°·1. Mean of all the Lowest = 34°·9. Difference, or Mean Daily Range, = 10°·2. Mean Temperature of Month = 40°·0.

Hygrometer.—Mean of Dry Bulb = 38°·7. Mean of Wet Bulb = 37°·1.

Rainfall.—Number of Days on which Rain fell = 20. Amount of Fall = 2·425 inches. Greatest Fall in 24 hours, on the 26th, = 0·730 inch.

A. D. RICHARDSON,
*Observer.*

## MEETING OF THE SOCIETY,

Thursday, April 13, 1893.

Dr. David Christison, President, in the Chair.

Mrs. Bayley Balfour was elected Resident Fellow of the Society.

Presents to the Library at the Royal Botanic Garden were announced. These included a folio volume of original drawings of the famous traveller Mungo Park, which had been received from Miss Brown, of Langfin.

The Curator exhibited plants of *Cassiope fastigiata* and *Xerophyllum asphodeloides* from the Royal Botanic Garden.

Mr. Campbell sent for exhibition cut blooms of *Escallonia macrantha*, *Erica carnea*, and species of *Acacia* from plants grown in open air in his garden at Ledaig, Argyllshire.

Professor Bayley Balfour exhibited the *Sclerotium Tulasnii* on tulip bulbs.

Professor Somerville sent for exhibition *Cordyceps militaris* from Northumberland.

The President exhibited drawings of the Ash tree of Logierait, Ross-shire.

Mr. Forgan exhibited a root of *Cupressus Lawsoniana* with a large tuber formed on a plant grown in a small pot.

The following Papers were read :—

The Genus Latania, and notes on Mascarene Palms By Professor Bayley Balfour.

Issued November 1893.

THE ORIGIN OF THE POMEGRANATE. By Professor BAYLEY BALFOUR.

LIFE-HISTORY OF PINGUICULA VULGARIS. By T. D. SADLER.

The author gave an interesting and critical summary of what is known of the morphology and physiology of this plant. The following list includes the chief literature of the subject:—

ALLMAN, PROFESSOR.—Note on the Probable Migration of *Pinguicula grandiflora* through the Agency of Birds.—Jour. Linn. Soc. London, XVII., 1878, pp. 157–58.

BOUCHE, C. D.—On the cultivation of *Pinguicula orchidioides.*—Gard. Chron., 1850, pp. 756–57.

BUCHENAU, FRANZ.—Morphologische Studien an Deutschen Lentibularieen.—Bot. Zeitung, XXIII., 1865, pp. 61–66, 69–71, 77–80, 85–91, 93–99.

CANDOLLE, A. DE.—Pinguicula (monograph).—Prodromus, VIII., 1843, pp. 8–27.

CASPARY, R.—Ueber Samen u. Keimung von *Pinguicula vulgaris.*—Schrift. Phys. ök. Ges. Königsberg, VIII., 1867, p. 16.

DANGEARD, P. A.—Nouvelles observations sur les Pinguicula.—Bull. Soc. Bot. de France, XXXV., 1888, pp. 260–62.

DANGEARD, P. A., ET BARBE.—La Polystélie dans le genre *Pinguicula* —Bull. Soc. Bot. de France, XXXIV., 1887, pp. 307–9.

DARWIN, C.—Insectivorous Plants.—1st ed. 1875; 2nd ed. 1888, pp. 297–318.

DICKSON, PROFESSOR A. — On the Development of the Flower of *Pinguicula vulgaris*, L.; with Remarks on the Embryos of *P. vulgaris*, *P. grandiflora*, *P. caudata*, and *Utricularia minor.*—Trans. Roy. Soc. Edin., XXV., 1869, pp. 639–54; and Proc., VI., pp. 531–34.

A short note on the Embryos of *P. vulgaris* and *P. grandiflora*, by the same author, is to be found in the Quart. Jour. Micros. Sc., VIII., pp. 121–22.

DUCHARTRE, P.—Observations sur la *Pinguicula caudata*, Schlecht.—Bull. Soc. Bot. de France, XXXIV., 1887, pp. 207–216; and in Jour. Soc. Nat. d'Hortic. de France, 1887.

FOURNIER, E.—*Pinguicula soladium.*—Bull. Soc. Bot. de France, XX., 1874, LXVII.

GENTY, A. — Contributions à la monographie des Pinguiculacees européennes, I., sur un nouveau Pinguicula du Jura français, *P. Reuteri*, Genty, et sur quelques espèces critiques du même genre. —Jour. de Bot., 1891.

HECKEL, ED.—Du movement dans les poils et les laciniations foliares du *Drosera rotundifolia* et dans les feuilles du *Pinguicula vulgaris.*—Comptes rendus, 1876, pp. 525–26.

HELMSLEY, W. B.—Butterworts.—Garden, 1881, pp. 212–13.

HOOKER, J. D.—*Pinguicula caudata.*—Bot. Mag., 1882, tab. 6624.

HOOKER, W. J.—*Pinguicula orchidioides.*—Bot. Mag., 1846, tab. 4231.

HOVELACQUE, M.—Sur les propagules de *Pinguicula vulgaris.*—Comptes rendus, etc., 1888.

KLEIN, J,—*Pinguicula alpina* als insectenfressende Pfanze und in anatomischer Beziehung.—Cohn's Beitr. sur Biol. Pfl., III., 1880, pp. 163–84.

Klein, J.—Epidermis der Blätter von *Pinguicula alpina*, Spaltöffnungen der Blätter von *P. alpina*, Bau des unterirdischen Stammchens von *P. alpina*, Bau der Wurzeln von *P. alpina*, Bau des Blattes von *P. alpina.*—In K. Goebel's "Zur Embryologie der Archegoniaten" in Arbeit. de Botan. Inst. in Würzburg, II., S. 437, 1880.

Klein, J.—Die Zellkern-Krystalloide von *Pinguicula* und *Utricularia.*—Pringsheim's Jahrbücher, XIII., 1882, pp. 60–73.

Lamarck, J. B.—Sur une nouvelle espèce de Grassette.—Jour. d'Hist. Nat., I., 1792, pp. 334–38.

Lankester, E.—On the Epidermal Appendages of the Genera *Callitriche*, *Hippuris*, *Pinguicula*, and *Drosera.*—Brit. Assoc. Report, 1850.

Morren, E.—Observations sur les procédès insecticides des Pinguicula.—Bull. Acad. Roy. d. Belgique, XXXIX., 1875 ; and La Belgique Horticole, 1875, p. 290.

Murray, A.—Carnivorous Plants.—Gard. Chron., 1874, pp. 354–55.

Russow, E.—Ueber das Vorkommen von Krystalloiden bei *Pinguicula vulgaris.*—Ebenda, Oct. 1880.

Tischutkin, N.—Die Rolle der Bacterien bei der Veränderung der Eiweisstoffe auf den Blattern von *Pinguicula.*—Bericht. Deut. Botan. Gesell., VII., 1889, pp. 346–55 ; Arb. St. Petersburg Naturf. Gesell. (Bot.), 1891, pp. 33–37.

Treviranus, L. C.—Hat *Pinguicula vulgaris*, Linn., zwei Cotyledonen?—Bot. Zeitung, VI., 1848, pp. 441–44.

Warming, E.—Bidrag til Kundskaben om Lentibulariaceen.—Vidensk. Meddel. Nat. For., Copenhagen, 1874.

Weiss, Ad.—Entwickelungsgeschichte des Trichome im Corollenschlunde von *Pinguicula vulgaris*, L.—Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften, Wien, 1891.

## On Temperature and Vegetation in the Royal Botanic Garden, Edinburgh, during the month of March 1893. By Robert Lindsay, Curator of the Garden.

During the month of March the thermometer was at or below the freezing point on fifteen mornings. The total amount of frost registered for the month was 64°, as against 156° for the corresponding month last year. The lowest temperatures were indicated on the mornings of the 17th, 27°; 18th, 23°; 19th, 21°; 21st, 26°; 22nd, 26°. The day temperatures were high, the lowest being 40°, on the 1st, and the highest 69°, on the 25th. There was a large amount of bright sunshine, and on the whole the month was a most favourable one.

Vegetation generally has made good progress. The leaf-buds of deciduous trees and shrubs are well forward, and only require some genial showers of rain to enable them to expand. The different varieties of flowering currant are in full blossom; *Rhododendron Nobleanum* was flowering most profusely till injured by frost on the 19th. Of the forty spring-flowering plants whose dates of flowering are annually recorded, the following twenty came into flower during March, viz.:—*Orobus vernus*, on March 2nd; *Sisyrinchium grandiflorum*, 2nd; *Arabis albida*, 3rd; *Iris reticulata*, 3rd; *Sisyrinchium grandiflorum album*, 5th; *Scilla bifolia*, 6th; *S. bifolia alba*, 7th; *S. taurica*, 7th; *Narcissus pumilus*, 10th; *Erythronium Dens-canis*, 13th; *Adonis vernalis*, 13th; *Draba aizoides*, 13th; *Omphalodes verna*, 15th; *Ribes sanguineum*, 17th; *Hyoscyamus Scopolia*, 18th; *Aubrietia grandiflora*, 20th; *Narcissus Pseudo-Narcissus*, 23rd; *Corydalis solida*, 24th; *Symphytum caucasicum*, 24th; *Mandragora officinalis*, 26th. *Fritillaria imperialis* came into flower on April 3rd, which completes the list much earlier than usual.

On the rock-garden 81 species and varieties came into flower, the largest number that we have had to record for March. Last year 39 came into flower during March. Amongst the most interesting were—*Anemone bracteata*, *Draba aizoides*, *D. Mawcana*, *Dentaria pentaphylla*, *Corydalis angustifolia*, *Epigæa repens*, *Hyoscyamus orientalis*, *Iberis saxatilis*, *Menziesia empetriformis*, *Orobus cyaneus*, *Primula cashmiriana*, *P. marginata*, *P. integrifolia*, *Podophyllum Emodi*, *Rhodothamnus Chamæcistus*, *Rhododendron ciliatum*, *Saxifraga juniperina*, *S. sancta*, *S. retusa*, *S. Milesii*, *S. Rocheliana*, *Scopolia Hladnikiana*, *Soldanella montana*, *Xanthorrhiza apiifolia*, *etc.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during March 1893.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 28° | 30° | 40° | 17th | 27° | 36° | 43° |
| 2nd | 30 | 38 | 45 | 18th | 23 | 37 | 44 |
| 3rd | 29 | 37 | 49 | 19th | 21 | 35 | 54 |
| 4th | 35 | 44 | 51 | 20th | 40 | 49 | 54 |
| 5th | 36 | 46 | 60 | 21st | 26 | 35 | 60 |
| 6th | 42 | 45 | 60 | 22nd | 26 | 44 | 66 |
| 7th | 38 | 49 | 59 | 23rd | 27 | 42 | 68 |
| 8th | 38 | 43 | 55 | 24th | 28 | 47 | 68 |
| 9th | 42 | 45 | 57 | 25th | 31 | 42 | 69 |
| 10th | 32 | 40 | 53 | 26th | 35 | 47 | 65 |
| 11th | 35 | 42 | 47 | 27th | 35 | 41 | 47 |
| 12th | 37 | 46 | 53 | 28th | 28 | 40 | 48 |
| 13th | 34 | 45 | 53 | 29th | 32 | 40 | 51 |
| 14th | 34 | 44 | 50 | 30th | 33 | 52 | 61 |
| 15th | 35 | 43 | 51 | 31st | 34 | 48 | 63 |
| 16th | 28 | 35 | 42 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of March 1893.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·335 | 40·0 | 32·4 | 32·8 | 32·1 | E. | Nim. | 10 | E. | 0·275 |
| 2 | 29·634 | 38·5 | 32·1 | 38·8 | 38·6 | W. | Cir. St. | 10 | N.W. | 0·001 |
| 3 | 30·097 | 41·9 | 31·4 | 38·5 | 36·2 | Var. | Cir. St. | 10 | S.W. | 0·045 |
| 4 | 29·762 | 48·8 | 37·9 | 46·2 | 44·0 | W. | Cum. | 10 | W. | 0·020 |
| 5 | 29·931 | 50·5 | 43·8 | 49·3 | 47·2 | S.W. | Cir. | 6 | N.W. | 0·000 |
| 6 | 30·049 | 56 0 | 44·8 | 46 0 | 44·8 | S.W. | Cum. | 10 | S.W. | 0 100 |
| 7 | 30·000 | 52·5 | 41·6 | 50·0 | 48·5 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 8 | 30·162 | 56·8 | 41·0 | 44·8 | 42·6 | W. | Cir. Cum. | 6 | N.W. | 0·000 |
| 9 | 29·845 | 52·0 | 44·0 | 47·3 | 45·0 | W. | Cum. | 8 | W. | 0·000 |
| 10 | 29 970 | 54·8 | 37·8 | 43·7 | 39·1 | W. | ... | 0 | ... | 0·000 |
| 11 | 29·897 | 49·8 | 38·6 | 42·9 | 40·0 | W.S.W. | Cum. | 10 | W.S.W. | 0·000 |
| 12 | 29·578 | 48·0 | 42·6 | 47·8 | 43·2 | S.W. | ... | 0 | ... | 0·000 |
| 13 | 29·528 | 52·7 | 36·0 | 43·7 | 40·1 | S.W. | ... | 0 | ... | 0·000 |
| 14 | 29·620 | 50·5 | 36·1 | 43·1 | 40·0 | S.W. | Cum. | 10 | S.W. | 0·010 |
| 15 | 29·262 | 48·2 | 43·0 | 45·0 | 41·5 | W.S.W | Nim. | 10 | W.S.W. | 0·135 |
| 16 | 29·279 | 50·8 | 31·6 | 35·1 | 32·6 | S.W. | Cum. | 3 | W. | 0·010 |
| 17 | 29·598 | 39·8 | 29·8 | 35·8 | 32 0 | W. | Cir. | 5 | W. | 0·000 |
| 18 | 30·114 | 39·9 | 27·0 | 35·2 | 31·8 | N.N.W. | Cum. | 1 | N.N.W. | 0·000 |
| 19 | 30·289 | 39·7 | 24·0 | 36·2 | 35·0 | W. | Cum. | 2 | W. | 0·000 |
| 20 | 30·244 | 49·2 | 36·0 | 49·1 | 45·8 | W. | Cir. | 1 | W. | 0·000 |
| 21 | 30·227 | 52·6 | 28·8 | 38·4 | 37·0 | Calm. | ... | 0 | ... | 0·000 |
| 22 | 30·174 | 58·7 | 29·4 | 45·9 | 41·4 | W. | ... | 0 | ... | 0·000 |
| 23 | 30·122 | 63·1 | 31·0 | 44·0 | 40·6 | W. | ... | 0 | ... | 0·000 |
| 24 | 30·233 | 63·8 | 31·1 | 47·9 | 43·4 | W. | ... | 0 | ... | 0·000 |
| 25 | 30 333 | 61·1 | 33·4 | 46·1 | 43·1 | W. | ... | 0 | ... | 0·000 |
| 26 | 30·245 | 66·2 | 33·0 | 44·1 | 41·9 | N.E. | ... | 0 | ... | 0·020 |
| 27 | 30·166 | 53 8 | 39·2 | 41·3 | 41·0 | E. | Nim. | 10 | E. | 0·000 |
| 28 | 30·199 | 47·0 | 31·1 | 38·6 | 36·8 | E. | Cum. | 10 | E. | 0·000 |
| 29 | 30·031 | 45·8 | 35·5 | 36·1 | 35·6 | E. | St. | 10 | E. | 0·000 |
| 30 | 29·790 | 49·4 | 35·5 | 49·7 | 46·7 | W. | Cir. | 3 | N.W. | 0·000 |
| 31 | 29·551 | 57·8 | 38·8 | 51·3 | 49·1 | S.W. | Cir.<br>Cum. | 2<br>2 | W. | 0·050 |

Barometer.—Highest Observed, on the 25th, = 30·333 inches. Lowest Observed, on the 15th, = 29·262 inches. Difference, or Monthly Range, = 1·071 inch. Mean = 29·912 inches.

S. R. Thermometers.—Highest Observed, on the 26th, = 66°·2. Lowest Observed, on the 19th, = 24°·0. Difference, or Monthly Range, = 42°·2. Mean of all the Highest = 47°·4. Mean of all the lowest = 36°·3. Difference, or Mean Daily Range, = 11°·1. Mean Temperature of Month = 41°·8.

Hygrometer.—Mean of Dry Bulb = 41°·3. Mean of Wet Bulb = 40°·2.

Rainfall.—Number of Days on which Rain fell = 10. Amount of Fall = 0·666 inch. Greatest Fall in 24 hours, on the 1st, = 0·275 inch.

A. D. RICHARDSON,
*Observer.*

## MEETING OF THE SOCIETY,

Thursday, May 11, 1893.

Dr William Craig, Vice-President, in the Chair.

The Curator exhibited the following plants in flower in pots from the Royal Botanic Garden:—*Androsace arachnoidea*, *A. lactea*, *A. sarmentosa*, *Alyssum arachnoidea*, *Bellis perennis* (two monstrous vars. and crimson var.), *Dianthus alpinus* hybrid, *D. microlepis*, *Daphne rupestris*, *D. striata*, *Hellonias bullata*, *Houstonia cærulea*, *Gentiana verna*, *Kernera saxatilis*, *Myosotis alpestris*, *Pinguicula vulgaris*, *Pentstemon Menziesii*, *Ranunculus auricomus* (abnormal variety), *Romanzoffia sitchensis*, *Saxifraga anceps*, *S. calyciflora*, *S. Launcestoni*, *S. MacNabiana*, *S. mixta*, *S. odontophylla*, *S. virginiensis*, *S. Seguierii*, *Trifolium uniflorum*, *Erica Chamissonis*, *Scilla Krauseii*.

Dr. Stuart, Chirnside, Berwickshire, sent cut flowers of hybrid *Trollius*, *T. europæus*, and *T. americanus*.

Mr. John Campbell sent cut flowers of *Wistaria sinensis*, *Deutzia gracilis*, *Cytisus fragrans*, *Spiræa hypericifolia*, etc., from plants in open air in his garden at Ledaig, Argyllshire.

Dr. J. H. Wilson exhibited a hybrid between *Passiflora cærulea* and *P. Bonaparte*.

Mr. Malcolm Dunn exhibited branches, well set with fruit, showing the earliness of the season, of the following:—

Peach—Hale's Early, and Alexander, half-grown. Apricots—New Large Early, Moorpark, Hemskirke, etc., also fully half-grown. Apples—Ecklinville, The Queen, Loddington, Stirling Castle, etc. Pears—Beurre d'Amanlis,

Issued November 1893.

Beurre Diel, Hessle, Louise Bonne of Jersey, etc. Plums—Kirke's, Early Transparent, and Jefferson, from walls; and Victoria, Pond's Seedling, and Early Prolific, from standards. Cherries—Frogmore Early Bigarreau, Early Orleans, and Early Lyons, from open wall. Gooseberries—Whitesmith, Early Kent, Industry, etc. Currants—Red Dutch, White Dutch, Cutleaved White, etc. Strawberries—John Ruskin, Noble, etc.

Professor Bayley Balfour exhibited the most recent addition to the Museum of the Royal Botanic Garden, of models for teaching purposes.

The following letter from the President at Stratford-on-Avon was read:—

I regret I shall not be able to attend the May meeting of the Society. Perhaps, if the Billet is not very full, a few notes on this extraordinary season, from the South, may be of interest to the members for comparison with your neighbourhood.

At Newland, Forest of Dean, Gloucestershire, I noticed the hawthorn in flower pretty generally on the 24th April, and I was informed that it began to flower fully a week earlier.

In the Public Garden at Bath on the 28th April, hawthorn, white and red, lilac, laburnum, and horse-chestnut were all in full bloom, and in such splendid condition as in some cases to conceal the leaves. I never saw a more splendid display, and as the other trees were in the fresh beauty of spring foliage, fully out, the scene was perfect of its kind.

On the 6th May, when I passed through Bath again, however, the beauty of the scene was over. In most of the trees the flowers had faded, and in many they were fast dropping to the ground. Thus the season has been both remarkably early and lamentably short.

At Bradford-on-Avon in the last week of April things were much in the same stage of advancement as in Bath. Half-a-dozen species of roses, wistaria, and clematis were in full bloom on the wall of Dr. Beddoe's garden and house, and so was a standard pæony, two months before its time. Many other species were in flower, including the strawberry, and the general remark was that nothing was left for June. The foliage of all the forest trees, except the ash, was fully out, or nearly so, by the end of April; old walnuts well advanced on the 6th May, and mulberry trees expanding their leaves. The foliage everywhere fine, and no great parching of the grass or young crops, although, of course, everything was short. The total rainfall in sixty-seven days was under half-an-inch, falling on five days in March, one in April, and one in May. Latterly, at least, the air must have been very dry, as, in spite of clear nights, there was no dew. Fortunately there had been a heavy rainfall all through February.

Here, in the centre of England, the ground has a more parched aspect, and flowering seems to have been checked by the excessive drought. That is to say that flowering, though very early, is imperfect. Fruit, however, promises very well, pears are well formed, and gooseberries fit for cooking since the end of April.

My host, Dr. Carter, lately of Leamington, takes great interest in his trees, and treats them with the combined skill of a practical gardener, a man of science, and a man of medicine. He showed me several fruit trees, which were languishing, and apparently dying, from fungoid growths. He cut out the growths as if they had been cancers, and applied paraffin oil to the surfaces, and the trees are now flourishing.

Other fruit trees, suffering from insects harbouring in fissures and axils, were completely restored to health by eradication of the evil. From what he sees in other orchards, he is convinced much more attention should be paid to the fruit trees than they generally get.

He showed me the results of an interesting experiment. A few years ago he put in a number of young pear trees on the same piece of ground, which was all under grass. A part of the ground he dug up, as it was slightly ridged from old cultivation, and he wished to level it. This part has been left since free from grass. The trees planted there are now twice the size, and have twice as good heads as those planted in the undisturbed grass. The effect he is inclined to ascribe to the grass intercepting the moisture and nourishment which would otherwise go to the roots of the pear trees; but the effect of turning up the soil has also to be considered.

The following paper was read:—

On Temperature and Vegetation in the Royal Botanic Garden, Edinburgh, during the month of April 1893. By Robert Lindsay, Curator of the Garden.

The past month of April has been one of the most favourable on record. Seldom has there been so little frost and so much sunshine during April, the only drawback has been the want of rain. Vegetation generally has made very rapid progress. The foliage of deciduous trees and shrubs is remarkably luxuriant, notwithstanding the lack of moisture: fortunately, drying winds have been less frequent than usual. The flowering of ornamental trees and shrubs is considerably above the average. Apple, pear, single and double cherry, currants and barberries being quite smothered with blossom. The thermometer was below the freezing point on four occasions, registering in all 12° of frost for the month, as against 72° for the corresponding month of last year. The lowest readings occurred on the 4th, 31°; 10th, 27°; 12th, 27°; 14th, 31°. The lowest day temperature was 44° on the 16th, and the highest 68° on the 20th.

The collective amount of frost registered this season up to the end of April is 517°, as against 620° for the same period last year. The following is the distribution for each month:—October, 44° of frost; November, 41°; December, 192°; January, 100°; February, 64°; March, 64°; April, 12°. The lowest point reached this season was 9° Fahr., or 23° of frost, which occurred on the 6th of January.

On the rock-garden 166 species and varieties came into flower during the month, as against 119 for April of last year. Among the more interesting were:—*Anemone Robinsoniana*, *Arnebia echioides*, *Asarum caudatum*, *Androsace coronopifolium*, *Aubrietia Hendersoni*, *A. Leichtlini*, *Bryan-*

*thus erectus*, *Cassiope fastigiata*, *Erythronium giganteum*, *Lamium Orvala*, *Muscari armeniacum*, *Phlox setacea* and varieties, *Polemonium humile*, *Primula integrifolia*, *P. Murettiana*, *P. magellanica*, *P. Sieboldii*, *P. viscosa*, *Rhododendron glaucum*, *Ranunculus uniflorus*, *R. speciosus*, *R. Traunfelneri*, *Saxifraga purpurascens*, *Trillium erectum*, *T. grandiflorum*, etc.

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during April 1893.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 40° | 42° | 57° | 16th | 33° | 35° | 44° |
| 2nd | 35 | 50 | 60 | 17th | 32 | 40 | 45 |
| 3rd | 40 | 49 | 62 | 18th | 46 | 48 | 58 |
| 4th | 31 | 46 | 58 | 19th | 44 | 54 | 66 |
| 5th | 34 | 44 | 58 | 20th | 42 | 54 | 68 |
| 6th | 34 | 44 | 56 | 21st | 39 | 48 | 52 |
| 7th | 36 | 46 | 49 | 22nd | 37 | 50 | 60 |
| 8th | 40 | 42 | 57 | 23rd | 41 | 44 | 56 |
| 9th | 36 | 43 | 52 | 24th | 32 | 47 | 66 |
| 10th | 27 | 34 | 53 | 25th | 35 | 50 | 62 |
| 11th | 38 | 44 | 54 | 26th | 40 | 45 | 61 |
| 12th | 27 | 46 | 62 | 27th | 35 | 52 | 65 |
| 13th | 39 | 45 | 56 | 28th | 40 | 54 | 62 |
| 14th | 31 | 45 | 53 | 29th | 39 | 43 | 53 |
| 15th | 39 | 44 | 59 | 30th | 35 | 51 | 59 |

## REGISTER OF SPRING-FLOWERING PLANTS, SHOWING DATES OF FLOWERING, AT THE ROYAL BOTANIC GARDEN, EDINBURGH, DURING THE YEARS 1892 AND 1893.

| No. | Names of Plants. | First Flowers opened. 1892. | | 1893. | |
|---|---|---|---|---|---|
| 1 | Adonis vernalis. . . . . . | April | 9 | March | 13 |
| 2 | Arabis albida, . . . . . | March | 22 | ,, | 3 |
| 3 | Aubrietia grandiflora, . . . . | April | 9 | ,, | 20 |
| 4 | Bulbocodium vernum, . . . . | February | 12 | February | 10 |
| 5 | Corydalis solida, . . . . . | April | 10 | March | 24 |
| 6 | Coryllus Avellana, . . . . | February | 12 | February | 8 |
| 7 | Crocus Susianus, . . . . . | ,, | 12 | ,, | 8 |
| 8 | ,, vernus, . . . . . | ,, | 24 | ,, | 14 |
| 9 | Daphne Mezereum, . . . . | ,, | 24 | ,, | 19 |
| 10 | Dondia Epipactis, . . . . . | ,, | 10 | January | 16 |
| 11 | Draba aizoides, . . . . . | April | 3 | March | 13 |
| 12 | Eranthis hyemalis, . . . . | February | 6 | January | 25 |
| 13 | Erythronium Dens-canis, . . . | March | 23 | March | 13 |
| 14 | Fritillaria imperialis, . . . . | ... | | April | 3 |
| 15 | Galanthus nivalis, . . . . | February | 2 | January | 30 |
| 16 | ,, plicatus, . . . . | January | 26 | ,, | 28 |
| 17 | Hyoscyamus Scopolia, . . . . | April | 20 | March | 18 |
| 18 | Iris reticulata, . . . . . | March | 17 | ,, | 3 |
| 19 | Leucoium vernum, . . . . | February | 9 | February | 6 |
| 20 | Mandragora officinalis, . . . . | March | 24 | March | 26 |
| 21 | Narcissus Pseudo-Narcissus, . . | April | 11 | ,, | 23 |
| 22 | ,, pumilus, . . . . | March | 27 | ,, | 10 |
| 23 | Nordmannia cordifolia, . . . . | ,, | 20 | February | 20 |
| 24 | Omphalodes verna, . . . . | April | 4 | March | 15 |
| 25 | Orobus vernus, . . . . . | March | 30 | ,, | 2 |
| 26 | Rhododendron atrovirens, . . | February | 10 | February | 4 |
| 27 | ,, Nobleanum, . . | March | 30 | ,, | 14 |
| 28 | Ribes sanguineum, . . . . | ,, | 31 | March | 17 |
| 29 | Scilla bifolia, . . . . . . | ,, | 19 | ,, | 6 |
| 30 | ,, ,, alba, . . . . . | ,, | 20 | ,, | 7 |
| 31 | ,, præcox, . . . . . | February | 12 | February | 10 |
| 32 | ,, sibirica, . . . . . | ,, | 12 | ,, | 14 |
| 33 | ,, taurica, . . . . . | March | 22 | March | 7 |
| 34 | Sisyrinchium grandiflorum, . . . | ,, | 23 | ,, | 2 |
| 35 | ,, ,, album, | ,, | 23 | ,, | 5 |
| 36 | Symphytum caucasicum, . . . | April | 25 | ,, | 24 |
| 37 | Symplocarpus fœtidus, . . . . | February | 23 | February | 14 |
| 38 | Tussilago alba, . . . . . | March | 4 | ,, | 18 |
| 39 | ,, fragrans, . . . . | February | 9 | ,, | 6 |
| 40 | ,, nivea, . . . . . | March | 2 | ,, | 18 |

## Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of April 1893.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·862 | 57·9 | 41·4 | 46·9 | 44·2 | W | Cir. | 8 | S.W. | 0·000 |
| 2 | 30·100 | 57·5 | 36·1 | 51·3 | 45·8 | S.W. | ... | 0 | ... | 0·000 |
| 3 | 30·133 | 52·0 | 44·2 | 51·6 | 47·9 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 4 | 30·248 | 58·6 | 33·0 | 47·7 | 44·5 | S.W. | Cum. | 8 | S.W. | 0·000 |
| 5 | 30·168 | 54·8 | 37·9 | 40·3 | 40·3 | N.E. | Cum. | 6 | N.E. | 0·000 |
| 6 | 30·182 | 53·4 | 36·2 | 47·2 | 45·0 | E. | ... | 0 | ... | 0·000 |
| 7 | 30·416 | 54·6 | 38·8 | 42·2 | 41·6 | N.E. | Cum. | 10 | N.E. | 0·010 |
| 8 | 30·568 | 50·0 | 41·7 | 43·8 | 42·4 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 9 | 30·444 | 51·9 | 37·0 | 43·2 | 40·8 | S.E. | Cum. | 3 | S.E. | 0·000 |
| 10 | 30·336 | 50·7 | 32·0 | 44·2 | 43·0 | E. | Cum. | 10 | E. | 0·010 |
| 11 | 30·398 | 48·0 | 41·2 | 46·2 | 41·0 | E. | Cir. | 2 | E. | 0·000 |
| 12 | 30·360 | 48·6 | 31·0 | 47·7 | 42·0 | N.W. | ... | 0 | ... | 0·010 |
| 13 | 30·374 | 57·4 | 41·0 | 44·3 | 39·4 | N.E. | Cum. | 5 | N. | 0·000 |
| 14 | 30·180 | 52·6 | 35·0 | 52·7 | 46·2 | W. | ... | 0 | ... | 0·000 |
| 15 | 29·944 | 59·0 | 40·4 | 50·7 | 44·8 | W. | Cir. St. | 8 | W. | 0·530 |
| 16 | 30·092 | 56·8 | 35·2 | 36·2 | 35·8 | E. | Nim. | 10 | E. | 0·355 |
| 17 | 30·204 | 40·0 | 34·9 | 40·2 | 37·7 | S.E. | Nim. | 10 | S.E. | 0·200 |
| 18 | 29·916 | 49·3 | 40·0 | 49·4 | 48·6 | S.W. | Nim. | 10 | S.W. | 0·225 |
| 19 | 29·900 | 55·2 | 44·2 | 50·3 | 49·3 | E. | Cum. | 9 | W. | 0·030 |
| 20 | 29·970 | 61·0 | 46·7 | 53·5 | 50·7 | E. | Cum. | 4 | S. | 0·000 |
| 21 | 30·232 | 61·0 | 44·0 | 46·0 | 44·1 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 22 | 30·182 | 51·5 | 41·0 | 47·7 | 45·1 | N.E. | ... | 0 | ... | 0·000 |
| 23 | 30·116 | 55·0 | 41·1 | 44·6 | 43·4 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 24 | 30·106 | 53·6 | 36·8 | 47·9 | 46·1 | N.E. | ... | 0 | ... | 0·000 |
| 25 | 30·112 | 61·8 | 38·0 | 49·8 | 47·1 | E. | Cir. | 4 | E. | 0·000 |
| 26 | 30·070 | 54·7 | 42·8 | 45·4 | 44·6 | E. | Cum. | 10 | E. | 0·000 |
| 27 | 29·986 | 56·0 | 39·3 | 55·0 | 50·0 | Calm | ... | 0 | ... | 0·000 |
| 28 | 29·924 | 61·0 | 43·0 | 52·5 | 46·7 | W. | Cir. | 2 | W. | 0·085 |
| 29 | 29·730 | 59·6 | 41·8 | 45.7 | 43·1 | S.W. | Nim. | 10 | S.W. | 0·100 |
| 30 | 29·748 | 51·8 | 37·4 | 50·3 | 45·4 | W. | Cum. | 5 | W. | 0·005 |

Barometer.—Highest Observed, on the 8th, = 30·568 inches. Lowest Observed, on the 29th, = 29·730 inches. Difference, or Monthly Range, = 0·838 inch. Mean = 30·097 inches.

S. R. Thermometers.—Highest Observed, on the 25th, = 61°·8. Lowest Observed, on the 12th, = 31°·0. Difference, or Monthly Range, = 30°·8. Mean of all the Highest = 54°·5. Mean of all the Lowest = 39°·1. Difference, or Mean Daily Range, = 15°·4. Mean Temperature of Month = 46°·8.

Hygrometer.—Mean of Dry Bulb = 47°·1. Mean of Wet Bulb = 44°·2.

Rainfall.—Number of Days on which Rain fell = 11. Amount of Fall = 1·560 inches. Greatest Fall in 24 hours, on the 15th, = 0·530 inch.

A. D. RICHARDSON,
*Observer.*

## MEETING OF THE SOCIETY.

Thursday, June 8, 1893.

Dr. William Craig, Vice-President, in the Chair.

Mrs. Sprague, Mrs. J. M. Bryden, Mrs. W. Sanderson, Mrs. A. P. Aitken, and Robert James Hunter, were elected Resident Fellows of the Society.

Robert Pullar, J.P., F.R.S.E., was elected Non-Resident Fellow of the Society.

Mr. Dunn exhibited an ash-stake which, after having been employed for a long period as a support for bushes, had developed buds and leaves.

The Curator exhibited pot plants in flower, from the Royal Botanic Garden, of the following:—*Albuca Nelsoni*, *Arthropodium paniculatum*, *Androsace foliosa*, *A. lactea*, *Bulbophyllum Lobbii*, *Disa tripetaloides*, *Calceolaria Kellyana*, *Dianthus alpinus*, *Actinotus Helianthi*, *Houstonia cærulea*, *Myosotis alpestris*, *Oldenlandia Dippeana*, *Saponaria Boissieri*, *Saxifraga cæsia*, *S. squarrosa*, *S. longifolia*, *Sedum spathulifolium*, *Polygonum sphærostachyum*, *Pratia angulata*, *Tradescantia viridescens*.

W. B. Boyd, Esq., Faldonside, sent cut flowers of—*Heuchera sanguinea splendens*, *Linaria origanifolia*, *Cypripedium spectabile*, *Anemone sulphurea*, *Orobus cyaneus*, *Delphinium triste*, *Begonia glaucophylla*, *B. heracleifolia*, *Pentstemon humilis*, *Rubus arcticus* also in fruit, *Symphytum bohemicum*, *Allium subhirsutum*, *Muscari moschatum*, *Ornithogalum narbonense*, *Anigozanthus Manglesii*, *Stylophorum diphyllum*.

Issued November 1893.

Mr. T. CUTHBERT DAY directed the attention of the Society to, and read a summary of, the valuable paper entitled "Contribution to the Chemistry and Physiology of Foliage Leaves," by Mr. Horace T. Brown, F.R.S., and Mr. G. H. Morris, published in the Journal of the Chemical Society.

The following paper was read:—

ON TEMPERATURE AND VEGETATION IN THE ROYAL BOTANIC GARDEN, EDINBURGH, during the month of MAY 1893. By ROBERT LINDSAY, Curator of the Garden.

The past month of May will be remembered as one of the most favourable experienced during recent years. No frost occurred, and vegetation has gone on advancing without any check. The rainfall of May was less than the average, still there was sufficient to prevent plants from suffering through lack of moisture. The foliage of all the ordinary deciduous trees and shrubs is now in perfect condition, being most luxuriant and healthy; varieties having variegated and coloured leaves are unusually rich in colour owing to the large amount of heat and bright sunshine experienced; specially noticeable are the various maples, hollies, yews, biotas, and retinosporas. The flowering of most kinds of ornamental trees and shrubs is above the average in richness and profusion of blossom; hawthorn, horse-chestnut, laburnum, weigelias, and lilac were among the finest and most effective. The lowest night temperature registered at the garden was 33°, which occurred on the 1st of the month. Other low readings were registered on the 2nd, 37°; 7th, 39°; and the 31st, 35°. The lowest day temperature was 49°, on the 2nd, and the highest 76°, on the 19th of the month.

The rock-garden was very attractive during the month from the large number of plants in blossom; 300 species and well-marked varieties opened their first flower in May. Among the most interesting were:—*Anemone alpina sulphurea*, *A. narcissiflora*, *Campanula Allioni*, *C. abietina*, *Cotoneaster thymifolia*, *C, horizontalis*, *Calochortus cæruleus*, *Cytisus decumbens*, *C. Andreanus*, *Anthyllis erinacea*, *A. montana rubra*, *Daphne Cneorum*, *Dianthus Michael Foster*, *Dodecatheon integrifolium, Dryas Drummondi, Edrianthus serpyllifolius, Erica australis rosea, Geranium anemonæfolium, G. Balkanum, Houstonia cærulea, Meconopsis Nepalensis, Ourisia coccinea, Onosma taurica, Lithospermum Gastoni, Veronica Godefroyana, V. linifolia, Vicia argentea, etc.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during May 1893.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 33° | 47° | 56° | 17th | 45° | 52° | 58° |
| 2nd | 37 | 43 | 49 | 18th | 44 | 46 | 67 |
| 3rd | 42 | 47 | 61 | 19th | 45 | 62 | 76 |
| 4th | 46 | 54 | 71 | 20th | 47 | 56 | 68 |
| 5th | 43 | 57 | 61 | 21st | 49 | 60 | 72 |
| 6th | 41 | 54 | 61 | 22nd | 46 | 55 | 73 |
| 7th | 39 | 54 | 63 | 23rd | 47 | 60 | 77 |
| 8th | 41 | 50 | 63 | 24th | 46 | 60 | 68 |
| 9th | 40 | 47 | 59 | 25th | 48 | 56 | 67 |
| 10th | 40 | 54 | 64 | 26th | 44 | 58 | 67 |
| 11th | 44 | 50 | 60 | 27th | 49 | 62 | 69 |
| 12th | 49 | 53 | 64 | 28th | 42 | 61 | 73 |
| 13th | 51 | 60 | 73 | 29th | 44 | 46 | 62 |
| 14th | 46 | 61 | 76 | 30th | 43 | 45 | 56 |
| 15th | 47 | 59 | 68 | 31st | 35 | 54 | 68 |
| 16th | 44 | 47 | 68 | | | | |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of May 1893.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| 1 | 29·839 | 56·0 | 36·0 | 50·1 | 44·8 | W. | Cum. | 2 | W. | 0·000 |
| 2 | 29·837 | 54·8 | 39·2 | 44·1 | 41·7 | E. | Cum. | 10 | E. | 0·140 |
| 3 | 30·005 | 48·4 | 44·0 | 47 9 | 46·8 | S.W. | Cum. | 10 | S.W. | 0·010 |
| 4 | 30·157 | 57·0 | 45·6 | 55·6 | 52·5 | W. | ... | 0 | ... | 0·000 |
| 5 | 30·278 | 66·7 | 45 2 | 52·3 | 50·1 | N. | Cir. | 3 | W. | 0·000 |
| 6 | 30·320 | 57·8 | 44·0 | 48·1 | 46·8 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 7 | 30·381 | 57·8 | 42·0 | 53·8 | 46·2 | E. | ... | 0 | ... | 0·000 |
| 8 | 30·494 | 58·8 | 45·1 | 49·8 | 46·8 | S.E. | Cum. | 8 | S.E. | 0·000 |
| 9 | 30·456 | 53·8 | 45·0 | 47·5 | 46·0 | E. | Cum. | 9 | E. | 0·000 |
| 10 | 30·378 | 57·1 | 42·1 | 50·3 | 48·1 | W. | ... | 0 | ... | 0·000 |
| 11 | 30·197 | 62·7 | 49·9 | 60·1 | 51·5 | W. | Cir.<br>Cum. | 9<br>1 | W.<br>S.W. | 0·020 |
| 12 | 29·971 | 64·0 | 51·9 | 55 1 | 52·5 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 13 | 30·051 | 61·6 | 51·3 | 59·9 | 54·6 | S.W. | Cum. | 8 | S.W. | 0·000 |
| 14 | 29·970 | 65·7 | 48·4 | 59·8 | 55·2 | S.W. | Cum. | 10 | S.W. | 0·000 |
| 15 | 29·988 | 69·0 | 48·1 | 52·8 | 49·3 | E. | Cum. | 8 | E. | 0·000 |
| 16 | 29·831 | 51·8 | 46·1 | 49·0 | 46·5 | E. | Cum. | 10 | E | 0·000 |
| 17 | 29·608 | 51·0 | 46·4 | 50·3 | 47·9 | E. | Cum. | 10 | E. | 0·510 |
| 18 | 29·430 | 54·0 | 47·1 | 48·2 | 48·1 | E. | Nim. | 10 | E. | 0·010 |
| 19 | 29·467 | 58·6 | 48·0 | 59·2 | 55·2 | S. | Cum. | 9 | S. | 0·110 |
| 20 | 29·392 | 62·5 | 50 6 | 56·9 | 53·9 | S.E. | Cum. | 10 | S.E. | 0·225 |
| 21 | 29·594 | 61·8 | 50·0 | 56·8 | 50·7 | S. | Cum. | 9 | S. | 0·090 |
| 22 | 29·746 | 64·0 | 45·1 | 55·7 | 53·3 | S.W. | Cum. | 8 | S.W. | 0·020 |
| 23 | 29·576 | 65 5 | 51·0 | 61·9 | 57·3 | S.W. | Cum. | 8 | S.W. | 0·005 |
| 24 | 29 618 | 65·6 | 48·9 | 59·7 | 55·1 | W. | Cum. | 5 | W. | 0·000 |
| 25 | 29·815 | 68·5 | 50·9 | 58·3 | 52·2 | W. | Cum. | 9 | W. | 0·000 |
| 26 | 30·109 | 67·3 | 47·0 | 55 7 | 50·9 | N.W. | Cum. | 10 | N.W. | 0·000 |
| 27 | 30·153 | 63 0 | 44·9 | 60·2 | 55·8 | N.W. | Cum. | 9 | N.W. | 0·000 |
| 28 | 30·094 | 68·8 | 47·0 | 61·2 | 56·9 | W. | Cum. | 10 | W. | 0·330 |
| 29 | 30·078 | 69·0 | 46·7 | 46·9 | 46·3 | E. | Nim. | 10 | E. | 0·035 |
| 30 | 30·076 | 52·7 | 45·3 | 44·6 | 44·0 | N.W. | Cum. | 9 | N.W. | 0·000 |
| 31 | 29·985 | 55·9 | 39·3 | 52·3 | 47·3 | N.W. | Cum. | 9 | N.W. | 0·000 |

Barometer.—Highest Observed, on the 8th, = 30·494 inches. Lowest Observed, on the 20th, = 29·392 inches. Difference, or Monthly Range, = 1·102 inch. Mean = 29·961 inches.

S. R. Thermometers.—Highest Observed, on the 15th and 29th, = 69°·0. Lowest Observed, on the 1st, = 36°·0. Difference, or Monthly Range, = 33°·0. Mean of all the Highest = 60°·6. Mean of all the Lowest = 46°·2. Difference, or Mean Daily Range, = 14°·4. Mean Temperature of Month = 53°·4.

Hygrometer.—Mean of Dry Bulb = 53°·7. Mean of Wet Bulb = 50°·2.

Rainfall.—Number of Days on which Rain fell = 12. Amount of Fall = 1·505 inch. Greatest Fall in 24 Hours, on the 17th, = 0·510 inch.

A. D. RICHARDSON,
*Observer.*

# MEETING OF THE SOCIETY,

Thursday, July 13, 1893.

Dr. WILLIAM CRAIG, Vice-President, in the Chair.

The CURATOR exhibited the following plants from the Royal Botanic Garden:—*Azolla filiculoides* in fruit, *Androsace glacialis*, *Anigozanthus rufa*, *Burbidgea nitida*, *Calceolaria Kellyana*, *Campanula Barrelierii*, *C. pumila*, *C. retrorsa*, *Disa grandiflora*, *D. racemosa*, *Erythræa diffusa*, *Dianthus neglectus roseus*, *Dicksonia antarctica* seedling from spores ripened out of doors in Arran, *Gentiana purpurea*, *Genista aspalathoides*, *Helianthemum amabile fl. pl.*, *Micromeria piperella*, *Nertera depressa*, *Primula Heerii*, *P. Poissonii*, *Xylophylla montana*, *Silene Schaftii*, *Tradescantia iridescens*.

The following paper was read:—

ON TEMPERATURE AND VEGETATION AT THE ROYAL BOTANIC GARDEN, EDINBURGH, during the month of JUNE 1893. By ROBERT LINDSAY, Curator of the Garden.

The past month of June was remarkable for the excessive heat and dryness which prevailed. The continued want of rain having lasted throughout nearly the whole of the past spring, the marvel is that its effects have not been more serious on vegetation. The lowest reading of the thermometer during June was 40°, which was registered on the 2nd; on the night of the 16th the thermometer did not fall below 62°. The lowest day temperature was 50°, on the 23rd, and the highest 89°, on the 18th of the month. Hardy herbaceous plants flowered freely, but went quickly past owing to the drought; the earlier flowering kinds have ripened their seeds abundantly.

Issued November 1893.

On the rock-garden fewer plants came into flower this month than for any June during the last eleven years, the largest number having blossomed this year in May. In all 294 species and varieties came into flower during the month. The most interesting were:—*Anemone palmata, Antirrhinum asarinum, Arnica montana, Asperula nitida, Cyananthus lobatus, Calochortus luteus, Celmisia spectabilis, Coronilla iberica, Crambe cordifolia, Campanula garganica alba, Craspedia Richei, Dianthus alpinus, D. neglectus, D. superbus, Dictamnus tauricus, Epilobium latifolium, Eriogonum aureum, Galax aphylla, Gentiana alba, G. lutea, Gillenia trifoliata, Hypericum Nummularia, Kniphofia caulescens, Linaria origanifolia, Lilium Kramerii, Meconopsis Wallichii, Mimulus Jeffreyanus, M. cardinalis, Potentilla nitida atrorubens, Rhododendron ferrugineum album, Ranunculus parnassifolius, Saponaria cæspitosa, Saxifraga cæsia major, S. fimbriata, Tropæolum polyphyllum, Veronica Bidwillii, V. cupressoides, V. rakaiensis.*

Readings of exposed Thermometers at the Rock-Garden of the Royal Botanic Garden, Edinburgh, during June 1893.

| Date. | Minimum. | 9 A.M. | Maximum. | Date. | Minimum. | 9 A.M. | Maximum. |
|---|---|---|---|---|---|---|---|
| 1st | 45° | 57° | 68° | 16th | 46° | 79° | 85° |
| 2nd | 40 | 60 | 69 | 17th | 62 | 73 | 86 |
| 3rd | 42 | 62 | 70 | 18th | 54 | 79 | 89 |
| 4th | 45 | 63 | 76 | 19th | 57 | 70 | 85 |
| 5th | 42 | 62 | 66 | 20th | 49 | 62 | 71 |
| 6th | 44 | 58 | 70 | 21st | 46 | 62 | 71 |
| 7th | 51 | 67 | 76 | 22nd | 49 | 59 | 63 |
| 8th | 51 | 55 | 66 | 23rd | 44 | 47 | 50 |
| 9th | 47 | 50 | 64 | 24th | 45 | 53 | 66 |
| 10th | 45 | 59 | 71 | 25th | 45 | 59 | 69 |
| 11th | 48 | 65 | 75 | 26th | 41 | 56 | 69 |
| 12th | 46 | 65 | 67 | 27th | 47 | 61 | 72 |
| 13th | 47 | 50 | 68 | 28th | 55 | 62 | 74 |
| 14th | 51 | 58 | 69 | 29th | 53 | 60 | 68 |
| 15th | 46 | 52 | 77 | 30th | 44 | 68 | 74 |

Meteorological Observations taken at Royal Botanic Garden, Edinburgh, during the Month of June 1893.

Distance from Sea, 1 mile. Height of Cistern of Barometer above Mean Sea-Level, 71·5 feet. Hour of Observation, 9 A.M.

| Days of the Month. | Barometer, corrected and reduced to 32°. (Inches.) | Thermometers, protected, 4 feet above grass. | | | | Direction of Wind. | Clouds. | | | Rainfall. (Inches.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | S. R. Thermometers for preceding 24 hours. | | Hygrometer. | | | | | | |
| | | Max. | Min. | Dry. | Wet. | | Kind. | Amount. | Direction. | |
| | | ° | ° | ° | ° | | | | | |
| 1 | 29·913 | 62·8 | 48·4 | 60·1 | 54·1 | N.W. | Cum. | 8 | N.W. | 0·000 |
| 2 | 29·818 | 62·2 | 41·2 | 58·1 | 50·6 | W. | Cum. | 1 | W. | 0·000 |
| 3 | 29·788 | 64·6 | 44·7 | 58·1 | 52·7 | E. | Cir. | 2 | S.W. | 0·000 |
| 4 | 29·926 | 70·8 | 46·9 | 63·0 | 56·1 | S.W. | Cir. Cum. | 4 | S.W. | 0·030 |
| 5 | 30·166 | 65·3 | 45·7 | 62·1 | 54·7 | N.W. | ... | 0 | ... | 0·000 |
| 6 | 30·217 | 65·6 | 48·0 | 57·0 | 53·8 | S.W. | Cum. | 10 | S.W. | 0·060 |
| 7 | 30·289 | 64·4 | 55·1 | 64·3 | 59·9 | S.W. | Cum. | 6 | S.W | 0·000 |
| 8 | 30·336 | 67·7 | 50·9 | 53·9 | 53·0 | E. | Cum. St. | 10 | E. | 0·010 |
| 9 | 30·314 | 59·0 | 49·7 | 50·3 | 49·9 | E. | St. | 10 | E. | 0·000 |
| 10 | 30·323 | 57·8 | 49 7 | 57·2 | 53·0 | E. | Cum. | 10 | N.W. | 0·000 |
| 11 | 30·207 | 64·7 | 50·3 | 60·3 | 55·6 | E. | ... | 0 | ... | 0·000 |
| 12 | 30·094 | 67·0 | 44·3 | 60·0 | 54·0 | S. | ... | 0 | ... | 0·000 |
| 13 | 30·006 | 63·8 | 50·9 | 51·9 | 50·3 | N.E. | Cum. St. | 10 | N.E. | 0·000 |
| 14 | 29·931 | 62·0 | 50·7 | 57·3 | 53·8 | N.E. | Cum | 2 | N.E. | 0·000 |
| 15 | 29·964 | 64 8 | 50·7 | 52·0 | 50·9 | N.W. | Cum. St. | 10 | N.E. | 0·000 |
| 16 | 30·008 | 69·8 | 50·7 | 69·9 | 62·2 | W. | Cir. | 2 | W. | 0·000 |
| 17 | 30·230 | 82·6 | 61·9 | 70·0 | 64·0 | N.W. | Cum. | 5 | W. | 0·000 |
| 18 | 30·239 | 80·0 | 54 2 | 72·7 | 65·2 | N.W. | ... | 0 | ... | 0·000 |
| 19 | 29·964 | 85·8 | 57·9 | 67·0 | 63·0 | W. | Cum. | 6 | W. | 0·000 |
| 20 | 29·831 | 79·8 | 51·9 | 58·9 | 51·3 | E. | Cum. | 9 | N.W. | 0·000 |
| 21 | 29·801 | 64·0 | 51·0 | 58·5 | 52 9 | E. | Cum. | 6 | N. | 0·000 |
| 22 | 29·507 | 65·6 | 47·1 | 58·1 | 54·1 | W. | Cum. | 10 | W. | 0·760 |
| 23 | 29·242 | 59·8 | 47·5 | 49·7 | 49·0 | N.E. | Nim. | 10 | N.E. | 0·620 |
| 24 | 29·358 | 54·8 | 48·4 | 54·9 | 50·8 | N.E. | Cum. | 10 | N.E. | 0·000 |
| 25 | 29 531 | 61·7 | 46·7 | 57·5 | 52·3 | N.W. | Cum. | 9 | N.W. | 0·100 |
| 26 | 29·673 | 65·8 | 44·0 | 59·6 | 51·3 | N.W. | Cum. | 8 | N.W. | 0·130 |
| 27 | 29·343 | 63 8 | 52·8 | 60·1 | 57·4 | S. | Cum. | 9 | S. | 0·150 |
| 28 | 29·254 | 67·0 | 58·4 | 65 3 | 58·8 | E. | Cum. | 10 | S.W. | 0·065 |
| 29 | 29·605 | 67·8 | 55·9 | 62·3 | 57·7 | W. | Cum. | 10 | W. | 0·000 |
| 30 | 30·074 | 67·8 | 46·9 | 63·4 | 55·9 | W. | ... | 0 | ... | 0·000 |

Barometer.—Highest Observed, on the 8th, = 30·336 inches. Lowest Observed, on the 23rd, = 29·242 inches. Difference, or Monthly Range, = 1·094 inch. Mean = 29·898 inches.

S. R. Thermometers.—Highest Observed, on the 19th, = 85°·8. Lowest Observed, on the 2nd, = 41°·2. Difference, or Monthly Range, = 44°·6. Mean of all the Highest = 66°·6. Mean of all the Lowest = 50°·1. Difference, or Mean Daily Range, = 16°·5. Mean Temperature of Month = 58°·3.

Hygrometer.—Mean of Dry Bulb = 59°·8. Mean of Wet Bulb = 54°·9.

Rainfall.—Number of Days on which Rain fell = 9. Amount of Fall = 1·925 inch. Greatest Fall in 24 Hours, on the 22nd, = 0·760 inch.

A. D. RICHARDSON,
*Observer.*

# APPENDIX.

## THE BOTANICAL SOCIETY OF EDINBURGH.

*Founded 1836.*

### 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 be open to Ladies and Gentlemen, and shall consist of Honorary, Resident, Non-Resident, and Corresponding Members, who shall have the privilege of denominating themselves Fellows of the Society; of Lady Members elected under the rule Chapter IV., Section 6 hereof, and of Associates elected under the rule Chapter IV., Section 5 hereof.

### 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, etc., 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 authorized 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 subscriptions 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.—CORRESPONDING MEMBERS.

1. Any person residing abroad may be balloted for as a Corresponding Member, 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, are not entitled to receive copies of the *Transactions,* and have no interest in the property 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, or may be elected and continue a Member on payment annually of a subscription of Ten Shillings ; but Lady Members elected under this rule shall not be entitled to receive copies of the *Transactions,* shall have no voice in the management of the Society, nor any interest in the property thereof.

*Note.*—Diplomas may be procured by Fellows from the Acting 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 December 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 November 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.

# ROLL
OF
# THE BOTANICAL SOCIETY OF EDINBURGH.

*Corrected to November 1893.*

*Patron:*
HER MOST GRACIOUS MAJESTY THE QUEEN.

## HONORARY FELLOWS.

*Date of Election.*

April 1863. His Royal Highness The PRINCE of WALES, K.G., Hon. F.R.S. L. & E.

Nov. 1863. His Royal Highness The DUKE of EDINBURGH, K.G., K.T., LL.D. Edin.

Dec. 1877. His Majesty Oscar II. KING of SWEDEN.

### BRITISH SUBJECTS (limited to six).

Jan. 1866. Babington, Charles Cardale, M.A., F.R.S., F.L.S., F.S.A., *Fellow of St. John's College and Professor of Botany, Cambridge;—Non-Resident Fellow, May* 1836.

Dec. 1890. Cleghorn, Hugh F. C., M.D., LL.D., F.R.S.E., F.L.S., *Strathvithie, St. Andrews;—Resident Fellow, June* 1838.

Nov. 1888. Dyer, William Turner Thiselton, M.A., C.M.G., C.I.E., F.R.S., *Director, Royal Gardens, Kew.*

Jan. 1866. Hooker, Sir Joseph Dalton, M.D., K.C.S.I., C.B., D.C.L. Oxon., LL.D. Cantab., F.R.S., F.L.S., F.G.S., *The Camp, Sunningdale, Berks.*

Dec. 1882. Oliver, Daniel, F.R.S., F.L.S., *Kew;—Non-Resident Fellow, Nov.* 1851.

Jan. 1886. Spruce, Richard, Ph.D., *Coneysthorpe, Malton, Yorkshire;—Non-Resident Fellow, Dec.* 1841.

### FOREIGN (limited to twenty-five).

Jan. 1866. Agardh, Jakob Georg, For. F.L.S., *Emeritus Professor of Botany, Lund.*

Jan. 1866. Baillon, Dr. Henri Ernest, For. F.L.S., *Professor of Natural History in the Faculty of Medicine, Paris.*

Dec. 1877. Cohn, Dr. Ferdinand, For. F.L.S., *Professor of Botany in the University, and Director of the Botanical Museum and Physiological Institute, Breslau;—Corresponding Fellow, Jan.* 1873.

May 1891. Cornu, Dr. Max, *Director of the Jardins des Plantes, Paris.*

Dec. 1885. Delpino, Dr. Frederico, *Professor of Botany in the University, and Director of the Botanic Garden, Bologna;—Corresponding Fellow, Jan.* 1873.

Dec. 1885. Duchartre, Pierre, Membre de l'Institut, For. F.L.S., *Professor of Botany, Paris;—Corresponding Fellow, Jan.* 1873.

May 1891. Engler, Dr. Adolf, For. F.L.S., *Professor of Botany in the University, and Director of the Royal Botanic Garden and Museum, Berlin;—Corresponding Fellow, Jan.* 1886.

*Date of Election.*

Dec. 1892. GOEBEL, Dr. K. E., For. F.L.S., *Professor of Botany in the University, and Director of the Botanic Garden, Munich.*

Dec. 1885. GRAND'EURY, *St. Etienne.*

May 1891. HARTIG, Dr. ROBERT, For. F.L.S., *Professor of Forestry in the University, Munich.*

Dec. 1885. HILDEBRAND, Dr. F., *Professor of Botany in the University, and Director of the Botanic Garden, Freiburgi, Br.*

Dec. 1878. LANGE, Dr. JOHANNES MARTIN, For. F.L.S., *Professor of Botany, Copenhagen;—Corresponding Fellow, Dec.* 1847.

Jan. 1874. MUELLER, Baron FERDINAND VON, M.D., K.C.M.G., F.R.S., For. F.L.S., *Government Botanist, Melbourne.*

Dec. 1877. NYLANDER, Dr. GUILLAUME, For. F.L.S., *Paris;—Corresponding Fellow, Jan.* 1865.

Dec. 1869. PRINGSHEIM, Dr. NATHAN, For. F.L.S., *Berlin;—Corresponding Fellow, Jan.* 1866.

Jan. 1873. SACHS, Dr. JULIUS VON, For. F.R.S., For. F.L.S., *Professor of Botany in the University, and Director of the Botanic Garden, Würzburg;—Corresponding Fellow, Dec.* 1869.

Dec. 1885. SCHWENDENER, Dr. S., For. F.L.S., *Professor of Botany in the University, Berlin.*

Dec. 1892. SOLMS-LAUBACH, GRAF. H. ZU., For. F.L.S., *Professor of Botany in the University, and Director of the Botanic Garden, Strasburg.*

Feb. 1876. STRASBURGER, Dr. EDOUARD, For. F.R.S., For. F.L.S., *Professor of Botany in the University, and Director of the Botanic Garden, Bonn;—Corresponding Fellow, Jan.* 1873.

Dec. 1885. TIEGHEM, PHILLIPE VAN, Membre de l'Institut, For. F.L.S., *Professor of Botany, Paris;—Corresponding Fellow, April* 1877.

Dec. 1885. WARMING, Dr. EUGENE, For. F.L.S., *Professor of Botany in the University, and Director of the Botanic Garden, Copenhagen.*

## RESIDENT AND NON-RESIDENT FELLOWS.

*No distinguishing mark is placed before the name of Resident Fellows who contribute annually and receive Publications.*

* *Indicates Resident Fellows who have compounded for Annual Contribution and receive Publications.*

† *Indicates Non-Resident Fellows who have compounded for Publications.*

‡ *Indicates Non-Resident Fellows who do not receive Publications.*

*Date of Election.*

Dec. 1888. *Aitchison, J. E. T., M.D., LL.D., C.I.E., F.R.S., care of Messrs. Grindlay, Groom, & Co., *Bombay.*

Jan. 1871. *Aitken, A. P., M.A., D.Sc., F.R.S.E., 57 *Great King Street.*—FOREIGN SECRETARY.

June 1893. Aitken, Mrs. A. P., 57 *Great King Street.*

Nov. 1884. †Alexander, J., *Forest Department, Galle, Ceylon.*

June 1875. *Alison, Rev. G., *Kilbarchan, Paisley.*

April 1877. ‡Allan, Francis J., M.D., 1 *Dock Street, London, E.*

Dec. 1855. ‡Allman, G. J., F.R.SS. L. & E., F.L.S., *Athenaeum Club, London.*

June 1852. ‡Anderson, John, M.D., F.L.S., 71 *Harrington Gardens, London, S.W.*

Feb. 1876. *Anderson, Rev. Thomas, 44 *Findhorn Place.*

Dec. 1866. *Archibald, John, M.B., C.M., F.R.C.S.E., 2 *The Avenue, Beckenham, Kent.*

Dec. 1850. ‡Armitage, S. H., M.D., 9 *Huntris Row, Scarborough.*

Dec. 1888. †Bailey, Colonel Fred., R.E., *Conservator of Forests,* 6 *Drummond Place.*

May 1872. *Balfour, I. Bayley, Sc.D., M.D., F.R.S., F.L.S., F.G.S., *Queen's Botanist, Professor of Botany, and Keeper of the Royal Botanic Garden, Inverleith House.*—CURATOR.

Dec. 1868. *Balfour, Thomas Alex. Goldie, M.D., F.R.S.E., 51 *George Square.*

Dec. 1863. †Barnes, Henry, M.D., F.R.S.E., 6 *Portland Square, Carlisle.*

July 1880. ‡Barty, Rev. Thomas, M.A., *The Manse, Kirkcolm.*

July 1848. *Bayley, George, W.S., 7 *Randolph Crescent.*

Feb. 1857. *Bell, John M., W.S., *East Morningside House.*

May 1891. *Berwick, Thomas, 56 *North Street, St. Andrews.*

*Date of Election.*
April 1857. ‡Beveridge, Jas. S., L.R.C.P. and S., 9 *Spring Gardens, London, S.W.*
Dec. 1879. *Bird, George, 24 *Queen Street.*
June 1850. ‡Birdwood, Sir George, M.D., *India Office.*
July 1870. *Black, James Gow, Sc.D., *Professor of Chemistry, University of Otago, New Zealand.*
May 1888. *Bonnar, William, 8 *Spence Street.*
Dec. 1886. *Bower, F. O., M.A., D.Sc., F.R.S., F.L.S., *Professor of Botany, University of Glasgow, 45 Kersland Street, Hillhead, Glasgow.*—PRESIDENT.
Jan. 1871. *Boyd, W. B., *of Faldonside, Melrose.*
Feb. 1870. †Bramwell, John M., M.B., C.M., *Burlington House, Goole, Yorkshire.*
Jan. 1837. ‡Branfoot, J. H., M.D., *West Indies.*
April 1857. †Brown, George H.W., *Victoria, Vancouver Island.*
June 1840. †Brown, Isaac, *Brantholme, Kendal.*
Dec. 1890. Brown, Richard, C.A., 23 *St. Andrew Square.*—TREASURER.
Dec. 1860. ‡Brown, Robert, Ph.D., F.L.S., *Fersley, Rydal Road, Streatham, London, S.W.*
Nov. 1882. †Brown, William, *Earlsmill, Forres.*
Mar. 1850. ‡Brown, William, M.D., *Cape of Good Hope.*
June 1893. Bryden, Mrs. J. M., 72 *Great King Street.*
Dec. 1864. Buchan, Alexander, M.A., LL.D., F.R.S.E, *Sec. Scot. Met. Soc.*, 72 *Northumberland Street.*
Dec. 1878. *Buchanan, James, *Oswald Street.*
April 1855. ‡Burnett, Charles John, *Aberdeen.*
May 1839. ‡Burslem, Willoughby Marshall, M.D., *Bournemouth, Hants.*
Feb. 1882. Caird, Francis M., M.B., C.M., 21 *Rutland Street,*
Dec. 1836. ‡Carnegie, W. F. Lindsay, *Kinblethmont.*
Dec. 1858. †Carruthers, William, F.R.S., F.L.S., *British Museum of Natural History, South Kensington, London.*
Nov. 1842. ‡Carter, James, M R.C.S., *Cambridge.*
Feb. 1848. Christison, Sir Alexander, Bart., M.D., 40 *Moray Place.*
Mar. 1893. Christison, Lady, 40 *Moray Place.*
April 1848. Christison, David, M.D., 20 *Magdala Crescent.*
June 1873. *Clark, T. Bennet, 15 *Douglas Crescent.*
Dec. 1854. ‡Clay, Robert H., M.D., 4 *Windsor Villas, Plymouth.*
Dec. 1856. †Cleland, John, M.D., F.R.S., *Professor of Anatomy, University of Glasgow.*
May 1861. ‡Coldstream, Wm., B.A., B.Sc., *Commissioner, Punjab, India.*
April 1850. ‡Collingwood, Cuthbert, M.A., M.B., F.L.S., M.R.C.P., 69 *Great Russell Street, London, W.C.*
Dec. 1868. †Collins, James, 13 *Napier Street, Deptford, London.*
April 1865. †Cooke, M. C., M.A., LL.D., 146 *Junction Road, London, N.*
Feb. 1870. †Cowan, Charles W., *Valleyfield, Penicuik.*
Dec. 1860. *Craig, Wm., M.D., C.M., F.R.C.S.E, F.R.S.E., 71 *Bruntsfield Place.*
Feb. 1874. †Crawford, William Caldwell, 1 *Locharton Gardens, Slateford.*
Nov. 1881. Croom, J. Halliday, M.D. F.R.C.P.E., 25 *Charlotte Square.*
July 1871. *Davies, Arthur E., Ph.D., F.L.S., *Tweed Bank, West Savile Road.*
Feb. 1863. ‡Dawe, Thos. Courts, *St. Thomas, Launceston.*
April 1862. ‡Dawson, John, *Witchhill Cottage, Kinnoul, Perth.*
Dec. 1892. Day, T. Cuthbert, 36 *Hillside Crescent.*
Mar. 1841. ‡Dennistoun, John, *Greenock.*
Jan. 1869. ‡Dickinson, E. H., M.D., M.A., 162 *Bedford St. South, Liverpool.*
June 1848. ‡Dobie, W. M., M.D., *Chester.*
Jan. 1860. †Dresser, Christopher, Ph.D., F.L.S., *Wellesley Lodge, Sutton, Surrey.*
July 1869. *Drummond, W. P., 5 *Granton Road.*
Dec. 1859. †Duckworth, Sir Dyce, M.D., 11 *Grafton Street, Bond Street, London, W.*
June 1851. ‡Duff, Alex. Groves, M D., *New Zealand.*
Dec. 1865. *Duncanson, J. J. Kirk, M.D., C.M., F.R.S.E, 22 *Drumsheugh Gardens.*
Dec. 1870. Dunn, Malcolm, *The Palace Gardens, Dalkeith.*
Feb. 1871. ‡Dupuis, Nathan Fellowes, M.A., *Professor of Mathematics, Queen's College, Kingston, Canada.*
Dec. 1869. †Duthie, J. F., B.A., F.L.S., *Superintendent of the Botanic Gardens, Saharunpore, N.W.P., India.*

*Date of Election.*

Feb. 1891. Edington, Alexander, M.B., C.M., *Cape of Good Hope.*
Nov. 1885. Elliot, G. F. Scott, M.A., B.Sc., F.L.S., *Newton, Dumfries.*
Dec. 1839. ‡Elliot, Robert, care of W. E. Lockhart, Esq. *of Cleghorn, Lanark.*
Jan. 1883. *Evans, Arthur H., M.A., 9 *Harvey Road, Cambridge.*
Mar. 1890. Ewart, J. Cossar, M.D., F.R.S.E., *Professor of Natural History, University.*
Dec. 1860. †Farquharson, Rev. James, D.D., *Selkirk.*
Dec. 1858. †Fayrer, Sir Joseph, M.D., K.C.S.I., F.R.SS. L. & E., 53 *Wimpole Street, Cavendish Square, London.*
April 1887. †Fingland, James, *Thornhill, Dumfries.*
June 1838. Fleming, Andrew, M.D., F.R.S.E., 3 *Napier Road.*
Nov. 1840. ‡Flower, Thomas Bruges, F.L.S., M.R.C.S., 9 *Beaufort Buildings West, Bath.*
Nov. 1861. †Foggo, R. G., *Invercauld, Aberdeenshire.*
Dec. 1861. ‡Foote, Harry D'O., M.D., *Crofts House, Rotherham, Yorkshire.*
Dec. 1887. Forsyth, John M., *Woburn, Bedfordshire.*
Mar. 1870. ‡Foss, Robert W., M.B., C.M., *Stockton-on-Tees, Durham.*
July 1885. Foulis, James, M.D., F.R.C.P.E., 34 *Heriot Row.*
July 1860. †Fox, Charles H., M.D., *Brislington House, near Bristol.*
Feb. 1873. *France, Charles S., care of Cardno & Darling, *Seedsmen, Aberdeen.*
Nov. 1879. Fraser, Alexander, *Canonmills Lodge.*
June 1874. Fraser, Rev. James, M.A., *The Manse, Colvend, Dalbeattie.*
June 1836. ‡Fraser, James A., M.D., *Cape Town.*
July 1872. *Fraser, John, M.D., 19 *Strathearn Road.*
Dec. 1865. †Fraser, John, M.A., M.D., *Chapel Ash, Wolverhampton.*
Dec. 1855. *Fraser, Patrick Neill, *Rockville, Murrayfield.*
Mar. 1862. Fraser, Thomas R., M.D., F.R.S., *Professor of Materia Medica,* 13 *Drumsheugh Gardens.*
April 1848. ‡French, J. B., *Australia.*
Feb. 1871. Galletly, Alexander, *Curator, Museum of Science and Art.*
Mar. 1871. *Gamble, James Sykes, M.A., F.L.S., *Conservator of Forests, Dehra Dún, North-West Provinces, India.*
Jan. 1866. *Gayner, Charles, M.D., F.R.S.E., *Oxford.*
Jan. 1881. Geddes, Patrick, F.R.S.E., *Professor of Botany, University College, Dundee, University Hall, Ramsay Gardens.*
May 1874. ‡Geikie, Sir Archibald, LL.D., F.R.SS. L. & E., *Director General, H.M. Geological Survey,* 4 *Jermyn Street, London.*
Jan. 1887. *Gibson, A. H., 5 *Crawfurd Road.*
Nov. 1836. †Gordon, Rev. George, LL.D., *Birnie, Elgin.*
Dec. 1836. ‡Gough, The Viscount George S., F.R.S., M.R.I.A., *Lougheutra Castle, Gort, Galway.*
Jan. 1889. *Grieve, James, *Pilrig Nurseries.*
Feb. 1879. *Grieve, Symington, 11 *Lauder Road*
Dec. 1892. *Gunn, Rev. George, M.A., *The Manse, Stitchel, Kelso.*
Mar. 1881. ‡Gunning, His Excellency Robert Halliday, M.A., M.D. Edin., 12 *Addison Crescent, Kensington, London.*
Feb. 1839. ‡Hamilton, John Buchanan, *of Leny and Bardovie.*
Dec. 1868. Hardie, Thomas, M.D., F.R.C.P.E., 10 *John's Place, Leith.*
April 1862. ‡Hay, G. W. R., M.D., *Bombay Army.*
May 1887. Hay, Henry, M.D., 7 *Brandon Street.*
June 1862. †Haynes, Stanley, Lewis, M.D., *Medhurst, Malvern, Worcestershire.*
Dec. 1860. ‡Hector, Sir James, K.C.M.G., M.D., F.R.SS. L. & E., F.L.S., *Wellington, New Zealand.*
May 1841. ‡Heslop, Ralph C., M.D., 2 *Winckley Square, Preston, Lancashire.*
Dec. 1847. ‡Hewetson, Henry, *Leeds.*
April 1886. Hill, J. R., *Secretary, Pharmaceutical Society, York Place.*
Dec. 1854. ‡Hill, W. R., M.D., *Lymington, Hants.*
May 1867. *Hog, Thomas Alex., *of Newliston, Linlithgow.*
Dec. 1888. *Hole, Henry E., *Quorndon Lodge, Loughborough.*
Feb. 1878. †Holmes, E. M., F.L.S., F.R.H.S., *Curator of Museum, Phar. Soc. of Great Britain, Bradbourne Dene, Sevenoaks, Kent.*
Dec. 1841. ‡Holmes, Rev. E. Adolphus, M.A., F.L.S., *St. Margaret's, Harleston, Norfolk.*
Nov. 1884. †Holt, G. A., 139 *Strangeways, Manchester.*
June 1850. ‡Hort, Fenton J. A., *Rev. Prof. D.D., St. Peter's Terrace, Cambridge.*
Dec. 1863. ‡Hossack, B. H., *Craigiefield, Kirkwall.*
Nov. 1873. ‡Hume, Thomas, M.B., C.M., *Madras.*

*Date of Election.*

Dec. 1890. Hunter, George, M.D , F.R.C.S.E., M.R.C.P.E., 33 *Palmerston Pl.*
Jan. 1860. ‡Hunter, Rev. Robert, LL.D., *Forest Retreat, Staples Hill, Loughton, Essex.*
June 1893. Hunter, Robert James, 24 *Craigmillar Park.*
Jan. 1851. ‡Hutchinson, Robert F., M.D., *Bengal.*
Jan. 1865. *Hutchison, Robert, F.R.S.E., 11 *Bellevue Crescent.*
Dec. 1847. ‡Ivory, Francis J., *Australia.*
Jan. 1855. ‡Jepson, O., M.D., *Medical Superintendent, City of London Lunatic Asylum, Stone, Dartford, Kent.*
Feb. 1891. ‡Jamieson, Thomas, *Lecturer on Agriculture, University, Aberdeen.*
May 1877. *Johnston, Henry Halcro, B.Sc., M.D., C.M , F.L.S., *Surgeon-Major, Army Medical Staff*, 1 *Great Wellington Street, Ferry Road.*
April 1858. ‡Johnston, John Wilson, M.D., F.R.S.E., *Dacre House, Shrewsbury Road, Oxton, Birkenhead.*
Nov. 1869. ‡Kannemeyer, Daniel R., L.R.C.S.E., *Burghersdrop, Cape Colony.*
Nov. 1877. Kerr, John Graham, *Christ's College, Cambridge.*
Mar. 1841. ‡Kerr, Robert, *Greenock.*
Jan. 1854. ‡Kirk, Sir John, K.C.B., M.D., F.R.S., F.L.S., *British Consul, Zanzibar.*
Jan. 1874. *Kirk, Robert, M.B., C.M., *Bathgate.*
Feb. 1856. ‡Lawson, George, LL.D., *Professor of Chemistry, Dalhousie University, Halifax, Nova Scotia.*
Feb. 1888. ‡Learmonth, W., *High School, Stirling.*
June 1874. *Leitch, John, M.B., C.M., *Silloth.*
Feb. 1878. ‡Lennox, David, M.D., *Crichton Royal Institution, Dumfries.*
April 1883. Lindsay, Robert, *Curator, Royal Botanic Garden;—Associate, July* 1879.
Feb. 1838. †Lingwood, Robert M., M.A., F.L.S., 6 *Park Villas, Cheltenham.*
Mar. 1874. Lister, Sir Joseph, Bart., F.R.SS. L & E , *Professor of Clinical Surgery*, 12 *Park Crescent, Portland Place, London, N.W.*
Jan. 1869. †Livesay, William, M.B., C.M., *Sudbury, Derby.*
June 1889. *Loudon, William, 14 *Belgrave Crescent.*
Feb. 1863. †Lowe, George May, M.D., C.M., *Lincoln.*
Jan. 1854. †Lowe, John, M.D., *Green Street, Park Lane, London.*
May 1838 ‡Lowe, William Henry, M.D., *Woodcote, Wimbledon.*
Dec. 1890. Lowson, J. Melvin, M.A , B.Sc., *University Tutorial College*, 32 *Red Lion Square, London, W.C.*
Jan. 1855. *Macadam, Stevenson, Ph.D., F.R.S.E., *Surgeons' Hall.*
May 1881. Macadam, W. Ivison, F.C.S., F.I.C., F.R.S.E., *Lecturer on Chemistry, Surgeons' Hall.*
Feb. 1892. M'Alpine, A. N., B.Sc. Lond , *Lecturer on Botany, Minto House.*
July 1836. ‡Macaulay, James, M.D., 22 *Cambridge Road, Kilburn, London, N.W.*
Mar. 1862. ‡Macdonald, John, M.D., F L.S., *Gothic House, Walton-on-Thames.*
Jan. 1881. †Macfarlane, John M., Sc.D., F.R.S.E., *Professor of Botany, University of Philadelphia, U.S.A.*
Feb. 1886. M'Glashen, D., 79 *Morningside Park.*
Feb. 1863. ‡Macgregor, Rev. Patrick, M.A., *Logie-Almond Manse, Perthshire.*
June 1880. *M'Intosh, W. C., M.D., LL.D., F.R.SS. L. & E., F.L.S., *Professor of Natural History, St. Andrews.*
Jan. 1889. Mackenzie, A., *Warriston Nurseries.*
May 1862. ‡Mackenzie, Stephen C., M.D., *Professor of Hygiene, Calcutta.*
Nov. 1836. Maclagan, Sir Andrew Douglas, M.D., P.R.S.E., *Professor of Medical Jurisprudence*, 28 *Heriot Row.* — HONORARY SECRETARY.
April 1857. ‡Maclagan, General Robert, F.R.S.E., 4 *West Cromwell Road, South Kensington, London, S.W.*
April 1880. ‡M'Laren, John, jun., 15 *Mill Street, Perth.*
June 1850. M'Laren, Hon. Lord, 46 *Moray Place.*
Feb. 1882. M'Murtrie, Rev. John, M.A., D.D., 5 *Inverleith Place.*
Dec. 1887. Mann, Gustav, 4 *Great King Street.*
Dec. 1872. †Maw, George, F.L.S., F.G.S., *Benthall, Kenley, Surrey.*
May 1867. *Maxwell, Wellwood H., *of Munches, Dalbeattie.*
Nov. 1849. ‡Melville, A. G., *Emeritus Professor of Nat. Hist., Galway.*
April 1837. ‡Melville, Henry Reed, M.D., *St. Vincent.*
Jan. 1870. Methven, John, 6 *Bellevue Crescent.*
Feb. 1890. *Millar, R. C., C.A., 8 *Broughton Place.*

*Date of Election.*

Mar. 1883. Milne, Alex., 32 *Hanover Street.*
Nov. 1875. *Milne, John Kolbe, *Kevock Tower, Lasswade.*
Feb. 1874. Moffat, Andrew, 9 *Wilfrid Terrace.*
June 1888. Moffat, W. J., *Secretary, Scottish Aboricultural Society,* 5 *St. Andrew Square.*
Mar. 1853. †More, A. G., F.L.S., F.R.S.E., M.R.I.A., *Ex-Curator, Science and Art Museum,* 74 *Leinster Road, Dublin.*
Dec. 1888. Morris, Rev. A. B., F.L.S., 18 *Eildon Street.*
July 1878. †Muirhead, George, F.R.S.E., *Mains of Haddo, Aberdeen.*
Feb. 1881. Murray, George, *Chemist, South Back of Canongate.*
Dec. 1889. ‡Murray, J. Russel, *Port-of-Spain, Trinidad.*
May 1884. Murray, William, 8 *Clifton Terrace.*
Nov. 1848. ‡Nevins, John Birkbeck, M.D., 3 *Abercromby Square, Liverpool.*
Dec. 1878. *Norman, Commander Francis M., R.N., *Cheviot House, Berwick-on-Tweed.*
July 1889. Normand, P. Hill, *Whitehill, Aberdour, Fifeshire.*
May 1873. Ogilvie, William M'Dougall, *Royal Bank, Lochee, Dundee.*
June 1890. Oliver, John S., 12 *Greenhill Park.*
Feb. 1863. *Panton, Geo. A., F.R.S.E., 73 *Westfield Road, Edgbaston, Birmingham.*
July 1841. †Parker, Charles Eyre, 13 *Scarborough Terrace, Torquay, Devon.*
May 1867. †Paterson, Alexander, M.D., *Fernfield, Bridge of Allan.*
Trans. Dec. 1858 } ‡Paterson, R., M.D., *Napier Road;—Wernerian, Dec.* 1836.
Mar. 1880. ‡Paton, James, F.L.S., *Industrial Museum, Kelvingrove, Glasgow.*
April 1883. *Paul, Rev. David, M.A., *Roxburgh Manse, Kelso.*
Nov. 1839. ‡Paul, James, M.D., *Jamaica.*
July 1889. *Paxton, W., *Orchardton, Fountainhall Road.*
April 1880. Peach, B. N., F.R.S.E., F.G.S., *Scot. Geol. Survey Office,* 86 *Findhorn Place.*
Nov. 1840. ‡Perry, William Groves, *Australia.*
Mar. 1874. ‡Pettigrew, J. B., M.D., LL.D., F.R.SS. L. and E., *Professor of Medicine, St. Andrews.*
April 1887. Peyton, Rev. W. W., *Broughty Ferry.*
Jan. 1838. ‡Pires, D'Albuquerque, Le Chevalier, *Brazil.*
Dec. 1874. ‡Playfair, D. T., M.B., C.M., *Heathfield, Bromley, Kent.*
May 1883. ‡Playfair, Rev. Patrick M., *Glencairn Manse, Thornhill.*
July 1836. ‡Pollexfen, Rev. John Hutton, M.A., *Middleton Tyas Vicarage, Richmond, Yorkshire.*
April 1877. ‡Porteous, George M., *Firknowe, Juniper Green.*
July 1871. ‡Post, G. E., M.D., *Beyrout.*
Nov. 1873. *Potts, George H., *of Fettes Mount, Lasswade.*
June 1891. †Prain, David, M.D., F.L.S., F.R.S.E., *Royal Botanic Garden, Shippur, Calcutta.*
Dec. 1849. ‡Priestley, Sir W. O., M.D., 17 *Hertford Street, Mayfair, London.*
‡Prior, R. C. Alexander, M.D., F.L.S., 48 *York Terrace, Regent's Park, London, and Halse House, Taunton.*
June 1893. ‡Pullar, Robert, J.P., F.R.S.E., *Tayside, Perth.*
Dec. 1858. †Ramsbotham, S. H., M.D., *Leeds.*
July 1884. *Rattray, John, M.A., B.Sc., F.R.S.E., *Dunkeld.*
Jan. 1878. ‡Reid, Jas. R., C.M.G., *Bengal Civil Service.*
April 1877. ‡Riddell, William R., B.A., B.Sc, *Prov. Normal School, Ottawa, Ontario, Canada.*
Dec. 1869. *Robertson, A. Milne, M.B., C.M., *Gonville House, Roehampton Park, London, S.W.*
Dec. 1890. Robertson, Robert A. M.A., B.Sc., *Lecturer on Botany, St. Andrews, Rattray, Perthshire.*
April 1861. Rutherford, William, M.D., F.R.SS. L. and E., *Professor of Physiology,* 14 *Douglas Crescent.*
Dec. 1864. †Rylands, Thomas Glazebrook, F.L.S., *Highfields, Thelwall, near Warrington.*
July 1882. *Sanderson, William, *Talbot House, Ferry Road.*
June 1893. Sanderson, Mrs. W., *Talbot House, Ferry Road.*
Mar. 1859. *Scot-Skirving, Robert, *of Camptown,* 29 *Drummond Place.*
May 1841. ‡Scott, D. H., M.D., *Altavilla, Queenstown, Cork.*
April 1881. ‡Scott, Daniel, *Wood Manager, Darnaway Castle, Forres.*
Dec. 1840. ‡Scott, John, *Greenock.*
Dec. 1887. Scott, J. S., L.S.A., 55 *Clowes Street, West Gorton, Manchester.*

*Date of Election.*

Dec. 1891. *Semple, Andrew, M.D., F.R.C.S.E., *Deputy Surgeon-General*, 10 *Forres Street.*
Feb. 1888. Sewell, Philip, 8 *Hanover Terrace, Whitby.*
May 1836. ‡Shapter, Thomas, M.D., *Sudbury, Derby.*
Dec. 1869. ‡Shaw, John Edward, M.B., 2 *Rodney Cottages, Clifton, Bristol.*
Mar. 1850. ‡Sherwood. E., M.D., *Prospect Hill, Whitby.*
Jan. 1851. *Sibbald, John, M.D., F.R.S.E., 3 *St. Margaret's Road.*
Nov. 1836. ‡Sidney, M. J. F., *Cowpen, Morpeth.*
Nov. 1840. ‡Simpson, Samuel, *Lancaster.*
Jan. 1887. Simson, W. B., *The Elms, Broughty Ferry.*
Jan. 1840. ‡Slack, Robert, M.D., *Holywalk, Leamington.*
Feb. 1891. *Smith, J. Pentland, M.A., B.Sc., *Horticultural College, Swanley, Kent.*
Mar. 1891. Smith, William G., B.Sc., 4 *Lorne Terrace, Maryfield, Dundee.*
Feb. 1886. †Somerville, Alexander, B.Sc., F.L.S., 4 *Bute Mansions, Hillhead, Glasgow.*
Jan. 1890. *Somerville, William, Œc.D., B.Sc., F.R.S.E., *Professor of Agriculture, Durham College of Science, Newcastle-on-Tyne.*
July 1853. ‡Southwell, Thomas, F.Z.S., *Earlham Road, Norwich.*
Dec. 1854. ‡Spasshatt, Samuel P., M.D., *Armidale, New South Wales.*
June 1874. Sprague, Thomas Bond, M.A., F.R.S.E., 29 *Buckingham Terrace.*
June 1893. Sprague, Mrs. T. B., 29 *Buckingham Terrace.*
Nov. 1883. †Stabler, George, *Levens, Milnthorpe, Westmoreland.*
July 1867. ‡Steel, Gavin, *of Carphin, Lanarkshire.*
Mar. 1888. Steele, A. B., *Museum of Science and Art.*
Feb. 1841. ‡Steele, Robert, *Greenock.*
Jan. 1837. ‡Stevens, Rev. Charles Abbott, M.A., *Port Slade Vicarage, Shoreham, Sussex.*
Feb. 1871. ‡Stewart, Samuel A., *The Museum, College Square North, Belfast.*
July 1883. Stewart, John, *Letham Mill, Arbroath.*
Dec. 1892. Stewart, Robert, S.S.C., 7 *East Claremont Street.*
Jan. 1893. Struthers, John, M.D., LL.D., *Emeritus Professor of Anatomy*, 24 *Buckingham Terrace.*
July 1884. Stuart, Charles, M.D., *Chirnside.*
Dec. 1869. Syme, David, 1 *George IV. Bridge.*
July 1853. *Taylor, Andrew, 11 *Lutton Place.*
Dec. 1837. ‡Taylor, R. H., M.D., 1 *Percy Street, Liverpool.*
Dec. 1887. Terras, J. A., B.Sc., 40 *Findhorn Place.*—ASSISTANT SECRETARY.
June 1877. Thomson, David, *Craigleith Nurseries.*
June 1836. ‡Thomson, Spencer, M.D., *Ashton, Torquay.*
Feb. 1871. †Tinne, John A., *Briarley, Aigburth, Liverpool.*
April 1846. †Townsend, F., M.A., F.L.S., *Honington Hall, Shipston-on-Stour.*
May 1888. *Trail, J. W. H., M.A., M.D., F.L.S., *Professor of Botany, Aberdeen.*
Dec. 1890. Tress, W. Maxwell, 7 *Melville Crescent.*
Dec. 1888. Turnbull, Robert, B.Sc., 9 *Dean Terrace.*
Mar. 1836. ‡Tyacke, N., M.D., *Westgate, Chichester.*
Nov. 1888. Ure, George, *Camphill Lodge, Broughty Ferry.*
July 1886. †Waddell, Alexander, *of Pallace, Jedburgh.*
Jan. 1856. ‡Waddell, Thomas, *Cumbernauld.*
Dec. 1861. *Walker, Arthur A., *Chislehurst, Putney Common, London, S. W.*
Jan. 1856. ‡Walker, V. E., *Arno's Grove, Southgate, Middlesex.*
Mar. 1836. ‡Wallich, George Charles, M.D., *Kensington, London, W.*
Dec. 1884. *Watson, Charles, *The Clouds, Duns.*
July 1884. Watson, William, M.D., *Waverley House, Slateford.*
May 1885. ‡Webster, A. D., *Holwood Park, Keston, Beckenham.*
May 1837. ‡White, Alfred, F.L.S., *West Drayton.*
Dec. 1861. †White, F. Buchanan, M.D., F.L.S., *Annat Lodge, Perth.*
July 1891. White, R. Brooman, *Arddarroch, Dumbartonshire.*
Mar. 1893. †Wilkinson, W. H., F.L.S., F.R.M.S., *Rockville, Manor Hill, Sutton Coldfield, Birmingham.*
Mar. 1837. ‡Wilks, G. A. F., M.D., *Woodburn, Torquay.*
Mar. 1873. ‡Wilson, A. Stephen, *North Kinmundy, Summerhill, Aberdeen.*
Dec. 1890. *Wilson, John H., D.Sc., F.R.S.E., care of Hunter, 1B *Eildon Street;—Associate, Nov.* 1886.
April 1880. Wilson, Dr Andrew, F.R.S.E., F.L.S., 110 *Gilmore Place.*
July 1892. Wood, Lieut.-Col.-Surgeon Julius John, M.B.

*Date of Election.*

May 1873. ‡Wright, R. Ramsay, M.A., B.Sc., *Professor of Natural History, University, Toronto.*

May 1863. †Yellowlees, David, M.D., *Gartnavel Asylum, Glasgow.*

## CORRESPONDING MEMBERS.

*Date of Election.*

Jan. 1878. Areschoug, Dr. F. W. C., *Professor of Botany in the University, and Director of the Botanic Garden, Lund.*

Jan. 1878. Ascherson, Dr. P., *Royal Herbarium, Berlin.*

April 1877. Blytt, Axel, *Professor of Botany in the University, and Conservator of the Botanical Museum, Christiania.*

Dec. 1881. Bohnensieg, Dr. G. C. W., *Conservator of the Library of the Museum Teyler, Haarlem.*

Jan. 1878. Bömmer, J. E., *Professor of Botany, Brussels.*

July 1879. Bornet, Dr. Edouard, Membre de l'Institut, For. F.L.S., *Paris.*

Dec. 1854. Brandis, Sir Dietrich, Ph.D., F.L.S., *Ex-Inspector-General of Indian Forests, Professor of Forestry in the University, Bonn.*

Mar. 1881. Caminhoá, Dr. Joaquim Monterio, *Professor of Botany and Zoology, Rio Janeiro.*

Jan. 1866. Candolle, Casimir de, *Geneva.*

July 1879. Cheeseman, T. F., F.L.S., F.Z.S., *Curator of the Museum, Auckland, New Zealand.*

July 1879. Cleave, Rev. W. O., LL.D., *College House, St. Helier, Jersey.*

May 1865. Clos, Dominique, M.D., Corresp. de l'Institut, *Professor of Botany in the Faculty of Sciences, and Director of the Botanic Garden, Toulouse.*

Dec. 1868. Crépin, François, *Director of the Royal Botanic Garden, Brussels.*

Jan. 1878. Eeden, F. W. Van, *Director of the Colonial Museum, Haarlem.*

Feb. 1893. Errera, Leo, *Professor of Botany in the University, Brussels.*

Jan. 1878. Garcke, Dr. A., *Professor of Botany in the University, and First Assistant in the Royal Botanic Museum, Berlin.*

April 1844. Gottsche, Dr. K. M., *Altona, Schleswig-Holstein.*

Jan. 1886. Haberlandt, Dr. G., *Professor of Botany in the University, and Director of the Botanic Garden, Graz.*

Dec. 1887. Hansen, Dr. E. C., *Director of the Physiological Department of the Carlsberg Laboratory, Copenhagen.*

Feb. 1876. Heldreich, Dr. Theodore de, *Director of the Botanic Garden, Athens.*

May 1891. Henry, Augustine, M.D., *Imperial Customs Service, China.*

April 1887. Horne, John, F.L.S., *Ex-Director of the Royal Botanic Garden, Mauritius.*

Jan. 1886. Janczewski, Dr. Ed. Ritter von, *Professor of Plant Anatomy and Physiology in the University, Cracow.*

July 1853. Jolis, Dr. Auguste le, *Cherbourg.*

Mar. 1878. Juranyi, Dr. L., *Professor of Botany in the University, and Director of the Botanic Garden, Buda Pest, Hungary.*

Jan. 1886. Kerner, Dr. Anton J. Ritter von Merilaun, *Professor of Botany in the University, and Director of the Botanic Garden, Vienna.*

April 1878. King, George, C.I.E., M.D., F.R.S., F.L.S., *Superintendent, Botanic Garden, Calcutta.*

Jan. 1886. Leichtlin, Max, *Baden-Baden.*

Jan. 1886. Luerssen, Dr. Ch., *Professor of Botany in the University, and Director of the Botanic Garden, Königsberg.*

Jan. 1873. Millardet, A., *Professor of Botany in the Faculty of Sciences, Bordeaux.*

Jan. 1878. Moore, Charles, F.L.S., *Director of the Botanic Garden, Sydney, New South Wales.*

Jan. 1866. Naudin, Dr. C., For. F.L.S., Membre de l' Institut, *Director of the Laboratory, Villa Thuret, Antibes.*

Jan. 1878. Nyman, Charles Frider, *Stockholm.*

Jan. 1878. Oudemans, Dr. C. A. J. A., *Professor of Botany in the University, and Director of the Botanic Garden, Amsterdam.*

Jan. 1886. Pfeffer, Dr. W., For. F.L.S., *Professor of Botany in the University, and Director of the Botanic Garden and Institute, Leipzig.*

Jan. 1872. Phillipi, Dr. R. A., *Professor of Botany in the University of Santiago, Chili.*

Dec. 1868. Radlkofer, Dr. L., *Professor of Botany in the University, Munich.*

*Date of Election.*

Mar. 1881. Rodrigues, Joas Barboza, *Director of the Botanic Garden, Rio Janeiro.*
Dec. 1858. Rostan, Dr. Edouard, *San Germano di Pinerolo, Piedmont.*
Mar. 1878. Sargent, C. S., *Professor of Arboriculture, Harvard University, Cambridge, and Director of the Arnold Arboretum, Brookline, Massachusetts.*
Feb. 1893. Schmitz, Fr., *Professor of Botany in the University, and Director of the Botanic Garden, Griefswald.*
Feb. 1876. Sodiro, Luis, *Professor of Botany in the University, Quito, Ecuador.*
Nov. 1888. Sully, W. C., *Cape Town.*
Dec. 1870. Suringar, W. F. R., *Professor of Botany, and Director of the Botanic Garden, Leyden.*
May 1876. Terracciano, Dr. Nicolao, *Director of the Royal Gardens, Caserta, near Naples.*
Jan. 1886. Treub, Dr. M., For. F.L.S., *Director of the Botanic Garden, Buitenzorg, Java.*
Nov. 1888. Tyson, W., *Forest Department, Cape Town.*
Dec. 1887. Wildpret, H., *Director of the Botanic Garden, Orotara.*
Dec. 1870. Willkomm, Dr. Maurice, *Professor of Botany and Director of the Botanic Garden, Prague, Bohemia.*

## ASSOCIATES.

Dec. 1861. Bell, William, *New Zealand.*
Mar. 1886. Bennett, A., F.L.S., 107 *High Street, Croydon.*
Mar. 1848. Boyle, David, *Boxhill Post Office, Nunwading, South Bourk, Melbourne.*
Jan. 1853. Brocas, F. Y., 4 *Mill Street, Conduit Street, London, W.*
Feb. 1878. Buchanan, John, C.M.G., *Blantyre, Shiré Highlands, Central Africa.*
Feb. 1876. Campbell, A., 14 *Marchmont Crescent, Edinburgh.*
Mar. 1878. Campbell, John, *Ledaig, Argyllshire.*
Feb. 1871. Evans, William, *Scottish Widows' Fund, St. Andrew Square.*
Feb. 1841. Gray, Peter, 12 *Perth Street, Henderson Row.*
Dec. 1885. Greig, James, *Woodville, Dollar.*
Dec. 1850. Howie, Charles, *St. Andrews.*
Dec. 1873. Jaffray, Andrew T., *Darjeeling.*
Dec. 1840. Kerr, Andrew, *Taxidermist, Montrose.*
April 1847. Laing, J., *Nurseryman, Foresthill, London.*
Mar. 1886. Landsborough, Rev. D., *Kilmarnock.*
June 1891. M'Andrew, James, *New Galloway, Kirkcudbrightshire.*
Feb. 1890. M'Intosh, Charles, *Dunkeld.*
June 1845. M'Nab, T., *Montreal, Canada.*
Dec 1868. Munro, Robertson, *Glasgow.*
Mar. 1840. Pamplin, William, A.L.S., *Llanderfel, Corwen, Merionethshire.*
Dec. 1883. Richardson, Adam D., *Royal Botanic Garden.*
Mar. 1878. Ross, George, 18 *Crombie Street, Oban.*
June 1891. Shaw, James, *Tynron, Dumfriesshire.*
May 1868. Shaw, William, *Gunsgreen, Eyemouth.*
Dec. 1858. Sim, John, *Perth.*
Mar. 1886. Traill, G. W., 3 *George Street.*
April 1877. Whittaker, Joseph, *Ferriby Brook, Morley, Derby.*

## LADY ASSOCIATE.

Nov. 1886. Ormerod, Miss E. A., *Dunster Lodge, Isleworth.*

## LADY MEMBER.

April 1893. Balfour, Mrs. Bayley, *Inverleith House;—Lady Associate,* 1886.

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*Moscow*, . . Société impériale des Naturalistes.
*St. Petersburg*, Hortus botanicus imperialis.

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