The British Mycological Society

(*Recognosce notum, ignotum inspice*)

TRANSACTIONS

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TRANSACTIONS

Volume VI

Edited by

CARLETON REA and J. RAMSBOTTOM

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British Mycological Society.

LIST OF MEMBERS.

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1. Boudier, Monsieur Emile, 22, rue Grétry, Montmorency (Seine-et-Oise), France (1905).
2. Saccardo, Professor P. A., R. Orto Botanico, Padova, Italy (1916).

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6. Bailey, Mr. Maurice A., B.A., John Innes Horticultural Institute, Mostyn Road, Merton, Surrey (1911).
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10. Bellerby, Mr. William, 8, Burton-stone Lane, York (1917).
11. Biffen, Professor R. H., M.A., F.R.S., 136, Huntingdon Road, Cambridge (1899).
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13. Blackwell, Miss Elsie M., M.Sc., Botanical Laboratories, The University, Liverpool (1917).
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16. Borthwick, Mr. A. W., D.Sc., Royal Botanic Garden, Edinburgh, and 46, George Street, Edinburgh (1911).
17. Boston, The Mycological Club, Boston, Mass., U.S.A. (1900).
18. Boyd, Mr. D. A., St. Clair, Caledonia Road, Saltcoats (1906).
19. British Museum, The Trustees of, Cromwell Road, London, S.W. (1914).
20. Brooks, Mr. F. T., M.A.,(Senior Demonstrator of Botany, Cambridge University), The Botany School, Cambridge (1907).
21. Bruxelles, Jardin Botanique de l'Etat (1911).
22. Bryce, Mr. G., B.Sc., Assistant Botanist and Mycologist, Peradeniya, Ceylon (1915).
23. Buckley, Mr. W. D., 27, Bengal Road, Ilford, Essex (1916).
24. Buller, Professor A. H. Reginald, D.Sc., Ph.D., F.R.S.C., Professor of Botany at the University of Manitoba, Winnipeg, Canada (1911).
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27. Cheesman, Mr. W. Norwood, J.P., F.L.S., The Crescent, Selby (1896).
28. Chicago, The Library, University of, Ill., U.S.A. (1914).
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30. Clarke, Miss H., M.Sc., Botanical Laboratories, The University, Liverpool (1917).
31. Cleland, Mr. J. Burton, M.D., 93, Macquaire Street, Sydney, New South Wales (1918).
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33. Cooper, Miss Charlotte A., Hillside Cottage, Bushey, Herts (1911).
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35. Curtis, Miss Kathleen M., M.A., c/o Bank of New Zealand, 1, Queen Victoria Street, London (1917).
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39.* Elliott, Mrs. J. S. Bayliss, Arden Grange, Tanworth-in-Arden, Warwickshire (1911).
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43. Farquharson, Mr. C. O., Government Mycologist, Ibadan, South Nigeria (1915).
44. Finlayson, Mr. Raymond, The Seed Testing Laboratory, Wood Green, London, N. (1910).
45. FitzGerald, Rev. H. P., F.L.S., Lidwells, Goudhurst, Kent (1896).
46. Fraser, Miss H. C. I., D.Sc., F.L.S., Birkbeck Institute, Chancery Lane, London. (See Mrs. H. C. I. Gwynne-Vaughan.) (1906).
47. Fynes-Clinton, Rev. C. E., M.A., St. James' Vicarage, Leyland, Preston (1917).
48. Gardner, Mr. Frederic, 16, Stow Park Avenue, Newport (1898).
49. Gibbs, Mr. Thomas, Armitage, Lindfield, Sussex (1896).
50. Goodwin, Mr. D. P., Oakden, Kidderminster (1902).
51. Grant, Mr. Angus, Drumälan, Drumnadrochit, N.B. (1903).
52. Green, Col. C. Theodore, A.M.S., M.R.C.S. England, L.R.C.P. London, F.L.S., 31, Shrewsbury Road, Birkenhead (1901).
53. Green, Mr. E. Ernest, F.Z.S., F.E.S., Way's End, Camberley, Surrey (1917).
54. Grinling, Mr. C. H., M.A., 17, Rectory Place, Woolwich (1913).
54*. Gwynne-Vaughan, Mrs. H. C. I., D.Sc., F.L.S., 93, Bedford Court Mansions, London, W.C. (1906).
55. Hadden, Mr. Norman G., Breezy Bank, West Porlock, Somerset (1911).
56. Harrison, Mr. H. W., formerly of Harboro', Torrington Road, Liscard, Wallasey (1913).
57. Harrison, Mrs. E., formerly of Harboro', Torrington Road, Liscard, Wallasey (1913).
58. Harvey, Mrs. Cecily D., Barwick in Elmet Rectory, near Leeds (1910).

59. Hastings, Mr. Somerville, M.S., F.R.C.S., 43, Devonshire Street, Portland Place, London, W. (1913).
60. Hawley, Sir H. C. (Bart.), Holly Mount, Hurst Wood, Buxted, Surrey (1907).
61. Hey, Mr. T., 98, Archer Road, Millhouses, Sheffield (1896).
62. Hibbert-Ware, Miss Alice, 3, Chaucer Road, Wanstead, E. 11 (1911).
63. Hildyard, Mr. F. W., 77A, Lexham Gardens, Kensington, London, W. (1913).
64. Hiley, Mr. Wilfrid E., M.A., Danesfield, Boar's Hill, Oxford (1913).
65. Holmes, Mr. E. Morell, F.L.S., F.R.H.S., Ruthven, Sevenoaks, Kent (1906).
66. Holt, Mr. W. H., 17, Ashville Road, Birkenhead (1914).
67. Hughes, Mr. G. C., Chesterton, Bicester, Oxon. (1898).
68. Huish, Mr. Charles Henry, F.R.M.S., Danehurst, 24, Champion Grove, Denmark Hill, London, S.E. (1913).
69. Jack, Mr. H. W., B.Sc., B.A., Assistant Agricultural Inspector Federated Malay States; Waterloo Place, Cork (1913).
70. Johnstone, Mr. R. B., 134, Cambridge Drive, Glasgow (1908).
71. Knight, Mr. H. H., The Lodge, All Saints Villas, Cheltenham (1914).
72. Lister, Miss Gulielma, F.L.S., Leytonstone and Highcliff, Lyme Regis (1903).
73. Lister, Mr. A. B., D.I.C., B.Sc. (London), Experimental and Research Station, Turner's Hill, Cheshunt, Waltham Cross, Herts (1916).
74. Lloyd, Mr. C. G., The Lloyd Library and Museum, 224, West Court Street, Cincinnati, Ohio, U.S.A. (1907).
75. Macfie, Dr. John William Scott, M.A., D.Sc., 21a, Alfred Street, Liverpool (1900).
76. Mackenzie, Mr. D., Afton, Busby, N.B. (1900).
77. Main, Mr. Robert, 1, Roslyn Avenue, Low Fell, Gateshead (1918).
78. Maire, Dr. René, D.Sc., Professeur à la Faculté des Sciences de l'Universite, Algers (Algeria) (1907).
79. Maitland, Mr. T. D., Agricultural Department, Kampala, Uganda (1916).
80. Marmont, Mr. Basil P., Windsoredge House, Inchbrook, near Woodchester, Gloucestershire (1908).
81. Mason, Mr. F. A., F.R.M.S., Member of the Society of Public Analysts, The Laboratory, 3, Queen's Square, Leeds (1912).
82. Menzies, Mr. James, 24, King Edward Street, Perth (1917).

83. Minnesota, The Library, University of, Mineapolis, U.S.A. (1915).
84. Missouri, The Botanical Garden, St. Louis, Ms. U.S.A. (1902).
85. Montague, Mrs. A., Penton, Crediton, N. Devon (1898).
86. Newcastle-upon-Tyne. The Literary and Philosophical Society (1902).
87. Newman, Mr. Leslie F., M.A., F.L.S., Dip. Agri. Cantab., School of Agriculture, Cambridge (1906).
88. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904).
89. Nicholson, Mr. Charles, F.E.S., 35, The Avenue, Hale End, Chingford, N.E. (1916).
90. Nicholson, Mr. W. E., Lewes (1913).
91. Noel, Miss E. F., 37, Moscow Court, London, W. (1913).
92. Ogle Mr. B. S., Hill House, Steeple Aston, Oxon. (1904).
93. Oke, Mr. Alfred William, B.A., L.L.M., F.G.S., F.L.S., 32, Denmark Road, Hove (1908).
94. O'Loughlin, Miss Bessie, Rocklands, Wallasey, Cheshire (1913).
95. Osborn, Professor Theodore George Bentley, M.Sc., Professor of Botany, Adelaide University (1910).
96. Paul, The Very Rev. David, LL.D., D.D., 53, Fountainhall Road, Edinburgh (1899).
97. Paulson, Mr. Robert, F.L.S., F.R.M.S., Glenroy, Cecil Park, Pinner, Middlesex (1918).
98. Peacock, Dr. H. G., Hareston Lodge, Torquay (1896).
99. Pearson, Mr. Arthur A., F.L.S., 59, Southwark Street, London, S.E. 1 (1911).
100. Peltereau, Monsieur E., Notaire honoraire, Trésorier de la Société Mycologique de France, Vendome, Loir et Cher.) France (1909).
101. Perceval, Mr. Cecil H. Spencer, Longwitton Hall, Morpeth (1901).
102. Petch, Mr. T., B.A., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon (1911).
103. Phillips, Professor Reginald W., M.A., D.Sc., F.L.S., Professor of Botany in University College, Bangor (1911).
104. Plowright, Mr. Charles Tertius Maclean, B.A., M.B., King Street, King's Lynn (1901).
105. Potter, Professor M. C., Sc.D., M.A., F.L.S., Armstrong College, Newcastle-upon-Tyne (1896).
106. Potts, Mr. George, Benthall House, Broseley, Salop (1910).
107. Price, Mr. S. Reginald, B.A., Fernleigh, Wellington, Somerset (1911).
108. Priestley, Professor J. H., B.Sc., F.L.S., Botanical Department, University of Leeds (1912).

109. Ramsbottom, Mr. J., M.A., F.L.S., British Museum, Cromwell Road, London S.W. (1910).
110. Ramsbottom, Mr. J. K., Gardeners' Magazine, 2, Adelaide Road, Brentford, Middlesex (1914).
111. Rayner, Mr. J. F., Swaythling, Southampton (1902).
112. Rea, Mr. Carleton, B.C.L., M.A., &c., 34, Foregate Street, Worcester (1896).
113. Rea, Mrs. Emma Amy, 34, Foregate Street, Worcester (1896).
114. Richards, Mr. R. M., A.R.C.Sc., The Laboratory, Caledonia Estate, Province Wellesley, Straits Settlement (1915).
115. Robson, Mr. R., M.Sc., F.Z.S., Writtle, Chelmsford, Essex (1914).
116. Rushton, Mr. W., A.R.C.S., D.I.C., Demonstrator in Biology at St. Mary's Hospital Medical School, Paddington, W., and Assistant Lecturer in Botany at the South Western Polytechnical Institute, Chelsea, 13, Grandison Road, Clapham Common, London, S.W. (1914).
117. Saunders, Miss E. R., F.L.S., Newnham College, Cambridge (1913).
118. Selborne, The, Society, 42, Bloomsbury Square, London, W.C. (1913).
119. Sharpe, Mr. C. J., Brambleside, Manor Road, Sidcup (1905).
120. Simon, Monsieur Eugène, 16, Villa Saïd, Paris (1906).
121. Small, Mr. W., Government Botanist, Department of Agriculture, Kampala, Uganda (1915).
122. Smith, Miss Annie Lorrain, F.L.S., 20, Talgarth Road, West Kensington, S.W. (1899).
123. Smith, Miss K. E., 64 Coton Road, Nuneaton (1913).
124. Stoward, Dr. F., 69, Tate Street, Leederville, Western Australia (1914).
125. Sutherland, Mr. G. K., M.A., B.Sc., University College, Southampton (1914).
126. Swanton, Mr. E. W., Brockton, Haslemere (1899).
127. Tabor, Mr. Richard John, B.Sc., F.L.S., Imperial College of Science and Technology, South Kensington (1914).
128. Tatum, Mr. E. J., Salisbury (1896).
129. Taylor, Miss Beatrice Katherine, 98, Cheyne Walk, Chelsea, S.W. (1910).
130. Taylor, Mr. H. V., A.R.C.S., B.Sc., (Inspector, Board of Agriculture) 4, Whitehall Place, London (1913).
131. Thomas, Mr. H. Hamshaw, The Botany School, Cambridge (1910).
132. Thomson, Miss Mary R. H., Cape Town (1917).
133. Tothill, Lieut. Vincent, R.A.M.C., Ilketshall, St. Andrew, Bungay, Suffolk (1912).

134. United States, Department of Agriculture (1907).
135. Vines, Professor S. H., M.A., D.Sc., F.R.S., Sherardian Professor of Botany, Botanic Garden, Oxford (1915).
136. Wager, Mr. Harold, F.R.S., F.L.S., Hendre, Horsforth Lane, Far Headingley, Leeds (1896).
137. Wakefield, Miss E. M., F.L.S., The Herbarium, Royal Botanic Gardens, Kew (1911).
138. Watkin, Mr. J., 38, Park Avenue, Oswestry (1909).
139. Wheldon, Mr. H. J., Ministry of Munitions, Belgian Village, Birtley, Co. Durham.
140. Whetzel, Professor H. H., Professor of plant pathology, Cornell University, Ithaca, New York (1914).
141. Wilson, Mr. Malcolm, D.Sc., A.R.C.S., F.L.S., Royal Botanic Gardens, Edinburgh (1912).
142. Woolhope, The, Naturalists' Field Club, Hereford (1896).

OFFICERS FOR THE SEASON 1917.

President: Miss A. Lorrain Smith, F.L.S., 20, Talgarth Road, West Kensington.

Vice-President: Miss Gulielma Lister, F.L.S., Leytonstone, Essex, and Highcliff, Lyme Regis.

Hon. Secretary and Treasurer: Carleton Rea, B.C.L., M.A., &c., 34, Foregate Street, Worcester.

THE SHREWSBURY FORAY.

24th-29th September, 1917.

The twenty-first annual week's fungus foray of the British Mycological Society was held at Shrewsbury, on Monday, the 24th of September, 1917. The members assembled at the headquarters The George Hotel, Market Street, Shrewsbury, where a room was reserved for the exclusive use of the Society. In the evening Miss E. M. Wakefield placed out on exhibition some eggs of a rare phalloid, which subsequently developed several handsome pilei; these were collected at Chiswick, on a heap of stable refuse, and were assigned by her to *Lysurus borealis* (Burt), P. Henn, but we should rather refer them to *Lysurus australiensis* Cke. and Massee, which is fully described, with plate, in our Transactions, Vol. II., 57, Pl. 3. The Very Rev. David Paul brought a large tuft of *Pleurotus sapidus* Kalchbr. from the Bishop's Palace at Wells, and also exhibited a fine photograph of *Clathrus ruber* (Micheli) Pers. (syn. *cancellatus*); these consisted of three specimens, two in the egg state and one fully developed, and were found by him at Kilmelford, Argyllshire, on the 10th of September. The Hon. Secretary reported that their past President, Mr. E. W. Swanton, had informed him that Miss Phœbe Keef about the same date gathered this rare phalloid in a wood near Sea View, Isle of Wight. Mr. James Menzies sent on some nice specimens of *Melastiza miniata* (Fuck.) Boud., gathered by Mr. Charles McIntosh at Dunkeld, and Mr. A. A. Pearson brought from Wimbledon a specimen that he referred to *Galera antipus* (Lasch) Fr.

On Tuesday, the 25th of September, the members assembled at the railway station and booked by the 10.5 a.m. train to Plowden, via the Craven Arms. On their arrival there at 11.35 they were met by Mr. R. Parry, who had most kindly offered to conduct them through the Plowden woods and had obtained permission to visit this estate from Captain Plowden. Mr. Parry first led them down to the bridge over the river Onny and then a traverse across the fields was made in the direction of Plowden Hall. The pastures yielded many specimens the most noteworthy including *Tricholoma brevipes* (Bull.) Fr., *Eccilia griseorubella*

(Lasch) Fr., *Marasmius urens* (Bull.) Fr., *Pleurotus corticatus* Fr. on elm, *Geoglossum ophioglossoides* (Linn.) Sacc., (syn. *glabrum*), *Cortinarius* (*Hydrocybe*) *dolabratus* Fr., *Pholiota squarrosa* (Müll.) Fr., on walnut, *Hygrophorus obrusseus* Fr., and *Clavaria fumosa* (Pers.) Fr. After luncheon the walk was continued through the woods in the direction of the road to Bishop's Castle, and the following fungi were gathered on the way : *Lepiota fulvella* Rea (new to science)*, *Boletus porphyrosporus* Fr., *Mycena pelianthina* Fr., *Lactarius obnubilus* (Lasch) Boud., *Marasmius fuscopurpureus* (Pers.) Fr., *Hygrophorus pudorinus* Fr., *Marasmius porreus* (Pers.) Fr., *Clavaria pistillaris* (Linn.) Fr., *Clavaria stricta* (Pers.) Fr., *Cortinarius* (*Telamonia*) *impennis* Fr. and *Collybia xanthopus* Fr. Miss Wakefield subsequently reported the finding of *Polyporus stipticus* (Pers.) Fr., which is an addition to the British list. It was past four o'clock when the highway was reached and over two miles of this had to be traversed before they could rejoin the other members who had accompanied the President and Mr. Parry to Walcot Park. Here they were most hospitably entertained to tea by the Earl and Countess of Powis and great regret was expressed that time did not allow for the investigation of the Walcot woods. The return train was taken from Plowden station at 5.55 p.m., and at Horderley Miss Lister rejoined the party having after luncheon, accompanied Messrs. W. B. Allen and W. N. Cheesman in a walk through the woods bordering the Onny valley. They made the following additions to the list :—*Lepiota Friesii* (Lasch) Fr., *Hygrophorus olivaceo-albus* Fr., *Cortinarius* (*Hydrocybe*) *saturninus* Fr., *Thelephora anthocephala* (Bull.) Fr., *Thelephora spiculosa* Fr., *Microglossum viride* (Pers.) Gill., *Cortinarius* (*Telamonia*) *psammocephalus* Fr., and *Lactarius pallidus* (Pers.) Fr. In the evening, at nine o'clock, the President (Miss A. Lorrain Smith F.L.S.) took the chair, and the following officers were unanimously elected for the ensuing year :—The Very Rev. David Paul, LL.D., D.D., President; Miss Gulielma Lister, F.L.S., Vice-President; and Mr. Carleton Rea, B.C.L., M.A., &c., Hon. Secretary and Treasurer. Selby was selected as the centre for the autumn foray of 1918 and Mr. W. Norwood Cheesman, F.L.S. very kindly undertook to arrange the details for the meeting; the date to be fixed subsequently by the Hon. Secretary after consultation with the President elect and Mr. Cheesman. Miss A. Lorrain Smith, F.L.S., was appointed

*See description (p. 61).

delegate to represent the British Mycological Society at the Conference of Delegates of Corresponding Societies of the British Association in 1918. The Hon. Treasurer reported that they now numbered one hundred and forty four members and had enrolled ten new members since the New Forest foray, viz :—Mr. F. Arnold, M.A., Holmdene, 56, Cathedral Road, Cardiff; Mr. William Bellerby, 8, Burton-stone Lane, York; Miss Elsie M. Blackwell, M.Sc., Botanical Laboratories, The University, Liverpool; Miss H. Clarke, M.Sc., Botanical Laboratories, The University, Liverpool; Mr. E. Ernest Green, F.Z.S., F.E.S., Way's End, Camberley, Surrey; Mrs. Annis Ellis, 13, Stoney Hey Road, New Brighton, Cheshire; Mr. James Menzies, 24, King Edward Street, Perth; Mr. J. F. Rayner, Swaythling, Southampton; Miss Mary R. H. Thomson, Cape Town; and Mr. H. J. Wheldon, 147, c Cottage, Holbrook Lane, Coventry. The credit balance at the post office saving's bank shewed a balance of twenty one pounds and eight shillings in their favour which contrasted favourably with the accounts as exhibited in their programme which showed no balance at all. The forty five pounds received from the bequest of the late Mrs. E. M. Robinson had with the accruing income been invested in fifty pounds War Loan. Mrs. A. Ellis had given the Society her late husband's copies of Saccardo's Sylloge Fungorum, vol. III, Sphaeropsideae et Melanconiae; Plowright's British Uredineae and Ustilagineae; and Tubeuf's and Smith's Diseases of plants induced by cryptogamic parasites: these would be available to the members who applied for them. A hearty vote of thanks was accorded to her for the kind gifts. Professor S. H. Vines had suggested that the Society should publish a paper on fungicides, and the Hon. Secretary reported that Mr. A. D. Cotton, F.L.S.,* had consented to do so and his action was approved.

On Wednesday, the 26th of September, the morning was devoted to placing out on exhibition the more uncommon fungi collected on the previous day, as the size of the room did not permit of the usual full display. Mr. Norman G. Hadden sent from the neighbourhood of Porlock, *Hydnum graveolens* (Delast.) Fr., *Geaster fimbriatus* (Vitt.) Fr., *Marasmius pruinatus* Rea, *Uromyces Loti* Blytt, on *Lotus corniculatus*, *Uromyces sparsus* Lév. on *Spergularia salina*, and *Uromyces Salicorniae* de Bary. At noon the members drove from the headquarters to Haughmond Abbey, where

*Pressure of war work has prevented Mr Cotton supplying us with this paper.

the woods in the immediate vicinity of the picturesque ruins were explored. Here some nice examples of *Cyphella galeata* (Schum.) Fr., *Lactarius circellatus* Fr., *Lactarius obnubilus* (Lasch) Boud. and *Mycena amicta* Fr. were collected. The roadway was then crossed and a prettily wooded bank traversed in the direction of Uffington. The ground, beneath numerous fine beeches growing amidst short grass and moss, yielded an abundant harvest of the common fungi but the rarer sorts were few and included *Pholiota adiposa* Fr., *Polyporus intybaceus Fr., Pleurotus corticatus* Fr., *Marasmius globularis* (Weinm.) Fr., *Russula atropurpurea* (Krombh.) Maire, *Fomes resinaceus* (Boud.) Rea and *Amanita recutita* Fr. On reaching the village of Uffington the return drive was taken to Shrewsbury. In the evening, at nine o'clock, Miss A. Lorrain Smith, F.L.S. delivered her presidential address entitled "Relation of Fungus Hyphae to other Organisms" (see p. 17).

On Thursday, the 27th of September, the members assembled at the railway station and departed by the 11.20 a.m. train for Buildwas Junction which was reached about mid-day. Mr. W. B. Allen met the members and led them across the pastures in the direction of Tickwood. The grass was somewhat long but specimens of *Trichoglossum hirsutum* (Pers.) Boud., *Clitopilus cretatus* B.&Br. and *Cortinarius* (*Hydrocybe*) *bicolor Cke.* were noticed on the way. The woods at Tickwood were then worked by kind permission of Col. G. G. P. Heywood, and under the able leadership of Mr. Allen, who is a native of these parts and intimately acquainted with this covert, they were conducted to the most favoured spots for the rarer fungi. The undergrowth was very rank but notwithstanding this drawback the following interesting plants were obtained :—*Naucoria escharoides* Fr., *Collybia vertirugis Cke., Helvella lacunosa* Afz., *Amanita strobiliformis* Vitt., *Cortinarius* (*Phlegmacium*) *scaurus* Fr., *Entoloma Bloxamii* Berk., *Amanita solitaria* (Bull.) Fr., *Lactarius scrobiculatus* (Scop.) Fr., *Hygrophorus sciophanus* Fr., *Cortinarius* (*Telamonia*) *stemmatus* Fr., *Armillaria ramentacea* (Bull.) Fr., *Inocybe incarnata* Bres., *Leptopodia ephippium* (Lév.) Boud., *Cortinarius* (*Dermocybe*) *cotoneus* Fr., *Marasmius foetidus* (Sow.) Fr., *Cortinarius* (*Phlegmacium*) *calochrous* (Pers.) Fr., *Boletus impolitus* Fr., *Polyporus stipticus* (Pers.) Fr., and *Lycoperdon velatum* Vitt. Tickwood Hall was reached about 4.30 p.m. and Mrs. G. P. P. Heywood welcomed the members to a dainty tea, which was much appreciated. The light began to fail and a rather hurried walk across the fields

brought the members to the Buildwas station in time to catch the last train back to Shrewsbury at 6.39 p.m. In the evening the President took the chair at nine o'clock Mr. W. Norwood Cheesman, J.P., F.L.S. read a paper on "The British Tremellineae" and Miss E. W. Wakefield, F.L.S., followed with "Observations on some Sand-Dune Fungi" (see p. 33).

On Friday, the 28th of September, the morning was occupied in the critical examination of the rarer fungi. These included *Strobilomyces strobilaceus* (Scop.), Berk., and *Boletus felleus* (Bull.) Fr., gathered by Miss C. Cooper and Miss K. Smith in Lythe Wood, near Shrewsbury, on the previous day. At 11.15 a.m. the 'bus was taken from the adjoining square to Bayston Hill, from whence a short walk across the fields brought them to Bomere. The members spread out in all directions through the woods surrounding this pool, but the woods were too overgrown and dry with the exception of the lower portions adjoining the water, which yielded an abundant crop of mycetozoa. A few additions were made to the list, namely, *Aleuria ampliata* (Pers.) Gill., *Tubaria paludosa* Fr., *Hydnum ferrugineum* Fr., *Psilocybe uda* (Pers.) Fr., *Inocybe calospora* Quél., and *Russula integra* (Linn.) Fr. A large patch of *Lactarius vellereus* Fr. was covered with the parasitic mould *Amblyosporium botrytis* Fres. The members returned to the headquarters about six o'clock.

In the evening, at 9 o'clock, Miss A. Lorrain Smith took the chair, and Mr. A. A. Pearson read a paper on "Two-spored basidia" (see p. 39). A hearty vote of thanks was passed to the Earl of Powis, Col. G. G. P. Heywood, Capt. Plowden, and Mrs. Hugh Corbet, for the kind permissions given to visit their estates, and to the two former for their kind hospitality. A similar vote was also passed to Mr. R. Parry and Mr. W. B. Allen for their able leadership in the field, and especially to the latter for the selection of places to visit during the foray. On Saturday, the 29th of September, some of the members availed themselves of Mr. Allen's kind offer to conduct them through Caughley Wood, adjacent to Linley Station, on the Severn Valley line. Many scarce fungi were collected, including *Lepiota hispida* (Lasch) Fr., *Lepiota pratensis* (Bull.) Fr., *Lepiota rosea* Rea (new to science),* *Lepiota haematosperma* (Bull.) Boud., *Lepiota sistrata* Fr., *Lepiota Bucknallii* B. & Br., *Pluteus salicinus* (Pers.) Fr., *Omphalia atropuncta* (Pers.) Quél., *Polystictus Wynnei* B. and Br., *Clavaria chionea* (Pers.) Quél. (new to Britain), *Clavaria rugosa* (Bull.) Fr., var.

*See description (p. 61).

juliginea Fr., *Clavaria cinerea* (Bull.) Fr., var. *gracilis* Rea (n. var.)† and *Poria vitrea* (Pers.) Fr. A fine circle of *Psaliota elvensis* B. & Br. was found by Mr. W. B. Allen growing under an oak in a pasture between Linley Station and a coppice further south, where Mr. George Potts was again successful in obtaining a specimen of *Armillaria bulbigera* (A. and S.) Fr. On the return walk to Linley railway station, the Very Rev. D. Paul boxed some examples of *Lenzites variegata* Fr. Over five hundred and fifty species of fungi and forty-seven mycetozoa were collected during the foray. The Hon. Sec. is indebted to Miss A. Lorrain Smith and Miss E. M. Wakefield for their kind assistance in preparing the subjoined list.

†See description (p. 62).

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

Species not generally distributed are marked *B.* = Bomere; *C.* = Caughley Wood; *H.* = Haughmond Abbey Woods; *P.* = Plowden; and *T.* = Tickwood.

Amanita phalloides (Vaill.) Fr., mappa Fr., recutita Fr., *H.*, muscaria (Linn.) Fr., pantherina (DC.) Fr., *P.*, strobiliformis Vitt., *T.*, solitaria (Bull.) Fr., *T.*, rubescens (Pers.) Fr., spissa Fr., *P.*

Amanitopsis vaginata (Bull.) Roze, fulva (Schaeff.) W. G. Sm.

Lepiota procera (Scop.) Fr., rachodes (Vitt.) Fr., *P.*, Friesii (Lasch) Fr., *Horderley*, acutesquamosa (Weinm.) Fr., *C.*, *T.*, hispida (Lasch) Fr., fulvella Rea (new to science) *C.*, pratensis (Bull.) Fr., *C.*, cristata (A.&S.) Fr., erminea Fr., *H.*, carcharias (Pers.) Fr., *P.*, amianthina (Scop.) Fr., rosea Rea (new to science), haematosperma (Bull.) Boud., *C.*, sistrata Fr., *C.*, Bucknallii B. & Br., *C.*

Armillaria bulbigera (A.&S.) Fr., *Coppice below Linley railway station*, ramentacea (Bull.) Fr., *T.*, mellea (Vahl.) Fr., mucida (Schrad.) Fr.

Tricholoma sejunctum (Sow.) Fr., *P.*, resplendens Fr., *B.*, *P.*, flavobrunneum Fr., albobrunneum (Pers.) Fr., *H. P.*, *T.*, rutilans (Schaeff.) Fr., columbetta Fr.,

Horderley, vaccinum (Pers.) Fr., *Horderley,* terreum (Schaeff.) Fr., argyraceum (Bull.) Fr., *T.,* chrysites (Jungh.) Fr., *T.,* saponaceum Fr., cuneifolium Fr., *P.,* *T.,* sulphureum (Bull.) Fr., bufonium (Pers.) Fr., *P.,* carneum (Bull.) Fr., *P.,* *T.,* album (Schaeff.) Fr., *P.,* *Horderley,* acerbum (Bull.) Fr., *P.,* *T.,* nudum (Bull.) Quél., panaeolum Fr., *T.,* grammopodium (Bull.) Fr., *C.,* melaleucum (Pers.) Fr., brevipes (Bull.) Fr., *P.,* sordidum (Schum.) Fr.

Clitocybe nebularis (Batsch) Fr., *T.,* clavipes (Pers.) Fr., virens (Scop.) Sacc., *H.,* odora (Bull.) Fr., rivulosa (Pers.) Fr., cerussata Fr., *P.,* candicans (Pers.) Fr., *H.,* *T.,* infundibuliformis (Schaeff.) Fr., geotropa (Bull.) Fr., *P.,* inversa (Scop.) Berk., metachroa (Fr.) Berk., ditopus Fr., fragrans (Sow.) Fr., *C.,* *T.*

Laccaria laccata (Scop.) B. & Br., var. amethystina (Vaill.) B. & Br., tortilis (Bolt.) Boud., *B.*

Collybia radicata (Relh.) Berk., platyphylla Fr., fusipes (Bull.) Berk., maculata (A. & S.) Fr., butyracea (Bull.) Fr., vertirugis Cke., *T.,* confluens (Pers.) Fr., conigena (Pers.) Fr., *P.,* cirrhata (Pers.) Fr., *C.,* *B.,* tuberosa (Bull.) Fr., xanthopus Fr., *P.,* succinea Fr., *P.,* esculenta (Wulf.) Fr., acervata Fr., *B.,* dryophila (Bull.) Fr., aquosa (Bull.) Fr., *C.,* *P.,* rancida Fr., *T.,* ambusta Fr., *T.*

Mycena pelianthina Fr., *P.,* pura (Pers.) Fr., coccinea (Sow.) Quél. *C.,* flavo-alba Fr., *H.,* rugosa Fr., galericulata (Scop.) Fr., polygramma (Bull.) Fr., inclinata Fr., *P.,* parabolica Fr., *T.,* atroalba (Bolt.) Fr., *H.,* alcalina Fr., *C.,* ammoniaca Fr., metata Fr., *T.,* filopes (Bull.) Fr., amicta Fr., *H.,* vitilis Fr., *H.,* haematopus (Pers.) Fr., *B.,* *C.,* sanguinolenta (A. & S.) Fr., galopus (Pers.) Fr., var. nigra Fl. D., *P.,* epipterygia (Scop.) Fr., rorida Fr., *C.,* discopus Lév., *T.*

Omphalia atropuncta (Pers.) Quél., *C.,* fibula (Bull.) Fr.

Pleurotus corticatus Fr., *P.,* sapidus Kalchbr., *B.,* ostreatus (Jacq.) Fr., *H.,* applicatus (Batsch) Berk., *B.,* *H.*

Hygrophorus eburneus (Bull.) Fr., *P.,* cossus (Sow.) Fr., *T.,* pudorinus Fr., *P.,* discoideus (Pers.) Fr., *T.,* olivaceo-albus Fr., *P.,* *Horderley,* pratensis (Pers.) Fr., var. pallidus Cke., *T.,* virgineus (Wulf.) Fr., var. roseipes Massee, *P.,* *T.,* niveus (Scop.) Fr., ovinus (Bull.) Fr., *P.,* *T.,* sciophanus Fr., *T.,*

ceraceus (Wulf.) Fr., *P.*, coccineus (Schaeff.) Fr., miniatus Fr., *P.*, puniceus Fr., obrusseus Fr., *P.*, conicus (Scop.) Fr., calyptraeformis Berk., *B.*, *P.*, chlorophanus Fr., psittacinus (Schaeff.) Fr., unguinosus Fr., *P.*

Lactarius scrobiculatus (Scop.) Fr., *T.*, torminosus (Schaeff.) Fr., *B.*, turpis (Weinm.) Fr., pubescens Fr., *B.*, *T.*, blennius Fr., circellatus Fr., *H.*, *P.*, uvidus Fr., *T.*, pyrogalus (Bull.) Fr., *T.*, chrysorheus Fr., *H.*, piperatus (Scop.) Fr., *P.*, vellereus Fr., deliciosus (Linn.) Fr., *T.*, pallidus (Pers.) Fr., *H.*, quietus Fr., aurantiacus (Fl. Dan.) Fr., *C.*, theiogalus Fr., *H.*, vietus Fr., *B.*, *P.*, rufus (Scop.) Fr., *B.*, glyciosmus Fr., *B.*, *T.*, fuliginosus Fr., serifluus (DC.) Fr., mitissimus Fr., *P.*, subdulcis (Pers.) Fr., obnubilus (Lasch) Boud., *H.*, *P.*

Russula nigricans (Bull.) Fr., adusta (Pers.) Fr., *H.*, chloroides (Krombh.) Bres., *P.*, furcata (Pers.) Fr., *H.*, *P.*, incarnata Quél., *P.*, virescens (Schaeff.) Fr., *P.*, lepida Fr., *B.*, *P.*, atropurpurea (Krombh.) Maire *B.*, *H.*, drimeia Cke., T., xerampelina (Schaeff.) Fr., *P.*, vesca Fr., *B.*, *P.*, cyanoxantha (Schaeff.) Fr., pectinata (Bull.) Fr., *H.*, *P.*, foetens (Pers.) Fr., fellea Fr., emetica (Schaeff.) Fr., fallax Fr., *H.*, ochroleuca (Pers.) Fr., fragilis (Pers.) Fr., var. nivea (Pers.) Cke., violacea Quél. *B.*, *P.*, integra (Linn.) Fr., armeniaca Cke., *P.*, lutea (Huds.) Fr.

Cantharellus cibarius Fr., *H.*, *P.*, aurantiacus (Wulf.) Fr., *C.*, *T.*

Nyctalis asterophora Fr., *B.*, parasitica (Bull.) Fr., *B.*, *C.*, *P.*,

Marasmius urens (Bull.) Fr., *P.*, peronatus (Bolt.) Fr., porreus (Pers.) Fr., *P.*, oreades (Bolt.) Fr., globularis (Weinm.) Fr., *H.*, fuscopurpureus (Pers.) Fr., *P.*, erythropus (Pers.) Fr., *H.*, *P.*, foetidus (Sow.) Fr., *T.*, ramealis (Bull.) Fr., rotula (Scop.) Fr., androsaceus (Linn.) Fr.

Panus stipticus (Bull.) Fr., *C.*, *B.*, torulosus (Pers.) Fr., *B.*

Lenzites betulina (Linn.) Fr., variegata Fr., *C.*

Pluteus cervinus (Schaeff.) Fr., salicinus (Pers.) Fr., *C.*, nanus (Pers.) Fr., *C.*, *P.*

Entoloma Bloxamii Berk., *T.*, jubatum Fr., *H.*, *T.*, rhodopolium Fr., *H.*, sericeum (Bull.) Fr., *T.*, nidorosum Fr., *P.*

Clitopilus prunulus (Scop.) Fr., *P.*, *T.*, cretatus B. & Br., *T.*

Leptonia lampropus Fr., *P.*, chloropolia Fr., *T.*, sericella (Fr.) Quél., *P.*

Nolanea pascua (Pers.) Fr., *H.*, proletaria Fr., *H.*, *P.*, papillata Bres., *H.*, *T.*, *P.*, pisciodora (Ces.) Fr., *B.*, *C.*

Eccilia griseorubella (Lasch) Fr., *P.*, *T.*

Claudopus variabilis (Pers.) W. G. Sm.

Pholiota togularis (Bull.) Fr., *C.*, squarrosa (Müll.) Fr., *P.*, spectabilis Fr., *B.*, *H.*, adiposa Fr., *B.*, *H.*, *P.*, mutabilis (Schaeff.) Fr., *B.*, *P.*, marginata (Batsch) Fr., *B.*, *T.*,

Inocybe hystrix Fr., *H.*, cincinnata Fr., *T.*, petiginosa (Fr.) Quél., *B.*, *P.*, pyriodora (Pers.) Fr., *B.*, *P.*, *T.*, incarnata Bres., *T.*, cervicolor (Pers.) Quél., *B.*, calospora Quél., *B.*, rimosa (Bull.) Fr., descissa Fr., *B.*, asterospora Quél., *P.*, geophylla (Sow.) Fr.

Hebeloma fastibile Fr., *B.*, *P.*, *T.*, glutinosum (Lindg.) Fr., *C.*, *T.*, crustuliniforme (Bull.) Fr., *T.*, var. minor Cke., *P.*, *T.*, elatum (Batsch) Fr., *T.*, longicaudum (Pers.) Fr., *H.*

Flammula gummosa (Lasch) Fr., *H.*, alnicola Fr., *P.*, flavida (Schaeff.) Fr., *H.*,

Naucoria melinoides Fr., *T.*, semiorbicularis (Bull.) Fr., *T.*, sobria Fr., *C.*, escharoides Fr., *T.*,

Pluteolus reticulatus (Pers.) Fr., *C.*,

Galera tenera (Schaeff.) Fr., *P.*, hypnorum (Schrank) Fr., mycenopsis Fr., *T.*

Tubaria furfuracea (Pers.) W. G. Sm., paludosa Fr., *B.*, crobulus Fr., *H.*

Crepidotus mollis (Schaeff.) Fr., *P.*

Cortinarius (Phlegmacium) varius (Schaeff.) Fr., *P.*, multiformis Fr., *P.*, glaucopus (Schaeff.) Fr., *P.*, calochrous (Pers.) Fr., *T.*, purpurascens Fr., *P.*, subpurpurascens Fr., *P.*, scaurus Fr., *T.*, decolorans (Pers.) Fr., *H.*

(Myxacium) collinitus (Sow.) Fr., *T.*, elatior (Pers.) Fr., *B.*, *H.*, *P.*

(Inoloma) argentatus (Pers.) Fr., *T.*, pholideus Fr., *B.*,

(Dermocybe) tabularis (Bull.) Fr., *H.*, *P.*, caninus Fr., *B.*, anomalus Fr., *B.*, *T.*, lepidopus Cke., *C.*, semisanguineus Fr., *P.*, cinnabarinus Fr., *B.*, *Horderley*, sanguineus (Wulf.) Fr., *P.*, cinnamomeus (Linn.) Fr., *P.*, *T.*, cotoneus Fr., *T.*,

(Telamonia) torvus Fr., *B.*, *T.*, impennis Fr., *P.*, scutulatus Fr., *B.*, hinnuleus (Sow.) Fr.,

B., *P.*, brunneus (Pers.) Fr., T., psammocephalus Fr., *Horderley*, hemitrichus (Pers.) Fr., *B.*, *P.*, *T.*, stemmatus Fr., *T.*, paleaceus (Weinm.) Fr., *T.*,

(Hydrocybe) saturninus Fr., *T.*, *Horderley*, bicolor Cke., *T.*, *Lythe Wood*, dolabratus Fr., *P.*, *Horderley*, leucopus (Bull.) Fr., *P.*, *T.*, decipiens (Pers.) Fr., *H.*, *P.*, *T.*, acutus (Pers.) Fr., *P.*

Paxillus involutus (Batsch) Fr.

Psaliota elvensis B. & Br., *near Linley railway station* campestris (Linn.) Fr., sylvicola (Vitt.) Fr., *B.*, comtula Fr., *T.*

Stropharia aeruginosa (Curt.) Fr., *B.*, *H.*, *P.*, albocyanea (Desm.) Fr., *H.*, squamosa (Pers.) Fr., *B.*, semiglobata (Batsch) Fr., stercoraria Fr., *T.*

Hypholoma sublateritium (Schaeff.) Fr., *H.*, *T.*, capnoides Fr., *H.*, fasciculare (Huds.) Fr., epixanthum Fr., *H.*, velutinum (Pers.) Fr., *B.*, appendiculatum (Bull.) Fr., *P.*, *T.*, hydrophilum (Bull.) Fr.

Psilocybe sarcocephala Fr., *P.*, uda (Pers.) Fr., *B.*, semilanceata Fr., foenisecii (Pers.) Fr., *P.*, *T.*

Psathyra corrugis (Pers.) Fr., *B.*, *P.*, *T.*, bifrons Berk., *P.*, fibrillosa (Pers.) Fr., *H.*

Bolbitius titubans (Bull.) Fr., *H.*, *T.*

Coprinus atramentarius (Bull.) Fr., *H.*, *T.*, cinereus (Schaeff.) Fr., *B.*, *P.*, niveus (Pers.) Fr., *B.*, *H.*, *P.*, micaceus (Bull.) Fr., *H.*, *P.*, radians (Desm.) Fr., *P.*, plicatilis (Curt.) Fr., *P.*

Panaeolus sphinctrinus Fr., *P.*, campanulatus (Linn.) Fr., papilionaceus (Bull.) Fr., *H.*, *P.*

Anellaria separata (Linn.) Karst., *B.*

Psathyrella gracilis (Pers.) Fr., *B.*, *H.*, *P.*, *T.*, atomata Fr., *B.*, disseminata (Pers.) Fr., *T.*

Gomphidius viscidus (Linn.) Fr., *P.*

Boletus elegans (Schum.) Fr., *P.*, *T.*, granulatus (Linn.) Fr., *H.*, chrysenteron (Bull.) Fr., *H.*, subtomentosus (Linn.) Fr., *H.*, *P.*, edulis (Bull.) Fr., *H.*, reticulatus (Schaeff.) Boud., *P.*, impolitus Fr., *T.*, luridus (Schaeff.) Fr., *B.*, *H.*, *P.*, laricinus Berk., *T.*, porphyrosporus Fr., *P.*, scaber (Bull.) Fr., *B.*, *T.*, felleus (Bull.) Fr., *Lythe Wood.*

Strobilomyces strobilaceus (Scop.) Berk., *Lythe Wood.*

Fistulina hepatica (Huds.) Fr., *H.*, *P.*

Polyporus rufescens (Pers.) Fr., *T.*, squamosus (Huds.) Fr., nummularius (Fr.) Quél., *P.*, intybaceus Fr., *P.*, *H.*, giganteus (Pers.) Fr., *P.*, stipticus (Pers.)

Fr., *P.*, *T.*, lacteus Fr., *P.*, mollis (Pers.) Fr., *B.*, rutilans (Pers.) Fr., *T.*, adustus (Willd.) Fr., *P.*, dryadeus (Pers.) Fr., *H.*, betulinus (Bull.) Fr., *B.*, *T.*,

Fomes applanatus (Pers.) Wallr., *H.*, *P.*, resinaceus (Boud.) Rea, *H.*, pomaceus (Pers.) Quél., *C.*, connatus Fr., *B.*, annosus Fr., *T.*

Polystictus versicolor (Linn.) Fr., velutinus Fr., *H.*, Wynnei B. & Br., *C.*, abietinus (Dicks.) Fr., *T.*

Poria vitrea (Pers.) Fr., *C.*

Ptychogaster albus Cda., *B.*, *P.*,

Trametes gibbosa (Pers.) Fr., *B.*, rubescens (A. & S.) Fr., *T.*

Daedalea quercina (Linn.) Fr., *P.*, *T.*

Merulius tremellosus (Schrad.) Fr., *B.*, lacrymans (Wulf.) Fr., *P.*

Solenia anomala (Pers.) Fr., *P.*

Hydnum repandum (Linn.) Fr., *P.*, *T.*, rufescens (Pers.) Fr., *P.*, ferrugineum Fr., *B.*, zonatum (Batch) Fr., *T.*, squalinum Fr., *B.*, alutaceum Fr., *B.*, udum Fr., *B.*, farinaceum (Pers.) Fr., *H.*

Caldesiella ferruginosa (Fr.), Sacc., *T.*

Irpex obliquus (Schrad.) Fr., *B.*

Radulum orbiculare Fr., *B.*

Phlebia merismoides Fr., *H.*

Grandinia helvetica Fr., *B.*

Craterellus cornucopioides (Linn.) Fr., *C.*, *P.*, crispus (Sow.) Fr., *C.*, *P.*, sinuosus Fr., *B.*

Thelephora anthocephala (Bull.) Fr., *Horderley*, terrestris (Ehrh.) Fr., *B.*, spiculosa Fr., *Horderley*.

Stereum hirsutum (Willd.) Fr., purpureum (Pers.) Fr., spadiceum (Pers.) Fr., *H.*, sanguinolentum (A. & S.) Fr., *T.*

Hymenochaete rubiginosa (Schrad.) Lév., *B.*

Corticium caeruleum (Schrad.) Fr., *H.*, confine Bourd. & Galz., *B.*, *T.*, praetermissum (Karst.) Bres., *B.*, sulphureum (Pers.) *T.* (=Phlebia vaga Fr.)

Peniophora quercina (Pers.) Cke., *P.*, *T.*, hydnoides Cke. & Massee (Odontioid form=Odontia conspersa Bres.), *B.*, pubera (Fr.) Sacc., *T.*, Aegerita von Höhnel, *B.* (with Aegerita candida (Pers.) Fr.)

Hypochnus fuscus (Pers.) Karst., *B.*, *on dead stems of Juncus effusus*, *H.*, *T.*, zygodesmoides (Ell.) Burt., *B.*, ferrugineus (Pers.) Fr., *T.*

Solenia anomala (Pers.) Fr., *B.*, *C.*

Cyphella capula (Holmsk.) Fr., *B.*, galeata (Schum.) Fr., *H.*, muscigena (Pers.) Fr., *C.*

Clavaria muscoides (Linn.) Fr., *P.*, cinerea (Bull.) Fr., *B.*,

P., *T.*, var. gracilis Rea, *C.*, cristata (Holmsk.) Fr., *B.*, *P.*, rugosa (Bull.) Fr., *H.*, *P.*, var. fuliginea Fr., *C.*, Kunzei Fr., *P.*, *T.*, chionea (Pers.) Quél., *C.*, abietina (Pers.) Fr., *P.*, stricta (Pers.) Fr., *P.*, fusiformis (Sow.) Fr., *P.*, luteoalba Rea, *H.*, dissipabilis Britz., *T.*, vermicularis (Scop.) Fr., *T.*, fumosa (Pers.) Fr., *P.*, pistillaris (Linn.) Fr., *P.*

Typhula phacorrhiza (Reich.) Fr., *B.*

Auricularia auricula-Judae (Linn.) Schröt., *H.*

Sebacina incrustans Tul., *B.*, *P.*, *T.*

Exidia recisa (Ditm.) Fr., *P.*, glandulosa (Bull.) Fr., *C.*

Dacryomyces deliquescens (Bull.) Duby, *H.*

Calocera cornea (Batsch) Fr., *H.*

Phallus impudicus (Linn.) Pers., *H.*

Mutinus caninus (Huds.) Fr., *H.*

Sphaerobolus stellatus (Tode) Pers., *P.*

Crucibulum vulgare Tul., *B.*, *H.*

Geaster fimbriatus (Vitt.) Fr., *T.*

Bovista plumbea Pers., *B.*

Lycoperdon perlatum Pers., *T.*, depressum Bon., *P.*, *T.*, caelatum (Bull.) Fr., *P.*, *T.*, pyriforme (Schaeff.) Pers., umbrinum Pers., *P.*, velatum Vitt., *T.*, excipuliforme (Scop.) Pers., *P.*

Scleroderma vulgare Hornem., *B.*, verrucosum (Bull.) Pers., *P.*

Puccinia Violae (Schum.) DC., *T.*, Malvacearum Mont., *H.*, Circaeae Pers., *T.*, obtegens (Link) Tul., *T.*, Primulae (DC.) Duby, *T.*, Betonicae (A. & S.) DC., *T.*, Glechomatis DC., *T.*, Menthae Pers., *B.*, *T.*, *on Clinopodium vulgare*, oblongata (Link) Wint., *H.*, *on Luzula sylvatica.*

Triphragmium Ulmariae (Schum.) Link, *T.*

Phragmidium mucronatum Schlecht., *P.*

Coleosporium Petasitis de Bary, *P.*

Pucciniastrum Circaeae (Schum.) Schroet., *T.*

Melampsora Lini (Pers.) Desm., *T.*

Melampsoridium betulinum (Pers.) Kleb., *B.*, *T.*

Urocystis Anemones (Pers.) Wint., *P.*, *T.*, *on Ranunculus.*

Frankiella Alni (Wor.) Maire, *B.*

Sphacelotheca Hydropiperis (Schum.) de Bary, *B.*

Sphaerotheca pannosa (Wallr.) Lév., *C.*, *T.*

Erysiphe communis (Wallr.) Fr., *T.*, *on Hypericum*, Cichoracearum DC., *T.*, *on Cynoglossum officinale.*

Uncinula Aceris (DC.) Sacc., *P.*, *T.*

Nectria cinnabarina (Tode) Fr., *H.*, *P.*, ditissima Tul., *H.*, episphaeria (Tode) Fr., *H.*, *T.*

Hypomyces lateritius (Fr.) Tul., torminosus (Mont.) Tul., *T., on Lactarius pubescens.*
Cordyceps militaris (Linn.) Link, *H., P.*
Leptospora ovina (Pers.) Fuck., *C.*
Rosellinia aquila (Fr.) de Not., *B.*, Clavariae (Tul.) Wint., *B., T.*
Bertia moriformis (Tode) de Not., *C.*
Leptosphaeria vagabunda Sacc., *T.*
Ophiobolus porphyrogonus (Tode) Sacc.
Valsa populina (Pers.) Wint.
Eutypa flavovirescens (Hoffm.) Sacc., *B.*
Melanconis stilbostoma (Fr.) Tul., *B., T.*
Diatrypella quercina (Pers.) Nke., *B., H., P.*
Diatrype stigma (Hoffm.) de Not., *B.*, disciformis (Hoffm.) Fr., *P.*
Hypoxylon udum (Pers.) Fr., *T.*, semiimmersum Nke., *B.*, multiforme Fr., *H.*, fuscum (Pers.) Fr., coccineum (Bull.) Fuck., *H., T.*
Ustulina vulgaris Tul., *H., T.*
Xylaria hypoxylon (Linn.) Grev., *H., P.*
Phyllachora graminis (Pers.) Fuck., *T.*
Dothidella betulina (Fr.) Sacc., *C., P*
Helvella crispa (Scop.) Fr., *P., T.*, lacunosa Afz., *P., T.*, *Horderley.*
Leptopodia elastica (Bull.) Boud., *C.*, ephippium (Lév.) Boud., *T.*
Acetabula ancilis (Pers.) Boud., *B., C.*
Macropodia macropus (Pers.) Fuck., *B.*
Aleuria ampliata (Pers.) Gill., *B.*,
Galactinia badia (Pers.) Boud., *B.*, succosa (Berk.) Sacc., *C., T.*
Otidea onotica (Pers.) Fuck. *P., Horderley.*
Peziza aurantia Pers., *H.*
Lachnea hemisphaerica (Wigg.) Gill., *P.*
Ciliaria scutellata (Linn.) Quél., *B., P.*
Cheilymenia coprinaria (Cke.) Boud., *T.*
Coprobia granulata (Bull.) Boud., *H., P.*
Ascobolus stercorarius (Bull.) Schröt. (syn. furfuraceus), *H.*
Trichoglossum hirsutum (Pers.) Boud., *T.*
Geoglossum ophioglossoides (Linn.) Sacc. (syn. glabrum), *P.*
Microglossum viride (Pers.) Gill., *Horderley.*
Leotia lubrica (Scop.) Pers., *H., P., T.*
Cudoniella acicularis (Bull.) Schröt., *C., P.*
Ombrophila imberbis (Bull.) Boud., *B.*

Calycella citrina (Hedw.) Quél., *B.*, *C.*
Coryne sarcoides (Jacq.) Tul., *B.*, *C.*, *T.*
Bulgaria inquinans (Pers.) Fr., *H.*, *P.*
Calloria fusarioides (Berk.) Fr., *B.*
Orbilia xanthostigma Fr., *H.*, luteorubella (Nyl.) Karst., *P.*, coccinella (Somm.) Fr., *B.*, *P.*
Phialea firma (Pers.) Gill., *B.*, *H.*
Chlorosplenium aeruginosum (Oeder.) de Not., *H.*, *P.*
Helotium herbarum (Pers.) Fr., *B.*, *T.*, fructigenum (Bull.) Fuck., *P.*, virgultorum (Wahl.) Karst., *B.*, *T.*, moniliferum (Fuck.) Rehm, *B.*
Dasyscypha virginea (Batsch) Fuck., *B.*, C.
Trichoscypha calycina (Schum.) Boud., *T.*
Hyaloscypha hyalina (Pers.) Boud., *C.*, *H.*
Mollisia cinerea (Batsch) Karst., melaleuca (Fr.,) Sacc., *C.*
Karschia lignyota (Fr.) Sacc.
Stegia Ilicis Fr., *C.*, *T.*
Rhytisma acerinum (Pers.) Fr., *H.*, *P.*, *T.*
Pilobolus crystallinus (Wiggers) Coem., *H.*
Phoma herbarum Westend.
Libertella faginea Desm.
Oidium alphitoides Griff. & Maulb., *B.*, *H.*, *T.*
Cephalosporium acremonium Cda.
Trichoderma lignorum (Tode) Harz., *B.*
Amblyosporium botrytis Fres., *B.*, *on Lactarius vellereus.*
Rhinotrichum Thwaitesii B. & Br., *B.*, repens Preuss.
Sepedonium chrysospermum (Bull.) Fr., *H.*
Ovularia obliqua (Cke.) Lindau, *H.*
Botrytis vulgaris Fr., epiphylla Pers.
Ramularia calcea (Desm.) Ces., *P.*, *T.*
Cladosporium epiphyllum (Pers.) Mart.
Macrosporium commune Rabenh.
Alternaria tenuis Nees.
Isaria farinosa (Dicks.) Fr., *B.*, *P.*
Aegerita candida (Pers.) Fr., *B.*
Tubercularia vulgaris (Tode) Tul.
Epicoccum vulgare Cda.
Anthina flammea Fr., P.
Ozonium auricomum Link.

Since the above list was in the press Dr. Bayliss Elliott informs me that she found the following species :—Otidea leporina (Batsch) Fuck., *T.*; Calycella claroflava (Grev.) Boud., *T.*; Pachydisca Laburni (B. & Br.) Boud., *T.*, *on Corylus;* Hyalinia inflatula (Karst.) Boud., *P.*, *T.*; Hyalinia Leightoni (Phill.) Boud., var. lignicola n. var. *P.*; Calloria extumescens Karst., *B.* (new to Britain); and Rhinotrichum Thwaitesii B. & Br., var. fulvum Grove.

MYCETOZOA SEEN DURING THE VISIT OF THE BRITISH MYCOLOGICAL SOCIETY TO SHREWSBURY, SEPTEMBER 24th to 29th, 1917.

By Gulielma Lister, F.L.S.

In the following list the places visited are referred to by their initial letters; *P.* for Plowden and Horderley Woods; *H.*, for Haughmond Abbey Woods; *T.*, for Tickwood; *B.* for the woods round Bomere; *C.* for Caughley Woods. Forty-seven species of Mycetozoa were found.

Badhamia utricularis (Bull.) Berk. *H.* Plasmodium only seen.

B. panicea (Fr.) Rost. *P., H.*

B. rubiginosa (Chev.) Rost. var. *globosa* Lister. *B.* found on soil and dead wood as bright yellow plasmodium which in a few days formed into sporangia.

Physarum psittacinum Ditm. *C.* the sporangia are weathered; this is usually a summer species.

P. viride (Bull.) Pers. *T.*

P. nutans Pers. *P., H., T., B.* var. *robustum*. Lister *C.* In this gathering the sporangia have stalks that are white from included lime-granules; they closely resemble *Physarum leucopus* Link in general appearance, but the character of the capillitium with its abundant and rather straight hyaline threads is that of *P. nutans* var. *robustum*. The specimen was on dead wood; *P. leucopus* seems to be found usually on dead leaves.

P. compressum Alb. & Schw. *B.*

P. cinereum Pers. P., T.

Fuligo septica Gmel. *H.* var. *candida* (Pers.) *B.*

Craterium minutum (Leers) Fries *H., T.*

C. leucocephalum Ditm. *T.*, in great abundance, *B.*

C. aureum (Schum.) Rost. *B.*

Leocarpus fragilis (Dicks.) Rost. *P.*

Diderma floriforme Pers. *B.* A large growth on a birch log.

Diachaea leucopoda (Bull.) Rost. *H.*

Didymium difforme (Pers.) Duby. *P., C.*

D. nigripes Fries. *H.*
D. melanospermum (Pers.) Macbr. *H.*
D. squamulosum (Alb. & Schw.) Fries. *P., H., T.*
Mucilago spongiosa (Leyss.) Morgan *P.*
Colloderma oculatum (Lippert) G. Lister. This species may be included in the present list although sporangia did not make their appearance till a month later on a bit of dead wood picked up at Horderley, and and brought home because it looked " promising " for *Colloderma*; that is to say the wood was partially clothed with a layer of gelatinous green algae, associated with which *Colloderma* has several times been found.
Stemonitis fusca Roth. *P., H., B., C.*
S. flavogenita Jahn *H., B., P.*
Comatricha nigra (Pers.) Schroeter *P., H., T., B.*
C. typhoides (Bull.) Rost. *H., B.*
Enerthenema papillatum (Pers.) Rost. *H., P.*
Dictydium cancellatum (Batsch) Macbr. *B.*
Dictydiaethalium plumbeum (Schum.) Rost. *P., H.*
Tubifera ferruginosa Gmel. *B.* Abundant on birch logs.
Reticularia Lycoperdon Bull. *B., T.*
Lycogala epidendrum (L.) Fries. *H., B., C.*
L. flavofuscum Ehrenb. *H.* A large aethalium of this uncommon species was found some feet from the ground on a beech tree the wood of which was partially decayed.
Trichia affinis de Bary. *B., C.*
T. favoginea (Batsch) Pers. *H., B.*
T. persimilis Karsten. *P., B., H., T.*
T. varia Pers. *P., H., T., B.*
T. decipiens (Pers.) Macbr. *P., H., T., B.*
T. Botrytis Pers. P.
Oligonema nitens (Lib.) Rost. *B.* A single development was found on a stick lying on moist earth by Bomere.
O. flavidum Peak *B.* Found in some abundance on the under side of logs lying on wet ground at the edge of Bomere. That the logs had been recently under water was proved by the fresh gelatinous masses of the eggs of a pond-snail attached to the wood close to the shining yellow clusters of *Oligonema* sporangia. Partially submerged logs appear to be a favourite habitat for both the species of this genus.
Hemitrichia clavata (Pers.) Rost. *B., C.*

H. Vesparium (Batsch) Macbr. *B.*
Arcyria cinerea Pers. *T., H.*
A. pomiformis (Leers) Rost. *P., H.*
A. denudata (L.) Sheldon. *P., H., T., B.*
A. incarnata Pers. *P., H., B., T.*
A. nutans (Bull.) Grev. *P., H.*

PRESIDENTIAL ADDRESS.

By Annie Lorraïn Smith, F.L.S.

THE RELATION OF FUNGI TO OTHER ORGANISMS.

The subject I have taken for consideration has recently been impressed on my mind in my study of the development of lichens and of the relationship and inter-action between the fungus and the alga, the two constituents of the lichen thallus.

From the mass of material bearing on the question I have selected some of the more important facts and instances, the results of research carried out by workers on many different aspects of this subject. It is impossible to do much more than give a sketch, as the subject is a very vast one.

Fungi, as we know, are dependent on other organisms for the carbohydrates, without which life cannot be sustained. To obtain these at second hand, as it were, is their great task in life, and it has been achieved in various ways: fungi have demonstrated that there are many different methods of securing the means of subsistence.

The only sources from which organized products can be obtained are either from dead material of plants or animals, in which case the relation is harmless or saprophytic, or from living bodies, by a parasitism which is antagonistic and harmful. There is however a third possible relationship known as symbiosis or mutualism, in which the two organisms—the body yielding the carbohydrates and the fungus—are mutually helpful. One might also include the symbiosis of bacteria with the animal organism, which is

often one of great benefit; but bacteria have not been included in the present survey.

Saprophytism. The saprophytic relationship is the most simple of all. There are no special organs of absorption or excretion in fungi; the active hyphæ travel over and through the dead substances—mostly wood, leaves, &c., and are constituted to take up food material over their whole surface. By means of ferments, in which they are peculiarly rich, they break up organic compounds and thus render them serviceable not only to the fungus itself but to the other plants. This fermentative action of fungi has been made use of in many different economic processes, and was familiar to experience for long ages before science gave the explanation. Most of our field fungi, large and small, are saprophytes and of great economic importance in breaking up organic remains which otherwise would hopelessly encumber the ground.

Parasitism. Parasites and saprophytes are intimately related. Certain fungi are constantly parasitic, they are obligate parasites, while others are facultative parasites, being able to pass from one condition to the other. There is no apparent distinction between the hyphæ of the different types: in all there are branching septate filaments, and, as Zellner* has pointed out, there are no principal differences between their cell contents, though as parasitic hyphæ are in direct contact with living protoplasm, the substances they excrete may be toxic and give rise to pathological phenomena.

Interesting experiments have been made on the origin of parasitism, which tend to prove that it is an acquired habit. Ray† found, for instance, that after prolonged culture on nutritive media, *Ustilago Maydis,* underwent certain changes that lessened its power of attacking the living host plant: it reverted to the saprophytic condition. Massee‡ studied the matter from the standpoint of the host, and he demonstrated that there is some substance in the cells of the host that is attractive to its particular fungal parasite "in other words, infection is due to positive chemotaxis." By injecting a substance chemotactic to a saprophytic fungus into the cells of the host, he could induce the saprophyte to become parasitic. It has also been observed that certain fungi pass very easily from the saprophytic to the parasitic stage even in natural surroundings. Massee§ quotes an instance observed by him in *Cladosporium epiphyllum,* a

* Zellner, '10. † Ray, '03. ‡ Massee, '04. § Massee, '14.

common saprophytic brown mould: it grew on the sugary exudations from the glands of *Clerodendron fallax* leaves, then gradually passed beyond the range of the gland, forming conspicuous dead patches on the leaf. Three weeks from the time when the injury was first noted, the spores of the fungus—a series of generations having intervened—were capable of infecting any part of the leaf.

The closeness of relationship between saprophytes and parasites is also well exemplified in the fungi that live on insects. Miraude* has demonstrated the presence of glucose in the chitinous covering of insects, located more especially at the place of insertion of the muscles but also spread over the whole surface. It is this substance presumably that attracts and affords sustenance to *Laboulbeniae, Saprolegniae,* etc. The fungi of these families are true saprophytes, but a case of parasitism has been proved† against a species of the former. *Trenomyces histophthorus* in which a tube from the basal spherical cell of the fungus emerges, pierces the cuticle of the insect and feeds on the adipose tissue, without, however, doing much injury to the host.

Method of parasitic attack. The fungus spore on germination emits a tube which is a very delicate structure. The higher plants are easily protected from its attack as to the trunks and branches by layers of cork—subject however to wounds and cracks; and as to the leaves by a covering cuticle which is interrupted at intervals by stomata. The germinating fungus most frequently gains entrance through these accidental or natural openings, and after reaching the interior the mycelium develops haustoria which pierce the living cells.

Certain leaf-fungi directly enter the host by piercing the cuticle. In the case of *Botrytis cinerea* a facultative parasite of the lily, Blackman and Welsford‡ have shewn that after germination the spore tube from the side lying against the leaf produces a peg-like outgrowth which pierces the cuticle by mechanical pressure alone. The large family of Erysiphaceae and such epiphyllous genera as *Asterina* and *Meliola*§ form haustoria at intervals along the creeping hyphæ which pierce the cells of the leaf and extract the required nourishment. It is only the larger hyphæ that form these haustoria, though the finer filaments may attack the cuticle to some extent.

The position of the hyphæ within the tissue varies with

* Miraude, '15. † Chatt. & Pic., '08.
‡ Black. & Wels., '16. § Maire, '08.

each type of fungus: in many cases it is intercellular, with occasional haustoria piercing the cells: thus *Phytophthora*, the potato disease, is confined mainly to the intercellular spaces and the cell walls, while *Pythium* hyphæ enter the cells, feed on the contents and pass to others.

In many or most tree and root parasites the fungus first gains entrance by wounds. *Fomes annosus*, a root rot, enters between the bark scales and reaches the living cortex killing the parenchyma by means of ferments; it penetrates the wood and travels up to the stem through the woody elements, lateral hyphal branches entering the medullary rays and the adjoining tracheids: the cells are delignified by the fungus from within outwards, the delicate lamellae remaining for a while as a skeleton and then also disappearing. The same action on the cells is effected by *Polyporus squamosus*. Different fungi have, however, different methods of attack. Marshall Ward* found that *Stereum hirsutum* causes delignification of the wood first, while *Collybia velutipes* consumes the cellulose and leaves the lignin behind.

The injury done to the host consists in the seizing of its oxygen, water and food supply, and by means of ferments converting them into substances required by the fungus. That the ferments may be also most virulently toxic was proved by Brown† who injected certain host plants with an extract from the *Botrytis* fungus and found that it produced exactly the same effect as the living fungus: in half an hour after treatment the cells of a potato had become disorganized and the brown or black colouration shewed that the contents had been killed. The cells were macerated by the ferment which dissolves the middle lamella; but the death of the cells only takes place at a late phase of the process of disorganization of the cell walls. The extract cannot, however, dissolve the cuticle: entrance must first be gained by mechanical means. It was found that the ferment could be rendered innocuous by heat, by violent agitation or by alkalis. In a study of yeast enzymes Bokorny‡ found that these were affected by poison in the same way as protoplasm, but they are more resistant so that it was possible to kill the protoplasm and yet leave the enzyme uninjured.

Reaction of the host cell. In many cases of disease, as in *Botrytis*, the fungus is directly toxic in action and the cells are quickly destroyed. This is not however always the case,

* Marshall Ward.

† Brown, '15 & '16. ‡ Bokorny, '06.

nor typical of parasitism generally. It has, on the contrary, been frequently observed that leaves attacked by fungi become more brightly green shewing thus increased assimilation, and transpiration is generally stronger in infected than in healthy leaves. There is also frequently a certain prolonged resistance, a reaction of the host plant that indicates increase of vitality due to toxic excitation by the fungus. There may be an abnormal growth and increase by division of the neighbouring cells so that a barrier of new tissue is often interposed against the invader. Thus in the attack of *Prunus* leaves by *Cylindrosporium*, Higgins* has described how the hyphæ of the fungus, gaining entrance by the stomata, travel towards the epidermis, generally of the upper surface where a thin stroma is built up which gives rise to the spores. Meanwhile beneath the stroma there is formed by the host a layer of much swollen cells which constitute a separation layer, so that in time the part of the leaf affected breaks away at the region of these cells leaving a "shot-hole." The swelling of the cells was found by Higgins to to be due to the breaking down of the amygdalin molecule of the host cells into smaller molecules by the emulsin of the fungus thus greatly increasing the pressure. As a result of the dropping out of the affected area, the fungus secures dispersal, but the leaf also benefits by casting out the diseased portion.

Another aspect of host reaction takes the form of "immunity" of varying degree to fungus attacks. Stakman† and others consider that the success of infection, including the successful development of the parasite, depends on the degree of symbiosis between the two organisms. In plants susceptible to fungus attacks, the hyphæ grow vigorously without immediately affecting the host cells to any great extent. In resistant forms the fungus gains entrance, but the cells in the neighbourhood are at once disorganized and killed and further penetration by the fungus is entirely hindered. The degree of resistance is thus commensurate with the rapidity of action. The hyphæ eventually die off either from lack of suitable nourishment, or possibly, Stakman thinks, there may be some very definite antagonism between the cells of the immune plant and the fungus which requires further explanation. Immune plants are often varieties or strains of susceptible species, and this peculiarity, as in the case of wheat, potato and other economic plants, is of very great importance in combating disease.

* Higgins, '14. † Stakman, '15.

Hypertrophy is a very frequent result of fungoid attack. There is a great increase in cells, and these revert to more primitive forms of tissue. Galls arise and there is abnormal development of leaves and shoots. Perhaps the most familiar and striking examples are the Witches' Brooms due to *Exoascus*.

Deformations and galls are also caused by the parasitism of certain Uredineæ, cases of which were investigated by Ruth Stämpfli.* She found galls might arise on stems, leaf-stalks or leaves, in the latter, usually on the veins. The palisade parenchyma is most influenced; epidermal cells and spongy parenchyma are altered in character, but do not take much part in gall formation. Leaf-stalks and stem galls arise through the activity of similar tissues, chiefly through the enlargement and increase of the pith, of the woody tissues, and of the cambium, and to a lesser degree of the cortex, phloem and epidermis. She found that usually there is a tendency for the tissues to revert to the more simple parenchyma structure; the thickening of cell-membranes both in wood and in bast fibres is less complete, while the cortex, pith, and other parenchymatous tissues are distinctly more developed.

†Wakker also has placed on record the changes induced in the host by various parasites. He finds in all true cases of hypertrophy an enlargement of the host cells with consequent obliteration of the intercellular spaces, as also certain alterations in the contents of the cell such as colouration of the cell-sap, the formation or the disappearance of crystals and the transitory accumulation of starch grains. There is also a formation in some cases of new tissues such as in the vascular bundles of *Cruciferæ* attacked by *Peronospora,* in the meristem in the overgrown cells of *Viola odorata* and of *Zea Mays* under the influence of *Ustilago,* and the exceptional sclerenchyma formation in the stem of *Cirsium arvense,* following infection by *Puccinia suaveolens*. In other instances there is a disappearance of tissues as, for instance, of interfascicular cambium in the host plants of *Cystopus candidus,* and more or less of the cambium, phloem and secondary wood in *Rhamnus,* due to the presence of an *Æcidium*.

In *Exobasidium* on *Vaccinium,* &c., the leaf-blister is due to the enlargement of the parenchyma cells, which also become more rounded and of simpler form, a reversion to a more primitive type of structure, while specialized tissues,

* Stämpfli, '9-'10. † Wakker, '92.

such as the stomatal, bundle and strengthening, are modified or undeveloped: very rarely does hypertrophy coincide with any forward developments.

A case of parasitism so harmless to the host as to have suggested symbiosis is described by G. R. Sutherland.* He found on the marine alga, *Pelvetia canaliculata,* the fruits of *Mycosphaerella Pelvetiae* n. sp., and he traced the mycelium of the fungus permeating the algal tissues in all directions without visibly injuring the host. The fungus in this case evidently lives on the mucilage and other excretions of the loose algal tissues. It fruits on the outer rind of the algal receptacles where nutritive substances would be especially abundant and as the spores issue from the Mycosphaerella perithecia some of them germinate in contact with the escaping oospores of the alga and thus readily infect the new host plant in its earliest stages.

In true cases of symbiosis there is mutual advantage afforded by the two plants one to the other. There is a delicate balance of gain which may tip to one side or the other causing disaster to one of the two plants, symbiosis giving place to parasitism; such varying results are to be found in the root fungus termed *mycorrhiza.*

Mycorrhiza. This name was first used by Frank† to designate the fungi that in their association with the roots of the higher plants vary between parasitism and symbiosis. He distinguished two types—ectotrophic and endotrophic—according as the hyphæ were external or internal. His researches convinced him that the higher plant had become more or less dependent on the fungal hyphæ as an intermediary agent between it and the humus of the soil: recent workers have questioned the universal truth of that statement.

Ectotrophic or external mycorrhiza is specially distinctive of the *Cupuliferae* and *Coniferae* and also appears in many other trees, shrubs etc. The fungus becomes attached to the outer wall of the root near the tip and then branches and spreads, forming a complete hyphal mantle and destroying the root hairs. Some branches of hyphæ from the mantle spread over the soil or humus on which they feed, others penetrate between the epidermal cells; they destroy the middle lamellae and split apart the cells of the outer cortex. The growth in length of the root is inhibited and excessive branching is induced, leading to the coral like formation of rootlets characteristic of this type of mycorrhiza.

Though the hyphæ of ectotrophic mycorrhiza do not enter

* Sutherland, '15. † Frank, '92.

the cells, they use up the cell-sap that passes between adjoining cells. McDougall§ holds that these fungi are in the main parasitic. This view was also held by Nadson* though he agreed with Frank that while dislodging the root hairs the fungus by its travelling hyphæ had taken over the provision of water and food materials, and this is undoubtedly the case.

Endotrophic mycorrhizas penetrate more deeply into the tissues: they are intra- as well as inter-cellular. A very exhaustive account of this type of fungus as affecting *Neottia Nidus-avis* was published by W. Magnus.† In that orchid the fungus gains entrance into the roots, and branches out occupying concentric layers of cells, three to four cell rows (from without inwards), while some six rows in the rhizome and stalk may be infected. The fungus penetrates the cells by means of haustoria which branch out within the cells forming a coil round the outer wall, from which new hyphal haustoria pierce to the cytoplasm of the cell and secure nourishment. Such cells Magnus designates as host cells in which the fungus never degenerates; they occupy in *Neottia* the central cells of the invaded tissue. In the cells of the outer and inner layers, on the contrary, the fungus dies off and is digested by the host protoplasm which increases rapidly; these are termed by Magnus digesting cells. Any undigested remains of the hyphæ in these cells are balled together as excreted material and are invested by layers of cellulose. In *Neottia* there is no possibility of the fungus conveying food from the open as it is entirely endophytic, and as *Neottia* possesses no chlorophyll, it has been suggested that the outer root cells possess a power, due to the irritant action of the fungus, of absorbing carbohydrates from the humus of the soil.

Fungi are constantly associated with Orchids as endophytes, though the arrangement of host, and digesting-cells is not so regular as in *Neottia*. In some species the seeds will not germinate without the aid of the fungus in the culture: possibly some irritant is supplied.

A very remarkable case is described by Kusano‡ in *Gastrodia elata,* a Japanese Orchid. It forms tubers which require to be infected by the rhizomorphs of *Armillaria mellea,* before the plant can develop flower and fruit. As in other Orchids, there is some resistance to the entrance of the fungus in the outer zone. In a deeper layer the fungus

§ McDougall, '14. * Nadson, '08. † Magnus, '00.
‡ Kusano, '11.

destroys the contents of the cells while in the innermost cells the hyphæ are digested by the host.

Endotrophic mycorrhiza is a very wide spread phenomenon and appears in many plants both in Monocotyledons and Dicotyledons. Gallaud* who studied thoroughly this type held that the hyphæ were attracted chemically by the roots; they penetrate the outer cells of the cortex and, in the deeper seated cells, they form branching haustoria termed "arbuscules," while on the tips of the hyphæ swollen vesicles are formed which function as reserve organs or may become reproductive bodies. In some cases only occasional cells are entered by the fungus; in others every cell of the cortex may be infected; the fungus never penetrates the vascular cylinder nor does it invade chlorophyll cells. The hyphæ may be coiled round the nucleus of the cell or may have no relation with it; they pass from cell to cell but they do not destroy the middle lamellae, nor split the cells apart as in ectotrophic mycorrhiza.

A wonderful instance of mycorrhiza association has been worked out by Miss Rayner† in *Calluna* and some other Ericaceae. She found that the seeds already harboured the mycelium of the fungus in the testa so that as the seed germinated, the hyphæ infected the seedling and formed mycorrhiza on the roots; without such infection all growth ceased and the seedling died off. Infection may begin at the tip of the root by hyphæ finding their way into the cells in which is formed a tangle of fine filaments. The fungus eventually spreads over and within the whole plant—root, stem, branches and leaves—so that when the seeds are formed it is again present. It penetrates continually from the open into any part of the host with ease and, within certain cells, it forms coils of extremely attenuated filaments which are then digested and used by the host. It even invades the chlorophyll cells and though it is digested, the chloroplasts and contents also suffer disintegration.

From pure cultures of the fungus evidence was obtained that it belonged to the genus *Phoma* or to *Phyllosticta*.

In discussing the biological relations between the host and the hyphæ of endophytic mycorrhiza, Cyril West‡ recognizes three different relationships:—

1.—A real symbiosis: (A) the host provides habitation, and carbohydrates (especially starch); (B) the fungus yields up to the higher plants mineral salts absorbed from the soil, and proteids converted by it from the humus. The fungus may also fix nitrogen from the air to the benefit of the host plant.

* Gallaud, '05. † Rayner, '15. ‡ West, '17.

II.—The host plant derives the greater advantage as in *Gastrodia elata.*

III.—The fungus evidently gains most as in many of the series of endophytic mycorrhizas.

Fungi have been demonstrated once and gain as somewhat harmless inhabitants of the thallus of hepatics: they may interfere with the metabolism of individual cells but they do not seem to produce any effect on the general life of these plants. A beneficial symbiosis with mosses has however been established by Servettaz.* He made a series of cultures of mosses on artificial media, and, in the cultures of *Phascum cuspidatum,* he found present a fungus of the *Oospora* type which reacted in an extraordinary way on the development of the moss. So important was the presence of the fungus, that without it the moss did not advance beyond the protonema stage, while in control cultures which were associated with the fungus, the stem had, during a similar period, reached full growth. Servettaz ascribes the advantage as due to gases produced by the fungus along with acid products formed by it from the glucose of the nutritive medium.

Lichen symbiosis. The most complete case of a living association between fungi and green plants is to be found in the large and varied class of lichen plants in which is represented a successful instance of mutual give and take between the two components, algae and fungi. Lichens as a well marked and recognizable group of plants have been known and classified from the early days of botanical study side by side with other divisions of the vegetable kingdom, though their exact relation to other groups was long a puzzle to systematists. Many workers had recognized the extraordinary likeness of the lichen plant to algae on the one hand and to fungi on the other, but it was Schwendener who about sixty years ago had the courage to announce the dual hypothesis, that two different organisms were combined in the lichen thallus. This theory, much combated at first, has been gradually accepted by lichenologists, and the controversies which never cease to rage round lichens, now centre on the relation between the two symbionts, the alga and the fungus. It is here also a question of nutrition, and of the mutual adaptation of the two associated plants to their composite existence.

It has been strongly held by some that the association is one of parasitism or semi-parasitism and that the fungus

* Servettaz, '13.

reaps most benefit from the alliance, since the carbohydrates so necessary to the continued life of the hyphæ are always being prepared and yielded up by the green cells which are eventually destroyed, with but little compensating advantage at any time. There is however a very delicate interchange of food material going on between the symbionts, it is not a simple tale of mere plunder. Pure cultures of allied algae and even of lichen gonidia—the term applied to algae within the lichen—have been made by various workers, and they have proved, that on certain substances such as vegetable acids, the green cells can live and thrive and form not only carbohydrates but even chlorophyll in the dark, and in the absence of carbon dioxide. Such substances as well as nitrogenous material are supplied more or less abundantly through the agency of the lichen fungus and contribute to the support of the algal partner, though the first and most fruitful source of carbon supply must be through the natural channel of assimilation from the atmosphere.

Lichen Algae and Fungi, and their method of association. Lichen Fungi belong to the Ascomycetes, with the exception of a few Basidiomycetes which form lichens in tropical countries. Lichen hyphæ are filamentous, branched and septate with apical development and frequently with thickened gelatinous walls, which absorb and retain moisture.

The algal cells or gonidia belong to the aerial Myxophyceae or Chlorophyceae, and are one-celled organisms or at most shortly filamentous. They increase within the lichen plant by cell-division or by sporulation, though in free conditions reproduction may be by zoospores.

The Myxophyceae or blue-green algae are mostly distinguished by their colouring and by the gelatinous cell-sheaths: the hyphæ as a rule permeate the sheath, leaving the cells intact. This type of contact prevails in *Gloeocapsa* and allied algal forms; in *Rivularia, Scytonema* and *Stigonema* algae which grow in tufted filaments, the hyphæ travel along their sheaths sharing in the apical development of the alga and the lichen formed is, like those algae, of tufted form. *Nostoc,* a coiled filamentous form, yields abundant mucilage which, in Collemaceae, is threaded by the lichen hyphæ. Certain cells of the *Nostoc* chain, however, were shown by Bornet to be attacked and entirely destroyed by the fungus, thus breaking the chain to short lengths which continue a healthy existence.

In the Chlorophyceae, which are mostly non-gelatinous,

the relations are naturally somewhat different. The filamentous forms are represented in one genus by *Cladophora* in others by *Trentepohlia*. The latter alga has frequently thick corrugated walls. In the lichen *Coenogonium*, which contains *Trentepohlia*, the composite structure is filamentous; the fungus either travels alongside the algal strands or surrounds them by a hyphal network. Growth is apical and considerable development in length may be attained; the fruits which—as in all lichens are fungal fruits—arise laterally on the strands which are thus vitally active well back from the growing point, the alga as well as the fungus maintaining all along a healthy existence. In other genera, such as in *Graphideae*, the *Trentepohlia* filaments are broken up and they lose their distinctive form and colour, but if they reach the open they at once resume their normal filamentous growth.

In *Graphideaæ* indeed the symbionts are mutually dependent to a striking degree: they lead but a meagre existence until contact or even mere association is established, when each partner is seen to take on new vigour. There has been no record of parasitized *Trentepohlia* cells.

The great majority of our familiar lichens are associated with *Protococcus* or closely allied species, the algae that in damp conditions cover stones, palings and trees with a cheerful green. The region of growth in lichens is at the edge of the thallus and there, as the hyphæ extend and branch, active cell-division goes on in the algal cells. These, as a general rule, are herded into a narrow zone beneath the upper cortex, where conditions are most favourable for photosynthesis. A section through this zone shews an abundance of green cells, some in the stage of increasing. Existence may be, doubtless is, restricted, but does not seem to be particularly unhealthy and interchange of food-stuffs must be constant between the symbionts. It has, however, been observed once and again by various workers that certain algal cells may be disturbed if not destroyed by the fungus.

A projection or haustorium from a fungus hypha may pierce the outer wall of the alga; the attack frequently excites the alga to prompt cell division, which by this means becomes free from the haustorium. In other instances, however, the haustorium penetrates to the centre of the cell, branches inside and destroys the contents. Elenkin, a Russian Botanist, claims to have proved by his researches and experiments, that such destruction of algal cells goes on to a very large extent at the lower side of the algal zone. He found in that region so many empty and destroyed algal

cells that he called it a 'necral zone'; Elenkin therefore rejects the symbiotic theory and looks on the association as one of modified parasitism.

While not rejecting Elenkin's facts, we would point out the necessary decay of all living organisms, when vitality becomes exhausted. The fungus in the lichen thallus suffers loss in the superficial layers owing to the wear and tear of life, and these losses are compensated for by new upward growth from the gonidial region. In the same way the lower algae have been gradually pushed down to positions further away from the light: they may have reached and passed their maximum of vitality and there is no doubt that decaying algae would promptly be used up by the hyphæ as food. That cells in the close grasp of the hyphæ remain active and healthy is abundantly proved by soredial development. Soredia consist of one or more algal cells generally completely invested by actively growing thin-walled hyphæ. Each one is a lichen thallus in miniature: it represents a budding off from the parent plant of the two constituents. At certain areas of some thalli, breaks occur in the cortex and soredia like a white powder escape into the open. They are scattered and vegetatively reproduce the lichen; in many species they are the chief form of reproduction, both the symbionts being ready for active increase.

We conclude therefore that in lichens there is a true symbiosis or mutualism, by which the fungus has acquired so much vigour, that a whole new class of plants with well-defined peculiarities of structure and of cell products have been evolved. The alga has been less affected than the fungus, but it has gained in capacity of endurance against time and against unfavourrable conditions, impossible without the shelter of the thallus and in some cases has attained to much greater size as in the *Stigonema* of *Ephebe* or the *Trentepohlia* of some species of *Coenogonium*.

The conception of symbiosis is familiar to us in many different cases, and fungi have adapted themselves to that mode of life with very considerable success, all the more easily that they do not make large demands for sustenance: they are able to live on an extraordinarily meagre diet, and with the possible exception of resting spores and stromatoid formations, they make no provision for storage. They are the happy-go-lucky members of the plant kingdom which yet have their appropriate place and function, though at times driven by some need to become predatory and therefore enemies in the plant society.

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LICHENOLOGY, A NEW DEPARTURE.

By A. Lorrain Smith F.L.S.

The question of adding Lichenology to our field of activity has been mooted several times, and after a short discussion at a recent meeting of members, it was decided that there was good reason for extending and enriching the scope of our work by associating the study of lichens with that of mycology.

There are numbers of 'fungi-lichens' or 'lichen-fungi' just on the border-line between saprophytism and symbiosis with algae, and much careful and exact work is waiting to be done on these species out in the field and in the laboratory, by some one acquainted with both fungi and lichens. There is also a very large flora of the smaller fungi parasitic on lichen thalli which will mainly be discovered and recognized by the student of lichens. A descriptive list of these was recently published in the Bulletin de la Société Mycologique de France Vols. xxviii.—xxx (1912-14) by the deeply lamented Abbé Vouaux, who was wantonly done to death by the Germans in the early stages of the war.

The great bar to the study of lichenology in our country has been the lack of suitable text-books, that lack will be, I hope, made good very soon. A general text-book on Lichenology is ready and awaits publication. The Monograph of British Lichens is now completed and a guide-book somewhat on the lines of Hayward's pocket flora is in an advanced stage of preparation. The two latter works are being published by the Trustees of the British Museum. It is earnestly hoped that these books will appeal to natural history students and will make the science easier and more attractive. It will be possible to appoint in the early future a member of our Society who will act as general referee for lichens.

OBSERVATIONS ON THE BIOLOGY OF SOME SAND-DUNE FUNGI.

By E. M. Wakefield F.L.S.

The following notes were for the most part made during July 1917, on some species of Agarics found growing on sand-dunes near the village of Oxwich, on the Gower coast, South Wales. Very little work has been done on the fungus-flora of sand-dunes, though Wheldon's list of the fungi of the Lancashire dunes* shows how surprisingly large this fungus-flora may be. It has been thought worth while to place these few observations on record, as offering some suggestion as to the means by which delicate Agarics manage to exist in what is apparently so unfavourable a habitat.

Psilocybe ammophila Mont.

This species, which is absent from Wheldon's list, occurs abundantly on the Gower dunes in the summer months, after rain. It grows on the exposed slopes of high dunes, usually about the tufts of Marram grass (*Ammophila arundinacea*). When dug out the stem appears to be clavately swollen below, and continued downwards as a tapering, rooting base. As a matter of fact the stipe itself is of equal diameter throughout, as may be seen in a vertical section, and it terminates abruptly an inch or so beneath the surface of the sand. The apparently clavate lower half, and the long root-like base are due to a weft of fine hyphæ mixed with particles of sand, which surrounds the buried part of the stem, and is continued downwards as a gradually tapering cord. This cord, however, is very different in structure from an ordinary mycelial cord. Consisting merely of loosely interwoven hyphæ, the interstices being filled with sand, it is extremely fragile, and hence difficult to trace to its point of origin.

After many attempts to dig out the underground portion of the fungus, I was at length able to satisfy myself that it is always connected with buried, decaying leaves of the Marram grass. Only occasionally, however, does it

*H. J. Wheldon in Lancash. and Chesh. Naturalist, 1914.

arise from a single leaf. It may do so if the leaf is near the surface, in which case the sandy cord is seen to be directly connected with a weft of hyphæ mixed with sand particles which surrounds the dead leaf. In the majority of cases the points of origin are more deeply seated. The " root " tapers to about the thickness of medium twine, and then, if great care has been taken in excavating, is found to fork or branch repeatedly. It is as a rule impossible to trace the ultimate ramifications on account of their fineness and fragility, but in a few cases I was successful in tracing a branch to a dead Ammophila leaf, which was covered by a fine weft of hyphæ. It appears therefore that the mode of nutrition of *Psilocybe ammophila,* though on a much smaller scale, is similar to that of *Collybia platyphylla,* in which a single sporophore is connected by a complicated branching system of underground cords with various decaying twigs, leaves, etc.

Geopyxis ammophila Sacc. of which an interesting description was published by Trail in the Annals of Scottish Natural History, 1893, pp 37-40, is probably similar in its mode of life. This species was noted by Trail to have an elongated " rooting stem," which is exceedingly fragile. In this case the grass with which it was associated was *Elymus.*

Coprinus Friesii Quél.

Another interesting Agaric found in July was a small species of Coprinus, apparently *C. Friesii* Quél. This occurred in one of the numerous hollows in these dunes which are liable to inundation at spring-tides from the overflowing of a small stream. In the bottom of such hollows the only phanerogamic vegetation is usually *Juncus maritimus* with occasional plants of *Glaux maritima.*

The Coprinus grew gregariously in patches, on the slopes of the tiny sand-hillocks formed round the tufts of *Juncus.* At first sight it appeared to be growing from the sand, but on investigation it was found that the clusters of fruit-bodies always arose from the dead stems of the *Juncus,* exactly at the surface of the sand. Hitherto I have only found this fungus on one occasion, which was on the day after a whole day's rain. The sand beneath the surface and the buried *Juncus* stems were saturated with moisture. On returning to the same spot a few days later, after a dry interval, I was only able to see a few shrivelled fruit bodies.

This fungus agrees well in macroscopic characters and in habitat with Quélet's original description of *C. Friesii;* it also agrees in micro-characters with Lange's description in his monograph of the Coprini of Denmark and with the

description of *C. tigrinellus* Boud., which is said to be very close to *C. Friesii*. Quélet described *C. Friesii* as growing on dead but still erect stems of grasses. Lange finds it typically on dead grass, and also a form on dead *Phragmites* straw, and another form on bits of straw from horse-droppings. *C. tigrinellus* Boud. grew on dead erect stems of *Carex*, and has been recorded in this country both on *Carex* and on *Juncus*.† All these forms thus agree in growing on dead erect stems of grasses, sedges, or rushes, in damp places. They agree closely also in macro- and microscopic characters, the chief point distinguishing *tigrinellus* from *Friesii* being that the flecks on the pileus are deep brown instead of white. As in my specimens the colour of the tomentum varied from white to rust-brown, it seems probable that *C. tigrinellus* and *C. Friesii* are hardly specifically distinct. The name Friesii is used as being the earlier.

Bolbitius tener Berk. and *Galera rubiginosa Fr.*

In the same hollow where the *Coprinus Friesii* grew, there occurred two small brown-spored Agarics, *Bolbitius tener* Berk. (distinguished from the more common species of Bolbitius by its white and less fragile pileus), and *Galera rubiginosa* Fr.

These grew directly from the sand, and were not connected in any way with any phanerogamic plant. In the course of digging up some specimens it was noticed that the top layer of sand came away easily as a flat crust about $\frac{1}{8}$in. in thickness. The fungi had no rooting base, the stipes ending abruptly in this upper crust of sand. Closer examination showed that the crust was slightly tinged green, and it was subsequently found that this colour was due to innumerable minute algae with which the sand was permeated. The algal layer consisted mainly of a species of *Oscillaria*, but a few unicellular green forms were also present.

These two species of Agarics, therefore, must have subsisted practically entirely on the small amount of humus derived from the algal crust. The Galera grew gregariously, in considerable quantity. *Bolbitius tener* was also represented by a number of specimens, but was not so abundant as *Galera rubiginosa*.

Inocybe dulcamara Fr. and *I. eutheles* B. and Br.

In the "slacks" or damp hollows of the dunes, and on dune-pasture, where phanerogamic vegetation is more

†Naturalist, 1908, p. 320.

abundant, the presence of Agarics is less difficult of explanation. Where there is a close carpet of grass, with other small flowering plants, mosses, liverworts, etc., there is necessarily a fair amount of humus mixed with the surface layer of sand. Consequently a number of species of fungi are to be found in such habitats. At the time these notes were made, in July, the most abundant species in the "slacks" was *Inocybe dulcamara* Fr. It grew for the most part on the ground beneath *Salix repens*, but specimens also occurred amongst the short grass in the open and in this position showed certain distinct variations, no doubt due to their greater exposure to light.

Specimens growing under the dwarf willow averaged about 1¼in. in diameter, but were occasionally larger. The rather fleshy pileus was tomentose-squamulose (not squarrosely scaly), and of a uniform rich tawny colour. When growing in the open the stem was shorter and the pileus smaller and more tough. The pileus of the sheltered specimens was practically always hemispherical and scarcely umbonate, whereas specimens in the open were more distinctly umbonate, and when old often showed an upturned margin. Furthermore, the tomentum, especially about the umbo, was in the exposed individuals aggregated to form little squarrose scales, of a distinctly darker brown than the margin of the pileus. These scales often eventually became rubbed off, leaving the pileus almost smooth and innately fibrous or strigose. Along with these external differences, a slight spore-variation was noticeable in the exposed specimens. In these the spore was inclined to be more obovate, or even somewhat triangular in shape, whereas in the sheltered specimens it was regularly elliptical. It is interesting to find such variations correlated with a distinct difference of exposure. In other respects, as to general aspect, absence of cystidia, type of gill edge, etc., the two forms agreed exactly, and were obviously variations within one species.

A single collection of *Inocybe eutheles* was made in the same situation, under *Salix repens*, but *I. rimosa*, which Wheldon notes as being abundant on the Lancashire dunes, was not present, at least at the time when I was able to examine the Gower dunes.

There is no doubt that if sand-dunes were examined thoroughly at all seasons of the year their fungus-flora would be found to be surprisingly rich, and much might be learnt as to the adaptation of species to these unpromising conditions.

ON THE METHOD OF GROWTH OF THE CONIDIAL CLUSTERS OF TRICHOTHECIUM ROSEUM.

By Jessie S. Bayliss Elliott, D. Sc. Birm., B. Sc. Lond.

On examining a dense mass of Trichothecium roseum which had been growing for some months on decaying vine leaves in a moist chamber, I came across what at first I thought was an abnormal method of conidia formation.

Crowning the tops of most of the conidiophores were dense racemes of conidia, more or less pendulous (fig. 1a), instead of the usual clusters (fig. 1b); some of the racemes were as long as the erect hypha bearing them.

The conidia were not inserted on an axis as anticipated but each conidium except the terminal one was attached to two others and thus a long raceme-like chain was formed (fig. 2).

The method of growth is peculiar and is basipetal; each conidium including the first arises obliquely (fig. 3a) sometimes even horizontally at the apex of the conidiophore, this is cut off from the conidiophore by a cell wall, and beneath the cell wall the hypha swells out into another conidium also obliquely placed and opposite the other one, but still attached to it (fig. 3b) and in its turn, it becomes cut off and so the process continues (fig. 3), conidia one after another in a close spiral being produced by the swelling out of the apex of the conidiophore; and thus a chain is produced in which each conidium is attached to two others, and of which the terminal conidium is the oldest, and the one the most recently formed is at the top of the hypha.

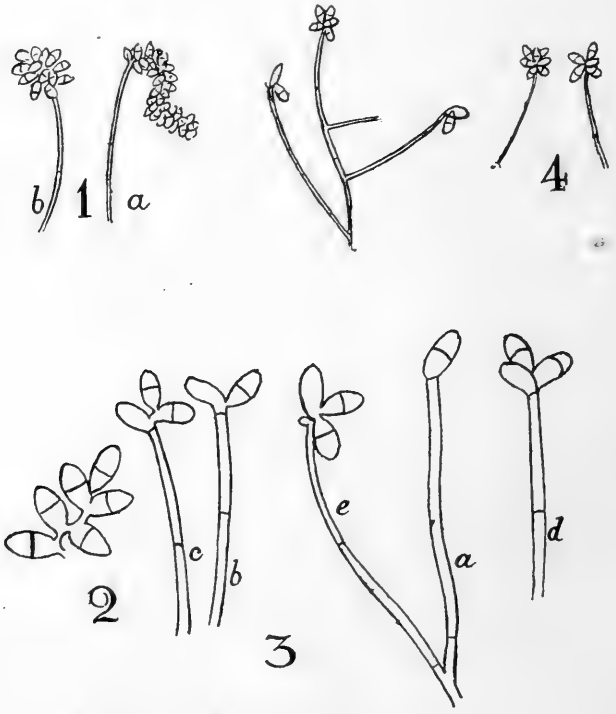
The various stages are easily followed in a small culture made in a hanging drop.

Under ordinary circumstances only a very short raceme or chain is produced, and this has evidently been mistaken for a head of conidia, because the conidia are very crowded together; but it has the same basipetal method of formation and the conidia are not inserted as they are usually figured—at the same level on the top of the conidiophore.

Under the favourable conditions of growth in a still, warm, moist, covered culture chamber instead of the usual small cluster of conidia or apparent head, a long pendulous structure is formed.

Grove* considers that *Cephalothecium roseum, Trichothecium roseum, T. candidum, T. obovatum, C. candidum* are varying states of one's species, and I am of the same opinion, but he further mentions Harz's suggestion that the genus *Arthrobotrys* also is only a more highly developed form of *Trichothecium* and that if so *Arthrobotrys superba* and *A. oligospora* and *A. rosea* are also other states of the same species: with the latter suggestion I do not agree since the conidial chains formed by the above described basi-petal mode of growth could hardly lead to the formation of the nodal conidiophore of Arthrobotrys.

* Grove: New or Noteworthy Fungi, part IV., Journal of Botany, 1912, p. 14.



EXPLANATION OF FIGURES.

1. a, Pendulous cluster of conidia, × 65.
   b, A head of conidia—the usual form, × 65.
2. Part of pendulous cluster, showing attachment of conidia to one another, × 800.
3. Conidiophores showing basipetal method of conidia formation, × 800.
4. Young conidiophores with small clusters of conidia, × 800.

ON TWO-SPORED BASIDIA AND OTHER MATTERS.

By A. A. Pearson, F.L.S.

During the last two years I have had occasion to examine the microscopic characters of a large number of Hymenomycetes. My observations have chiefly been made on the Agarics, and of course have not been exercised over sufficiently long a period to permit of any conclusions of a general character. I find, however, that so few students of the larger fungi trouble about the microscopic details of these organisms, that the observations I have made may be found interesting. There is curiously little of a concrete character to be found in the fungus floras, and new species of Agarics have been made even in recent years without any particulars of a microscopic character other than spore measurements being given.

It would of course be wrong to suggest that such studies have been entirely neglected. Mr. Cotton in his 1913 Presidential address to this Society gave us some useful information on this score. Among French mycological works, those of Patouillard are justly esteemed, and his " Hyménomycètes d' Europe " and his later and completer " Essai Taxonomique " are evidence of a profound study of the larger fungi, but even recently it was not very evident that such studies were being made use of by systematists. In such a modern work as that of Messrs. Bigeard & Guillemin, the second volume of which was published in 1913, we find the most meagre and frequently incorrect microscopic details given, spores being measured by length only, as copied from Quélet for the most part, and no mention being made of the cystidia which, I have no hesitation in saying, will be of considerable help in the elucidation of many groups which up to the present have been imperfectly studied. Perhaps it is hardly fair to mention this work, which is supposed to be of a popular character. However, in spite of the pioneer work of their compatriots, only recently have the French appreciated the need for using the microscope more extensively in the taxonomic studies of the Agarics, and the admirable and indeed almost too elaborate notes of Monsieur René Maire

in the "Bulletin de la Société Mycologique de France" are doubtless the beginning of a more thorough revision of this large order of Fungi. We are all looking forward to Monsieur Maire's promised monograph of the genus Russula, the general lines of which he laid down some time ago. The completion of such work is reserved, we hope, for better and happier days.

Patouillard published his "Hyménomycètes d' Europe" in 1887 and his "Essai Taxonomique" in 1900, but neither of these contains any description of species. As far as I know he has not published any monographs of the kind which mycologists are pining for. I picture Patouillard as snowbound in a vast accumulation of mycological notes from which he cannot escape. He amuses himself by throwing out a few notes on foreign or extra-European species, which are published by various journals, but which nobody reads. The perfect systematic work on European Hymenomycetes which might have been written by him is left for some future worker to produce.

Turning from France to Germany, Dr. J. Schroeter published the first volume of "Die Pilze Schlesiens" in 1889. This first volume contains the Hymenomycetes. It is so very rarely mentioned by British mycologists when dealing with Agarics, that it is only just to call attention to it as the beginning of what could be done on a larger scale. Unfortunately it contains comparatively such a small number of species of the larger fungi, that it cannot be considered as much more than a general sketch of a new classification with numerous detailed examples. It is therefore of very little practical value for general use to-day. Many of the commonest species are missing, and such a large genus as *Russula* only contains 33 species, divided between white spored and yellow spored, the latter being placed in a separate genus—*Russulina*. Schroeter was evidently as bewildered as we are when faced with the necessity of giving systematic coherence to the *Russulae*. Many other genera are equally sketchy, and his specific names are maddening, but on the other hand we have good macroscopic and microscopic description of many species, doubtless of those he had examined himself, and he gives very careful and, as I have found, reliable measurements of the spores and cystidia, although I doubt whether measurements of cystidia are of any use—it is important to know if they exist and what their shape is, or if they project beyond the basidia. Schroeter made a feature of the cystidia or sterile projecting cells on the gill edge.

I have not consulted other German works; doubtless there are many books and papers scattered among the botanical literature of the world which, if properly correlated would add to our specific knowledge of the Agarics. One of the features of the first number of our transactions in 1897 was a list of recent foreign mycological publications in the form of short notices. I would like to see this feature revived and extended; it would be a useful guide to students.*

When we come to the English works on the Agaricaceae, I find very little microscopic detail given. There is of course Massee's monograph of the genus *Inocybe,* which is indispensable to all who would identify the species of this puzzling genus, although one frequently meets with species that do not fit into his framework. It is, however, a basis for future workers and that is what is so badly wanted. Fortunately we are likely to get it from the Danish mycologist, J. K. Lange,† who has published in English three booklets during the last three years, the first containing microscopic particulars of the Mycenae of Denmark, the second dealing with the genera *Amanita, Lepiota* and *Coprinus,* and the third with *Pluteus, Collybia* and *Inocybe.* Mr. Lange's English is rather quaint. For instance, he describes his work as supplying a "documentary fundament" to the study of the agarics; but in spite of these occasional lapses he writes with clearness, and I hope we shall appreciate the compliment he pays us in writing in our language. I must leave to others more competent to judge as to whether Mr. Lange's specific determinations can be relied upon. If they can be accepted as correct, I have no hesitation in saying that his work will be of enormous assistance towards the elucidation of the Agaricaceae. His tables of spore figures are especially to be commended. The shapes of spores reproduced with the same relative magnification are very helpful and may sometimes be decisive in identifying a species. Spore descriptions in the old works are often too vague to be of any value. Such a word as "elliptical" is used for a variety of shapes. Massee used the description "pip-shaped" in a somewhat indiscriminate fashion. The spores of most species present some differentiating feature. When growing under natural conditions these features are fairly constant. Small differences do exist, but are not of material importance. A

*Mr. Ramsbottom has, during the last few years, dealt fully in our Transactions with the cytological papers which have appeared in the different countries, and we all hope he will be able to continue his fine work.

† Published by Dansk Botanisk Forening, Copenhagen.

careful drawing of the spore is therefore of considerable taxonomic value.

Amongst other valuable data given by Lange, he points out that several species of Mycenae have two spored basidia; for instance *Mycena galericulata, lactea, gypsea, Adonis, filipes*, and many others.

I have not been able to confirm many of these yet, but I have no doubt that we could add considerably to the list. For instance, what I believe is generally accepted as *Mycena metata* has 2-spored basidia. In this connection I came across an interesting note among some delightful coloured sketches of Mycenae made by Miss Ivy Massee. The note was written by the late Mr. George Massee in his own characteristic handwriting and referred to a specimen of Mycena named by Berkeley as *metata* which had 2-spored basidia. Lange gives 4-spored basidia to this species, but says that a 2-spored form had been met with in some cases. He also mentions that he found one specimen of *Mycena rorida* with two spored basidia; the specimens of this species which I have examined have all had two spored basidia, which brings me to the question whether this feature is a sufficiently stable one to justify its use for the purpose of identifying or helping towards the identification of a species. We know that in some sections of the Hymenomycetes, the character of the basidium is very unstable. The resupinates are remarkable in this respect, as Miss Wakefield has shewn us in her descriptions of British species and Bourdot & Galzin in their splendid contributions to the transactions of the French Mycological Society.

Mr. Rea has told me that he knows of no paper shewing that species of 2-sterigmata have continued through a succession of pure cultivations in producing two sterigmata only, and that four sterigmata species do not occasionally deteriorate or progress to this condition. I do not quite appreciate his view of the need for pure culture experiments in a matter of this kind.* My own experience, however, partly confirms his healthy scepticism. I have in fact observed that certain species are found sometimes with two, sometimes with four sterigmata. *Naucoria semi-orbicularis* is of this type; so is *Galera hypnorum*. I am a little doubtful, even, about *Mycena galericulata*. Patouillard gives a sketch of the two spored basidia of *Mycena galericulata*

* Curious changes may take place under cultivation which are an unreliable guide to what happens in nature. A case in point is the cultivated mushroom, that tasteless product of richly manured soil in dark cellars. This is supposed to be a variety of the field mushroom (*Psaliota campestris* (Linn.) Fr.). The latter has normal quadrisporous basidia, but the cultivated variety (var. *hortensis*) usually has basidia with two sterigmata only.

var. carneifolia in his *Tabulae analyticae Fungorum* and queries whether the two spored basidia are found in the other varieties. However, I think the genuine Mycena galericulata has 2-spored basidia and those we find with 4-spored basidia belong to some other species. For instance, the so-called variety *calopus* is not a variety at all, but a distinct species and we should call it to-day *Mycena inclinata*. Then there is at least one small species of *Coprinus* which has two spored basidia but seems to vary the monotony of life by producing basidia with 3 and possibly 4 sterigmata. On the other hand certain species would appear consistently to have basidia with two sterigmata. One of the groups of *Nolanea* which we have been in the habit of lumping together under the name of *pascua* has two spored basidia. Schroeter has described a Nolanea under the name *Hyporhodius cetratus*, the basidia of which, he says, have two long awl-shaped sterigmata. This may be the same species as the one I have so often examined and which there can be little doubt is the genuine *pascua* of Persoon & Fries. A species of *Naucoria* which appeared frequently in various places on Wimbledon Common within the last two years always has two spored basidia. I have examined numbers of this species and always with the same result. A similar remark applies to *Pholiota pumila*, and also to a species of *Galera* which grows on cultivated ground manured with cow-dung. I have been calling it *Galera antipus* but I have only found two specimens with the long fusiform base which gave this species its name. Then there is a viscid species of Mycena belonging to the *epipterygia* type which is sometimes met with in pine woods. It grows rather plentifully in the pine woods of Oxshott and St. George's Hill, Surrey. This always has two spored basidia and the spores are different in shape and size from *Mycena epipterygia*. It is probably a distinct species.

Now it seems to me that if after repeated examination of specimens gathered from different places it is found that a species always has two spored basidia, it is desirable to mention this feature in the description, and it will be found a valuable aid for identifying the species. After all, Schroeter, who was certainly a most competent mycologist, considered this feature alone as a justification for a new genus of *Clavariaceae*. Species familiar to us as *Clavaria rugosa, cinerea and cristata* are called by him *Clavulina rugosa, cinerea** and *cristata*, because they all

* Patouillard gave a figure of the two spored basidia of *Clavaria cinerea* in his Tabulæ analyticæ.

have 2-spored basidia. Not that this appeals to me very strongly; as a worker in the field I do not fancy the use of microscopic characters for marking off genera unless they are accompanied by macroscopic distinctions as well. It is pleasant to be able to say unhesitatingly that this is an *Inocybe* or that a *Clavaria* and so on. However, I am afraid that the field men will have to retire before superior forces when an open-air mycologist like Mr. Rea shews a desire to adopt Schroeter's genus *Asterosporina* for the rough spored *Inocybes*, and Patouillard's *Androsaceus* for the filiform *Marasmii* with warted cystidia on the pileus, which are by no means easy to observe in all cases.

But I must not enlarge further on this subject.

In this short paper, I have only dealt in a concrete manner with a comparatively unusual feature in the Agarics. I have found that two spored basidia are not often met with except among the smaller species. The large fleshy agarics under natural conditions do not appear to produce any but 4-spored basidia: I am of course only referring to the genuine agaric; among the Cantharellaceae, basidia with a varied number of sterigmata are not uncommon, but among the Agarics proper the 4-spored basidium is the normal arrangement. Lange has shewn that this normal arrangement is departed from in certain species of the genus *Mycena*. He has used this feature, together with the still more useful phenomenon of the cystidia on the gill edge, to construct a key which enables one to identify the Mycenae of his native country, and he is preparing similar keys for other genera. Every mycologist is aware of the difficulty of running down small specimens of Mycena and Galera. They are as often as not put aside as impossible to identify with sufficient accuracy to make it worth while troubling about them. Doubtless many species are not recorded—one might almost say they are not recordable in macroscopic terms only, except perhaps by the use of a group name. The relative differences cannot be described with sufficient clearness to distinguish them, although one may carry the distinguishing points in one's eye. If it is proved that microscopic features are of some assistance, we many find that the maze of descriptions of appalling similarity can be supplied with guide posts which will put us on the road to the correct identification.

I have endeavoured to give you a glimpse of my initial efforts in the microscopic study of the smaller agarics. In addition to the authors cited, I have been helped by

Professor Buller's illuminating biological studies and by the unfailing kindness and severely critical attitude of our hon. secretary, Mr. Carleton Rea. I have also been helped by the use of an unusually high-powered eye-piece (Orth. Ok n. Kellner F=15.) which I obtained last year for my microscope. This has enabled me to observe the gill both in section and on the flat face without exercising as much skill as is expected from the professional microscopist. Fine razor sections are rarely necessary. The gill when observed on the flat will be seen to have a regular spacing for the spores, either like a series of double-four dominoes, when the basidia are quadrisporous, or they will be spaced in pairs when the basidia are bisporous. In most species there is no difficulty in making the observation. In some, however, the basidia project so little and the spores are so transparent, that a section must be made. Rough sections are usually sufficient, and no cover glass need be used. It is better always to make the observations both on the flat and in section, thus avoiding the chance of errors. The use of the high power eye-piece combined with a low-power objective enables one to make observations quickly. This is essential with the small fleeting Agarics. I have never used this eye-piece for measuring spores or cystidia but only for observations on the naked gill. When the high-power objective is used, as it must be for measuring spores, one can get clearer definition with a less powerful eye-piece.

The advantage, however, of using a low powered objective is that one can get better illumination and look at the gill in the natural state without making fine sections or distorting the fibres with a cover glass. Such observations are confessedly imperfect and possibly of only very restricted scientific value. They are better than nothing, and as they are within reach of people without laboratory training or experience, it seems desirable to encourage them. For it is important that field mycologists should use the microscope more than they do; it adds so enormously to the interest and value of their work. What a revelation it is for instance to see the horned cystidia of *Pluteus cervinus* or the spacing pegs of many of the Coprini. A knowledge of the existence of cystidia gives a new meaning to the fringe of colour seen so often on the gill edge and leads one to think they may be organs of excretion or transpiration. Other kinds probably have a totally different function. In fact endless biological problems are open to the student, who need not be repelled by the thought of the mysterious methods of the professional worker, with his acquired skill in cutting sections and using staining agents.

Mr. Rea has pointed out that no mention has been made of René Maire's "Recherches Cytologiques & Taxonomiques sur les Basidiomycètes," published in 1902. This is an omission that should certainly be rectified, and on again looking through this masterly work, I find several interesting points bearing on the matters dealt with in the foregoing paper. Maire proposes a new classification of Basidiomycetes based on the more intimate characters of the cell: on the transverse or vertical position of the kariokinetic spindle. Such studies are beyond the reach of ordinary busy mortals like myself and are hardly likely to form an acceptable basis for classification.

Maire creates a new genus, the outstanding feature of which is that the basidia are uniformly bisporus. Hygrophorus conicus and Hygrophorus ceraceus are transformed into *Godfrinia conica* (Scop.) R. Maire, and *Godfrinia ceracea* (Wulf.) R. Maire. Thus we are shewn another group of Agarics where this phenomenon asserts itself.

Maire also studied *Mycena galericulata,* and compares his observations to those recorded by Wager in 1894, but the Mycena galericulata described by Maire has 4-sterigmata, and we are left wondering whether this is the same species as studied by Wager.

As I have touched upon Schroeter's new genus *Clavulina,* I ought to mention that according to R. Maire's observations, it would appear that the basidia in *Clavaria rugosa* are not uniformly bisporous. Maire writes:

> "Le nombre de stérigmates est typiquement de quatre, mais ce cas se trouve rarement réalisé et la plupart des basides ont deux stérigmates, d'autres trois, d'autres un seul."

I should have said that under the circumstances the basidia are typically but not uniformly two-spored. Presumably Maire adopts the view that the perfect or typical basidium has four sterigmata and that it is in the nature of things that all basidia should strive after perfection which some fail to attain.

Another work which every student of the Agarics should consult is the *Prodrome d'une Histoire Naturelle des Agaricinés* by V. Fayod, which was published in the Annales des Sciences Naturelles, 1889. He points out that basidia with two sterigmata are rare, but they are a characteristic feature of *Hygrophorus agathosmus, Hygrophorus conicus, Mycena tenerrima, Tubaria conspersa* and *Pholiota togularis.*

NEW OR RARE MICROFUNGI.

By A. Lorrain Smith F.L.S., and J. Ramsbottom M.A., F.L.S.

Mr. Ramsbottom's departure for Salonika to assist in the military hospitals has prevented him from joining in the final revision of these pages for the press. As in previous years we have to thank Mr. D. A. Boyd for the very valuable material he has sent. The new genus of Discomycetes, *Discocera,* was discovered by W. Watson while collecting lichens. Our special thanks are due to him for sending us such an interesting plant.

PHYCOMYCETES.

Rhizophidium acuforme (Zopf) Fisch. Rabenh. Krypt. Fl. I. 4, p. 93, 1892.

Sporangia of the host cell sometimes seated on stalks, often crowded in groups of 1-10, globose or lemon-shaped 6-16μ diam., with a short apical papilla, and at the base, a slender branched minute rhizoid. Zoospores minute, 2μ in diam., globose, with minute oil-drops and one cilium. Resting spores smaller than the sporangia, globose, with a large oil-drop almost filling the cells.

On *Chlamydomonas intermedia* in a cart-rut at Harborne, April 1917. Coll. W. B. Grove. (New Phytologist xvi. pp. 177-80 (1 fig.) 1917).

PYRENOMYCETES.

Melanospora lagenaria Fuck.

Already recorded for Britain (Trans ii. p. 93, 1905). It has been found by D. A. Boyd at Eglinton, Ayrshire, Aug. 1917. The perithecia are mostly in groups; the spores are slightly larger than the size given, measuring about 16 × 7μ. It grew on *Polystictus versicolor* along with *Hypomyces aurantius.*

Chaetomium pannosum Wallr. Flora Crypt. Germ. II. p. 267, 1833.

Perithecia solitary or generally in crowded groups, ellipsoid, up to 0.5 mm. high, 0.3-4 mm. thick, with a short

colourless ostiole. Rhizoidal hyphæ abundant. Lateral hairs of the perithecium tapering, brown, incrusted; terminal hairs spreading, branched, very stiff, the cell walls thick, incrusted, brown. Asci large, clavate, stalked, up to 100μ × 15-20μ 8-spored; spores ellipsoid (side view fusiform) apiculate at each end, olive-brown, 10-14μ × 8-9μ.

On decaying branches and stalks of herbaceous plants. The above fungus was found by Miss Winifred Page on a culture mixed with dung solution at Birckbeck College. Feb. 1918.

DISCOMYCETES.

DISCOCERA gen. nov.

Ascomata parasitica, sessilia, immarginata, colorata, firme ceracea; disco patellato, dein plano-convexo. Asci clavati, supra rotundati, inoperculati, 8-spori; paraphyses tenerae, supra ramosissimae, epithecium densum formantes; Sporae ellipsoideae, continuae, hyalinae.

A somewhat remarkable genus resembling *Humaria* in the appearance of the large smooth spores, but the inoperculate asci and the branching of the paraphyses to form a dense epithecium show its affinity with the lichenicolous genus *Nesolechia*.

D. LICHENICOLA n. sp.

Ascomatibus subrotundatis, usque ad 1.5 mm. latis, fusco-coccineis, glabris. Ascis elongato-clavatis c. 140μ × 20μ, membranis ad apices c. 12μ crassis, cum iodo vino-rubescentibus; paraphysibus tenerrimis, c. 1μ crassis, septatis, supra persaepe ramosis, interdum irregulariter nodosis, hyalinis, granulosis, ad basim coalitis; sporis glabris, intus roseo-hyalinis, guttulatis 20-26μ × 10-13μ.

Ad thallum Lichenis, supra saxa. Coll. W. Watson at Treborough, Somerset, Dec. 1915.

The fungus is a dark crimson-red when dry, but when moistened becomes lighter in colour, and, under the microscope, the whole ascus contents, more especially the spore guttulae, are a beautiful rose-red.

SPHAEROPSIDEAE.

Phyllosticta fuchsiicola Speg. Fungi Chil. p. 138, 1910; Sacc Syll xxii. p. 839, 1913.

Spots whitish, orbicular, on both sides of the leaf 1-5 mm. across, determinate and bordered by a wide purple line. Pycnidia few, innate, lentiform, minute, 75-90μ diam.,

ostiolate, membranaceous; spores colourless, subcylindrical-ellipsoid, 4-6μ × 1.5-2μ.

On living leaves of *Fuchsia coccinea.*

Recorded by Spegazzini from Chili. A specimen corresponding to the above has been found by Mr. D. A. Boyd at West Kilbride, Ayrshire, on the dead bark of Fuchsia stems. There is a difference of habitat (on stems instead of leaves) and no specialized spots, but the similarity is otherwise very close.

Ascochyta Papaveris Oudem. Contr. Fl. Myc. Nowaja Senilaja p. 12, l.i., fig. 10, 1885; Sacc. Syll. x. p. 301, 1892.

Pycnidia scattered over the surface of the leaves, black, small, 200μ diam., the peridium membranaceous, of rather large fuliginous cells; spores broadly fusiform or sub-ellipsoid, hyaline, 1-septate, 9μ × 3.5μ.

On leaves of *Papaver nudicaulis* in the island of Nova Zembla. Specimens have been collected by D. A. Boyd on the leaves of *Dicentra spectabilis* which agree fairly closely with the above description. The pycnidia are scattered or congregate from 135μ to 170 in diam., with a minute pore about 35μ diam. The spores are fusiform or sub-ellipsoid and measure 8-12μ × 2-3μ.

Septoria Scillae Westend. in Kickx Fl. Crypt. Flandres I. p. 423 (1867).

Leaf spots pale-brown. Pycnidia semi-immersed, brownish, becoming darker, about 200μ in diam; spores long, cylindrical, straight or slightly bent, 50-75μ × 2.7μ; 5-7 irregularly septate, colourless.

On leaves of *Scilla nutans.*

Coll. by D. A. Boyd, May, 1917 at West Kilbride, Ayrshire.

Kickx describes the pycnidia of his species as brown. Allescher has recorded them as black. They became darker with age but so far I have not seen any black specimens.

S. violae-palustris Died. Krypt. fl. Mark Brandenb. ix. p. 522, 1914.

Leaf spots at first very small, round, later up to 4 mm. across, thin, transparent, surrounded by a thickish, reddish-brown line. Pycnidia epiphyllous, numerous, semi-immersed, the upper surface composed of darker cells, and about 75-90μ wide with a pore about 12μ wide, Spores

filiform, indistinctly guttulate, straight or bent, 25-40μ × 1-1.2μ.

On leaves of *Viola palustris*.

Collected by D. A. Boyd on fading leaves of *Viola palustris* at Ardrossan, Ayrshire Aug. 1916. The fungus agrees wholly with that described by Diedicke though some of the spores from the Ardrossan specimen are slightly longer.

S. Chenopodii Westend. Bull. Acad. Roy. Belg. 1851, p. 396; Sacc. Syll iii. p. 556.

Var. *emaculata* Grove in Journ. Bot. lv. p. 348, 1917. Pycnidia occurring on stems without distinct spots.

On living plants of *Atriplex* and *Chenopodium*.

S. Oenanthis Ell & Ev.

This species was previously found by D. A. Boyd on *Oenanthe* leaves in Cumbrae and at Ardrossan (Trans. v. p. 245, 1916). He now sends further specimens from West Kilbride, which occurred in a damp wood on the stems of the host, and which were causing the death of the plants. In these stem pycnidia, the spores measure up to about 48μ in length but do not otherwise differ from those on the leaves.

Camarosporium Stephensii Sacc. Syll. iii. p. 469, 1884. *Hendersonia Stephensii* B. & Br. Not. Brit. Fungi n. 502 in Ann. Mag. Nat. Hist. vii. p. 95, 1851.

" Perithecia irregularly seriate under the brown epidermis, bursting in a wide line; spores large, ovoid, reticulately cellular.

On dead stems of *Pteris aquilina,* Bristol."

This fungus has not again been recorded and the description is somewhat indefinite, but one found by D. A. Boyd is evidently the same :—the pycnidia have a thin, dark brown cellular wall and measure about 300μ across. The spores on short colourless sporophores are as described by Berkeley and Broome: they are divided by three stout transverse septa and the compartments are irregularly divided again by longitudinal and transverse delicate walls; they measure about 45μ × 20μ and become browner with age.

Collected by D. A. Boyd on stems of *Pteris aquilina*. Cumbrae, Buteshire, June 1915.

MELANCONIACEAE.

Myxosporium lanceola Sacc. & Roum. Rev. Mycol. 1884, p. 36.

Acervulae gregarious, like tubercles, bursting the epidermis, flesh coloured, with a darker base, white above; spores elongate, fusiform, guttulate, colourless, 20-22μ long (or shorter), about 4μ thick; sporophores rod-like, half the length of the spores.

On dead bark of *Quercus Robur*. D. A. Boyd, Stevenston, Ayrshire, Sept., 1917.

M. pubescens Sacc. Syll. x. p. 465, 1892.

Acervulae roundish, pale coloured; spores blunt at the ends, straight or slightly bent, mostly filled with guttulae. Sporophores (?) one-celled, in the mature fungus projecting like hairs.

On dead bark of *Tilia*. Coll. D. A. Boyd, West Kilbride, Ayrshire, May, 1917.

The size of the spores is not given in the original diagnosis. In Mr. Boyd's specimens they are oblong, rounded at the ends and full of small guttulae, they measure about 15 × 7μ. The projecting filaments are not present.

AMPHICHAETA Mac Alp. Proc. Linn Soc. N. S. Wales 1904 p. 118; Sacc. Syll xviii. p. 486, 1906.

Acervulae subcutaneous, often erumpent, disciform or pulvinate. Conidia elongate, 2-pluriseptate, become partly coloured, 1-ciliate, at each end.

A. EUROPAEA Grove in Journ. Bot. lx. p. 136, 1917.

On thick dead shoots of *Vitis vinifera*, King's Cliffe, (Berkeley, 1851). In Kew herbarium.

Leptostromella pteridina (Sacc. et Roum. Mich. ii. p. 353, 1880-82); Sacc. Syll. iii. p. 660, 1884.

Pycnidia elongate, applanate, 1-1.5mm. long, immersed then subsuperficial, not sulcate; spores filiform, acicular, colourless, 5-6-septate, 80μ × 1.5μ.

On stems of *Pteris aquilina*. West Kilbride, Ayrshire, May, 1917. Comm. D. A. Boyd.

In Mr. Boyd's specimen the spores measure about 50μ to 75μ. None have been seen up to 80μ in length, and usually they are between 50 and 60μ. There seems however no reason to doubt that the specific determination is justified.

Libertella blepharis A. L. Sm.

Described in Trans. i. p. 155, 1900 on branches of *Prunus cerasus* and *Pyrus malus,* collected by D. A. Boyd in Ayrshire. It has been again found in Ayrshire at Stevenston, also by Mr. Boyd, on branches of *Crataegus oxyacantha.* It is characterized by the strongly falcate spores measuring up to 40μ in length.

Amerosporium patellarioides n. sp.

Pycnidiis superficialibus, subsphaericis vel ellipsoideis ca.7mm. long. tandem siccis collabescendo patellaribus, atro-brunneis, sparse pilosis; pilis erectis, septatis, brunneis 250μ × 10μ, Apice obtusis et subhyalinis, sporophoris gracilibus, ramosis; sporis cylindraceo-fusiformibus 8-10μ × 2μ.

In foliis dejectis *Rosae caninae.* Coll. D. A. Boyd, Kilwinning, Ayrshire, Jan., 1916.

The peridium is composed of rusty-brown, strong-walled cells. The whole pycnidium is swollen when moist, and collapses to a concave form when dry. It is possible that the above may be identical with *Amerosporium chaetostroma* (Berk. and Br.) Sacc. But there is no specimen of this fungus either in the herbarium of the British Museum or at Kew. Miss Wakefield has kindly given dimensions from *A. macrotrichum* (Berk. and Br.):—hairs varying from 230μ to 810μ × 12-15μ and spores lunate-fusiform, 5-6μ × 5μ.

HYPHOMYCETES.

Ramularia umbrosa n. sp.

Maculis purpureo-brunneis, effusis, magnam partem foliorum necantibus; caespitulis minutis, gregariis, epiphyllis; conidiophoris e base brunneolo parenchymatico ortis, dense fasciculatis, simplicibus, parum flexuosis, saepe subgeniculatis et dentatis, sursum attenuatis vel obtusis; ca. 25μ × 4μ; conidiis cylindraceo-ellipsoideis, interdum catenulatis, simplicibus, hyalinis, 10-16μ × 2μ.

In foliis vivis *Saxifragae umbrosae.* D. A. Boyd, West Kilbride, Ayrshire, May, 1917. A hypophyllous species *R. Saxifragae* Syd. has been described, which differs in the characters of the fertile tufts as well as in their position on the leaf.

Zygodesmus fulvus Sacc. Mich. II. p. 147, 1880-82.

Recorded by W. B. Grove in Journ. Bot. lv. p. 136, 1917, from Lyndhurst, Hants, collected by Dr. J. S. Bayliss Elliott.

Stemphylium macrosporoideum Sacc. Syll. iv. p. 519, 1886.

Epochnium macrosporoideum B. & Br. Not. Brit. Fig. n. 131 (t. 8, fig. 14) in Ann. Mag. Nat. Hist. Ser. 1. 1., p. 263, 1838.

On Plaster of Paris disc on which *Saccharomyces* had been grown for sporulation; W. J. Hodgetts. Recorded by W. B. Grove in Journ. Bot. lv. p. 136 (i. fig.), 1917.

Stysanus microsporus Sacc. Mich. I. p. 274 (1878).

Gregarious, grey then brown. Stem thread-like, formed of brown almost continuous hyphæ, the head clavate; conidia in chains almost globose, hyaline (purplish-brown in the mass), 2-4μ long, 2-2.5μ thick. On decaying wood, or herbaceous stems, &c.

Collected by W. N. Cheesman on decaying wood at Selby, Yorkshire, Sept., 1917.

There is in the specimen a rich production of conidia, so that the heads (in the protected specimen) had become overweighted, split up and fallen apart in tripartite lobes. The stems are very slender and black, the heads a delicate purplish brown.

Volutella longepila n. sp.

Sporodochiis subsessilis, hemisphericis, albidis, parvis, 250μ-350μ latis, margine ciliatis; setis longis, hyalinis, cylindraceis, levibus, septatis, apice obtusis vel sensim attenuatis, usque ad 650μ longis, 8μ latis; conidiophoris dense congestis, gracilibus ca. 40μ ad 70μ longis; conidiis hyalinis, ellipsoideo-cylindraceis, 5-7μ × 1-2μ.

Hab. In ramulis dejectis *Ulicis europaei,* Ardrossan, Ayrshire. Collected by D. A. Boyd, Feb., 1913.

The species is characterized by the long smooth cilia and by the small spores.

UREDINEAE.

Puccinia longissima Schröt in Cohn's Beitr. iii. p. 70, 1883; Grove in Journ. Bot. lv. pp. 135-6 (1 fig.), 1917.

On *Koeleria cristata,* near Aberdeen.

Hitherto put doubtfully under *P. paliformis* Fuck.

HYPHOMYCETES AND THE ROTTING OF TIMBER.

By A. Lorrain Smith, F.L.S.

Specimens of decaying timber from houses in Surrey and Suffolk have been sent to me recently to be examined. In both houses there was an outbreak of dry-rot on walls and floors, but there were also beams in other parts of the buildings attacked by fungi that had no relation to *Merulius lacrymans*.

In the Surrey house, a modern building, the end of a beam was affected, and small portions were submitted for examination. One of which, over an inch in length, was marked by dark speckles. Under the microscope a strong brown mycelium was found invading the woody tissues. The medullary rays were partially destroyed: in them the mycelium was more luxurious and had formed dark-brown chlamydospores which gave the speckled effect to the specimen. On the extreme end of the beam there was a confused tuft of dark mycelium and small round spores also very dark in colour but the material was too old and too formless for exact identification. A thin section of the affected wood was placed in a culture of water with a slight admixture of glucose-agar. In a few days there grew out a tuft of colourless mycelium from which developed conidiophores, these being the ultimate branchlets of the hyphæ. From these tips and from side branchlet chains of small subglobose spores arose: they were colourless at first but gradually changed to brown. They measured the same as those found on the end of the beam, 3-4μ in diam. or 3-4$\mu \times 3\mu$; the mycelium did not become brown in the open culture; there seems no doubt however that it is continuous with the brown hyphæ within the wood. The fungus seems to be identical with *Torula abbreviata* Corda, which grows on wood etc. and bears short chains. I am not sure of its identity with the superficial black tufts.

The wood so far shewed little injury as it was quite firm, but in time trouble might arise.

The diseased timber from an old house in Suffolk (other

than that affected by dry-rot) formed part of a beam built into the wall behind a shutter. It was very dark brown in colour and extremely friable and dry, breaking easily into debris. There were blacked portions in channels and patches suggesting the presence of insects but no trace of these could be found, the fragments in question were minute portions of disintegrated woody tissue traversed and tangled by brown mycelium. The mycelium travelled between the woody cells and did not specially affect the medullary rays. Inside one of the split portions of the wood I was fortunate enough to find the fructifications of a Hyphomycete, the conidiophore of which bore a striking resemblance to the mycelium that was found traversing the wood. It was a *Haplographium* with a very dark, long, stout stalk, penicillioid branching at the tips, and bearing chains of innumerable minute colourless spores massed into heads. One of these measured about 70μ across, another of ovoid form about 200$\mu \times 100\mu$. The spores are extremely small, subglobose or ovoid, and measure about 1μ in diam. or 2$\mu \times 1\mu$. It resembles most nearly **Haplographium finitimum* Sacc., though the spores are somewhat smaller than in that species. There were on the stalk small swellings where a previous apical head or a lateral head had been borne. Cultures on a glucose-agar medium were attempted but without success: the fungus had evidently lost viability.

There was also associated with the *Haplographium* a species of *Verticillium,* brownish in colour and with colourless or brownish spores about 2.3$\mu \times 2\mu$ probably a form of *V. tenuissimum* Corda. It evidently aided in the work of disintegration, though the *Haplographium* is the principal agent.

It is a commonplace of mycology that the abundant hyphomycetous flora of our woodlands assists in the breaking up of plant debris, and the above instances are examples of this action. The fungi were probably present on the beams when placed in position and favourable conditions of moisture, etc., encouraged their continued growth, resulting in the slow destruction of the timber.

*Trans. III., p. 36 (pl. 1, fig. 4), 1908.

SOME NEW SPECIES OF FUNGI IMPERFECTI

By Jessie S. Bayliss Elliott D.Sc. Birm. B.Sc. Lond.

During the last two years (1916-1917) I have found the following six species of Fungi Imperfecti; four of them are new, and two are new records for the British Isles. With the exception of one, which appeared in a culture in the Botanical Laboratory of the Birmingham University, all were growing on decaying wood or fallen pine cones, lying under pine trees in my garden (Tanworth-in-Arden, Warwickshire).

AEGERITA VIRIDIS Bayliss Elliott. *Sp. nov.*

Crowded, granuliform, minute, globose, 0.5 mm. diameter, deep green when fresh; conidophores profusely dichotomously branched so that they sometimes appear fasciculate instead of simple at the base; conidia formed in branching chains, globose, 4μ diameter, or frequently subglobose when part of a chain, olive and smooth, (Figs. 1, 2, 3, 4).

On rotten wood, Tanworth-in-Arden, Warwickshire.

This fungus is very abundant on rotten wood lying in damp places in the district of Tanworth-in-Arden throughout the year. It is distinguished from *A. virens* Carm. by the crowded habit and the very much smaller conidia.

Latin diagnosis. Conferta, granuliformis, minuta, globosa, 0.5 mm. diametro, recens saturate viridis; hyphis fertilibus profuse dichotomis ut interdum basi quasi fasculatis; conidiis in catenas ramosas digestis, globosis vel subglobosis, olivaceis, levibus, 4μ diam. Hab. in ligno putrido (Figs. 1-4).

CLONOSTACHYS DICHOTOMA Bayliss Elliott. *Sp. n.*

Forming effused tawny patches; sterile hyphæ septate, broad, 10μ diameter, pale ochraceous; fertile hyphæ lax, very much branched, repeatedly dichotomous or sometimes trifurcate, colour tawny; branches ascending, 2.5μ diameter, with few septa, tapering to an elongated thread 20-30μ long which forms the axis of a compact spike of closely crowded conidia; conidia globose, 2μ colourless, (Figs. 5. 6. 7).

On decaying wood. Tanworth-in-Arden.

It is difficult to decide in which genus this fungus should be placed—*Clonostachys* or *Sporotrichum*; but I have assigned it to *Clonostachys* because of the conidia occuring in closely crowded spikes such as are seen in *C. araucaria Cda.*; nevertheless in the method of branching of the fertile hyphæ the genus *Sporotrichum* is more in agreement.

Latin diagnosis. Plagas effusas fulvas efformans; hyphis sterilibus septatis, 10μ diam., pallide ochraceis, fertilibus laxis, ramosissimis, repetite dichotomis, subinde trichotomis, fulvis, ramulis adscendentibus, 2.5μ diam., septis paucis instructis in filum, 20-30μ longum attenuatum conidiis dense constipatis spicæ ad instar abeuntibus; conidiis globosis, achrois, 2μ diam.

Hab. in ligno putrescente. (Figs. 5-7)

DENDRODOCHIUM ALBUM Bayliss Elliott. Sp. n.

Sporodochia minute, erumpent, scattered, circular, slightly depressed in centre, 100-200μ diameter; conidiophores simple with trifurcate apex, 22-25 × 1.5μ septate; conidia smooth, spherical, white 2.5μ diameter, (Figs. 8, 9, 10, 11).

On fallen pine cones, December 1916; Nov. 1917.

Tanworth-in-Arden, Warwickshire. (Figs. 8-11).

The conidia are evidently abstricted from the trifurcate conidiophores in a basipetal manner, and become immediately detached since no chains of conidia are to be seen; they are produced in enormous quantities and in a damp atmosphere a slowly growing column-like mass is formed on the top of the sporodochium which ultimately topples over, and the conidia on coming in contact with water are very rapidly dispersed.

Latin diagnosis. Sporodochiis minutis, sparsis, erumpentibus, orbicularibus, centro depressulis, 100-200μ diam.; conidiophoris simplicibus, apice trifurcatis, septatis, 22-25 × 1.5μ conidiis levibus, sphaericis, albis, 2.5μ diam.

Hab. in conis *Pini silvestris* delapsis.

TRICHOCREA March in Camp, copr. VI. p. 14. Sacc. Syll. X, p. 410.

Pycnidia superficial, ovoid, at first closed, then wide open, almost discoid; texture parenchymatous, rather soft and waxy, pale coloured. Spores very numerous, narrow cylindrical, 1-septate, hyaline; sporophores elongated, filiform, densely fasciculate, branched above.

TRICHOCREA OÖDES Bayliss Elliott. *Sp. n.*

Pycnidium superficial, gregarious, lemon or egg-shaped, 130-190μ × 180-200μ, stalk, 50-100μ long, shining, whitish; excipulum consisting of very narrow interwoven septate hyphæ; at first closed, then open, margin fringed with converging hairs. Pycnospores elongate, linear, some slightly bent and thicker in the middle, 30-60 × 0.5μ aseptate and pluriguttulate, colourless, situated on branched sporophores, which rise in dense clusters from the base of the pycnidium: the pycnidia turn black with age, (Figs. 12, 13, 14, 15, 16).

On a fallen cone of *Pinus sylvestris*. Tanworth-in-Arden, Warwickshire.

I have included this is the genus Trichocrea although it does not quite agree, seeing that the excipulum is not parenchymatous but of interwoven hyphæ; also the spores are continuous, not septate, but they may become so since they are pluriguttulate: but as the genus *Trichocrea* hitherto only contains one species, *Tr. stenospora* March. recorded for Belgium, which has some points of resemblance with this species, it seems better to do this than burden the classification with another genus.

The spores germinate readily in 24 hours and by means of connecting hyphæ often anastomose with one another.

A group of pycnidia looks very like a cluster of insect's eggs, so much so that although I had frequently seen groups of them I had not troubled to examine them, thinking they were insect's eggs.

The hyphæ forming the excipulum, the long branched conidiophores, the attenuated pycnospores are all so nearly of the same narrow width that a crushed pycnidium appears little more than a mass of pycnospores unless very carefully examined.

Latin diagnosis. Pycnidiis gregariis, superficialibus, ovatis vel limoniiformibus, 150-190 × 180-200 μ, pedicello 50-100μ longo præditis, nitidis, albidis, senio nigrescentibus, initio clausis, dein apertis, excipulo hyphis angustissimis septatis intertextis constante, margine pilis convergentibus ciliato. Sporulis elongatis, linearibus, raro flexis medioque crassioribus, 30-60 × 0.5 μ, eseptatis, pluriguttulatis, achrois, sporophoris e basi pycnidii oriundis dense fasciculatis suffultis.

Hab. in cono delapso *Pini silvestris,* (Figs 12-16).

Haplographium fuscipes (Preuss) Sacc. Syll. iv. 307.

Forming delicate inconspicuous cinder-grey patches; mycelium creeping, dark brown, fertile hyphæ erect, 110 × 3μ, simple, occasionally branched, septate, dark brown below, becoming paler and colourless above, where each divides into two or sometimes three main colourless branches which again branch freely and bear numerous short branches, to which are attached conidia in short chains, which may also branch; these branches and conidial chains form a rather lax globose or sub-globose head; conidia hyaline, globose, 1.5μ diameter, (Figs. 17, 18).

On fallen cones of *Pinus sylvestris*, Tanworth-in-Arden, Warwickshire.

This agrees with Saccardo's description of *H. fuscipes*, found on the fallen leaves of *P. sylvestris* (Germany).

Sterigmatocystis phæocephala Sacc. (Fungi Ital. t. 908).

Creeping hyphæ large, colourless; fertile hyphæ erect, unbranched, with pale brownish contents, transparent and tinged brown when empty, aseptate; apex inflated, 46μ diameter, conidiophores 15-17μ long with 3 or 4 sterigmata 10-14μ long; conidia in chains, globose, minutely warted, brown, 2.5-3.5μ diameter, (Figs. 19, 20, 21).

On agar culture medium infected for bacteria in a Petri dish in the Botanical Laboratory, University of Birmingham.

This fungus agrees except in a few minor details with the description of *S. phæocephala* Sacc. previously recorded for Algeria, Italy, Germany, Argentine, and Madras as occuring on decaying roots, etc.

In the original description the fertile hyphæ are described as " Sub apice globoso inflato strangulatis," but only a very slight trace of strangulation is to be seen in the figure appended and with this my specimen almost agrees.

Also although the conidia are said to be subglobose they are figured as I find them—globose.

The fertile hyphæ with their heads of conidia are quite white in mass for several days before they assume the brown colour, hence zoning is a very conspicuous feature in cultures.

The shade of brown varied very much with the amount of light to which the fungus was exposed. Cultures grown in bright light were a chocolate brown and afforded a marked contrast to the fuscous brown colouration of those grown in darkness or dim light. Cultures under varying conditions

of temperature, or of acidity or alkalinity of medium produced no corresponding change of colour.

The fungus bears some resemblance to *Aspergillus nigricans* described by Cooke, 1885, as occurring "in the meatus auditorius of the human ear," but the conidia are smaller and the colour does not approach black; moreover it is a *Sterigmatocystis* not an *Aspergillus*.

In conclusion, I wish to express my indebtedness to Mr. W. B. Grove, M.A., for helpful criticism and for the Latin diagnoses, and to Professor West for the loan of books of reference, and also to Miss Lorrain Smith for her kindness in consulting books of reference inaccessible to me.

DESCRIPTION OF PLATE.

Fig.

1. *Ægerita viridis.* Groups of sporodochia showing the crowded habit, × 10
2. Conidiophore and dense mass of conidia, × 80.
3. Conidia forming branching chains, × 600.
4. Conidia, from a young sporodochium × 600.
5. *Clonostachys dichotoma.* Small portion of a much branched conidiophore, × 80.
6. Branch of a conidiophore with conidia arranged in the form of a spike, × 600.
7. Sterile hyphæ, × 600.
8. *Dendrodochium album.* Group of pycnidia, each pycnidium surmounted by a mass of pycnospores, × 50.
9. Pycnidium seen to be erumpent × 600.
10. Pycnospores, × 600.
11. Trifurcate conidiophores, × 600.
12. *Trichocrea oödes.* A group of pycnidia, × 40.
    a. Young pycnidia.
    b. Mature pycnidium with mass of pycnospores just appearing through the ostiole.
    c. Immature pycnidium whose pycnospores have been pressed out.
13. Branched conidiophores, × 600.
14. A mass of branched conidiophores.
15. Pycnospores which are very long and attenuated.
16. Germinating pycnospores which are connected by anastomosing hyphæ, × 600.
17. *Haplographium fuscipes.* Group of conidiophores × 92.
18. Conidiophores showing branching chains of conidia, × 600.


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Fig.
19. *Sterigmatocystis phæocephala.* Group of fertile hyphæ, × 120.
20. Inflated apex of fertile hyphæ with conidiophores bearing 3 or 4 sterigmata, × 350.
21. Conidia, some in chains, and some still attached to sterigmata × 600.

NEW OR RARE BRITISH FUNGI.

With Plate II.

By Carleton Rea, B.C.L., M.A., etc.

LEPIOTA FULVELLA Rea, v. t. II., fig. 2.

Pileus 3-5 cm. latus, *fulvellus,* carnosulus, margine tenuis, e convexo-campanulato expanso-subumbonatus, *squamulis adpressis, saturatioribus arcte vestitus.* Stipes 3-6 cm. longus, 3-6 mm. crassus, pileo concolor, aequalis, vel deorsum attenuatus, fistulosus, laevis; annulus albidus, inferus, fugax. Caro aquosa, albida, inodora et insapora. Lamellae 4-6 mm. latae, e pallido ochraceae, postice rotundato liberae, confertae. Sporae hyalinae, angulato-oblongatae, basi truncatae, apice acutae, 9-10 × 3.5-4μ. ut plurimum 1-2-guttulatae; basidia clavata, 4-sterigmatica, cystidia subglobosa vel pyriformia, 14-18 × 8-12μ. Ad terram nudam in nemoribus frondosis, Plowden, Salop, 25-ix.-1917.

Distinguished in the Clypeolariae section of Lepiotae by its tawny colour, adpressedly squamulose pileus, smooth stem, and the oblong spores, truncate at the base and acute or acutely angular at the apex.

LEPIOTA ROSEA Rea, v. t. II., fig. 1.

Pileus 2-3.5 cm. latus, *laete roseus,* carnosulus, margine tenuis, e convexo expansus, *granulis globosis dense obsitus.* Stipes 5-6 cm. longus, 3-5 mm. crassus, albidus, dein pileo concolor, aequalis, fistulosus, laevis; annulus pileo concolor, angustus, medius, mox evanidus. Caro albida *dein rubescens,*

inodora et insapora. Lamellae 4-5 mm. latae, ex albido subochraceae, postice rotundato liberae, confertae. Sporae hyalinae, ellipticae, $5 \times 3\mu$, 1-guttulatae; basidia clavata, 4-sterigmatica; cystidia in speciminibus examinatis nulla. Ad terram nudam in nemoribus humosis et frondosis, Caughley, Salop, 29-ix.-1917.

Easily known amongst the Granulosae group of Lepiotae by its deep rose colour, granular pileus, smooth stem, and the flesh becoming reddish. The fugacious globose cells on the pileus measure 45-50μ in diameter.

Boletus lacteus Lév. Lév. An. sc. n. (1848), 124. Quél. Fl. Myc., 425.

Pileus 10-15 cm. wide, *pure white*, convex, gibbous, minutely tomentose. Stem 9-12 cm. long, 4-6 cm. thick, *pure white, incrassated at the base*, firm, *velvety*, stuffed with a spongy pith and cavernous, at length hollowed out. Tubes *white*, free, short; orifice of pores *white*, minute, round or angular. Flesh white, *becoming deep indigo blue on exposure to the air*, spongy, thick at the disc, thin at the margin of the pileus. Spores white, pip-shaped, $8\text{-}9 \times 4\text{-}5\mu$, 3-5-guttulate.

On the ground, under oak and nut bushes, Shrawley Wood, 12th August, 1917.

Resembling *Boletus cyanescens* in the flesh, turning a deep indigo blue color when sectioned, but differing in the pure white colour of the pileus and stem and the thickened base of the stem.

Clavaria cinerea (Bull.) Fr. var. *gracilis* Rea, v. t. II., fig. 4.

Varietas a typo recedens, *statura majore, trunco tenui, ramis ramulisque gracilibus.*

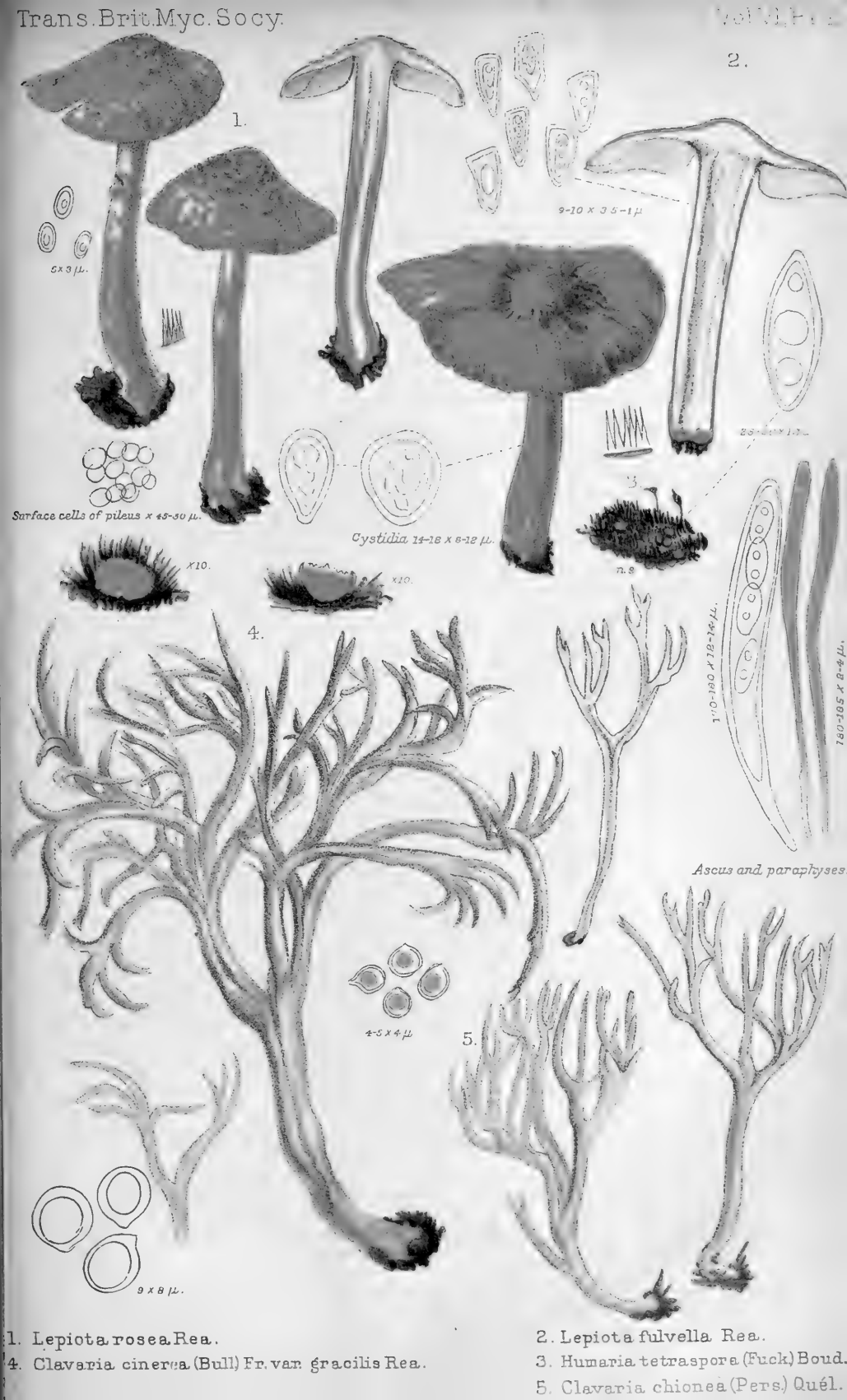
This variety has a facies quite distinct from the type. The trunk is long and slender and divides up into numerous tapering branches and branchlets. The spores are white, subglobose, with a basal apiculus, $9 \times 8\mu$, with a large central gutta.

On bare soil in woods. Caughley, Salop, and Shrawley, Worcestershire.

Clavaria rugosa (Bull.) Fr. var. *fuliginea* Fr. Fr. Hym. Eur. 669.

Differs from the type in the dark, sooty colour of the clubs and flesh.

On the ground, Caughley Wood, Salop, 29th September, 1917.



1. Lepiota rosea Rea.
2. Lepiota fulvella Rea.
3. Humaria tetraspora (Fuck.) Boud.
4. Clavaria cinerea (Bull.) Fr. var. gracilis Rea.
5. Clavaria chionea (Pers.) Quél.

Clavaria chionea (Pers.) Quél. Pers. Myc. Eur. I., 167. Quél. Fl. Myc. 465. See pl. II., fig. 5.

Snow white. Trunk thin, 2-3 cm. long, 2-3 mm. thick, tough, very much branched, branches long, thin, unequal, pointed. Spores pale yellow in the mass, hyaline under the microscope, subglobose, with a basal apiculus 4-5 × 4μ, with a large central gutta.

On bare soil, Caughley Wood, Salop, 29th September, 1917.

Geaster triplex Jungh. Jungh. nov. gen. et sp. plant, fl. Jav. 287. Hollós Gasteromyc. Ungarns. 73. Lloyd, The Geastrae 25.

A specimen of this uncommon Geaster was sent to me by Miss Gulielma Lister, on the 14th October, 1917, from Prestwood, near Wycombe, Bucks. Worthington G. Smith includes it in his list of British Basidiomycetes at p. 71. It is characterized by the outside of the exoperidium cracking up into areolae, the very thick, fleshy collenchyma-like inner layer of the exoperidium, which makes the exoperidium on section appear very like that of a Scleroderma, and the elongate columella reaching to the centre of the endoperidium. Spores light brown, globose, 4-5μ, warted, capillitium threads light brown, 6-7μ in diameter.

Cyathipodia villosa (Hedw.) Boud. Hedwig Musc. frond. II., 54. Sacc. Syll. viii., 150. Boud. Icon. Myc. iv., 128, t. 240.

Ascophore stipitate, cup-shaped, ·5-2 cm. wide; margin thin, slightly sinuate; hymenium brown; externally fuliginous grey, villosely squamulose, stem 1-3 cm. high, 2-3 mm. thick, concolorous with the exterior of the cup, paler and whitish at the slightly bulbous base, villose. Asci cylindrical, gradually attenuated to the base, 210-235 × 15-18μ, 8-spored. Spores elliptical, 16-18 × 12-13μ, with a large central gutta and accompanied or not with more or less numerous guttulae. Paraphyses linear, slightly thickened at the apex, 220-240 × 5-7μ yellowish.

On the ground, Weybridge, Surrey, 7th October, 1917, Mr. A. A. Pearson.

Humaria tetraspora (Fuck.) Boud. Fuck. Sym. Myc. 317. Boud. in Bull. Soc. Myc. Fr. I., 106. Rabenh. Krypt. Fl. III., 937. Boud. Icon. Myc. iv., 222, t. 393. See pl. II., fig. 3.

Ascophores 1-4 mm. wide, scattered, sessile, hemispherical; margin distinct, crenulate; hymenium bright orange, plane,

then convex, externally paler and covered with a delicate white tomentum. Flesh concolorous. Asci cylindrical, attenuated at the base, 170-180 × 12-14μ, *4-spored,* not turning blue with iodine. Spores fusiform, 25-30 × 10-12μ, obtuse, smooth, hyaline, 2-4-guttulate. Paraphyses flexuose, simple, or branched, septate, gradually attenuated downwards, 180-185 × 2-4μ, filled with reddish granules and turning green with iodine.

Amongst moss, near Perth, 14th September, 1917, Mr. J. Menzies. Mr. Menzies also reported that he had gathered this species in company with Mr. C. McIntosh on the sandy bank of the Tay near Ballinluig in 1913.

Dermatea umbrina Cke. & Massee. Cke. & Massee in Grev. xxi., 72.

Mr. J. Menzies found a number of specimens growing on *Ulex,* near Perth, on the 1st January, 1918. Asci cylindrical, somewhat abruptly attenuated at the base, 110-120 × 12μ, 8-spored. Spores elliptical, 13-16 × 8-10μ, hyaline, becoming brownish with age, with a large central gutta. Paraphyses linear, 120-140 × 2-3μ, septate.

ANTROMYCES Fresen. Beitr. I., 37 (1850). Sacc. Syll. iv., 626.

Coremia compact, dark brown. Stem cylindrical. Heads hemispherical, somewhat waxy, consisting of compact, dichotomously branched conidiophores. Conidia at first continuous, hyaline, then 1-septate, cylindrical-fusiform, brownish, catenulate.

Antromyces copridis Fresen. Beitr. I., 37 (1850), Tab. iv., figs. 40-45. Bizzoz. Micol. Venet., 528. Boudier in Bull. Soc. Myc. France III., 152, Tab. xvi. Sacc. Syll. iv., 626, x., 698.

Mycelium pale. Coremia *Stilbella*-like, dark grey, 2-3 mm. high. Stem cylindrical, or slightly attenuated above, somewhat thickened at the base, simple, or very rarely forked, consisting of smoke-coloured, septate hyphae. Heads round, 5-7 mm. in diameter, somewhat umbilicate on the underside, composed of dichotomously branched threads. Conidia arising from the ends of the hyphae in long, dichotomously branched threads, oblong, cylindrical, 13-20 × 5 -8μ, continuous, then divided by a cross-wall, not or only slightly constricted at the septum, darker and granular inside, pale brownish.

On the inside of the case of dung of the *Copris* beetle, ex Mr. Hugh Maine per Miss A. Hibbert-Ware, 14th September, 1917.

WORTHINGTON G. SMITH AS MYCOLOGIST.

By A. Lorrain Smith, F.L.S.

Worthington George Smith, F.R.A.I., F.R.S.A. Ireland, F.L.S., the distinguished archæologist and botanist, died at Dunstable on the 27th October, 1917, at the age of eighty-two. His loss is of particular significance to mycologists. In his study of plants he possessed the unusual advantage of thorough scientific field knowledge, combined with great artistic skill in delineating the living specimens, an advantage of extreme value in dealing with such perishable plants as fungi.

Smith specialized on fungi from an early date in his career; he was one of the leading members of the mycological group of the famous Woolhope Club, which did so much to keep alive the study of mycology in this country after Berkeley's day. Our own members have seen and enjoyed the menu cards with their overflowing humour which he prepared for the annual fungus feasts at Hereford. In 1898 he was enrolled a member of the British Mycological Society and in 1903 was unanimously elected President, but his advancing years and precarious health prevented him from taking any active part in the work of the Society, and, unfortunately, he was unable to preside over the meeting at Whitby in the following year.

One of his first papers on fungi was published in the Journal of Botany II. p. 215, 1864, and gives his experience of the serious results that followed the eating of a poisonous fungus, *Agaricus fertilis* Pers. In the same Journal there was recorded, the following year, his discovery of a new British truffle, *Tuber excavatum* Vitt.; and yet another side of the subject was dealt with two years later (Op. cit. v. p. 367, 1867), in an account of the successful artificial culture of *Agaricus Loveianus* (*Volvaria Loveiana*), which grows parasitically on species of *Clitocybe*. Thereafter until nearly the end of his life, followed a long series of papers and notes (some two hundred and fifty and upwards), which appeared in the above journal, the Gardener's Chronicle, Nature, &c. These papers, as we might infer, deal with every aspect of mycology.

An economic consideration of fungi, possibly suggested from his poisoning experience, was treated in "Mushrooms and Toadstools: how to distinguish easily the differences between edible and poisonous Fungi." The book or pamphlet was published in 1867 and is finely illustrated by two

folded sheets of coloured figures representing the commonest edible and poisonous species; subsequent editions were called for in quick succession, the fourth being issued in 1879. It is now, however, out of print.

Many of the notes and papers published during these early years dealt with plant diseases due to the attacks of parasitic fungi, and in 1875 the Royal Horticultural Society shewed its appreciation of his work by awarding him the Knightian Gold Medal for his researches into the life-history of the potato disease fungus. In 1884 he issued a notable contribution to the Fungology of the British Isles:—"Diseases of Field and Garden Crops, chiefly such as are caused by Fungi." The book, as he tells us, embodies the reports of a series of addresses given at the request of the officers of the Institute of Agriculture at the British Museum, S. Kensington. Twenty years earlier, Cooke had published "Microscopic Fungi," but Smith treated the whole subject in its economic aspect: he gives in detail the life-history of the parasites, and suggests means to stay if not entirely to remedy the diseases.

Worthington Smith's systematic studies and publications were also of very great importance. The "Clavis Agaricinorum, an analytical Key to the British Agaricini, with characters of the genera and subgenera," was prepared for the Woolhope Club and published as a thin octavo volume or pamphlet in 1870. Much of it is included in his subsequent works. In 1891 he published the "Outlines of British Fungology, Supplement," thus bringing the earlier volume by Berkeley up to date. A Guide to Sowerby's Models of British Fungi in the British Museum (Natural History) was issued in 1893 and was reissued in 1908. It is a remarkably good introduction to the study of the larger fungi. The more recent Museum Guide to drawings of Field and Cultivated Mushrooms and Poisonous or Worthless Fungi often mistaken for Mushrooms" (1910), is accompanied by a large folded sheet of coloured drawings of the Mushroom in its many forms. The largest and most important of his systematic works is, however, the "Synopsis of the British Basidiomycetes," also published by the British Museum (1908). It provides a standard and reliable work on the subject, but suffers somewhat from necessary compression.

Smith's skill as a botanical artist was in constant requisition, his studies of orchids and other plants appeared from time to time in the Gardener's Chronicle between the years 1875 and 1910.* With his illustrations of Bentham's British

*For other details see Obituary notice in Gardener's Chronicle, lxii., p. 180, 1917, where also is reproduced a characteristic and life-like photograph.

Flora (in collaboration with W. H. Fitch) we are all familiar. His own publications are mostly accompanied by delightfully executed drawings. A work entitled "Mycological Illustrations" was projected by W. Wilson Saunders, the drawings in which were to have been supplied by W. G. Smith. Only one volume was issued, which contains 48 coloured plates with accompanying descriptions. The text figures in Stevenson's "Hymenomycetes Britannici" are other instances of his wonderful draughtsmanship. The unpublished drawings are no less noteworthy. A large and attractive series representing all the larger British Fungi is exhibited in the Botanical gallery of the Natural History Museum. These coloured drawings are in constant request during the Fungus season. A further extensive series of similar drawings illustrating forms and varieties is a substantial component of the valuable museum collection carefully preserved in the cryptogamic herbarium.

Smith's work was almost wholly confined to British Fungi. Only one excursion does he seem to have made into foreign fields in supplying the Section "Fungi" of Seeman's "Flora Vitiensis." Few fungi had been collected, but these include a black *Rhizomorpha* which, as a fringe, formed a much coveted article of dress in Fiji. The plant is called Wa loa in the vernacular, meaning creeper; it grows on decaying wood in swamps.

Worthington Smith had a thorough knowledge of British fungi with their many forms and varieties, and that knowledge he was always ready to share with others. No one who came in contact with him will ever forget his ready and willing assistance and his kindly, courteous personality.

RESUPINATE HYMENOMYCETES FROM THE NEIGHBOURHOOD OF WEYBRIDGE, SURREY.

By E. M. Wakefield F.L.S. and A. A. Pearson F.L.S.

All the species recorded in this paper were found during the winter months of 1917-18. They are an interesting series, including as they do six species and two genera new to the British Fungus Flora, with one species new to science.

The resupinate basidiomycetes make a very suitable study for the winter months. Very little else can be found. The fleshy agarics disappear with the first serious frost and afterwards only appear sporadically. The frost doubtless affects the resupinates also, and the specimens found in or after frosty weather are not in good fruiting condition. They also dislike too much wet. On the whole, however, they would appear to be among the hardiest members of the tribe, and this is partly explained by their protected position underneath logs and sticks resting on the ground. Frequently a sporophore would appear actually to touch the ground, but there is presumably sufficient room, due to the inequalities of the soil, for the spores to escape from this confined position by means of the air currents that pass underneath the wood.

A large number of species take part in breaking down the tissues of old logs and sticks. In the notes attached to the specific descriptions of Bourdot and Galzin, some species are designated as "lignivore," others "peu lignivore," and so on. Long experience and careful observation are necessary before the exact part played by any particular species can be judged. Certain species are well known to cause rot in worked timber, and in the woods it is easy to conclude that the common *Irpex obliquus* is an active agent in destroying old wood. Other species, however, do not allow of such ready judgments. *Protodontia uda*, for instance, was growing on damp wood in the last stage of decay. Was this decay due to the action of the fungus, or had the wood reached a spongy crumbling condition before it was attacked by the Protodontia? The answers to such questions are of considerable interest.

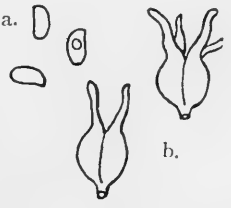
It may be of some value to give a list of the resupinates collected during three months, from the middle of November to the middle of February. They were all gathered within easy distance of Weybridge, and may therefore serve as a contribution to a Surrey list of Fungi. The resupinates do not usually form a prominent feature of such lists. In the following both the common and the rarer species are included, but many that at present seem to be rare may prove to be common when sought for.

PROTODONTIA von Hoehnel in Sitzber. k. Akad. Wiss. Wien, Math.-naturw. Kl., Bd. CXVI, Abt. 1, 1907, p. 83.

A genus resembling Odontia in appearance, but distinguished by possessing the vertically septate basidia characteristic of the order Tremellaceae. It is analogous to the genera Tremellodon and Protohydnum, differing from the latter, which does not occur in Britain, in its thinner, less fleshy subiculum, and more slender spines.

Protodontia uda von Hoehn. in Sitzber. k. Akad. Wiss. Wien, Math.-naturw. Kl., Bd. CXVI, Abt. 1, 1907, p. 83.

Fructification effused, indeterminate, pure white and slightly hyaline when fresh, very soft and delicate. Subiculum very thin, sometimes almost wanting. Spines slender, acute, up to 400μ long and 100-150μ wide, at the base, subgelatinous and slightly hyaline, becoming yellowish and collapsing as they dry. When quite dry the subiculum appears white and mealy, and the spines subtranslucent, yellowish, thread-like and curved.



Protodontia uda von Hoehnel. a, Spores; b, Two basidia × 850.

Basidia globose, sunken, vertically septate, 7-8μ in diameter with 2-4 sterigmata 8-10 × 1-5μ. Spores hyaline, elliptical, one side flattened, 6-8 (-9) × 3-4μ. Hyphæ very fine and closely adherent, hence scarcely to be distinguished.

On very soft, rotten wood, near Effingham, A. A. Pearson, Dec. 15th, 1917.

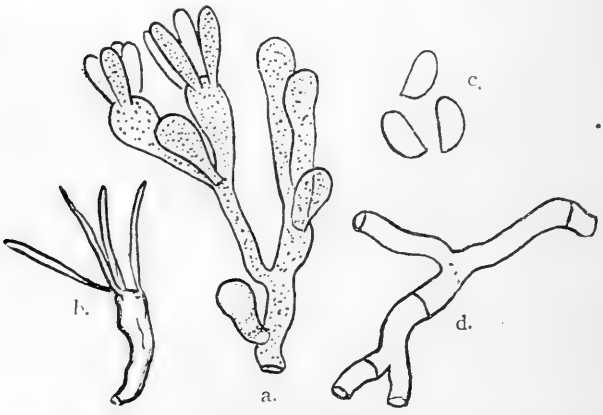
At first sight this plant would suggest a "water-logged" specimen of *Odontia farinacea*. On microscopic examination it is at once distinguished by the septate, *Tremella*-like

basidia, which, however, can only be seen in the fresh specimen, as they collapse completely on drying.

TULASNELLA TREMELLOIDES Wakef. et Pearson, sp. nov.

Sporophorum late effusum, purpureum, gelatinosum, plicato-undulatum, margine concolore. Basidia clavata, 15-18 × 6.5-7μ, 4-sterigmatica, intus granulosa; sterigmata primo oblonga, intus granulosa, 15 × 3-3.5μ, demum collapsa, ad 20μ longa. Sporae ellipsoideae, uno latere depressae, basi lateraliter apiculatae, 8-10 × 4.5-5 (-5.5)μ, hyalinae. Hyphæ subhymeniales 6-8μ, basales 4μ, pallide purpureae. *Hab.* On pine needles covering a nest of *Formica rufa*, L., at the foot of a stump, extending for about a square foot, Weybridge, A. A. Pearson, Nov., 1917.

This fine plant differs from most other species of Tulasnella in the thick gelatinous consistency. When fresh it bears a strong resemblance both in colour and habit to some forms of the conidial stage of *Coryne sarcoides*. *T. fusco-violacea* Bres. is described as being gelatinous when fresh, but that species differs from the present in its longer spores, obovate sterigmata, and in drying lilac. The present species becomes blackish and horny as it dries and collapses to a thin film. It made only a fleeting appearance; the cold wind and a touch of frost shrivelled it up and turned it black.



Tulasnella tremelloides Wakef. et Pearson.
a, Group of basidia of varying ages; b, Old basidium from which spores have been discharged; c, Spores; d, Basal hypha × 850.

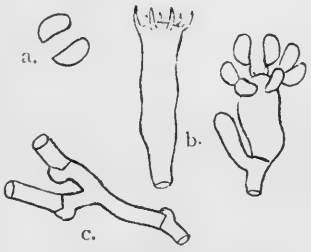
Corticium laeve Pers., *roseo-cremeum* Bres.

Corticium Galzini Bourd. et Galz. This species has hitherto

been recorded on conifers. The Weybridge specimen is noteworthy for occurring on birch bark.

Corticium niveo-cremeum von Hoehn. et Litsch. Oesterr. Corticieen, in Wiener Festschrift, 1908, p. 65. and in Sitzber. k. Akad. Wiss. Wien, Math.-naturw. Kl., Bd. CXVII, 1908, p. 1117.

Effused, indeterminate, very thin, greyish white to cream, closely adherent to the substratum. Hymenium when fresh waxy and slightly granular in places, when dry very minutely and abundantly cracked, giving a characteristic appearance as seen under the lens, the cracks being bridged by numerous fine byssoid strands of the subiculum. Basidia very abundant, more or less clavate, but rather abruptly broader and truncate above, with 4-6-8 (frequently 8) sterigmata, 15-35 × 7-10μ. Spores cylindric-ellipsoid, one side flattened or slightly incurved, 6-7 × 3-3.5μ, occasional spores up to 10 × 5μ. Basal hyphae indistinct, branched, septate, with clamp-connections at the septa, 4-5μ.



Corticium niveo-cremeum v. Hoehn. & Litsch. a, Spores; b, Two basidia; c, Basal hypha × 850.

On a piece of very rotten wood under alders, Weybridge, A. A. Pearson, Jan. 12, 1918.

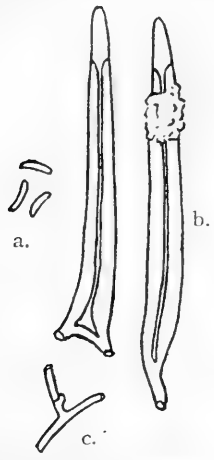
The numerous white species of Corticium are difficult of distinction in words. The present species is marked by a quite characteristic appearance when dry, and in spite of its name is hardly snow-white, but rather greyish white. The basidia and spores are further distinguishing features.

Corticium arachnoideum Berk., *botryosum* Bres., *subcoronatum* von Hoehnel & Litsch., *confluens* Fr., *confine* Bourd et Galz., *sulphureum* Pers., *echinosporum* Ellis (pink form), *comedens* Fr.

Corticium (*Gloeocystidium*) *praetermissum* (Karst.) Bres., *albostramineum* (Bres.) Wakef., *porosum* Berk. et Curt.

Peniophora glebulosa Bres. subsp. *subulata* Bourd. et Galz. in Bull. Soc. Myc. Fr. 1912, p. 385.

Under *P. glebulosa* Bourdot and Galzin distinguish a number of forms, differing in details of spores and cystidia, which they found to be remarkably constant, and designate as "espèces jordaniennes." To give them binominal names which may subsequently be taken up as the equivalent of other specific names, however, as Bourdot and Galzin have done, is to introduce unnecessary difficulties in the practical determination of species. *P. glebulosa* in the aggregate is very distinct in its peculiar type of cystidium combined with its narrow, cylindrical, more or less curved spores. The differences between the various sub-species or micro-species of Bourdot and Galzin are not at all of the same rank as the differences between *P. glebulosa* and any other usual species of Peniophora. The present form is distinguished from the type by its more acute, or subulate cystidia, and by not showing the characteristic cracking when dry from which the type species takes its name.



Peniophora glebulosa Bres. sub sp. *subulata* Bourd. & Galz. a, Spores; b, 2 Cystidia; c, Basal hypha × 550.

Peniphora pallidula Bres., *byssoidea* (Pers.) von Hoehn. et Litsch. (including the thin whitish form which has been distinguished as *P. tomentella* Bres.), *sanguinea* (Fr.) Bres., *cremea* Bres., *velutina* (DC.) Cooke, *setigera* (Fr.) Bres., *hydnoides* Cooke et Mass., *gigantea* (Fr.) Mass., *incarnata* (Pers.) Cooke, *cinerea* (Fr.) Cooke, *quercina* (Pers.) Cooke.

Hypochnus fuscus (Pers.) Karst.

Coniophora puteana Fr., *arida* Fr.

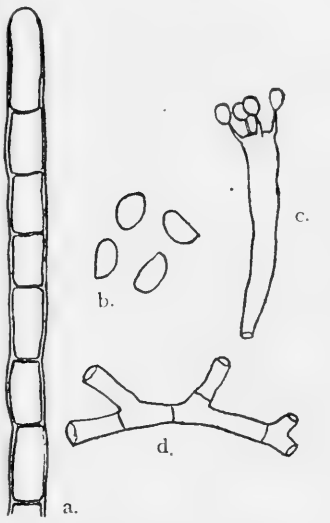
Coniophorella, Karst. Finlands Basidsv. p. 438.

This genus differs from Coniophora only in the possession of long, cylindrical cystidia. Burt in his recent monograph includes it in Coniophora.

C. olivacea (Fr.) Karst, loc. cit. p. 438.

Hypochnus olivaceus Fr. Obs. 2, p. 284; *Coniophora olivacea* Karst, Hattsv. II., p. 162, non auctt. nonnull.

Fructification thinly effused, following the inequalities of the matrix, distinctly olive when fresh, drying to a colour varying between Saccardo's Olive, Buffy citrine, and Isabella colour, the growing margin very thin and whitish. Hymenium setulose under the lens, and pulverulent with the spores. Cystidia cylindrical, brownish, paler and blunt at the apex, many septate, slightly constricted at the septa, 160-290 × 12-18μ projected about 75-100μ. Basidia elongated, tapering gradually downwards, about 40-80μ long, 7-8μ wide above, with 4 curved sterigmata 5-8μ long. Spores rather variable in shape, but more or less elliptical with one side flattened, 10-13 × 4-6 (-7)μ, yellow-brown. Basal hyphae branched, frequently sepate, with clamp-connections, 4-7μ in diameter, clear dark brown.



Coniophorella olivacea **Karst.**
a, Upper portion of cystidium; b, Spores; c, Basidium; d, Basal hypha × 550.

This was found in several places in uprooted pine stumps, which it sometimes takes possession of so completely as to cover the under side with several feet of fruiting surface. The long septate cystidia give the fresh specimens a velvety pruinose appearance, and this, together with the less fleshy texture, distinguishes it from the more common *Coniophora puteana,* which is also at times olive in colour.

This plant is the one identified with *Hypochnus olivaceus* Fr. by Bresadola, who examined the Upsala type. The specimen so labelled by Fries in the Kew Herbarium is a different species, and this appears to have been the reason for the confusion existing in this country as to the identity of *C. olivacea.* Although the name "*Coniophora olivacea*" has been included in the British lists, this appears to be the first time that the true plant with cystidia has been found. Most of the specimens existing under this name in collections are *C. puteana.*

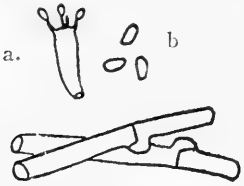
Stereum rugosum (Pers.) Fr., *spadiceum* (Pers.) Fr., *sanguinolentum* (A. S.) Fr., *hirsutum* Fr., *purpureum* (Pers.) Fr.

Hymenochaete rubiginosa (Schrad.) Lév.

Auriculariopsis ampla (Lév.) R. Maire.

Grandinia Brinkmanni (Bres.) Bourd. et Galz. in Bull. Soc. Myc. Fr. xxx., 1914, p. 252. *Odontia Brinkmanni* Bres. in Ann. Myc. I., 1903, p. 88.

Fructification effused, indeterminate, at first pure white, becoming yellowish with age, adherent. Subiculum very thin, at first pruinose, later waxy and cracked. Granules at first very fine, giving a mealy appearance, later more wartlike, or at times even developing into short spines. Basidia clavate, 15 × 4μ, with 4-6 (-8) curved sterigmata, 2-3μ long. Spores elliptical, one side flattened, 4 × 2μ. Hyphæ indistinct, soon, collapsing, up to 4μ in diameter, septate, with clamp connections. The flesh contains numerous crystals of calcium oxalate.



Grandinia Brinkmanni Bourd. & Galz.
a, Basidium; b, Spores; c, Hyphae × 850.

On birch bark, Weybridge, A. A. Pearson, Nov. 24th, 1917.

Recognisable by its finely granular appearance with scanty subiculum, spores, and abundance of crystals in the tissue.

Odontia farinacea (Pers.) Quél. = *Hydnum farinaceum* (Pers.) Fr.

Odontia bicolor (A. et S.) Bres. = *Hydnum bicolor* A. & S. = *Hydnum subtile* Fr.

This is the plant the structure of which was described in these Transactions for 1910, p. 280, under the name *Grandinia mucida*. It was always referred by Berkeley to G. *mucida*, but according to Bresadola it agrees undoubtedly with Fries' *H. subtile*, and is the same as *H. bicolor*.

The peculiar microscopic characters have also been pointed out by von Hohnel, in an article which was overlooked at the time the 1910 note was written.*

*Fragmente zür Mykol. I., in Sitzber. k. Akad. Wiss. Wien, Math.-naturw. Kl., Bd. CXI., Abt. 1, 1902, p. 1008.

Caldesiella ferruginosa Sacc.

Merulius serpens Fr. *lacrymans* (Wulf.) Fr.

Phlebia merismoides Fr.

Irpex obliquus (Schrad.) Fr.

Poria sanguinolenta (A. et S.) Fr.

Poria sericeo-mollis Romell in Arkiv f. Bot., xi., 1912, No. 3, p. 22.

Fructification very soft, white, thick, resupinate, loosely adherent, margin often separating, but scarcely reflexed, or in the dry state sometimes incurved. Hymenium white or at length somewhat cream to pallid. Pores usually angular, variable in diameter. Hyphae septate, with clamp-connections, 2-4μ wide. Basidia 4-spored, $20 \times 5\mu$. Spores ellipsoid, $4\text{-}6 \times 2\text{-}3\mu$.

On rotten coniferous wood.

The above is Romell's description, which agrees very well with a plant found several times near Weybridge on pine wood and bark, and apparently fairly common there. It is rather thick and spongy, but so fragile and hard to gather in good condition that although it must have been seen repeatedly it has probably been put aside as unnameable.

Romell adds, "Some specimens which seem to belong to this species are partly or totally reduced into a floccose-pulveraceous state of sulphurous or pallid colour, which contains abundant subglobose or ellipsoidal, apparently asperulate, 1-guttulate chlamydospores of $5\text{-}7.5 \times 4\text{-}5\mu$, not unlike those of *Ptychogaster albus*, though more hyaline."

This conidial stage is also very evident in the Weybridge specimens. Sometimes the conidia occur only at the margin, at other times the whole fungus appears to be a pale yellow powdery mass of conidia, and the true basidiospores cannot be found. The conidia are smooth, not asperulate, but have granular contents, which give a rough appearance.

Poria sericeo-mollis Romell
a, Basidiospores; b, Conidia × 850.

Polyporus amorphus Fr., *caesius* (Schrad.) Fr., *fragilis* Fr., all in the resupinate state.

Fomes ferruginosus (Fr.) Mass.

Published 17th August, 1918.

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15. Bloom, Rev. James Harvey, 601, Bank Buildings, 329, High Holborn, London, W.C. (1915).
16. Borthwick, Mr. A. W., D.Sc., Royal Botanic Garden, Edinburgh, and 46, George Street, Edinburgh (1911).

17. Boston, The Mycological Club, c/o Miss Jennie F. Conant, 26, Prospect Street, Melrose, Mass., U.S.A. (1906).
18. Boyd, Mr. D. A., St. Clair, Caledonia Road, Saltcoats, N.B. (1906).
19. Brand, Mr. Frederick J., High Beech Road, Loughton, Essex (1918).
20. Brierley, Mr. William B., M.Sc., Institute of Phytopathological Research, Rothamsted Experimental Station, Harpenden (1919).
21. British Museum, The Trustees of, Cromwell Road, South Kensington, London, S.W. 7 (1914).
22. Brooks, Mr. F. T., M.A., The Botany School, Cambridge (1907).
23. Bruxelles, Jardin Botanique de l'Etat (1911).
24. Bryce, Mr. G., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon (1915).
25. Buckley, Mr. W. D., 27, Bengal Road, Ilford, Essex (1916).
26. Buller, Professor A. H. R., D.Sc., Ph.D., F.R.S.C., University of Manitoba, Winnipeg, Canada (1911).
27. Carr, Professor J. W., M.A., University College, Nottingham (1896).
28. Cayley, Miss Dorothy M., John Innes Horticultural Institute, Mostyn Road, Merton, Surrey (1913).
29. Cheesman, Mr. W. Norwood, J.P., F.L.S., The Crescent, Selby (1896).
30. Chicago, The Library, University of, Ill., U.S.A. (1914).
31. Chipp, Mr. Thomas Ford, B.Sc., F.L.S., Assistant Director, Botanic Gardens, Straits Settlements (1919).
32. Clarke, Miss H., M.Sc., Botanical Laboratories, The University, Liverpool (1917).
33. Cleland, Mr. J. Burton, M.D., 93, Macquarie Street, Sydney, New South Wales (1918).
34. Coimbatore, The Librarian, Agricultural College, South India (1918).
35. Cooper, Miss Charlotte A., Hillside Cottage, California Road, Bushey Heath, Herts (1911).
36. Cotton, Mr. Arthur D., F.L.S., Pathological Laboratory, Kew (1902).
37. Curtis, Miss Kathleen M., M.A., c/o Bank of New Zealand, 1, Queen Victoria St., London, E.C. 4 (1917).
38. Darbishire, Dr. O. V., B.A., Ph.D., University College, Bristol (1913).
39. Drinkwater, Mr. Harry, M.D., C.M.Edin., M.R.C.S.Eng., F.R.S.E., F.L.S., J.P., Lister Lodge, Wrexham (1910).
40. Edwards, Mr. W. H., Curator, The Museum, Birmingham (1896).

41.* Elliott, Mrs. J. S. Bayliss, Arden Grange, Tanworth-in-Arden, Warwickshire (1911).
41. Elliott, Dr. W. T., L.D.S., R.C.S., F.Z.S., Arden Grange, Tanworth-in-Arden, Warwickshire (1913).
42. Ellis, Mrs. Annis, 13, Stoney Hey Road, New Brighton, Cheshire (1917).
43. Essex Field Club, c/o Mr. Percy Thompson, F.L.S., Essex Museum of Natural History, Romford Road, Stratford, London, E. 15 (1919).
44. Evans, Mr. William, F.R.S.E., 38, Morningside Park, Edinburgh (1911).
45. Eyre, Miss J. C., Ipplepen, Newton Abbot, Devon (1915).
46. Finlayson, Mr. Raymond, The Parsonage Farm, Downton, Wilts (1910).
47. FitzGerald, Rev. H. P., F.L.S., Lidwells, Goudhurst, Kent (1896).
48. Fraser, Miss H. C. I., D.Sc., F.L.S. (See Mrs. H. C. I. Gwynne-Vaughan.)
49. Fynes-Clinton, Rev. C. E., M.A., St. James' Vicarage, Leyland, Preston (1917).
50. Gardner, Mr. Frederic, 16, Stow Park Avenue, Newport (1898).
51. Goodwin, Mr. D. P., Oakden, Kidderminster (1902).
52. Gould, Mr. F. G., Elmhurst, Church Hill, Loughton, Essex (1918).
53. Grant, Mr. Angus, Drumalan, Drumnadrochit, N.B. (1903).
54. Green, Col. C. Theodore, A.M.S., M.R.C.S.Eng., L.R.C.P. Lond., F.L.S., 31, Shrewsbury Road, Birkenhead (1901).
55. Green, Mr. E. Ernest, F.Z.S., F.E.S., Way's End, Camberley, Surrey (1917).
56. Grinling, Mr. C. H., M.A., 17, Rectory Place, Woolwich (1913).
56.* Gwynne-Vaughan, Mrs. H. C. I., D.Sc., F.L.S., O.B.E., 93, Bedford Court Mansions, London, W.C. 1, and Birkbeck Institute, Chancery Lane, London, W.C. 2 (1906).
57. Hadden, Mr. Norman G., Breezy Bank, West Porlock, Somerset (1911).
58. Harrison, Mr. H. W., formerly of Harboro', Torrington Road, Liscard, Wallasey (1913).
59. Harrison, Mrs. E., formerly of Harboro', Torrington Road, Liscard, Wallasey (1913).
60. Harvey, Mrs. Cecily D., Barwick in Elmet Rectory, near Leeds (1910).
61. Hastings, Mr. Somerville, M.S., F.R.C.S., 43, Devonshire Street, Portland Place, London, W. 1 (1913).

62. Hawley, Sir H. C., Bart., Holly Mount, Hurst Wood, Buxted, Surrey (1907).
63. Hey, Mr. T., 98, Archer Road, Millhouses, Sheffield (1896).
64. Hibbert-Ware, Miss Alice, 3, Chaucer Road, Wanstead, E. 11 (1911).
65. Hildyard, Mr. F. W., 14, Lambridge, Bath (1913).
66. Hiley, Mr. Wilfred E., M.A., Research Institute, School of Forestry, Oxford (1913).
67. Holmes, Mr. E. Morell, F.L.S., F.R.H.S., Ruthven, Sevenoaks, Kent (1906).
68. Holt, Mr. W. H., 17, Ashville Road, Birkenhead (1914).
69. Howard, Mr. H. J., F.R.M.S., 94, Rosary Road, Norwich (1918).
70. Hughes, Mr. G. C., Chesterton, Bicester, Oxon. (1898).
71. Huish, Mr. Charles Henry, F.R.M.S., The Limes, London Road, Redhill, Surrey (1913).
72. Jack, Mr. H. W., B.Sc., B.A., Department of Agriculture, Kuala Lumpur, Federated Malay States, and Waterloo Place, Cork (1913).
73. Johnstone, Mr. R. B., 134, Cambridge Drive, Glasgow (1908).
74. Jones, Mr. Robert Fowler, 8, Lendal, York (1918).
75. Knight, Mr. H. H., The Lodge, All Saints' Villas, Cheltenham (1914).
76. Lister, Mr. A. B., D.I.C., B.Sc. (Lond.), Experimental and Research Station, Turner's Hill, Cheshunt, Waltham Cross, Herts (1916).
77. Lister, Miss Gulielma, F.L.S., Leytonstone, Essex, and Highcliff, Lyme Regis (1903).
78. Lloyd, Mr. C. G., The Lloyd Library and Museum, 224, West Court Street, Cincinnati, Ohio, U.S.A. (1907).
79. Macfie, Dr. John William Scott, M.A., D.Sc., 21a, Alfred Street, Liverpool (1900).
80. Mackenzie, Mr. D., Afton, Busby, N.B. (1900).
81. Main, Mr. Robert, 1, Roslyn Avenue, Low Fell, Gateshead (1918).
82. Maire, Dr. René, D.Sc., Professeur à la Faculté des Sciences de l'Université, Algers (Algeria) (1907).
83. Maitland, Mr. T. D., Curator, Botanic Gardens, Entebbe, Uganda (1916).
84. Marmont, Mr. Basil P., Windsoredge House, Inchbrook, near Woodchester, Gloucestershire (1908).
85. Mason, Mr. F. A., F.R.M.S., M.S.P.A., The Laboratory, 3, Queen's Square, Leeds (1912).
86. Menzies, Mr. James, 24, King Edward Street, Perth (1917).

87. Minnesota, The Library, University of, Minneapolis, U.S.A. (1915).
88. Missouri, The Botanical Garden, St. Louis, Mo., U.S.A. (1902).
89. Montague, Mrs. A., Penton, Crediton, N. Devon (1898).
90. Newcastle-upon-Tyne, Literary and Philosophical Society (1902).
91. Newman, Mr. Leslie F., M.A., F.L.S., Dip. Agr. Cantab., School of Agriculture, Cambridge (1906).
92. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904).
93. Nicholson, Mr. Charles, F.E.S., 35, The Avenue, Hale End, Chingford, N.E. (1916).
94. Nicholson, Mr. W. E., Lewes (1913).
95. Noel, Miss E. F., F.L.S., 37, Moscow Court, London, W. (1913).
96. Ogle, Mr. B. S., Hill House, Steeple Aston, Oxon. (1904).
97. Oke, Mr. Alfred William, B.A., LL.M., F.G.S., F.L.S., 32, Denmark Road, Hove (1908).
98. O'Loughlin, Miss Bessie, Rocklands, Wallasey, Cheshire (1913).
99. Osborn, Professor Theodore George Bentley, M.Sc., Adelaide University, South Australia (1910).
100. Paul, The Very Rev. David, LL.D., D.D., 53, Fountainhall Road, Edinburgh (1899).
101. Paulson, Mr. Robert, F.L.S., F.R.M.S., Glenroy, Cecil Park, Pinner, Middlesex (1918).
102. Peacock, Dr. H. G., Hareston Lodge, Torquay (1896).
103. Pearson, Mr. Arthur A., F.L.S., 59, Southwark Street, London, S.E. 1 (1911).
104. Peck, Mr. A. E., Tosti, 20, Avenue Road, Scarborough (1918).
105. Peltereau, Monsieur E., Vendôme (Loir-et-Cher), France (1909).
106. Perceval, Mr. Cecil H. Spencer, Longwitton Hall, Morpeth (1901).
107. Petch, Mr. T., B.A., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon (1911).
108. Pethybridge, Dr. G. H., Department of Agriculture and Technical Instruction for Ireland, Royal College of Science, Upper Merrion Street, Dublin (1919).
109. Phillips, Professor Reginald W., M.A., D.Sc., F.L.S., University College, Bangor (1911).
110. Plowright, Mr. Charles Tertius Maclean, B.A., M.B., King Street, King's Lynn (1901).

111. Potter, Professor M. C., Sc.D., M.A., F.L.S., Armstrong College, Newcastle-upon-Tyne (1896).
112. Potts, Mr. George, Benthall House, Broseley, Salop (1910).
113. Price, Mr. S. Reginald, B.A., Fernleigh, Wellington, Somerset (1911).
114. Priestley, Professor J. H., B.Sc., F.L.S., Botanical Department, University of Leeds (1912).
115. Priestley, Mrs. Marion E., 10, Monk Bridge Road, Headingley, Leeds (1919).
116. Ramsbottom, Mr. J., M.A., F.L.S., O.B.E., British Museum, Cromwell Road, South Kensington, London, S.W. 7 (1910).
117. Ramsbottom, Mr. J. K., c/o Geo. Monro, Ltd., 4, Tavistock Garden, Covent Garden, W.C. 2.
118. Rayner, Mr. J. F., Swaythling, Southampton (1902).
119. Rea, Mrs. E. A., 6, Barbourne Terrace, Worcester (1896).
120. Richards, Mr. R. M., A.R.C.S., The Laboratory, Caledonia Estate, Province Wellesley, Straits Settlements (1915).
121. Robson, Mr. R., M.Sc., F.Z.S., Writtle, Chelmsford, Essex (1914).
122. Rushton, Mr. W., A.R.C.S., D.I.C., 13, Grandison Road, Clapham Common, London, S.W. 11 (1914).
123. Saunders, Miss E. R., F.L.S., Newnham College, Cambridge (1913).
124. Selborne Society, 42, Bloomsbury Square, London, W.C. 1 (1913).
125. Sharpe, Mr. C. J., Brambleside, Manor Road, Sidcup (1905).
126. Simon, Monsieur Eugène, 16, Villa Saiid, Paris (1906).
127. Small, Mr. W., M.A., Government Botanist, Department of Agriculture, Kampala, Uganda (1915).
128. Smith, Miss Annie Lorrain, F.L.S., 20, Talgarth Road, West Kensington, London, W. 14 (1899).
129. Smith, Miss K. E., 64, Coton Road, Nuneaton (1913).
130. Smith, Mr. Thomas, 25, Lyme Street, Stockport (1918).
131. Stoward, Dr. F., 69, Tate Street, Leederville, Western Australia (1914).
132. Sutherland, Mr. G. K., M.A., B.Sc., University College, Southampton (1914).
133. Swanton, Mr. E. W., Brockton, Haslemere (1899).
134. Tabor, Mr. Richard John, B.Sc., F.L.S., Imperial College of Science and Technology, South Kensington, London, S.W. 7 (1914).

135. Tatum, Mr. E. J., Salisbury (1896).
136. Taylor, Miss Beatrice Katherine, 98, Cheyne Walk, Chelsea, London, S.W. 3 (1910).
137. Temperley, Mr. Nicholas, 4, Carlton Terrace, Low Fell, Gateshead-on-Tyne (1918).
138. Thomas, Mr. H. Hamshaw, M.A., The Botany School, Cambridge (1910).
139. Thomson, Miss Mary R. H., 34, Barrowgate Road, Chiswick, London, W. 4, and Cape Town (1917).
140. Tothill, Lieut. Vincent, R.A.M.C., Ilketshall, St. Andrew, Bungay, Suffolk (1912).
141. United States, Department of Agriculture (1907).
142. Vines, Professor S. H., M.A., D.Sc., F.R.S., Botanic Garden, Oxford (1915).
143. Wager, Dr. H., F.R.S., F.L.S., Hendre, Horsforth Lane, Far Headingley, Leeds (1896).
144. Wakefield, Miss E. M., F.L.S., Herbarium, Royal Botanic Gardens, Kew (1911).
145. Watkin, Mr. J., 38, Park Avenue, Oswestry (1909).
146. Wheldon, Mr. H. J., Cubbington, Leamington Spa (1917).
147. Whetzel, Professor H. H., Cornell University, Ithaca, New York (1914).
148. Wilson, Mr. Malcolm, D.Sc., A.R.C.S., F.L.S., Royal Botanic Garden, Edinburgh (1912).
149. Woolhope, The, Naturalists' Field Club, Hereford, c/o Mr. C. S. Scobie, 2, Offa Street, Hereford (1896).

Elected since the above went to Press.

Alcock, Mrs. N. L., Pathological Laboratory, Kew.
Beer, Mr. Rudolph, B.Sc., F.L.S., Pathological Laboratory, Kew.
Cheel, Mr. E., Botanic Gardens, Sydney, South Australia.
Clarke, Dr. Henry, Cournswood, North Dean, High Wycombe.
Morris, Mr. T. N., B.A., Dip. Agr. (Cantab.), St John's College, Cambridge.
Mysore, The Library, University of.
Owen, Miss M. Nest, The Botany School, Cambridge.

Members deceased.

Sir Charles Thomas Dyke Acland (Bart.).
Mr. C. O. Farquharson, B.Sc., M.A.
Mr. Thomas Gibbs.

THE SELBY FORAY.

9th–14th September, 1918.

The twenty-second annual week's Fungus Foray was held at Selby, from September 9th to September 14th, 1918. Until immediately before the Foray the weather unfortunately had been very dry, and the harvest of fungi was therefore smaller than had been expected in such a favourable locality. Microfungi were fairly varied. As a rule these follow quickly after rainy weather has set in.

The meeting was held in conjunction with that of the Yorkshire Naturalists' Union, and the latter, with a few members of the British Mycological Society, began work on the previous Saturday, September 7th. Bishop's Wood, Camblesforth, Cliffe Common and Staynor Wood were visited, and consequently a number of fungi had been collected and laid out for inspection by the time the majority of the party assembled.

The headquarters were at the Londesborough Arms Hotel, where a large room was available for holding meetings and exhibiting the specimens. Here on Monday evening, September 9th, Dr. H. Wager opened the proceedings by delivering an interesting and suggestive popular address on "Fungi" to a large audience composed of members of both Societies and of the Selby Natural History Society. After the lecture members examined the various exhibits which had been brought. Mr. H. J. Wheldon showed a small collection of water-colour drawings of Lichens, Ascomycetes, and Uredineae. Miss E. M. Blackwell had brought from the sand-dunes near Liverpool a tufted form of *Mycena acicula*, and Miss C. A. Cooper showed specimens of *Tricholoma sordidum* and *Lentinus lepideus* from Castleford.

On Tuesday morning the party booked by the 11.23 a.m. train to Burton Salmon. During an hour's wait at Church Fenton, necessitated by the vagaries of the train service, a few common species were found. On arrival at Burton Salmon the party at once set out for Byram Park, permission to visit which had been given by Sir John Ramsden. The grounds were thoroughly explored, and a fair number of interesting fungi secured, particularly pasture-loving Agarics. *Lepiota Bucknallii*, easily recognised by its smell of gas-tar, *Tricholoma acerbum*, *Pluteus ephebius*, *Leptonia sericella*, *L. incana*, *L. chalybea*,

Inocybe Godeyi, I. rhodiola, Psaliota villatica, Corticium lactescens, exuding white latex when perfectly fresh and in good condition, *Odontia fimbriata,* and *Clavaria rosea* (the latter collected by Col. Barr), were amongst the most interesting species identified in the field. Subsequently *Galactinia Howsei**, new to Britain, and *Orbilia curvatispora,* first recorded by Dr. Bayliss Elliott in 1917, were determined. Miss A. Lorrain Smith reported finding *Stysanus cybosporus* Sacc., which has been previously recorded from near Birmingham. The tufts are greenish-grey in colour and of lax growth; the fertile hyphae gradually develop long strings of cube-like conidia.

On the following day, after a morning's work in examining specimens, the afternoon was spent in exploring the woods at Escrick. Fewer fungi of interest were found here than on the previous day, the larger fungi especially being represented mainly by common species. Among the smaller forms, however, a few rare species were obtained. Miss A. Lorrain Smith collected for the first time in Britain *Hypochnus umbrinus*†, one of the darkest of the species of Hypochnus, and noteworthy for its very compact hymenium. Some fine specimens of *Peniophora aurantiaca* and of *Pistillaria quisquiliaris* occurred, and Dr. Bayliss Elliott afterwards reported having found *Urceolella puberula* growing on larch, an unusual host. Among microfungi the best find was *Arthroderma Curreyi* Berk., the minute golden-yellow fluffy perithecia of which grew in abundance on vegetable debris; it is an interesting and very rare fungus. *Menispora ciliata,* with its very distinctive spores, ciliate at each end, formed a felt of brown hyphae on the bark of a decaying branch. With it was associated *Dactylella ellipsospora*; the long slender conidiophores with a somewhat massive spore swaying to and fro with any current of air were easily visible with a hand lens. *Morticrella candelabrum* also appeared on the same branch. *Botrytis argillacea,* another unusual mould, formed a dense, dull brownish felt on dead bark; the stoutish short branches are subverticillate, and terminate in a knob covered with small projections on which the spores are borne.

On Wednesday the party took the 12.35 p.m. train to Garforth, where they were met by the Rev. R. H. Harvey, who acted as leader. The programme was to visit Parlington Park and Lotherton, by permission of Col. Gascoigne, but as so much of interest was found there was not time to visit the latter place. This was by far the best day of the week both for the numbers and interest of the fungi found. *Lepiota castanea* with its curious "projectile-shaped" spores, *Tricholoma immundum,*

* For description see p. 133.

† For description see p. 132.

THE BRITISH MYCOLOGICAL SOCIETY. SELBY FORAY, 9TH TO 14TH SEPT. 1918

E. Blackwell R. H. Harvey R. F. Jones
K. M. Curtis M. Thompson N. Temperley C. J. Sharpe E. E. Green T. Smith R. Barr

C. D. Harvey A. Hibbert-Ware Mrs Potter E. M. Wakefield H. Clarke A. A. Pearson F. A. Mason A. D. Cotton W. T. Elliott
E. A. Rea M. C. Potter C. Rea (*Hon. Sec.*) D. Paul (*President*) G. Lister H. Wager A. L. Smith
G. Fysher H. J. Wheldon W. N. Cheesman V. Rea C. A. Cooper A. E. Peck J. S Bayliss Elliott

Marasmius pruinatus, Entoloma ameides, Leptonia incana, Coprinus picaceus, last found at Haslemere in 1912, and *Boletus porphyrosporus* were among the best of the higher fungi. A charming group of the light ochraceous sporophores of *Cyphella cernua,* new to Yorkshire, grew on branches of *Sambucus nigra.* On the branches of the same tree were numerous groups of the perithecia of *Gibberella pulicaris,* distinguished by the beautiful blue colour as seen in a thin section. The minute yellow pycnidia of *Zythia mercurialis* Kickx, dotted the leaves of the Dog Mercury; it is a new record for Britain*. Other moulds, such as *Botrytis cinerea, Cladosporium, Penicillium,* etc., were abundant everywhere, and are included in the Foray list.

Some of the moulds were only noted after placing the vegetable substratum in a moist chamber for a time. On some of the debris from Parlington Park there appeared after a lapse of some weeks a beautiful growth of one of the Myxobacteriaceae. It agrees in colour and in cocci with *Myxococcus pyriformis,* recorded in Trans. Brit. Myc. Soc. III, 1909, p. 82. The form is slightly different, as some of the bodies of bacteria rest on a broader basis than those of previous gatherings.

Staynor Wood, visited on the Friday, yielded little of interest. *Russula azurea, R. punctata* and *Collybia xanthopus* occurred, the latter very close to *C. dryophila* and perhaps only a form of that species, distinguished by its larger size and different shape. *Pluteus nanus* var. *lutescens,* with its yellow stem, and the large *Galera ovalis* were also noted. *Hypochnus isabellinus,* new to Britain†, was collected and handed to Miss A. Lorrain Smith as a mould. It is distinguished among the species of Hypochnus by its isabelline colour, so that at first sight it might suggest a Botrytis. Examination with the microscope, however, at once reveals that it is a Basidiomycete. Very few microfungi occurred on this day, and none of any special interest.

In the evenings, as usual, papers were read and exhibits shown. Dr. Paul's Presidential Address, "On the Earlier Study of Fungi in Britain," was listened to by a large and appreciative audience. Dr. H. Wager gave two interesting papers, on "Spore Coloration in the Fungi," and on "A Fluorescent Colouring-matter from *Leptonia incana.*" As *L. incana* was found during the Foray, Dr. Wager was able to demonstrate from fresh specimens. Mr. H. J. Wheldon read "Observations on some Sand-dune Fungi," and exhibited a specimen of *Ustilago hypodytes* on *Elymus arenaria,* sent by Mr. J. A.

* For description see p. 155.

† For description see p. 133.

Wheldon from the Formby sand-dunes. Mr. A. D. Cotton contributed notes on "Some New or Rare British Fungi," specimens of which he exhibited. The fungi in question were Onion Smut (*Urocystis cepulae*), Oak Mildew (*Microsphaera alphitoides*) on coppiced Beech, and an unidentified fungus, suggesting one of the Ustilagineae, causing large galls on the roots of *Lamium album*.

At the business meetings, Officers and Council for the year 1919 were elected, and a draft of revised Rules was prepared. Full notice of the changes made has already been given to all members. A list of Officers and Council appears on p. ii of the cover. In recognition of his past services to the Society, Mr. Carleton Rea was unanimously elected an Honorary Member. He is the third. Honorary Member, and the first British mycologist to whom the honour has been granted.

At the concluding meeting votes of thanks were passed to Mr. W. N. Cheesman, for his energy and kindness in arranging for the comfort of the party, to Dr. Paul for presiding, and to the various proprietors and factors who had given facilities for visiting their estates.

The Hon. Secretary is much indebted to Miss A. Lorrain Smith for assistance in drawing up the above report, and has to thank in addition Mr. Carleton Rea, Mr. A. A. Pearson, Mr. H. J. Wheldon, and Dr. Bayliss Elliott for help in compiling the subjoined list of species gathered.

As a rule, where no locality is specified, the species listed was found generally in all the places visited.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

By. = Byram Park; *B.W.* = Bishop's Wood; *Cl.* = Cliffe Common; *C.* = Camblesforth; *S.* = Staynor Wood; *P.* = Parlington Park; *E.* = Escrick.

Amanita phalloides (Vaill.) Fr., mappa Fr., muscaria (Linn.) Fr., rubescens (Pers.) Fr., strobiliformis Vitt., *P.*

Amanitopsis vaginata (Bull.) Roze, fulva (Schaeff.) W. G. Sm.

Lepiota procera (Scop.) Fr., *E.*, rachodes (Vitt.) Fr., *E.*, acute-squamosa (Weinm.) Fr., *E.*, castanea Quél., *P.*, felina (Pers.) Fr., *E.*, cristata (A. & S.) Fr., granulosa (Batsch) Fr., *S.*, amaianthina (Scop.) Fr., *C.*, Bucknallii Berk. & Br., *By.*

Tricholoma albobrunneum (Pers.) Fr., *B.W.*, rutilans (Schaeff.) Fr., *P.*, immundum Berk., *P.*, terreum (Schaeff.) Fr.,

B.W., *By.*, *P.*, argyraceum (Bull.) Fr., *P.*, cuneifolium Fr., *By.*, personatum Fr., *S.*, melaleucum (Pers.) Fr., *P.*

Clitocybe clavipes (Pers.) Fr., *By.*, odora (Bull.) Fr., *By.*, rivulosa (Pers.) Fr., *By.*, infundibuliformis (Schaeff.) Fr., flaccida (Sow.) Fr., *C.*, ditopus Fr., *P.*, *S.*, fragrans (Sow.) Fr., *B.W.*, *By.*, *P.*

Laccaria laccata (Scop.) Berk. & Br.

Collybia radicata (Relh.) Berk., *By.*, *P.*, *S.*, platyphylla Fr., *Cl.*, *B.W.*, *E.*, fusipes (Bull.) Berk., *P.*, maculata (A. & S.) Fr., *C.*, *E.*, distorta Fr., *E.*, velutipes Fr., *By.*, confluens (Pers.) Fr., *Cl.*, *B.W.*, *E.*, *P.*, cirrhata (Pers.) Fr., *B.W.*, *E.*, *S.*, tuberosa (Bull.) Fr., *E.*, xanthopus Fr., *S.*, dryophila (Bull.), *E.*, *P.*, *S.*, aquosa (Bull.) Fr., *B.W.*, *E.*, *S.*

Mycena olivaceo-marginata Mass., pura (Pers.) Fr., *By.*, *P.*, rugosa Fr., *Cl.*, *B.W.*, *E.*, galericulata (Scop.) Fr., inclinata Fr., *E.*, ammoniaca Fr., *By.*, *P.*, *S.*, vitilis Fr., *Cl.*, *S.*, acicula (Schaeff.) Fr., *P.*, haematopus (Pers.) Fr., *Cl.*, *B.W.*, *P.*, sanguinolenta (A. & S.) Fr., galopus (Pers.) Fr., var. nigra Fl. Dan., var. alba Fl. Dan., rorida Fr., *S.*, stylobates (Pers.) Fr., *C.*, *E.*, tenerrima Berk., *B.W.*, *P.*

Omphalia fibula (Bull.) Fr., var. Swartzii Fr., *E.*, gracilis Quél., *P.*

Pleurotus ostreatus (Jacq.) Fr., *P.*, applicatus (Batsch) Berk., *C.*, *By.*, *E.*, *P.*

Hygrophorus chrysodon (Batsch) Fr., *S.*, pratensis (Pers.) Fr., *By.*, *E.*, virgineus (Wulf.) Fr., *By.*, niveus (Scop.) Fr., *Cl.*, ceraceus (Wulf.) Fr., *B.W.*, coccineus (Schaeff.) Fr., *By.*, conicus (Scop.) Fr., *By.*, *E.*, *P.*, psittacinus (Schaeff.) Fr., *By.*, *E.*, *P.*

Lactarius turpis (Weinm.) Fr., blennius Fr., *By.*, pallidus (Pers.) Fr., *By.*, quietus Fr., rufus (Scop.) Fr., *Cl.*, *E.*, glyciosmus Fr., *E.*, serifluus (DC.) Fr., *E.*, subdulcis (Pers.) Fr., *By.*, *S.*

Russula nigricans (Bull.) Fr., *Cl.*, *S.*, adusta (Pers.) Fr., *P.*, chloroides (Krombh.) Bres., *P.*, mustelina Fr., *Cl.*, *S.*, furcata (Pers.) Fr., *B.W.*, *S.*, virescens (Schaeff.) Fr., *E.*, lepida Fr., *Cl.*, *S.*, atropurpurea (Krombh.) Maire, *E.*, xerampelina (Schaeff.) Fr., *Cl.*, *B.W.*, vesca Fr., *Cl.*, *E.*, *S.*, cyanoxantha (Schaeff.) Fr., *P.*, *S.*, pectinata (Bull.) Fr., *E.*, foetens (Pers.) Fr., *Cl.*, *B.W.*, *E.*, subfoetens W. G. Sm., *By.*, fellea Fr., *By.*, *S.*, emetica (Schaeff.) Fr., *E.*, azurea Bres., *S.*, ochroleuca (Pers.) Fr., fragilis (Pers.) Fr., var. nivea (Pers.) Cooke, *E.*, punctata Gill., *S.*, lutea (Huds.) Fr., *S.*

Nyctalis parasitica (Bull.) Fr., *E.*
Marasmius peronatus (Bolt.) Fr., *B.W.*, *E.*, *S.*, oreades (Bolt.) Fr., ramealis (Bull.) Fr., *Cl.*, *B.W.*, *S.*, rotula (Scop.) Fr., *C.*, androsaceus (Linn.) Fr., *C.*, *E.*, *S.*, pruinatus Rea, *P.*
Crinipellis stipitarius (Fr.) Pat., *C.*
Pluteus cervinus (Schaeff.) Fr., ephebius Fr., *By.*, salicinus (Pers.) Fr., *Cl.*, *P.*, nanus (Pers.) Fr., *E.*, var. lutescens Fr., *By.*, *S.*
Entoloma ameides Berk. & Br., *P.*, jubatum Fr., *C.*, *E.*, griseocyaneum Fr., *By.*, sericeum (Bull.) Fr.
Clitopilus prunulus (Scop.) Fr., *By.*
Leptonia lampropus Fr., *By.*, *E.*, chalybea (Pers.) Fr., *By.*, incana Fr., *By.*, *P.*, sericella (Fr.) Quél., *C.*, *B.W.*, *By.*
Nolanea pascua (Pers.) Fr., proletaria Fr., *Cl.*, *B.W.*, *P.*, *S.*, papillata Bres., *By.*
Eccilia griseorubella (Lasch) Fr., *E.*
Claudopus variabilis (Pers.) W. G. Sm., *C.*
Pholiota ombrophila Fr., *By.*, squarrosa (Müll.) Fr., *P.*, spectabilis Fr., *Cl.* marginata (Batsch) Fr., *Cl.*, *S.*
Inocybe cincinnata Fr., *By.*, *S.*, rhodiola Bres., *By.*, fastigiata (Schaeff.) Fr., *E.*, Godeyi Gill., *By.*, rimosa (Bull.) Fr., *B.W.*, *By.*, *E.*, *S.*, duriuscula Rea, *B.W.*, asterospora Quél., *Cl.*, proximella Karst., *By.*, geophylla (Sow.) Fr. conformata Karst., *B.W.*
Hebeloma fastibile Fr., *P.*
Flammula sapinea Fr., *Cl.*, *B.W.*, *By.*, *P.*, *S.*, alnicola Fr., *P.*
Naucoria sobria Fr., *By.*, escharoides Fr., *S.*, graminicola (Nees) Fr., *S.*
Pluteolus aleuriatus Fr., *C.*, *B.W.*, *By.*
Galera tenera (Schaeff.) Fr., *C.*, *By.*, *E.*, ovalis Fr., *S.*, hypnorum (Schrank) Fr., *C.*, *B.W.*, *E.*
Tubaria furfuracea (Pers.) W. G. Sm., crobulus Fr., *P.*, *S.*, inquilina Fr., *B.W.*
Crepidotus mollis (Schaeff.) Fr., *P.*
Cortinarius (Dermocybe) lepidopus Cooke, *B.W.*, (Telamonia) hinnuleus (Sow.) Fr., *Cl.*, *E.*, *P.*, *S.*, rigidus (Scop.) Fr., *E.*, *P.*, (Hydrocybe) castaneus (Bull.) Fr., *S.*
Paxillus involutus (Batsch) Fr., panuoides Fr., *P.*
Psaliota villatica (Brond.) Fr., *By.*, arvensis (Schaeff.) Fr., *S.*, xanthoderma (Genev.) W. G. Sm., *By.*, campestris (Linn.) Fr., sylvicola (Vitt.) Fr., *By.*
Stropharia aeruginosa (Curt.) Fr., *E.*, *P.*, *S.*, squamosa (Pers.) Fr., *P.*, semiglobata (Batsch) Fr., coronilla (Bull.) Fr., *By.*, *P.*
Hypholoma capnoides Fr., *C.*, fasciculare (Huds.) Fr., epixan-

thum Fr., *C.*, velutinum (Pers.) Fr., appendiculatum (Bull.) Fr., *C.*, *By.*, pilulaeforme (Bull.) Fr., *By.*, *E.*, *P.*, hydrophilum (Bull.) Fr., *Cl.*, *B.W.*, *E.*, *P.*, *S.*

Psilocybe uda (Pers.) Fr., *C.*, *S.*, bullacea (Bull.) Fr., *B.W.*, semilanceata Fr., foenisecii (Pers.) Fr.

Psathyra corrugis (Pers.) Fr., *Cl.*, *By.*, *P.*, *S.*, obtusata Fr., *P.*, fibrillosa (Pers.) Fr.

Bolbitius titubans (Bull.) Fr., *Cl.*

Coprinus atramentarius (Bull.) Fr., *By.*, *S.*, *E.*, *P.*, picaceus Fr., *P.*, cinereus (Schaeff.) Fr., *B.W.*, *E.*, *P.*, *S.*, niveus (Pers.) Fr., *Cl.*, *By.*, *P.*, micaceus (Bull.) Fr., *E.*, *P.*, radiatus Fr., *B.W.*, plicatilis (Curt.) Fr., *By.*, *E.*, hemerobius Fr., *By.*, ephemerus Fr., *By.*

Panaeolus sphinctrinus Fr., *C.*, *E.*, campanulatus (Linn.) Fr., *By.*, *E.*, *P.*, papilionaceus (Bull.) Fr., *E.*, *S.*

Anellaria separata (Linn.) Karst., *Cl.*, *E.*, *P.*

Psathyrella gracilis (Pers.) Fr., *By.*, *E.*, *P.*, *S.*, hiascens Fr., *Cl.*, atomata Fr., *C.*, *By.*, *E.*, crenata (Lasch) Fr., *By.*, disseminata (Pers.) Fr.

Gomphidius viscidus (Linn.) Fr., *By.*

Boletus luteus (Linn.) Fr., *B.W.*, elegans (Schum.) Fr., *B.W.*, *E.*, *P.*, chrysenteron (Bull.) Fr., *B.W.*, *S.*, versicolor Rost., *Cl.*, subtomentosus (Linn.) Fr., *E.*, *S.*, pruinatus Fr., *By.*, edulis (Bull.) Fr., *S.*, luridus (Schaeff.) Fr., *By.*, porphyrosporus Fr., *P.*, scaber (Bull.) Fr., *Cl.*, *E.*, felleus (Bull.) Fr., *E.*, *S.*

Strobilomyces strobilaceus (Scop.) Berk., *By.*

Fistulina hepatica (Huds.) Fr., *C.*, *E.*, *P.*

Polyporus rufescens (Pers.) Fr., *E.*, squamosus (Huds.) Fr., *By.*, *P.*, hispidus Fr., *C.*, *E.*, *P.*, rutilans (Pers.) Fr., *B.W.*, adustus (Willd.) Fr., *C.*, *By.*, *S.*, caesius (Schrad.) Fr., *P.*, betulinus (Bull.) Fr., *By.*, *P.*

Fomes applanatus (Pers.) Wallr., *B.W.*, *By.*, *P.*, nigricans Fr., *B.W.*, igniarius Fr., *B.W.*, connatus Fr., *S.*, annosus Fr., *C.*, *P.*, ferruginosus (Fr.) Mass., *C.*

Polystictus versicolor (Linn.) Fr., velutinus Fr., *By.*

Poria eupora Karst., *By.*, hymenocystis Berk. & Br., *P.*

Daedalea quercina (Linn.) Fr., *C.*, *E.*

Merulius lacrymans (Wulf.) Fr., *Cl.*

Hydnum udum Fr., *By.*

Caldesiella ferruginosa (Fr.) Sacc., *P.*

Irpex obliquus (Schrad.) Fr.

Odontia alutacea (Fr.) Quél., *By.*, fimbriata (Pers.) Fr., *B.W.*, *By.*, farinacea (Pers.) Quél., *B.W.*, *By.*, *P.*, *S.*

Grandinia granulosa Fr., *By.*, *P.*

Thelephora laciniata (Pers.) Fr., *C.*, *B.W.*, *E.*

Stereum hirsutum (Willd.) Fr., purpureum (Pers.) Fr., *P.*, spadiceum (Pers.) Fr., *E.*, *P.*, sanguinolentum (A. & S.) Fr., *B.W.*, rugosum (Pers.) Fr., *S.*

Hymenochaete rubiginosa (Schrad.) Lév., *B.W.*

Corticium laeve (Pers.) Fr., *P.*, arachnoideum Berk. & Br., *C.*, Sambuci (Pers.) Fr., botryosum Bres., *S.*, subcoronatum von Hoehn. & Litsch., *B.W.*, *P.*, *S.*, confluens Fr., confine Bourd. & Galz., *By.*, *S.*, sulphureum (Pers.) Bres., *C.*, *P.*, praetermissum (Karst.) Bres., *By.*, lactescens Berk., *By.*, albostramineum (Bres.) Wakef., *C.*, *P.*

Peniophora subalutacea (Karst.) von Hoehn. & Litsch., *By.*, velutina (DC.) Cooke, *C.*, *P.*, setigera (Fr.) Bres., *C.*, pubera (Fr.) Mass., *C.*, *By.*, *P.*, aurantiaca Bres., *E.*, cinerea (Fr.) Cooke, *By.*, *P.*, quercina (Pers.) Cooke, *By.*, *B.W.*, *P.*

* Hypochnus umbrinus (Fr.) Quél., *E.* (new to Britain), *isabellinus Fr. (new to Britain), *S.*

Coniophora puteana (Schum.) Fr., *B.W.*, *By.*, *P.*, *S.*

Cyphella cernua Mass., *P.*, villosa (Pers.) Karst., *By.*

Clavaria cinerea (Bull.) Fr., *C.*, *E.*, *P.*, *S.*, cristata (Holmsk.) Fr., *C.*, *S.*, muscoides (Linn.) Fr., *By.*, *E.*, inaequalis (Müll.) Fr., *B.W.*, *S.*, persimilis Cotton, *By.*, vermicularis Fr., *By.*, fumosa (Pers.) Fr., *By.*, rosea (Dalm.) Fr., *By.*

Typhula erythropus (Bolt.) Fr., *S.*

Pistillaria quisquiliaris Fr., *E.*, pusilla Berk., *C.* (on poplar leaves).

Auricularia auricula-Judae (Linn.) Schroet., *C.*, *B.W.*, *P.*, *S.*

Exidia albida (Huds.) Bref., *P.*

Tremella mesenterica (Retz.) Fr., *S.*

Dacryomyces deliquescens (Bull.) Duby, *B.W.*, stillatus (Nees) Fr., *C.*, *By.*, *P.*, *S.*

Calocera viscosa (Pers.) Fr., *C.*, *P.*, cornea (Batsch) Fr., *Cl.*, *By.*, *P.*, *S.*

Phallus impudicus (Linn.) Pers., *C.*, *E.*, *P.*

Mutinus caninus (Huds.) Fr., *C.*, *B.W.*, *E.*, *P.*

Sphaerobolus stellatus (Tode) Pers., *B.W.*, *P.*, *S.*

Cyathus vernicosus (Bull.) DC., *E.*, *S.*, striatus (Huds.) Pers., *E.*, *P.*

Crucibulum vulgare Tul., *E.*, *P.*, *S.*

Bovista plumbea Pers., *By.*

Lycoperdon depressum Bon., *Cl.*, *E.*, pyriforme (Schaeff.) Pers., *B.W.*, *E.*, *P.*, umbrinum Pers., *E.*, perlatum Pers., *B.W.*, *P.*, giganteum (Batsch) Pers., *B.W.*

* For descriptions see pp. 132, 133.

Geaster fimbriatus Fr., *P.*
Scleroderma vulgare Hornem., *By.*, *E.*, *S.*, verrucosum (Bull.) Pers., *E.*
Puccinia Violae (Schum.) DC., *B.W.*, Malvacearum Mont., *B.W.*, obtegens (Linn.) Tul., *By.*, obscura Schroet. (Aecidium on *Bellis perennis*), *C.*, Poarum Niels. (Aecidium on *Tussilago*), *P.*, glumarum (Sch.) Erikss., *E.*, dispersa Erikss. & Henn., *E.*
Coleosporium Tussilaginis (Pers.) Kleb., *Cl.*
Sphacelotheca Hydropiperis (Schum.) de Bary, *S.*
Ustilago Avenae (Pers.) Jens., *E.*, *P.*
Podosphaera oxyacanthae (DC.) de Bary, *By.*
Sphaerotheca pannosa (Wallr.) Lév., *By.*
Microsphaera grossulariae (Wallr.) Lév., *E.*
Erysiphe communis (Wallr.) Fr., on *Circaea*, *P.*, *Heracleum*, *By.*, *Polygonum aviculare*, *C.*, cichoracearum (DC.) Fr., on *Lappa*, *By.*, *P.*, graminis (DC.) Fr., *By.*
Nectria cinnabarina (Tode) Fr., episphaeria (Tode) Fr., coccinea (Pers.) Fr., Peziza (Tode) Fr., *P.* (on *Polyporus squamosus*).
Hypocrea gelatinosa (Tode) Fr., *S.*
Hypomyces aurantius (Pers.) Fuck. (on *Polystictus velutinus*), *By.*, rosellus (A. & S.) Tul.
Claviceps purpurea (Fr.) Tul., *E.*
Cordyceps militaris (Linn.) Link, *B.W.*, with conidial stage also.
Gibberella pulicaris (Fr.) Sacc., *P.*
Chaetomium elatum Kunze.
Sordaria fimicola (Rob.) Ces. & de Not.
Sporormia intermedia Auersw., minima Auersw.
Leptospora ovina (Pers.) Fuck., spermoides (Hoffm.) Fuck.
Melanomma pulvis-pyrius (Pers.) Fuck.
Rosellinia aquila (Fr.) de Not., pulveracea (Ehrh.) Fuck.
Venturia inaequalis (Cooke) Aderh., *E.*, pirinum Aderh., *P.* (conidial stages).
Zignoella ovoidea (Fr.) Sacc., eutypoides Sacc. fide H. J. Wheldon (on hazel branch).
Leptosphaeria acuta (Moug. & Nestl.) Karst., vagabunda Sacc.
Ophiobolus porphyrogonus (Tode) Sacc.
Diaporthe (Chorostate) Taleola (Fr.) Sacc., on oak, (Tetrastaga) insignis Fuck., on *Rubus*.
Melanconis Alni Tul., stilbostoma (Fr.) Tul.
Diatrype stigma (Hoffm.) de Not., bullata (Hoffm.) Fr., *By.*, disciformis (Hoffm.) Fr., *P.*
Diatrypella quercina (Pers.) Nke., *E.*
Valsa populina (Pers.) Wint.

Eutypa lata (Pers.) Tul., Acharii Tul., flavovirescens (Hoffm.) Tul.
Hypoxylon multiforme Fr.
Daldinia concentrica (Bolt.) Ces. & de Not., *By.*, *P.*
Ustulina vulgaris Tul., *By.*
Xylaria polymorpha (Pers.) Grev., *By.*, Hypoxylon (Linn.) Grev.
Phyllachora graminis (Pers.) Fuck., *E.*, Junci (Fr.) Fuck.
Rhopographus Pteridis (Sow.) Wint.
Arthroderma Curreyi Berk.
Helvella crispa (Scop.) Fr., *By.*
Leptopodia elastica (Bull.) Boud., *S.*
Aleuria vesiculosa (Bull.) Boud., *E.*
Galactinia badia (Pers.) Boud., *E.*, * Howsei Boud., *By.* (new to Britain).
Ciliaria scutellata (Linn.) Quél., *P.*, setosa (Nees) Boud., *P.*
Cheilymenia dalmeniensis (Cooke) Boud., *P.*
Coprobia granulata (Bull.) Boud.
Ascobolus Crouani Boud., *S.*, stercorarius (Bull.) Schroet.
Taphrina aurea (Pers.) Fr., *C.*, on seedlings of *Betula.*
Leotia lubrica (Scop.) Pers., *By.*
Cudoniella acicularis (Bull.) Schroet., *E.*
Ombrophila alniella (Nyl.) Karst., *E.*
Coryne sarcoides (Jacq.) Tul., *C.*
Bulgaria inquinans (Pers.) Fr., *By.*, *P.*
Polydesmia pruinosa (Berk. & Br.) Boud., *E.*
Orbilia xanthostigma Fr., *C.*, *B.W.*, *E.*, *S.*, curvatispora Boud., *By.*
Hyalinia inflatula (Karst.) Boud., *By.*
Chlorosplenium aeruginosum (Oeder.) de Not., *P.*
Helotium epiphyllum (Pers.) Fr., *E.*, virgultorum (Wahl.) Karst., *B.W.*, *E.*
Dasyscypha nivea (Hedw. fil.) Sacc., *E.*, ciliaris (Schrad.) Sacc., *S.*
Trichoscypha calycina (Schum.) Boud., *E.*
Hyaloscypha hyalina (Pers.) Boud., *Cl.*, *C.*
Micropodia chrysostigma (Fr.) Boud., *E.*, aspidiicola (Berk. & Br.) Boud., *S.*
Urceolella puberula (Lasch) Boud., *E.*, on larch.
Mollisia benesuada (Tul.) Phill., *S.*, cinerea (Batsch) Karst.
Rhytisma acerinum (Pers.) Fr., punctatum (Pers.) Fr., *B.W.*, *E.*
Phytophthora infestans (Mont.) de Bary, *By.*
Peronospora parasitica (Pers.) Tul., *C.*
Spinellus macrocarpus (Corda) Karst., *By.* (on *Mycena inclinata* Fr.).

* For description see p. 133.

Pilobolus crystallinus (Wiggers) Tode, *Cl.*
Mortierella candelabrum van Tiegh. & le Monn., *E.*
Phoma herbarum West., *E.*, on stem of *Urtica.*
Cytospora ambiens Sacc.
Coniothyrium Hellebori Cooke & Mass.
Ascochyta Pisi Lib., *P.*
Septoria glumarum Pass., *By.*
Gloeosporium Ribis (Lib.) Mont. & Desm., *E.*
Melanconium zonatum Ell. & Ev., *By.*, on birch.
Dinemasporium gramineum Tul., *By.*
* Zythia mercurialis (Lib.) Kickx, *P.* (new to Britain).
Cylindrium Cordae Sacc.
Fusidium griseum Link.
Aegerita candida (Pers.) Fr., *C.*, *S.*
Cephalosporium acremonium Corda.
Trichoderma viride (Pers.) Fr.
Penicillium glaucum Link, candidum (Link) Fr.
Rhinotrichum repens Preuss., Thwaitesii Berk. & Br., *E.*, *S.*
Botrytis vulgaris Fr., cinerea (Pers.) Fr., argillacea Cooke, *E.*, pyramidalis (Bon.) Sacc.
Ramularia calcea (Desm.) Ces., *E.*, *S.*
Sepedonium chrysospermum Fr.
Acrostalagmus albus Preuss.
Gonatobotrys flava Bon.
Tricothecium piriferum Sacc.
Dactylella ellipsospora Grove, *E.*
Periconia pycnospora Fres.
Acremoniella atra Sacc.
Menispora ciliata Corda, *E.*
Cladosporium epiphyllum Mart., herbarum Link.
Brachysporium oosporum Sacc.
Helminthosporium gramineum Rabenh., *E.*
Dendryphium curtum Berk. & Br.
Macrosporium commune Rabenh.
Alternaria tenuis (Nees) Corda.
Isaria brachiata Schum.
Stysanus cybosporus Sacc., *By.*
Tubercularia vulgaris (Tode) Fr.
Dendrodochium citrinum Grove.
Volutella gilva Sacc., ciliata Fr., *By.*
Fusarium roseum Link, culmorum (W. G. Sm.) Sacc., *By.*
Epicoccum purpurascens Ehrenb.
Myxococcus pyriformis A. L. Smith, *P.*

* For description see p. 155.

MYCETOZOA FOUND DURING THE SELBY FORAY.

By Gulielma Lister, F.L.S.

The visit of the British Mycological Society to Selby proved a successful one for those of the party who were interested in Mycetozoa. Owing to the Yorkshire Naturalists' Society holding its meeting at Selby about the same time, although starting a few days earlier, and combined expeditions being taken, the number of days for collecting were more than usual, and extended from Saturday, September 7th, to Friday, September 13th.

Sufficient rain had fallen in the previous weeks to make the woods and heaps of dead leaves thoroughly moist, and the weather during the time of the foray was, on the whole, fair.

Osgoodby Woods, Camblesforth Wood and Bishop's Wood were visited before the main party arrived; and Mycetozoa were collected under the able guidance of Mr. W. N. Cheesman.

On Tuesday, September 10th, Byram Park, with its fine lawns, groups of living and felled beeches, as well as denser woodland, was searched. Large developments of *Dictydiaethalium plumbeum*, both mature and in rose-red plasmodium, were found on beech logs. On another prostrate beech, growths of purple-brown sporangia of *Dictydium cancellatum* were seen extending interruptedly for a length of about twelve feet. Another dead beech stump yielded a conspicuous cushion-like mass of translucent white plasmodium an inch across, which, on being carefully removed, developed in a few days into a fine growth of *Stemonitis fusca* var. *confluens*—a completely aethalioid form without trace of stalks or columellae. In the denser woodland, the rare *Lycogala flavofuscum* was found at the foot of a tall elm, looking so much like a big grey puff-ball, that it was mistaken for one by its finder and broken open. The aethalium measured an inch across, and was produced at the base on one side into a curious pale yellow stalk-like strand of hypothallus. Under large hollies, deep beds of decaying leaves afforded a favourable haunt for many Mycetozoa. Here were found *Craterium aureum*, *C. minutum*, *Diderma effusum*, *Didymium nigripes*, *D. Clavus*, *D. squamulosum* and

Lamproderma scintillans. Altogether twenty-four species were seen that day. On Wednesday, September 11th, the Escrick Woods were visited. These consisted of plantations of young sycamore and Scots pine, and also of extensive young birch woods having a dense undergrowth of bracken sheltering old decaying stumps of birch; further on was older mixed woodland. Although only eight species of Mycetozoa were collected, the list included *Colloderma oculatum*, recorded only once before in Yorkshire. It occurred in some abundance among moss and liverworts on old birch stumps; the shining dark-brown sporangia could hardly be detected without the aid of a lens, and even then were easily confused with the numerous minute beetle-mites (*Oribatidae*) that were slowly crawling about the same moss. Some of this moss brought indoors and kept moist has produced fresh crops of *Colloderma* sporangia up to the end of October. Parlington Park was visited on Thursday, September 12th, a rather gloomy and showery day, but affording the party a harvest of thirty-three species of Mycetozoa. The most noteworthy of these was perhaps *Physarum psittacinum*, on dead ash wood; it appears to be a completely summer species, and was found lingering on in a mouldy condition. *Badhamia panicea* and *Physarum compressum* were seen on a felled sycamore within a few feet of each other; the two species seem to be frequently associated. *Didymium melanospermum* occurred, as usual, on coniferous wood; *Physarum sinuosum* and *Diderma hemisphericum* were also found. On Friday, September 13th, search was made in Staynor Wood. Here oak was the prevalent tree, with some undergrowth of bramble and much of bracken, neither of which yielded Mycetozoa in any abundance. On some old yew stumps were found three species of *Cribraria*, a genus usually frequenting coniferous wood. The species were *C. rufa*, *C. aurantiaca* and *C. intricata*; the last is common in the tropics and in the United States of America, but rare in Britain; it does not appear to have been recorded before from Yorkshire. In a stretch of swampy ground, under sycamores, the dead leaves and lower parts of stems of yellow iris and gipsywort were adorned with a magnificent growth of *Diachaea leucopoda*, extending intermittently over an area of about forty-eight square yards. In the same swamp a specimen of the elegant var. *tenerrima* of *Comatricha pulchella* was found.

The following list gives the species recorded during the whole foray. *O.* stands for Osgoodby Woods, *C.* for Camblesforth, *B.* for Bishop's Wood, *By.* for Byram Park, *E.* for Escrick, *P.* for Parlington, and *S.* for Staynor Wood.

Ceratiomyxa fruticulosa (Muell.) Macbr., *O., C., By.*
Badhamia panicea (Fr.) Rost., *B., P.*
B. utricularis (Bull.) Berk., *C., P.*
Physarum nutans Pers. Found daily.
P. viride (Bull.) Pers., *By., P., S.*
P. psittacinum Ditm., *P.*
P. compressum Alb. & Schw., *P.*
P. sinuosum (Bull.) Weinm., *P.*
P. cinereum Pers., *B., P.*
Fuligo septica (L.) Gmel. *O., By.*
Leocarpus fragilis (Dicks.) Rost., *O., E., S.*
Craterium aureum (Schum.) Rost., *By.*
C. minutum (Leers) Fries., *C., By., P., S.*
Diderma effusum (Schw.) Morg., *By.*
D. hemisphericum (Bull.) Hornem., *P.*
Diachaea leucopoda (Bull.) Rost., *S.*
Didymium difforme (Pers.) Duby, *O., C., P., S.*
D. Clavus (Alb. & Schw.) Fr., *By.*
D. nigripes Fr., *By.*
D. melanospermum (Pers.) Macbr., *P.*, var. *minus* Lister, *P.*
D. squamulosum (Alb. & Schw.) Fr., *O., C., By., E.*
Colloderma oculatum (Lipp.) G. Lister, *E.*
Stemonitis fusca Roth., *O., P., S.*, var. *confluens* List., *By.*
S. flavogenita Jahn., *By., P.*
Comatricha nigra (Pers.) Schroet. Found daily.
C. pulchella (Ch. Bab.) Rost., var. *tenerrima* Lister, *S.*
C. typhoides (Bull.) Rost., *C., E.*
Lamproderma scintillans (Berk. & Br.) Morg., *By.*
Enerthenema papillatum (Pers.) Rost., *P.*
Cribraria rufa (Roth.) Rost., *S.*
C. aurantiaca Schrad., *S.*
C. intricata Schrad., *S.*
Dictydium cancellatum (Batsch) Macbr., *By., P.*
Dictydiaethalium plumbeum (Schum.) Rost., *By., P.*
Reticularia Lycoperdon Bull., *C., P.*
Lycogala flavofuscum (Ehr.) Rost., *By.*
L. epidendrum (L.) Fr., *C., By., P.*
Trichia persimilis Karst., *C., P.*
T. scabra Rost., *P.*
T. varia Pers., *O., C., By., P.*
T. contorta (Ditm.) Rost., *By.*
T. decipiens (Pers.) Macbr., *By., P.*
T. Botrytis Pers., *C., P.*
Hemitrichia Vesparium (Batsch) Macbr., *O.*
Arcyria ferruginea Saut., *O.*
A. denudata (L.) Sheldon, *By., P., S.*

A. incarnata Pers., *By.*, *P.*, *S.*
A. cinerea (Bull.) Pers., *By.*, *E.*, *P.*, *S.*
A. pomiformis (Leers) Rost., *C.*, *P.*, *S.*
A. nutans (Bull.) Grev., *C.*, *By.*, *E.*, *P.*, *S.*
Perichaena corticalis (Batsch) Fr., *P.*
P. depressa (Lib.) Rost., *By.*, *P.*

This makes a total of fifty-two species, and is the second largest list of Mycetozoa recorded on our forays. The wonderful Forres visit in 1912 yielded eighty-one species, that of Swansea, in 1915, forty-seven species; Shrewsbury in 1916 and Wrexham in 1910 each gave us forty-four species; Haslemere, in 1913, forty-two species; and Doncaster, in 1914, thirty-six species.

PRESIDENTIAL ADDRESS.

By the Very Rev. David Paul, LL.D., D.D.

ON THE EARLIER STUDY OF FUNGI IN BRITAIN.

It was natural that, among those who in ancient times began to observe the vegetable world, and to unite its individual productions into groups, attention should have first been directed to the Flowering Plants. The striking beauty of so many of them, their wonderful diversity in form and colour and fragrance, and the manifold ways in which they could be made use of for the advantage of man, early arrested the eye, and stimulated curiosity, and led to their closer study. But Fungi had a hard fight to be included in the awakened interest in trees and shrubs and herbs, and it is only in comparatively recent times that they have won their way to adequate recognition. No doubt Theophrastus, three hundred years before Christ, wrote a History of Plants which is still extant, in which he makes many references to these lower and less conspicuous plants, and a hundred years later Dioscorides compiled a Treatise on *Materia Medica* which was for many centuries received as a standard authority, and in which Fungi are not overlooked. Then soon after the middle of the first century of our era Pliny the Elder wrote his *Historia Naturalis*. It is

in no sense a scientific work, and it is not even the work of an original observer; Pliny was only a man of astonishing industry who collected his material from all available sources, and set it down in very confused form. We have to thank him, however, for his diligence in gathering together a storehouse of information on the ancient world and its knowledge of plants, which otherwise we should have known nothing of. These earliest writers while they mention various Fungi seem to regard them as being so well known as to require no exact description, and it is, except in a few cases, impossible to identify them satisfactorily. They looked at them almost entirely from the gastronomic point of view, and the true study of Fungi cannot be said to have then begun. They did not contribute any helpful suggestions to the earliest observers of fungi in Britain.

Many centuries elapsed before even the roughest foundation of the science of Mycology was laid. All through the Middle Ages plants were studied mainly for their supposed curative properties, and Fungi do not appear to have found a place in the curious prescriptions of the old leeches. It was not till the sixteenth century that they began to be included among plants, or to be dealt with either in this country or abroad alongside of the observed and described Phanerogams. At the opening of that century no book on Botany had been published in Britain, but during its course at least four passed through the press, none of them of much use for our purpose, but all of them of great interest as illustrative of the manner in which what is now a great science was born, and nursed in its infancy. The development of that science is a vast subject, and I propose only to sketch to-night the steps by which our knowledge of Mycology was gradually advanced by our earlier writers.

In 1516 the first edition of the *Greate Herball* was published, no author's name being attached to it. It is a very curious book in black letter and is the earliest British book on Plants. It deals mainly with their medicinal qualities, and gives practically no descriptions. To turn over its pages and read here and there affords a good idea of the position of plant study before it had been rescued from the childishness of the Middle Ages. The writer evidently draws largely on still earlier books of the same kind published on the Continent. There is one short chapter on Fungi, the only one that we need notice, and it will illustrate the character of the book if I quote the quaint remarks the author makes on them:

"Fungi ben muscherons. They be cold and moyst in y^{e} third degre and that is shewed by theyr vyolent moysture. There be twoo maners of them, one maner is deadly and sleeth them that eateth of thē, and be called tode stools, and the other

doeth not. They that be not deadly have a gross gleymy moystur, that is disobedient to nature and digestion, and be perillous and dredful to eate, and therefore it is good to eschewe them, such as eate them and fear not to fall inconvenience, seeth them in water and medle them with gynger, peper, caruy, calamint, or orygan and such other, and then drinke olde wyne, pure and stronge. And they that be of olde complexion, after thē take grene gynger, dyaterion, pyperion, solergenne and tryacle. The deadly muscherons ben of diuers actions after their diversitie and sleeth by their exceeding great cold and moysture y^e^ is in the fourth degre. Some slee by the evell quality of the place that they grow in as by rusty yron, rotten cloth or wood or nigh the hole that serpēts brede in, or thei that grow by great trees that have glewmy humours and frothe. The signs of them that be deadly is a slymye softenesse as they were puffed and be of thick substaunce, and if they lye a whyle broken they will rotte."

I have given this at length as shewing the style of the book, and as being the first notice of Fungi I have met with in the English language. Evidently the writer has in view only the larger and gilled Fungi, and just as clearly he has not even a rudimentary knowledge of them.

Passing from that book, the next that claims attention is *The Herbal of Wm. Turner*, Doctor in Phisick, as he is called on the title page, which was first published in 1551, and afterwards in an enlarged edition in 1568. This shews a great advance on the *Greate Herball*, and if one were dealing with flowering plants it would be necessary to consider it at some length, but it contains no notices of Fungi. Among the many woodcuts are some of ferns which are not separated from flowering plants. Turner was a theologian and a church dignitary, a scholar and a Reformer, who wrote much on religious questions, but he is now known only as a botanist who was an original observer, and who had shaken himself clear of most of the medieval fancies. It would have been interesting to know what were the views on Fungi of this "first of English botanists," as he is deservedly called.

A very important work was published in 1597, the well-known *Gerard's Herball*. However interesting it may be from a general botanical point of view, the day of Fungi had not yet arrived. Gerard does not indeed omit Fungi altogether, for he devotes one chapter to them. He calls them "bastard plants" and speaks of them as "earthy excrescences called mushrumes or toadstooles, whereof some are very venomous and full of poison, others not so noisome, and neither of them very wholesome meate; wherefore for the avoiding of the

venomous quality of the one, and that the other which is lesse venomous may be discerned from it, I haue thought good to set forth their figures, their names, and places of growth." There is no attempt at classification except that they are divided into edible and non-edible, but there are fairly good woodcuts of seventeen species including the Fly mushroom, a *Clavaria*, apparently *aurea*, Jew's ear, *Clathrus cancellatus*, Morel, Stinkhorn, and a kind of Tuber. It may be noted that the Morel is put among the non-edible Fungi, and that the figure of *Clathrus* was taken, as well as almost all the others, from the *Icones* of Tabernaemontanus, published in 1590.

Another well-known Herbal was published in 1640 by John Parkinson under the title of *Theatrum Botanicum*. He calls himself "Pharmacopaeus and King's Botanist." Among the 4000 plants which he attempts to describe are 64 Fungi—32 wholesome and 32 dangerous. His figures are mostly the same as Gerard's, figures that did duty in other botanical books of the period, the blocks having been brought from the Continent. His classification and descriptions shew no improvement on those of Gerard.

Parkinson was the last of the Herbalists. Their notions of the nature and affinity of plants were of the crudest. Anything that could be called a system of classification was unknown to them. They still burned incense religiously to Theophrastus and Dioscorides, whose authority they would regard it as little short of blasphemy to question, and whose wildest flights of fancy they quote with evident approval. One looks through their huge tomes with admiration of their industry and zeal, but with amazement at their naïve simplicity and lack of a scientific spirit. Their merit lies in their collection of so many plants, however disorderly it may be, and in their illustrative woodcuts. Fungi have naturally suffered most at their hands, even those that required no microscope for their observation. In justice to them we must remember that they had no books to refer to which could throw light upon the subject. They were dealing with the very beginnings of a difficult branch of Botany, and little could be expected of them.

Taking leave of these, we pass into the next century to notice a work which marks an epoch in British Botany—the *Synopsis methodica stirpium Britannicarum* of John Ray, first published in 1690 and third edition in 1724, after his death. Ray, the son of an Essex blacksmith, went to Cambridge and afterwards took Holy Orders. Two of his sermons were famous in their day. At College he lectured on Greek, Mathematics and Latin successively. Leaving it in 1662 he gave himself entirely to his favourite study of plants, travelling in search of them

through the greater part of Britain, as well as the Low Countries, Germany, Italy and France, and embodying his researches in his great work, *Historia Generalis Plantarum*, first issued in 1686. It was impossible for a man of his acute mind to neglect Fungi, though he threw his strength into the Phanerogams. In his *Synopsis methodica* we find the first classification of them in the English language which is of any interest. He divides them into five classes:

I.—Fungi with both pileus and gills—of which he describes 57 including *Lactarii* and *Cantharellus*.

II.—Fungi with a pileus but no gills, such as the *Boleti* and *Phallus*—17 described.

III.—Fungi without a pileus. Twenty-two species of these are described, and he divides them into three groups. The first group he calls *Fungoides*, and defines the term as a fungus without a pileus, whose stems are variously shaped and divided but whose substance is uniform and is destitute of gills or pores. As examples *Xylaria polymorpha* and *X. hypoxylon* are given. The second group under this head is *Pezizae*, of which he gives 22, including among them the Jew's ear. The third group is *Agaricus*, a term used by him in its old sense, and defined by him as a "fungus which has neither pileus nor stem, and generally grows laterally and horizontally on trees, sometimes smooth beneath, but for the most part with the under surface divided into gills or pores." Of these he describes 28, and among them what he calls *Agaricus intybaceus* and *A. igniarius*. He would include, in addition to the stemless *Polypori*, such Fungi as *Pleurotus*, *Crepidotus*, etc.

IV.—Fungi pulverulenti. "Puff-balls; dusty mushrooms; Bull-fists." He describes 13, including *Lycoperdon giganteum* and *Geaster*.

V.—Fungi subterranei. All underground Fungi, e.g. Truffles.

It will be noted that, however imperfect, this is still a classification. It is a groping after an orderly arrangement, and is distinctly superior to anything we have yet met with. Ray had evidently been giving Fungi considerable attention, for in each successive work of his there is an advance. In his *Catalogus Plantarum* (1677) about 25 Fungi are given but without any order or classification at all. In his *Historia Plantarum* (1686) he divides them into four classes: (1) Terrestrial Fungi, with pileus and gills, which are subdivided into the old groups of edible and noxious; (2) Terrestrial Fungi without gills, but having a more or less distinct pileus; (3) Fungi of every kind that grow on trees; (4) Underground Fungi. This is a much poorer classification than that of the *Synopsis* which has been already given. In it the foolish distinction between edible

and poisonous, which had obsessed all previous British authors, is dropped, as also his class of tree-fungi, and his final classification shews scientific progress in his ideas. Ray, as well as Turner, has been called the "first British Botanist," and even in regard to Fungi that honourable title is deserved. His *Synopsis* was for long the standard English Flora.

After the death of John Ray at the beginning of the eighteenth century the first name which claims attention in connection with the study of Mycology is that of William Hudson (1732–1793). He was a Fellow of the Royal Society and Director of the Botanic Garden at Chelsea. His reputation rests on his *Flora Anglica* of which the first edition was published in 1762. By this time the writings of Linnaeus had become known in England, particularly after his visit to this country in 1732, and his system of classification became the subject of much criticism and controversy. Hudson was one of his principal champions, and his *Flora* was the first of any importance to be arranged according to the principles of the great Swedish botanist. With its general merits we are not concerned here further than to note that it was received with acclamation, and superseded as the chief English text-book Ray's *Synopsis*, which had held that position for seventy years. It is interesting to us now from the fact that he dealt as fully with Cryptogams as was possible at the time, describing Ferns, Mosses, Algae and Fungi. He adopts with great advantage the binomial nomenclature of Linnaeus. His indebtedness to Ray's *Synopsis*, as well as to Bauhin's *Pinax*, is freely acknowledged. The method he adopts is, first to give the description of Linnaeus from his *Species Plantarum*, then those of Bauhin and Ray when available; to this he adds an English name and the habitat. His meagre list is divided into nine genera: *Agaricus*, *Boletus*, *Hydnum*, *Phallus*, *Elvella*, *Peziza*, *Clavaria*, *Lycoperdon* and *Mucor*. And the curious thing is that instead of adding to the number of Ray's plants he does not describe nearly so many. Ray gives 57 gilled Fungi, while Hudson has only 24; of his order *Boleti* (including *Polypori*) Ray gives 17 and Hudson 9, and so on. No doubt in the second edition of the *Flora Anglica* published in 1778, the number of *Agarici* has mounted from 24 to 51, and the number of *Boleti* from 9 to 13, but as the *Agarici* included all gilled Fungi and the *Boleti* included all Fungi with pores, it is evident that a very large number of quite common plants in both genera were overlooked by him. In his second edition he adds a genus *Clathrus*, containing eight *Mycetozoa*. It is not however worth while to examine this *Flora* further. Hudson had given little time or attention to Fungi, and he did not know more than a very few. He had

too much on hand in trying to deal with phanerogams and cryptogams together. In his preface he frankly acknowledges that in the field of Fungi he was greatly deficient, and that taught by experience he could repeat the words of Linnaeus that the whole subject was still in chaotic confusion. It was impossible for any one in his day seeking a knowledge of Fungi to obtain help from his book.

From Hudson let us pass to Relhan whose *Flora Cantabrigiensis* was published in 1785, twenty-three years after the *Flora Anglica*. Like so many of the botanists of that century and the preceding, Richard Relhan was a clergyman, and he became a Fellow of King's College, Cambridge. In his first edition he follows closely on the footsteps of Hudson, but adds a separate class of *Sphaeria*, composed of Xylarias and Hypoxylons with one *Nectria*. His second edition however which was published in 1820, contains several features which mark an advance in classification. Under the influence of Withering he attempts to break up the genus *Agaricus*, in which were still included all gilled Fungi. He first splits it up into three groups of stalked, slightly stalked, and stemless, dividing these again according to the attachment and colour of the gills. He adopts a genus *Merulius*, which is not found in his first edition, containing five *Marasmii*, two *Cantharelli*, and a *Craterellus*. The number of his *Agarici* is increased from 35 to 96, his *Boleti* from 7 to 22, and so on. Another genus added is *Auricularia* of Bulliard, embracing three *Stereums*, one *Corticium*, a *Thelephora* and a *Merulius*. He did not altogether overlook the minute Fungi, but includes *Sphaeria*, *Stemonitis*, *Trichium*, *Aecidium*, etc., giving two or three of each. His second edition of the *Flora Cantabrigiensis* is thus an advance on his first edition, and of much greater value to students, but his descriptions are too short for satisfactory identification. This defect is partially counterbalanced by his constant references to the figures of Sowerby, Bulliard and Bolton.

The *Flora Scotica* of Lightfoot appeared in 1777, and passed into a second edition in 1792. It is of much interest, especially to Scotsmen, so far as phanerogams are concerned, but it contains nothing noteworthy in regard to Fungi, only 67 species being referred to.

John Sibthorp, Professor of Botany at Oxford, published in 1794 his *Flora Oxoniensis*, but that too as a contribution to Mycology was of no particular importance.

Then, in 1788, there appeared Bolton's *Historia Fungorum circa Halifax sponte nascentium*, which is valuable for its well-known illustrations, but is mentioned here that a passage from

its preface may be quoted. "The plants," he says, "which now compose the order Fungi were formerly supposed to be of equivocal generation, the sport of nature, the effect of putrefaction or the brood of chance, but that they owe their original to the seeds of a parent plant is now well known, having been proved by, *inter alios*, the ingenious Hedwig, who in a work entitled *Historia generationis et fructificationis Plantarum Cryptogamicarum*, published in quarto at Petropolis in 1784, has by means of the microscope proved beyond dispute the existence of stamen and style, or of male and female organs in these, as perfect and regular and effective in the production of proper seeds as in any other vegetable where they are more obvious to the sight." The passage is of interest, not as being a correct statement of the method of the reproduction of fungi, but as an attempt to dissipate the crude ideas that formerly prevailed, and to provide a definite place for fungi within the vegetable kingdom.

The popular interest in Botany which was growing in the last half of the eighteenth century is evidenced by the number of Floras that it produced. Hill's *Flora Britannica* appeared in 1760, Hudson's *Flora Anglica* in 1762, Martyn's *Plantae Cantabrigienses* in 1763, Withering's *Botanical Arrangement* in 1776, Lightfoot's *Flora Scotica* in 1777, Relhan's *Flora Cantabrigiensis* in 1785, Sibthorp's *Flora Oxoniensis* in 1794, Dickson's *Catalogus* in 1795, and Hull's *British Flora* in 1799. It was the era of Floras. No doubt interest mainly centred in Flowering Plants, but it was gradually spreading to Cryptogams also. Of these Fungi were the last to be brought into the current, and the progress in the century, since Ray's *Synopsis* appeared in 1690, was not all that might have been expected, even in the case of the larger Fungi that can be examined with such ordinary lenses as were then in use. To deal in detail with all these Floras would occupy much time, and is unnecessary for our purpose, but the appearance of Withering's *Arrangement of British Plants* is worth a short notice. It is a work for which I have an affection, as it is the only botanical book I had access to when I was a boy.

Withering was born in 1741 at Wellington and was educated at the University of Edinburgh, where he took the degree of M.D. in 1766, afterwards practising at Stafford and at Birmingham. In 1776 he published his *Arrangement of British Plants* which reached its third edition in 1796, three years before his death. It is in four volumes, the last volume being devoted to cryptogamic plants. He was not a distinguished botanist, and he seems to have taken little or no share in the discussion of the plant problems that then occupied the attention

of his botanical brethren. His merit lies in the fact that he was an able and industrious field-botanist whose labours went far to increase the knowledge of plants in this country. Both Sir James E. Smith and Sowerby held his work in high esteem. He had the good sense to write his Flora in English whereas Hudson, Relhan and their predecessors had used Latin. In the Fungus part of his book the descriptions and notes are fuller and clearer, so that it is always possible to identify the plant he is dealing with. His division of the gilled Fungi too is more elaborate and he passed a much larger number under review. Evidently he had examined them carefully for himself. His subdivisions rest on the nature of the stem, whether solid or hollow, whether central or lateral or wanting, on the colour of the gills, and their mode of attachment. This is so far a convenient grouping, but it is not natural; it does not take account of volva or ring or the character of the veil or the substance of the flesh. Consequently utterly different groups of gilled Fungi, such as *Agarici* proper, *Cortinarii, Hygrophori, Marasmii, Lactarii,* are found side by side. At the same time it was the most complete division of the vast order of *Agaracini* that had yet been proposed. In principle it is the same as that of Hudson but it is more fully elaborated. His division of the *Boleti,* including the *Polypori,* is similar—pored Fungi with stem central or lateral or wanting, and with pores white, brown, buff, etc. His remaining genera are similar to Hudson's—*Hydnum, Helvella, Auricularia, Peziza, Nidularia, Phallus, Clavaria, Tuber, Lycoperdon, Reticularia, Sphaeria, Trichia, Mucor.* Though a great field of Mycology was not traversed either by him or by any of his predecessors, partly because of the inferiority of their microscopes, and partly because so much work among the less minute Fungi had still to be performed, yet the knowledge of Fungi was increasing yearly, as is plain from the fact that Relhan's 96 gilled Fungi had mounted up in Withering's Flora to no fewer than 280. The true principles of classification, however, had not as yet been grasped. Nevertheless, those British students of Fungi of the eighteenth century, whose works we have been able only to glance at, beginning with John Ray, author of the *Synopsis Methodica,* ought not to be forgotten, or their work undervalued. They prepared the way for fuller light to be shed on a difficult subject, and perhaps none of them is more worthy of recognition than Withering, who has not, I think, received all the credit that he deserves.

For the first quarter of the nineteenth century there is not much of moment to notice. Sowerby's admirable figures of Fungi were published between 1797 and 1803, and Greville's *Scottish Cryptogamic Flora* between 1823 and 1828. The

plates in both these works have not been surpassed, and they were of first-class importance at the time for the study of fungi, and indeed are so still. It was only however in the second quarter of the century that any forward movement was made in this country in the study of Fungi, that which will always be associated with the name of Berkeley. Before touching briefly on his great contribution to Mycology, it is necessary to mention the name of one to whom he was much indebted, Elias Fries of Sweden. I have not hitherto taken notice of the work of foreign botanists or of their influence on our own countrymen as that would have led into too vast a field, but Fries stands by himself in the department of Mycology and his influence on all his contemporaries and successors has been too marked to be left unmentioned.

His first important work on Fungi, the *Systema mycologicum*, was published between 1821 and 1832; his *Epicrisis* in 1838; his *Monographia* between 1857 and 1863, and his *Hymenomycetes Europaei* in 1874. How he prepared himself for these works he tells us himself. He describes his wanderings through every accessible part of Sweden, his untiring industry in observing and collecting specimens, the unflagging enthusiasm with which he pursued the study of Fungi from the time that as a boy of twelve he accompanied his mother into a wood to gather strawberries, and there found a very large specimen of *Hydnum corralloides*, his passion for accuracy shewn in his examination and description, three times repeated, of all the species he could discover, and his determination to make his different lists as complete and perfect as he possibly could. That spirit in which he worked for more than sixty years lay at the root of his success, and prepared the way for the high position he received among European mycologists. He developed a genius for classification and for detecting affinities, and among the *Hymenomycetes* in particular his grouping of the plants has hardly been improved on. Perhaps our love of Fries and our obligations to him cause us to exaggerate his merits, but after all allowance has been made for the devotion of pupil to master, and the warping of judgment that may arise from it, the study of earlier works on Mycology in our own country makes it perfectly clear that he stood head and shoulders above all our authors in that branch of Botany. We are not on that account to minimise what those earlier authors have done; they were groping their way among difficulties, dealing with plants presenting great perplexities, and gradually working out a scientific system. Each of the early students of Mycology made his contribution, and, as they succeeded one another, each enjoyed the benefit of his predecessors' attempts and failures.

It could not have been otherwise, and Fries would have been the first to acknowledge his indebtedness to those who went before him. These considerations must not however blind us to the fact that in botanical classification and description he occupies a foremost place. It is mainly due to him that Mycology has so many ardent students in this country as it has to-day.

Let us pass now to Berkeley. Like so many other British Mycologists he was a clergyman, and performed the duties of two country charges in succession while he was carrying on his scientific work. His eminence as a Mycologist is well known. As far back as 1836 his reputation in that branch of Botany was so well established that Sir William Hooker entrusted him with the preparation of the volume on Fungi which completed Sir James E. Smith's *English Flora*. Elias Fries held him in the highest estimation, and regarded him as the man qualified above all others to draw up a synopsis of the Extra-European *Hymenomycetes*. As regards British Fungi he has been styled the virtual founder of our Mycology. He possessed Fries' enthusiasm, his accuracy, his power of patient observation, his wide outlook over the field of Botany, and his instinct in the detection of affinities and differences. During a long life he maintained his high place in Botany. No doubt he was a Taxonomist much more than a Morphologist, but that was in the natural order of things. Classification of plants must precede the minute investigation of their structure, and the first claim which Fungi made on a botanist in the third decade of last century was classification. We have dealt with some of the attempts to arrange the larger fungi that had already been made; let us look at Berkeley's contribution.

The first volume of Fries' *Systema Mycologicum* appeared in 1821, fifteen years before Berkeley's volume on Fungi contained in Smith's *English Flora*. It embraced the *Hymenomycetes*. On comparing the classification of these in the two books we find that they are practically the same; Berkeley simply adopted Fries' classification. Subsequently Fries improved that arrangement, adding two new genera, *Hygrophorus* and *Marasmius*, whose members had previously been included in one or other of the subgenera of *Agaricus*, and Berkeley in his "Outlines" adopted that improvement, as well as the addition of the genus *Lentinus*. There is no originality then in Berkeley's work so far as the classification of these higher Fungi is concerned. His merit as a British Mycologist lies in this, that he immediately recognised the value of Fries' divisions, and adopted them for the benefit of science in his own country. It is not indeed a perfect classification, for it is partly natural

and partly artificial. The large genus *Agaricus* had to be broken up in some way or other, as otherwise it was unmanageable, and Fries accordingly split it into what he calls *series*, determined by the colour of the spores. One had then manageable groups to deal with, but they are artificial groups, for the colour of the spores is not a sufficient basis to rest them on, and has the effect of keeping fungi far apart whose affinities are very close. It is no doubt a convenient arrangement, and as such it has held its ground. Within the series of groups, however, the arrangement is strictly natural, one might say beautifully natural, drawing together into corresponding subgenera the plants that have the closest affinity. Even in regard to the employment of spore-colour as a prime feature in the classification of *Agaricus*, there is this to be said in its favour that it is a great improvement on the use of gill-colour for the same object, as the colour of the spores is fairly constant and unchangeable, which the colour of the gills is far from being, and it is strange that the earlier mycologists did not take account of the colour of the spores at all. That Berkeley should have adopted and popularised in this country the classification of Fries is one of his chief merits.

He has, however, merit of another kind. He is, I think, unsurpassed in his description of species, and this is best seen in the fifth volume of Smith's *British Flora*. Fries' descriptions of species in the *Monographia Hymenomycetum* are very fine, but Berkeley's are as careful and minute, and appeared long before that work of Fries was published. The early descriptions of Fungi were so imperfect that it is often impossible to identify the plant described. One has only to compare the descriptions of the same species in the *Pinax* of Caspar Bauhin and in Ray's *Synopsis* and Hudson's *Flora Anglica* with those of Berkeley in Smith's *Flora* to appreciate the great advance that had been made. In plants like fungi ample descriptions are of special value, as both Fries and Berkeley recognised, if a species is to be certainly determined, and they both set themselves to provide such descriptions drawn up by themselves after comparison of many individual specimens. That is one of the debts we owe to them both, to Berkeley at least as much as to Fries.

Berkeley's merit and reputation rest on more than his identification, description and classification of species, though it may perhaps be said that in connection with that his best work was done. I have purposely laid stress on that part of his work, because in that field he was carrying on and perfecting what the earlier writers on fungi had for two centuries been giving their attention to. In dealing with the early study of

fungi in this country his name need not perhaps have been mentioned at all, and he might have been properly regarded as the inaugurator of the newer era of Mycology. But in that case the story of earlier progress would not have been rounded off, and the contrast between the earlier and later results of the study of the subject would not have appeared. When we compare him with those who went before him, we must set his work parallel with theirs, and mark how far he surpassed them on their own lines, as in the number of species he added to the British Fungus Flora and in the admirable way in which he dealt with the already recognised species both in description and classification. I have not sought to characterise his work among the lower minute fungi, because that is outside the field of the earlier study, nor to estimate the value of his *Introduction to Cryptogamic Botany*, published in 1857, in which he treated the relations to one another of the different Families of Cryptogams, though it is a work of the highest merit, and was the first comprehensive work on the subject ever produced, nor have I done more than allude to his unrivalled knowledge of exotic fungi, though it was unequalled in his day, and is witnessed to by the fact that Sir W. J. Hooker entrusted him with the description and classification of all the fungi sent to Kew from abroad, and notably with those collected by Darwin during the voyage of the *Beagle*. It does not enter into the scope of this paper to deal with Berkeley's varied and valuable contributions to British Mycology generally, it only falls within its range to contrast the results of his study of the larger and more conspicuous fungi with those of his predecessors, regarding him as being, at least in the first part of his life, the last of the earlier students of the science.

We have thus travelled down the road of mycological study, from the dark age of the Herbals when classification was practically non-existent, and when corals and sponges were included among Fungi, onwards through successive gropings after a systematic arrangement, and through gradually increasing knowledge of the plants themselves, down to the time when Berkeley in his first published work of importance, but especially in his "Outlines," settled for British mycologists the system of classification of the higher Fungi which still, after the lapse of fifty-eight years, with slight alteration holds the field. I would end with the words of the great Swede in his preface to his *Monographia Hymenomycetum*: "To botanists who live in the country I commend the study of these fungi as a perennial fountain of pleasure and of admiration of the Wisdom which directs the whole of nature."

NOTES ON SOME SAPROPHYTIC SPECIES OF FUNGI, ASSOCIATED WITH DISEASED POTATO PLANTS AND TUBERS.

With Plates III and IV.

By G. H. Pethybridge, B.Sc., Ph.D.

During the progress of a series of investigations* on various diseases of the potato plant in Ireland, which have extended over several years, special attention was naturally devoted to the part played by parasitic fungi. In the course of the work, however, a number of saprophytic species associated with the parasites were met with, some of which were previously undescribed or imperfectly known; and a certain amount of attention was devoted to them.

It is proposed, in the following notes, to deal briefly with a few of these saprophytes; and the observations and descriptions which follow are based, to a large extent, on the characters and behaviour of the various species, when grown in pure culture, a single conidium or spore having been made the starting-point of the culture in each case. The study of micro-fungi in pure cultures offers many advantages, and had this method been available to and employed by earlier workers in mycology, many mistakes would have been avoided. It is clear, for reasons which need not be discussed here, that whenever possible this method should be adopted by workers in future.

I. NECTRIA INVENTA.

(Syn. *Verticillium cinnabarinum* Reinke et Berth.)

The more or less ubiquitous fungus *Acrostalagmus cinnabarinus* Corda† was, in 1879, re-named *Verticillium cinnabarinum* by Reinke and Berthold‡, who pointed out that Corda's generic name was founded upon an error of observation as to the manner in which conidia were produced. Nevertheless both Saccardo§ and Lindau‖ retain Corda's original name.

* Reports on these investigations will be found in the Journal of the Department of Agriculture and Technical Instruction for Ireland, x.–xviii. 1910–1918.

† Icon. Fung. ii. p. 15, 1838.

‡ Zersetz. d. Kartoff. p. 63, 1879.

§ Syll. iv. p. 163, 1886.

‖ Rabenh. Krypt. Fl. i. 8, p. 339, 1904.

This fungus is found quite frequently on the surfaces of decayed potato tubers in its well-known red conidial stage. It was grown in pure culture for a period of fifteen months on various nutrient media in the hope that some other form of fructification might develop in one or other of them. This, however, did not occur.

In July 1915 a number of old, diseased "seed" potatoes that had been thrown into a wet ditch in the spring were examined, more or less as a matter of curiosity. On the surfaces of several of these tubers a number of perithecia were found. A few of the latter were almost black; and microscopical examination showed that they probably belonged to some species of Gibberella. Most of the perithecia, however, were dark red in colour, somewhat similar to those of *Hypomyces Solani* R. et B. Since, however, a stroma was present it was evident that they belonged not to the genus Hypomyces, but to Nectria. Comparison with type material of *N. Solani* R. et B. showed that they were certainly not that species*.

Closely associated with the red perithecia was a copious development of the conidial stage of *V. cinnabarinum*, so close, in fact, that in some cases conidiophores of this fungus were present on the stroma, and even on the surfaces of the perithecia themselves. The question arose, therefore, as to whether this was a case of mere association, or whether the perithecia actually belonged to *V. cinnabarinum*. Many of the perithecia were still unripe, but in others ripe ascospores were present, and trials made in hanging-drops showed that the spores were viable.

Careful and continuous microscopic observations were made in five separate instances on the development of isolated individual ascospores in film cultures on the undersides of coverglasses, this being a more advantageous method of study than the hanging-drop. In each case the spore germinated and produced mycelium, which soon gave rise to conidiophores and conidia exactly similar to those of *V. cinnabarinum*, the growth from the original ascospore to the development of conidiophores and conidia being traced in unbroken sequence.

In another case the course of development from ascospore to conidia-production was followed under the microscope with a culture on a thin film of nutrient medium in a Petri dish. This is illustrated in Fig. 3, Plate III. The two-celled ascospore

* *N. Solani* does not appear to be a common species. I have never come across it and there is no reliable record of its occurrence in the British Isles. For years, however, in English phytopathological literature this fungus was credited, quite erroneously, with being the cause of the dry-rot of the potato tuber.

(*a*) is still discernible in the middle of the growth on the right, while on the left the young conidiophore borne on the hypha (*h, h*) is shown. Although this hypha is drawn in the figure with partially discontinuous walls, it was, as a matter of fact, continuous. The figure was drawn with the aid of a camera lucida which did not permit of the whole growth being outlined in one single field of view.

A stock pure culture was raised from a single ascospore, and this was made the basis of a series of sub-cultures on seven different media. A stock pure culture of *V. cinnabarinum* was raised from a single conidium of the fungus growing on a decayed potato, and sub-cultures from it were made on the same media. No differences, either macro- or micro-scopic, were discernible in the growths developed in the series of parallel cultures. Hence it is concluded that the perithecia, originally found on the surfaces of the rotting tubers in very intimate association with the conidial stage of *V. cinnabarinum*, are indeed the perfect state of fructification of this fungus*. This species, therefore, must be removed from the Fungi Imperfecti and be placed amongst the Ascomycetes.

The ripe perithecia are spherical or globular in shape and possess an ostiole, but are scarcely papillate. They are "cameo-brown"† in colour and bear short, stiff multi-cellular hairs or appendages on their upper halves. A stroma is present which in some cases bears only one perithecium, and in others more than one. The wall of the perithecium is several cells in thickness and more or less leathery, or cartilaginous in substance, not brittle. Long paraphyses are present in young perithecia, at any rate, but they are not easily made out and they disappear later on. They are more easily seen in the carefully teased out contents of a perithecium which is not too ripe than in sections. The asci are typically eight-spored but a lesser number sometimes occurs. The ascospores are arranged in one row and are 1-septate when ripe, single-celled when young. The walls of the paraphyses and asci appear to become mucilaginous, so that a fully ripe perithecium contains a mass of isolated ascospores embedded in a more or less gelatinous matrix. Fig. 4, Plate III, represents a longitudinal section (not quite a median one and slightly diagrammatic) through a perithecium and its stroma. The asci

* After this pure culture work was completed a case was met with in which one of the actual appendages of a perithecium had developed a conidiophore of *V. cinnabarinum* as a lateral branch, proceeding from near its distal end. This affords yet another link in the chain of proof that the fungus producing the perithecia is *V. cinnabarinum*.

† Ridgway, R. Color Standards and Color Nomenclature. Washington, D. C., 1912. Plate 28. 7″ k.

and the paraphyses are shown in more detail in Fig. 5, while Fig. 1 illustrates ripe and unripe ascospores and Fig. 2 shows ascospores germinating.

As regards nomenclature, the combination *Nectria cinnabarina* cannot, of course, be adopted, since this name is already in use for the well-known "Coral Spot" fungus. Since the perithecia were discovered more or less by accident the specific name *inventa* does not seem inappropriate. The characters of the fungus may be summed up, as follows:

NECTRIA INVENTA Pethybridge.

Peritheciis gregariis, globosis, atro-rufis, superiore parte pilosis, 300–500μ diam., paraphysibus filiformibus dein obsoletis, 3–4μ × 150μ; ascis cylindricis, vel cylindraceo-clavatis, 60–100μ × 4–6μ, octosporis; sporidiis monostichis, oblongis, hyalinis, 1-septatis, 4–5μ × 9–10μ.

Hab. In tuberibus putresc. *Solani tuberosi* in Hibernia. Status conid. sistit *Verticillii cinnabarini* R. et B. (*Acrostalagmi cinnabarini* Corda).

Inoculations with pure cultures, through wounds into living potato stems and tubers, did not result in any sort of infection; hence the fungus is a saprophyte, so far as the potato is concerned at any rate. Control inoculations into stalks of healthy growing potato plants were made at the same time with a pure culture of *Verticillium albo-atrum* R. et B. and hadromycosis was set up in each case.

II. COLLETOTRICHUM TABIFICUM.

(Syn. *Rhizoctonia tabifica* Hallier.)

In a paper published in 1875 Hallier* attributed the disease in potatoes known as "Curl" to the presence (chiefly in the pitted vessels of the wood) of a parasitic fungus which he named *Rhizoctonia tabifica*. Of course no cultures of the fungus were made, nor were any infection experiments carried out, and a critical study of the paper leaves no doubt in one's mind but that Hallier was dealing with at least two (if not more) distinct organisms. It is highly probable that the principal one of these was the fungus *Verticillium albo-atrum*, described later by Berthold† and Reinke, investigated more fully by the present author‡ still more recently, and shown to be the cause

* Hallier, E. Die Ursache der Kräuselkrankheit. Zeits. f. Parasitenkunde, iv. 1875, p. 97.

† Loc. cit., p. 67.

‡ Pethybridge, G. H. The Verticillium Disease of the Potato. Sci. Proc. Roy. Dublin Soc. xv. (N.S.), 7, 1916, p. 63.

of a specific disease, hadromycosis, which is one of that congeries of diseases included under the term "Curl" by older writers.

Hallier placed his fungus in the genus Rhizoctonia, because he supposed that it produced certain black, pseudo-parenchymatous bodies (provided with stiff black hairs or setae) which he found on the diseased plants and which he regarded as being sclerotia. There is, however, no proof that these bodies belonged to the fungus luxuriating in the wood vessels, and it is now certain that *V. albo-atrum* produces no such sclerotia.

Bodies corresponding to Hallier's sclerotia were very frequently met with on dead or dying portions of potato stalks, especially on the parts below ground, and often in plants attacked by *V. albo-atrum*. They have not been seen on tubers, although no special search for them there was instituted. They arise beneath the epidermis through which the setae first make their appearance, and one of them in this condition is illustrated in Fig. 6, Plate III. By bursting through, or by the decay of the superficial tissues of the stalk, the whole black body ultimately becomes exposed. The setae are just visible with the naked eye but are somewhat easily broken off on handling the material. Occasionally (when still present) the pith of potato stalks bearing these bodies is of an amethyst tinge.

In some respects these bodies do resemble sclerotia, and they may perhaps function as such temporarily. When young, at any rate, they appear to contain appreciable quantities of oil. But the walls of the hyphae making up the pseudo-parenchymatous tissue are not so thick as one commonly finds in sclerotia.

For some time I was in doubt as to what these bodies really were. Hence, portions of potato stalks bearing large numbers of them were placed in a moist dish, and kept under observation for a considerable time during the summer of 1915. After a while a moist, amethyst-coloured globule arose on the upper surfaces of a number of the black bodies resembling bacterial colonies, but made up, in reality, of masses of conidia. Sections through the bodies showed that they were solid, and that the conidia were produced from a compact surface layer of conidiophores. From this surface the setae also arise; their bases are surrounded by the conidiophores and become submerged in the uprising conidial mass, their tops alone protruding above it.

The structure, as thus revealed, is evidently the fructifying stage of a species of Colletotrichum, and the puzzle as to the nature of what Hallier figured as sclerotia of a Rhizoctonia may now be regarded as solved. A vertical section through

a portion of one of these bodies is illustrated in Fig. 8, Plate III. The ripe spores are easily washed away but four detached ones are shown.

The once or twice septate conidiophores are arranged in a vertical palisade-like fashion and are absent when the "sclerotia" first emerge. They are usually simple, but a few branched ones have been observed. The setae are 1- to 3-septate.

The conidia are elongated, cylindrical, or slightly spindle-shaped, with somewhat bluntly pointed ends. Their size varies, but averages $21\mu \times 3\mu$. They are hyaline and contain either one central vacuole, or two situated towards the ends. They germinate by producing a germ tube from near one end; and after germination many of them, but by no means all, develop a transverse septum and become two-celled. After a few days' growth the mycelium produced gives rise to conidia borne on the ends of short branches and similar to those already described.

From a single conidium a pure culture was raised and sub-cultures were made on several different kinds of media. The mycelium produced is at first hyaline and almost wholly submerged. Old mycelium is smoke-coloured and bears appressoria (see Fig. 7, Plate III). A striking characteristic of all the cultures was the development of a beautiful amethystine fluorescence throughout the medium. After about a week's growth the development of the black bodies (always bearing setae) begins; and they are always produced in a series of concentric zones which are circular in Petri dishes, and oval on slants in test tubes. After a time many of these bodies produce on their surfaces the amethyst-coloured globule of conidia already described. The fungus thus produces conidia directly from the mycelium and also in fructifications of the Colletotrichum type. No other form of fructification appeared in the cultures. Its chief characters may be summarised as follows:

Colletotrichum tabificum (Hallier pro parte) Pethybridge.

Acervulis gregariis, primo sub-epidermicis, demum erumpentibus, atris, 100–270μ; conidiis continuis, cylindricis vel sub-fusiformibus, hyalinis, multitudine aggregata amethystinis apicibus abrupte aculeatis, $3\mu \times 21\mu$; basidiis fasciculatis, cylindricis, 1–2 septatis, 20–30μ longis; setulis simplicibus, erectis, 1–3 septatis, atris 100–340μ longis; appressoriis atro-fuligineis.

Hab. In stirpibus subterraneis mortuis, vel paene mortuis *Solani tuberosi*, in Hibernia.

Healthy living potato stalks and tubers were inoculated

through wounds with a pure culture of the fungus, but beyond a strictly limited growth at the expense of the cells injured in making the wounds, no development occurred, and no trace of any kind of rot was set up. Since, however, the fungus was found occasionally on stalks not completely dead there may possibly be special conditions under which it behaves as a parasite or at least a feeble parasite.

After the above described study of *C. tabificum* had been made a paper was published by O'Gara* in which a new species of Colletotrichum (*C. solanicolum*) occurring on potato stalks was described. An attempt to obtain a culture of this species failed, but judging from the published description it is just possible that it may be identical with *C. tabificum*.

The setae in the latter appear to be longer and the conidia rather longer and narrower than in *C. solanicolum*, but too much stress must not be laid on these somewhat variable characters. Perhaps the most striking point of difference is that, although O'Gara grew his fungus in pure culture, he does not mention the development in the medium of any amethystine fluorescence such as is so characteristic of *C. tabificum*, and which he would scarcely have failed to observe had it been present. Nor, apparently, was the mass of spores borne by the acervuli of this colour. There appears to be some doubt as to whether *C. solanicolum* is parasitic or not, for no inoculation experiments are reported. But the fungus is stated to have been found on living as well as on dead potato stalks. No amethystine coloration of the pith of affected stalks was noted.

Taubenhaus† has also described a Colletotrichum, derived from potato tubers, which he regards as being identical with *C. solanicolum*. On priority grounds, however, he maintains that it should be called *C. atramentarium* since he regards this fungus as being equivalent to Frank's *Phellomyces sclerotiophorus* and this, in turn, to Berkeley and Broome's *Vermicularia atramentaria*.

Those of us who are familiar with the sterile *P. sclerotiophorus* and its fructifying stage *Spondylocladium atrovirens*, both as it occurs on the potato tuber in Europe and as it behaves in pure culture, will perhaps not readily concur in this view.

In his primary isolation experiment Taubenhaus obtained three fungi from the surface tissue of a potato tuber affected

* O'Gara, P. J. New Species of *Colletotrichum* and *Phoma*. Mycologia, vii. 1915, p. 38.

† Taubenhaus, J. J. A contribution to our knowledge of Silver Scurf (*Spondylocladium atrovirens* Harz) of the white potato. Mem. New York Bot. Gard. vi. 1916, p. 549.

with Silver Scurf, viz. a Colletotrichum, a Fusarium and *Spondylocladium atrovirens*. It seems possible that the sclerotia originally present may have been partly those of Spondylocladium (formerly known as Phellomyces) and partly those of a Colletotrichum. Or, the Colletotrichum may have been present in mycelial form (as also the Fusarium probably was) and was not killed by the preliminary treatment with mercuric chloride. The matter, at any rate, deserves further careful study before the view that Phellomyces is a Colletotrichum and not Spondylocladium can be accepted.

Vermicularia varians has been described by Ducomet* as producing a disease of potatoes in France, and the same disease apparently occurs in Australia† and South Africa‡. The published descriptions of this "dartrose" or "Black Dot" disease recall, to some extent, what one has seen of *Colletotrichum tabificum*; but whether there is any real connexion between these two fungi can only be decided by further study.

III. HYPOMYCES SOLANI Reinke et Berth.

This fungus was described by Reinke and Berthold§ in 1879, who stated that it was a pure saprophyte. Since the ascospores on germination gave rise to conidia which these authors took to be those of *Fusisporium Solani*, they regarded *Hypomyces Solani* as the perithecial stage of this species.

Fusisporium Solani Martius was renamed *Fusarium Solani* by Saccardo; and in the older literature this fungus was often regarded as a parasite and the cause of the "Dry Rot" of the potato tuber.

The investigations of recent years on the genus Fusarium have, however, shown that the name *F. Solani* has been used in the past for more than one species of this genus; and this doubtless explains some of the confusion that has arisen.

Hypomyces Solani in its perithecial stage does not appear to be very common. I have only found it on three or four occasions, and always on the surface of potato tubers in an advanced stage of decay; never on tubers still partially living. Several years ago I was able to obtain type material of the fungus which has been useful for purposes of comparison.

The object of the present study was to trace the complete life-cycle of *H. Solani* from ascospore to ascospore *in vitro*; to make a careful comparison between its conidial stage and some

* Ducomet, V. Ann. Ecole Nat. Agric. Rennes, ii. 1908.
† McAlpine, D. Potato Diseases in Australia, 1911, p. 92.
‡ Doidge, E. M. Agric. Journ. Un. South Africa, vii. No. 6, 1914, p. 879.
§ Loc. cit. p. 27.

of the species of Fusarium which commonly occur on the potato, and to settle the question as to whether it is a saprophyte or a parasite. The species of Fusarium with which it has been more closely compared in culture are *F. Solani* (Mart.) A. & W., *F. Martii* A. & W., *F. caeruleum* (Lib.) Sacc., *F. trichothecioides* Wr., *F. discolor* (A. & W.) var. *sulphureum* (Schlecht.) and *F. arthrosporioides* Sherb.

Large numbers of cultures on numerous different kinds of media have been studied and a variety of inoculation experiments carried out, but it is only proposed to give a brief account of some of the most important results here.

General growth in pure culture. The stock pure culture which served as the basis for all subsequent work was derived from a single ascospore. These spores germinate readily, each cell sending out a germ tube. A photograph of a germinated ascospore is shown in Fig. 1, Plate IV.

Growth on all media used was luxuriant, the aerial portion being usually copious and snow white. An eight-day old individual growing on wort-gelatine is illustrated in Fig. 2, Plate IV. No colour of any kind was ever developed, such as is characteristic of several species of Fusarium. The older growth, especially on media slanted in test tubes, is not fluffy or cottony, as a rule, but may rather be described as somewhat fibrous, that is to say, the hyphae combine laterally to form more or less pointed strands, roughly comparable with fibrous asbestos. None of the several species of Fusarium under study at the same time showed this kind of growth. The consorting hyphae are not merely mechanically adherent to one another but actual anastomoses or "H-shaped" unions are frequent. Cultures in Petri dishes show very distinct concentric zonation. One such culture is shown in Fig. 4, Plate IV. Each zone consists of a horizontal chiefly submerged vegetative growth of mycelium and a corresponding vertical, aerial growth, the latter consisting of conidiophores bearing conidia-globules and being formed during the night. Each zone requires twenty-four hours for its formation. Growth of this kind has not been observed in any species of Fusarium.

Conidiophores. These are usually long, erect, multicellular and simple. Conidiophores with one or two lateral branches are occasionally seen, but the mode and extent of branching does not resemble that typical of Fusarium. They are sometimes submerged in the medium. Very frequently they are aggregated together in the form of conical coremia, as described and figured by Reinke and Berthold; and much of the aerial growth of the fungus often consists of such coremia. The second type of much branched conidiophores figured by these

authors* and obtained by them from pustules on tubers and stems evidently does not belong to Hypomyces, but to some species of Fusarium. Hypomyces does not appear to form pustules breaking through the skin of the potato like some species of Fusarium do, and attempts to produce them by pure culture inoculation of both healthy and sterilised tubers with intact skins failed.

Conidia. The conidia are produced singly at the apex of the conidiophore. When the conidium is ripe it becomes pushed on one side and does not immediately fall off. As the formation of conidia proceeds, a globule—at first elliptical, then spherical—forms at the tip of the conidiophore. This consists of a mass of conidia held together in a slightly alkaline fluid, just as occurs in some species of Verticillium. Not infrequently neighbouring globules of conidia in a culture touch one another and coalesce, forming thus a much larger globule which is then supported on several coremia. These globules are seen in Fig. 3, Plate IV, and they can just be discerned with the naked eye in Figs. 2 and 4, Plate IV.

After the first conidium is formed the protoplasmic contents of the conidiophore contract slightly, and a minute, slightly expanded collar remains at the extreme tip. The conidium next arising grows up and becomes seated in this collar, looking in its early stages like an egg in a cup. (See Fig. 10, Plate III.) When the conidium has reached its full size separation occurs at its base between its protoplasm and that of the conidiophore and a slight gap is seen. Subsequently the base of the conidium and the slightly contracted contents of the conidiophore each develop a thin wall. Somewhat the same kind of thing was described for *Fusarium caeruleum*† and accounts for the development of the foot-like base of the conidium often seen in Hypomyces as well as in several species of Fusarium.

Typical conidia of *Hypomyces Solani* are 3-septate, i.e. 4-celled, but forms with less or more septa are not uncommon. The average of many measurements of typical 3-septate forms was found to be $38\mu \times 6{\cdot}2\mu$. Similar measurements for *F. Solani* were found to be $30\mu \times 5{\cdot}3\mu$ so that the conidia of the latter are considerably smaller than those of *Hypomyces Solani*. Examples of them are shown in Fig. 9, Plate III. On germination the two terminal cells of the conidium invariably produce germ tubes first; the intermediate ones either later or not at all. In *F. Solani* the cells of the conidium were observed to germinate more or less simultaneously.

* Loc. cit. Pl. I, Figs. 5 and 6.

† Pethybridge and Lafferty. Sci. Proc. Roy. Dublin Soc. xv. (N.S.), No. 21, 1917, p. 204.

Chlamydospores. Reinke and Berthold refer to these as macroconidia and to the fusiform conidia as microconidia, following Tulasne's terminology. As a matter of fact the chlamydospores are smaller than the conidia, and there seems no adequate reason for retaining these somewhat obsolete terms. There is practically nothing to add to Reinke and Berthold's description of these spherical spores. They were produced in considerable numbers in all cultures but not so freely as the conidia. They developed extraordinarily abundantly in a sterilised cold water extract of ground Quaker Oats.

Their walls are thicker than those of the conidia and they are often more or less "warty," although this irregular thickening varies somewhat in different media and is sometimes completely absent. They germinate readily enough, but probably are more resistant to adverse conditions than the conidia and may serve, therefore, as resting spores. No experiments, however, were made on this point. A germinating chlamydospore is illustrated in Fig. 11, Plate III.

Development of Perithecia. During the first three or four months that the fungus was cultivated no perithecia were formed on any of the media used. Since they occur naturally on rotting potato tubers, special attention was devoted to culture on these. The fungus was planted on tubers affected with blight (*Phytophthora infestans*) both sterilised and unsterilised, as well as on sterilised tubers affected with "Pink Rot" (*P. erythroseptica*). Luxuriant growth developed in all cases but no perithecia were formed, although the cultures were kept under observation for fifteen months.

During the winter of 1913–14, the detailed culture work was suspended, but the stock culture was kept going by transfers at monthly intervals, mostly on oat extract agar, all the intermediate transfers being kept. After the fungus had been in culture for nearly a year perithecia began to develop both in some of the older transfers, which had been kept, and in the more recent sub-cultures on oat extract agar.

It would appear, therefore, that the fungus requires a more or less prolonged period of growth under artificial conditions, before it becomes stimulated to produce its perfect form of fructification. Having once reached this stage, the production of perithecia proceeds more rapidly. Thus, from a culture in which perithecia were present sub-cultures were made on sterilised potato stalks and sterilised portions of tubers, and within a month perithecia were developed. They were also formed on oat extract agar, Quaker Oat agar and beer-wort gelatine, but not quite so rapidly. In no case were they formed

in these media as freely and abundantly as on decaying tubers under natural conditions.

The form and structure of the perithecia have been described in detail by Reinke and Berthold, and there is little to be added in this connexion. When ripe the ascospores are expressed through the mouth of the perithecium in the form of a yellow mass. Perithecia with two necks have occasionally been observed in naturally growing material but they were not seen in any of the cultures.

Inoculation Experiments. Healthy living potato stalks, tubers and rhizomes were inoculated at various times and repeatedly with ascospores, conidia and mycelium bearing both conidia and chlamydospores, but no infection occurred in any single case and no rot was set up. *Hypomyces Solani*, therefore, is a saprophyte which in addition to its perithecial stage produces conidia and chlamydospores resembling in some respects those produced by certain species of Fusarium. There are, however, pronounced differences between typical species of Fusarium and the conidial stage of Hypomyces, and it is concluded that *H. Solani* is not the perithecial stage of *Fusarium Solani* or of any other species of Fusarium.

IV. TWO NEW SPECIES OF VERTICILLIUM.

In a previous paper* dealing with the disease of the potato plant caused by *Verticillium albo-atrum* R. et B. attention was called to the discovery of two new species of Verticillium, occurring on the surface of potato tubers, which, in the absence of infection experiments or study in cultures, might easily be mistaken for *V. albo-atrum*. Indeed, it seems not at all unlikely that it was the presence of one or the other of these species on the surface of the tuber which led Berthold and Reinke into the error of supposing that *V. albo-atrum* did not actually enter the tuber, as it has now been proved to do, but reached the developing sprouts from without, after having traversed the outer surface of the tuber. A brief description of these two species seems, therefore, desirable.

One of them, which it is proposed to call *V. nubilum*, was found at a spot on the surface of a tuber attacked by *Phytophthora infestans* where the skin had received a slight mechanical injury; the other, *V. nigrescens*, on the skin of a tuber affected with ordinary "scab." Both were obtained in pure culture, starting from a single conidium in each case, and both were grown on a large number of different solid and liquid media

* Pethybridge, G. H. The Verticillium Disease of the Potato. Sci. Proc. Roy. Dublin Soc. xv. (N.S.), No. 7, 1916, p. 75.

and the growths compared with one another and with that of *V. albo-atrum* on the same media.

In their conidial form all three species are much alike, so far as their aerial parts are concerned. The conidiophores are very similar in each case. The size of the conidia in each species varies considerably, but parallel cultures on the same media showed that those of *V. albo-atrum* were on the average the smallest, and those of *V. nubilum* the largest; while those of *V. nigrescens* were intermediate. The measurements were made on what were considered to be the predominating type of conidia, omitting the extreme forms in each case.

The most striking differences are to be found in those portions of the growths which are submerged in the culture medium. In all three cases this submerged growth becomes dark after a time, and finally almost black. In the case of *V. albo-atrum* this darkening, as is well known, is caused by the turning black of the submerged hyphae. In *V. nubilum* and *V. nigrescens*, on the other hand, it is due, not to any change in the colour of the submerged mycelium, but to the production of large numbers of what may be regarded as chlamydospores which develop very dark, almost black, walls.

The chlamydospores of *V. nubilum* are more or less spherical cells hyaline at first, but soon developing thickish, dark brown or black walls. They may be borne singly or in groups of up to seven or so. They may be terminal but are frequently intercalary in rows of three or four or more. Examples are illustrated in Fig. 5, Plate IV. They are not, however, produced on all media and are usually absent in those containing gelatine. The mycelium on which they are formed remains visible for a long time.

The chlamydospores of *V. nigrescens* are considerably smaller than those of *V. nubilum*. They may be spherical, oval or somewhat pear-shaped. Generally they are single-celled, but occasionally they are septate. Many of them arise in an intercalary fashion by the thickening and blackening of non-contiguous cells in a hypha, and they retain, more or less, the shape of such cells. Often they are laterally sessile and then generally spherical. The cells of the hyphae which do not become chlamydospores become rather indistinct in old cultures, and the general impression is that of a row of irregular beads arranged at unequal intervals along, or at the side of, a faintly visible band. Examples are illustrated in Fig. 6, Plate IV. They are developed in very large numbers; and the blackening of the medium produced by them is considerably more intense than that caused by the two other species.

Although the two fungi were kept continuously in culture

for three years, no reproductive organs, other than conidia and chlamydospores, were ever observed.

A considerable number of inoculation experiments were carried out with these two species on living potato stalks and tubers. In no case did infection occur and there was no indication of any ability to invade or grow in the vessels of the wood such as characterises the parasitic *V. albo-atrum*.

The characters of these two species may be summed up as follows:

VERTICILLIUM NUBILUM Pethybridge.

Mycelio albo effuso; ramis fertilibus ascendentibus, verticillatis; conidiis continuis, oblongatis, hyalinis, magnitudine varia plerumque $9\mu \times 3\mu$; hyphis in matrice submersibus chlamydosporis moniliformis vel conglobatis subglobosis, atris 8·5–12μ diam.

Hab. In tuberis putrescentibus *Solani tuberosi*, in Hibernia.

VERTICILLIUM NIGRESCENS Pethybridge.

Mycelio albo effuso; hyphis fertilibus erectis, ramis verticillatis; conidiis hyalinis, continuis, oblongatis, magnitudine varia plerumque $7\mu \times 2\mu$; mycelio in matrice submerso, chlamydosporis terminalibus, vel lateralibus, vel intercalariis, aut globosis, circ. 4·3μ diam., aut sub-ovalis, circ. $6\mu \times 4\mu$ atris.

Hab. In tuberis scabiosis *Solani tuberosi*, in Hibernia.

V. LANGLOISULA MACROSPORA A. L. Sm.

When examining blighted potato foliage in the search for possible oospores of *P. infestans*, isolated brown spores were again and again met with, the origin and identity of which were not clear. The same spores have also been met with on blighted tubers.

No difficulty was experienced in getting a pure culture from these spores, and the resulting fungus was identified by Mr. J. Ramsbottom and Miss A. Lorrain Smith as *Langloisula macrospora* by comparison with type material in the British Museum. This species was described in 1901 by Miss Smith* who found it spreading over a grass seed in the germinating case.

On agar media the submerged mycelium is hyaline and about 3μ thick. Over the surface of the medium much larger hyphae about 9μ thick run, and from these conidiophores arise here and there in more or less isolated tufts or balls. The

* Smith, A Lorrain. Fungi found on farm seeds when tested for germination; with an account of two Fungi new to Britain. Journ. Roy. Microscop. Soc. 1901, p. 617. In the description in the text the species-name *heterospora* is given but this is probably a misprint for the name *macrospora* which is applied to the figures on the accompanying plate and which is given to the fungus in the account published in Trans. Brit. Myc. Soc. i. 1902, p. 194.

hyaline conidiophores develop in a peculiar sympodial fashion which give them a zig-zag appearance as illustrated in Fig. 12, Plate III.

The conidia are egg-shaped and brown in colour. The wall is slightly thickened but it is not nearly so thick as would appear from Miss Smith's drawings. Nor is it so strongly thickened as is shown in figures of the conidia of *L. spinosa* Ell. et Everh. In young conidia the wall is quite smooth and not warty. In old cultures the wall is slightly rough, but even in this condition can scarcely be described as warted. Careful examination of old conidia shows that the outermost portion of the wall is not continuous over the whole conidium and the slight roughness is due to this fact.

The conidia germinate easily, a germ tube being produced at the narrower end through a thin place in the wall at the point where the conidium was attached to the conidiophore. A germinating conidium is illustrated in Fig. 13, Plate III.

Attempts were made to infect living potato leaves (both intact and wounded) as well as stems and tubers, but without success. The fungus is a saprophyte.

As regards the systematic position of the fungus, it seems doubtful whether it should really be placed in the genus Langloisula. Its conidiophores are not dichotomously branched as in the type of that genus, and its conidia are not so thick walled. Miss Smith and Mr. Ramsbottom suggested to me that it would perhaps be better placed in the genus Monopodium of Delacroix*. Material was sent to Paris for comparison with Delacroix's specimens, but unfortunately no type material of them had been preserved.

M. Arnaud was good enough to look into the matter, however, and found that the specimen sent agreed exactly with an unpublished drawing by M. Griffon which the former believed to represent Delacroix's Monopodium. M. Arnaud further suggested that both the Monopodium of Delacroix and *Langloisula macrospora* were probably identical with *Acremoniella atra* Corda, and pointed out that the specimen of Langloisula forwarded resembled Saccardo's† drawing of this species rather more closely than the original one of Corda‡.

In concluding these notes I desire to acknowledge gratefully the assistance given me, in cultural and other work with the organisms described, by Mr. H. A. Lafferty, A.R.C.Sc.I., who was also good enough to prepare the drawings for the figures on Plate III.

* Bull. Soc. Myc. France, vi. 1890, p. 99.
† Fungi Italici. No. 713.
‡ Icon. Fung. i. Tab. III, fig. 168.

EXPLANATION OF PLATES.

Plate III.

(All figures were drawn with the aid of a Zeiss Camera Lucida.)

Fig.

1. Unripe (single-celled) and ripe (two-celled) ascospores of *Nectria inventa*. × 547.
2. Ascospores of *N. inventa* in various stages of germination in tap water. × 547.
3. An ascospore (*a*) of *N. inventa*, the germination and subsequent development of which on a cover-glass film was followed uninterruptedly under the microscope. The hypha *h*, *h* was continuous and developed on the left a characteristic conidiophore bearing conidia of *Verticillium cinnabarinum*. × 333.
4. Vertical section through a perithecium of *N. inventa* on its stroma. The section is not quite median and therefore does not pass through the ostiole, although the near presence of the latter is seen from the arrangement of the cells at the top. For the sake of clearness a large portion of the contents of the perithecium has been omitted. In an actual section the paraphyses are not nearly so clearly defined as is shown, owing to crowding. The mycelium permeating the cork-cells of the skin of the tuber on which the stroma sits, although present in the section, has been omitted from the drawing. × 55.
5. Portion of the contents of a perithecium of *N. inventa* teased out, showing the asci and septate paraphyses with rather swollen bases. × 340.
6. Young "sclerotium" (acervulus) of *Colletotrichum tabificum* on a potato stalk. The long black setae have penetrated through the epidermis but the remainder is still submerged in the tissue. × 91.
7. Appressoria of *C. tabificum* as developed in pure culture. × 560.
8. Vertical section through the acervulus of *C. tabificum*, as developed in pure culture. Four ripe conidia are shown isolated. The upper surface consists of a palisade-like layer of septate conidiophores, and the basal portions of two setae are shown. The lower part consists of rather thin walled pseudo-parenchymatous tissue. × 340.
9. Typical conidia of *Hypomyces Solani* from a 30-day old culture on oat extract agar. × 560.

Fig.

10. Two conidiophores of *H. Solani* from a 30-day old culture on a sterilised potato stalk. The one on the right shows the "collar" at its apex, that on the left is in process of developing a fresh conidium. × 340.
11. Germinating chlamydospore of *H. Solani*. × 560.
12. Conidiophore of *Langloisula macrospora*. × 340.
13. Germinating conidium of *L. macrospora*. × 340.

Plate IV.

1. Portion of the mycelium produced from a single ascospore (seen in the centre) of *Hypomyces Solani* in four days on a wort-gelatine cover-glass film. × 200.
2. An 8-day old individual of *H. Solani*, developed from a single ascospore on a wort-gelatine. The very numerous globules of conidia can just be seen with the naked eye as black dots. × 10.
3. Portion of the individual shown in Fig. 2, showing the conidiophores with their terminal globules of conidia.
4. A culture of *H. Solani* on oat extract agar, eleven days old. The first six days' growth occupies the centre and is more or less blurred by the presence of the large numbers of conidia-globules, many of which have fused together. The growth during the subsequent five days is clearly zoned. The lighter circles consist of aerial conidiophores, bearing conidia-globules; the darker, wider bands consist of more or less submerged mycelium. A dark and a light band, forming one zone, developed each 24 hours, the light circle of conidiophores being produced last and during the night. × $1\frac{1}{4}$.
5. Groups of chlamydospores of *Verticillium nubilum* from a pure culture on oat extract agar. × 360.
6. Chlamydospores of *V. nigrescens* from a pure culture on oat extract agar. The mycelium which bore these spores is now practically invisible. × 310.


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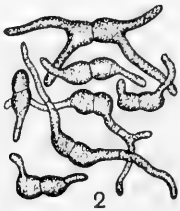
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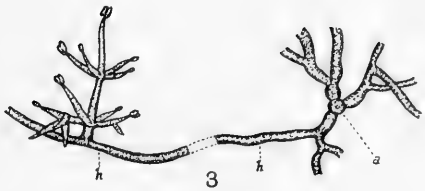

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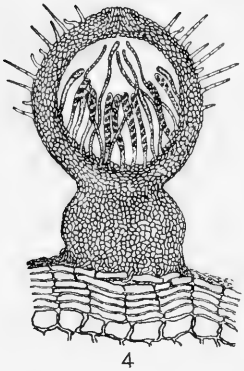
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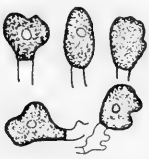
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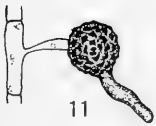
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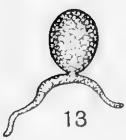
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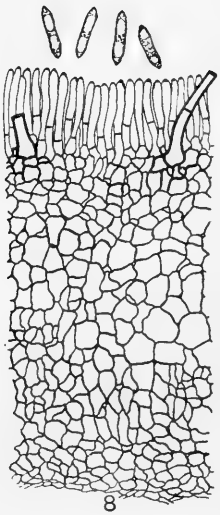
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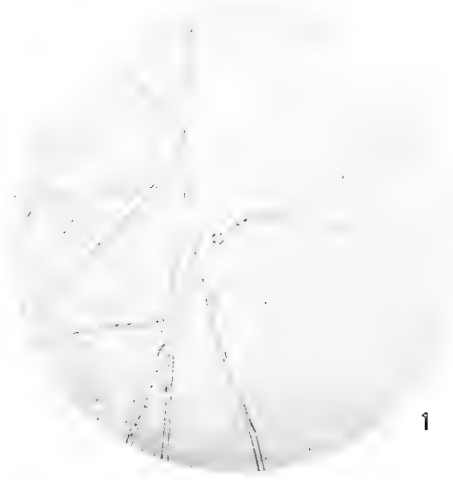
H. A. Lafferty del.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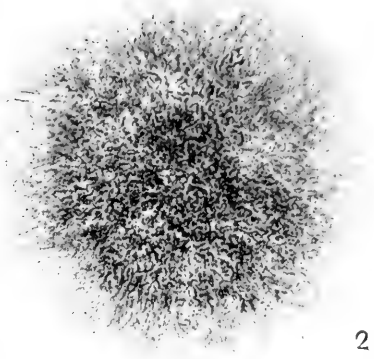
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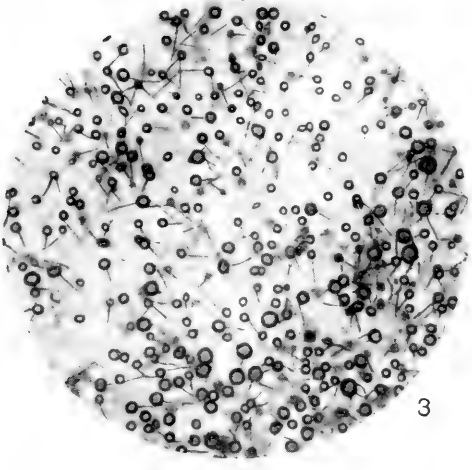
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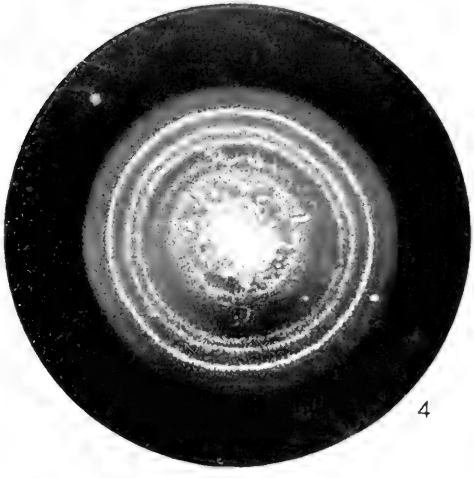
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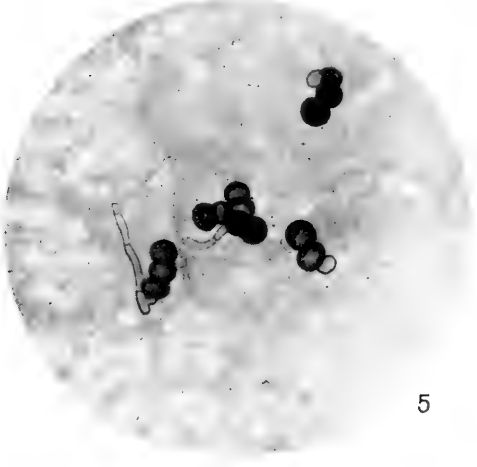
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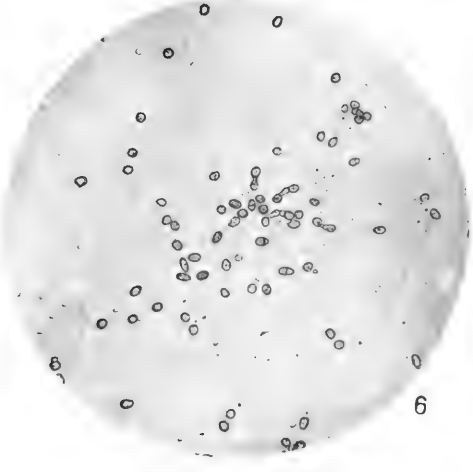
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FURTHER NOTES ON COLUS GARDNERI (BERK.) FISCHER.

With Plate V.

By T. Petch, B.A., B.Sc.

Colus Gardneri was described by Berkeley under the name of *Lysurus Gardneri* in Hooker's London Journal of Botany, v. p. 535. In "Versuch einer systematischen Uebersicht über die bisher bekannten Phalloideen" (1886), Ed. Fischer transferred it to Colus. The description, as given in Saccardo, is: "Receptaculo elongato, stipitiformi 17–18 cm. alto; stipite longo (15 cm. alto) superne dilatato in partem clathratam apicem conicum receptaculi efformantem transeunte; partis clathratæ interstitiis 5, verticalibus, linearibus; ramis superne attenuatis, apice junctis, extus medio structura stipiti æqualibus, latere rugosis."

In Grevillea, xix. p. 94, Massee wrote, "Berkeley, in describing the present species [*Lysurus Gardneri*], says that the vertical lobes bearing the hymenium are united at the tips, and on this account the species has been removed to the genus Colus by Fischer; but in reality the segments are not organically united at the tips, but during the young stage are closely pressed together, and having been dried in this condition appear to be united; however, when the mucilage is moistened the tips are found to be quite free, and are normally so in several out of the twenty-three specimens from Gardiner (*sic*) in the Kew Herbarium. The above is an average illustration as to how synonyms originate, i.e., by manipulating descriptions and not specimens, which, however, answers the desired object, that of enabling the manipulator to bracket the founder's name and bring his own to the front."

Whatever may be the condition of the Kew specimens now, there can be no doubt that Massee's statement is incorrect. The fungus is not common at Peradeniya, but I have gathered and examined over thirty specimens and in all of them the arms are "organically united" at the apex. They are not glued together by mucilage, nor united by a membrane, but each arm is continued as a tube up to the apex where it is continuous with the others.

In "Untersuchungen zur vergleichenden Entwicklungsgeschichte und Systematik der Phalloideen" (1890), Fischer retained this species in the genus Colus. He had examined a specimen from Berkeley in Herb. Mus. d'Hist. Nat., Paris, but was unable to determine the nature of the dorsal line of the arm and the apex. Fischer stated that *Colus Gardneri* is, as it were, *Colus hirudinosus* in which the stalk has lengthened and the apical meshes disappeared, or an Anthurus with its arms united at the tip; it differed from Lysurus in that in the latter the stem structure was not continued into the arms; in *C. Gardneri*, as in Anthurus and the other species of Colus, the stalk expands gradually to the receptaculum, whereas in Lysurus it is constricted above as in *Simblum sphaerocephalum*.

In "Neue Untersuchungen" (1893) Fischer wrote "In Berkeley's and the Kew Herbarium there are numerous examples of this fungus, all from Ceylon. I was able to determine with certainty on some of them that the arms are actually united at the apex, though the junction is extraordinarily thin. But the possibility is not excluded that examples may occur in which the arms are free. Further, it is characteristic of this species that the lowest part of the arm is free from spores, and, correspondingly, is not transversely wrinkled."

In "Untersuchungen zur vergleichenden Entwicklungsgeschichte," etc. (1900), Fischer notices Massee's statement in Grevillea and refers his readers to his views expressed in 1893.

In 1907, C. G. Lloyd published "The Phalloids of Australasia," and gave copies of the figures of *Lysurus australiensis* and *Mutinus pentagonus*, which, in general appearance, closely resemble *Colus Gardneri*. Lloyd expressed his opinion of the latter in the following terms. "The early stages of Lysurus with the arms connivent have led to some very misleading pictures. Thus, Berkeley's original picture of *Lysurus Gardneri* so misled Professor Fischer that he transferred it to another genus, but after he visited Kew and saw that it misrepresented the plant he should have transferred it back. Our American species *Lysurus borealis* was named *Anthurus borealis*, but in my opinion is a Lysurus, and I think the same as the Ceylon species. It was originally illustrated with a drawing subject to the same criticism as the original drawing of *Lysurus Gardneri*" (p. 12). "*Lysurus Gardneri* of Ceylon, which was so named and described by Berkeley, is a true Lysurus with spreading arms, and not a Colus, as found in Fischer's latest work. Fischer referred it to the genus Colus on the strength of Berkeley's figure, and he was justified, if one is ever justified in changing classification on the evidence of a figure. When Professor Fischer came to Kew, however, and saw the specimens,

he should have receded from his position, for it is quite evident that the plant is a Lysurus, and not a Colus in any sense of the word. The arms are entirely separate and spreading when mature. Like all species of Lysurus, they are connivent when young, but they are not joined at the apex, however slightly" (p. 14).

In 1908, the present writer redescribed *Colus Gardneri* in "The Phalloideae of Ceylon" (Ann. Perad. iv. pp. 139–184), pointing out that the arms are always united at the apex, and that the structure of the gleba-bearing area of the arms is similar to that of the cap of *Dictyophora irpicina* (*Clautriavia irpicina*). Additional details were published in "Further Notes on the Phalloideae of Ceylon" (Ann. Perad. v. pp. 1–21).

In "Synopsis of the known Phalloids" (1909) Lloyd adopts Berkeley's name *Lysurus Gardneri* for the Ceylon species. Under "The Genus Lysurus," he writes: "This genus has been very much misunderstood though of a very simple structure. It consists of free arms borne on a hollow columnar stem. The gleba is borne on the arms. It has been shown that in the original species the gleba is borne on the outer side of the arms, hence species with gleba on the inner surface of the arms have been transferred to Anthurus, which genus does not have a columnar stem. I think it is much simpler to define Lysurus as originally defined, viz.: a columnar stem bearing free arms at the apex. With respect to the position of the gleba, there are evidently two series, and a new genus will probably be made for those with the gleba on the inner side of the arms. It has recently been shown by Mr. T. Petch, Ceylon, that the arms of *Lysurus Gardneri* (which was the second species known) are not entirely free, but are united by a delicate membrane. We would therefore modify the definition of the genus to include species with arms free or very slightly united."

In the second of the publications referred to above, I have pointed out that the junction of the arms is not a delicate membrane.

Lloyd's final conclusions on the subject are contained in Mycological Notes, No. 43 (Sept. 1916), p. 594. They are quoted here in full.

"We present herewith a sketch of *Lysurus Gardneri*, recently sent us by C. C. Brittlebank, Melbourne. In our Phalloid Synopsis, we presented nine species of Lysurus, and the evidence since is that four of them, viz., *Lysurus Gardneri* (Ceylon), *Lysurus australiensis* (Australia), *Lysurus borealis* (United States), and *Lysurus Clarazianus* (Argentina) are all one and the same thing. We have believed it for a long time, and there was no longer any room for doubt on the appearance of 'Notes

on Australian Fungi, No. 2,' August, 1915, by Dr. Cleland and Edwin Cheel. We suspected it from the first, but Professor Petch maintained that *Lysurus Gardneri* had its arms joined by a membrane at the apices, which was not the case as far as known in the other species. Messrs. Cleland and Cheel have satisfactorily explained this. In Australia, while the arms are usually free, they are sometimes 'united at the apex by a thin membrane which gives the specimen a somewhat clathrate appearance.' The figure 836 which we produce from Messrs. Cleland and Cheel presents the top of a young specimen with two of the arms joined. Mr. Brittlebank's sketch (Fig. 835) shows the arms connivent, as they are at first. They afterwards spread out, as shown in the fine photograph by Hollis Webster, published in Mycological Notes, p. 513.

"There is a long story connected with the species. First it was sent Berkeley from Ceylon and named *Lysurus Gardneri*. It is rare in Ceylon, but recently collected by Professor Petch. One collection reached Kew from Australia (Bailey, Brisbane River) which Cooke named *Lysurus australiensis*, and gave in the Handbook a most inaccurate and exaggerated drawing of it. It seems to not be common in Australia, though there are twelve collections in the National Herbarium, Sydney. Fischer gives a very good figure of it from Argentina under the name *Lysurus Clarazianus*. The European and American history is all recent, for it is supposed to be introduced into both these countries. With us it was first collected at East Galway, New York, by Professor Burt in 1893. He published it as *Anthurus borealis* under a misconception of the genus Anthurus. A few stations were added from time to time (Cfr. Myc. Notes, pp. 183, 219, and 515), and of late years it is sometimes found in abundance. It seems to grow where sod has been turned and rotted. In Europe it has been collected once in Germany, and twice in England (Cfr. Syn. Phalloids, p. 40), no doubt adventitious. The native home of the species is probably the East (Ceylon and Australia). Cleland and Cheel consider that *Mutinus pentagonus* (Syn. Phalloids, Fig. 28) is the same plant. I examined the specimens at Kew, and I thought the arms were consolidated in one piece. If they separate, then I think it is *Lysurus Mokusin* of China, which differs from *Lysurus Gardneri* in having an angular, fluted stem. Petch in his latest work insisted that the Ceylonese plant and Australian are not the same."

The opinions expressed by the different mycologists who have dealt with *Lysurus Gardneri* from Ceylon and *Lysurus australiensis* from Australia have, of course, been based on drawings and dried specimens, and they are the best possible on that

material. Of recent years, the systematic study of Australian fungi (as distinct from plant pathology) has been vigorously pursued by Dr. J. B. Cleland and Mr. E. Cheel, and thanks to them we are now able to obtain material in a condition more suitable for investigation. In order to decide the identity, or otherwise, of *Lysurus Gardneri* and *Lysurus australiensis*, I sent specimens of the former, in alcohol, to Dr. Cleland, and, in return, Mr. Cheel has very kindly forwarded specimens of the Australian species in formalin. Comparison of the two species shows that they are entirely different. Each has a stalk and five arms, but there the resemblance ends.

Before proceeding to enumerate the differences between the two species named, it may be as well to call attention to a point in the classification of phalloids which has not received the consideration it should. In spite of Fischer's work, there appears to be too great a tendency to base the systematic arrangement of this group on general appearance, and to ignore details which, to some, seem to be more important. We do not group the Dog Rose and the Christmas Rose together, even though to the casual observer their flowers may look very much alike.

In all the phalloids, the gleba is borne on certain definite areas. The main mass of the plant may be regarded as a foundation or scaffolding on which the gleba-bearing regions are situated. The foundation is, in general, composed of chambered tissue, and its surface usually bears close-set convex elevations, which represent the outer walls of the chambers. But the surface underlying the gleba is usually of a different nature, and in many genera it has a characteristic form. This surface may be called the glebiferous layer, from its function, without any necessary implication as to its origin.

It is generally recognised that the shape of the foundation may vary to a considerable extent. A species which usually has five arms may sometimes have four or six. A stalk which generally consists of three layers of chambers might conceivably have only two; Cleland and Cheel suggest such a variation to account for the fact that the wall of the stalk of *Lysurus australiensis* has usually three layers of chambers, while that of the supposed identical *Lysurus Gardneri* has usually only one. In *Aseroë rubra*, the number of arms varies considerably, and while some specimens have narrow simple arms, others may have broader bifid arms owing to the partial fusion of adjacent pairs, and in yet others, all the arms may be fused in pairs to form broad simple arms; stages of this variation may be found on opposite sides of the same specimen. But

what is often not recognised is that the form of the glebiferous layer is practically constant.

In Mutinus, the glebiferous layer consists of a series of close-set slightly-elevated tubercles. Jansia is indistinguishable from Mutinus when the head is covered with gleba, but when the gleba is removed, the glebiferous layer (in the type species) is found to bear numerous scattered appendages. Hence Jansia is distinguished from Mutinus by the form of the glebiferous layer.

The point I would wish to emphasise is that, in classification, the shape of the glebiferous layer, as well as the general shape of the foundation, should be taken into account. Otherwise, the classification would appear to be in the same category as a classification of flowering plants based on general form and habit.

Dictyophora offers a standard example. *Dictyophora irpicina* is of the same general form as *D. phalloidea*. When the cap is covered with gleba, there is nothing evident to indicate that the two are not structurally alike. But when the gleba is removed, the latter is found to have its cap widely reticulated with high, narrow ridges, while the cap of the former has an irregular granular appearance, due to the fact that its glebiferous layer consists of innumerable thin processes and contorted plates, perpendicular to the basal layer and closely packed together. Recognising this difference, Fischer divided Dictyophora into two sections, Reticulati and Rugulosi. Recent writers have gone further and have raised Patouillard's section Clautriavia, which is Fischer's Rugulosi, to the rank of a genus.

According to the idea outlined above, it is not possible to classify an unknown phalloid accurately, unless the gleba is washed off and the glebiferous layer examined. If this test is applied to *Lysurus australiensis* and *Lysurus Gardneri*, it is immediately clear that the two species are not the same and do not even belong to the same genus. The glebiferous layer of *Lysurus australiensis* consists of smooth broad folds or wrinkles; that of *Lysurus Gardneri* is rough and granular, of the same nature as that of *Clautriavia irpicina*. If *Dictyophora irpicina* is admitted to be generically distinct from *D. phalloidea*, there can be no escape from the conclusion that *Lysurus Gardneri* is generically distinct from *L. australiensis*.

The arm of *Lysurus australiensis* bears a glebiferous layer along the whole of its length. Laterally, this layer extends nearly round the arm, leaving, however, a shallow longitudinal furrow on the outer side free from gleba. It is composed of a series of close-set horizontal wrinkles, each 0·4–0·5 mm.

broad. These wrinkles seldom extend right across the arm, but those which begin at the sides thin out and are finally wedged between others which arise on the inner face. The separate wrinkles have a smooth white rounded outer edge. In longitudinal section, it is seen that these wrinkles are merely folds in the wall of the arm.

The arm of *Lysurus Gardneri* bears its glebiferous layer along the middle two-thirds or three-quarters of its length, the base and apex being free. The layer extends laterally almost completely round the arm, being interrupted by a deep narrow furrow on the outer side. This furrow is usually so narrow that it is hidden by the projection of the gleba over either edge. The glebiferous layer is slightly furrowed transversely, but the whole surface is minutely granular, the granules being the ends of thin processes, or the irregular edges of contorted plates, so closely packed together that their outer ends form a continuous surface. These processes arise from the wall of the tube which forms the arm, and as they are 1·5–2 mm. long, they constitute the greater part of the thickness of the arm. As in *Clautriavia* (*Dictyophora*) *irpicina*, the glebiferous layer, after the removal of the gleba, is dark olivaceous, not white.

The above is the fundamental distinction between the two species. *Lysurus australiensis* has a glebiferous layer, similar to the commoner type in phalloids; *Lysurus Gardneri* has a "rugulose" glebiferous layer, practically identical with that of *Clautriavia irpicina*.

The less important points of difference are numerous, and would be sufficient to maintain the two species distinct, if they belonged to the same genus.

The arm of *Lysurus australiensis* is irregularly chambered below, and becomes a simple tube, with a wrinkled wall, above. The wrinkled glebiferous layer is continued from arm to arm round the sinus between the arms. (It may be noted that a continuation of the gleba may mean nothing, because the soft gleba mass may be washed down into an abnormal position, but, on the other hand, the continuation of the glebiferous layer postulates a definite type of structure.) The head of *L. australiensis* may be roughly compared to a star-shaped disc, perforated in the centre, glebiferous along the whole outer edge, the points of which have been turned up. The comparison is not a very accurate one, as it ignores the continuation of the glebiferous tissue across the inner surface of the arms. But it may serve, as it illustrates also the fact that the "head" consists not only of the arms, but also includes the upper edge, or rim, of the tube which constitutes the stalk. This "head"

is separated from the stalk by a distinct constriction, in most cases. This distinction between stalk and head, and the continuation of the glebiferous layer from arm to arm at its base were noted by Fischer: the points are clearly shown in Brittlebank's figure.

The arms of *L. australiensis* are apparently glebiferous to the apex: in section they are obtusely triangular, the rounded apex of the triangle being on the inner side. The stalk in cross section is composed of several layers (usually three) of small chambers.

In *Lysurus Gardneri*, the glebiferous layer is not continued below from arm to arm. The stalk divides at the apex into five small stalks, and these do not bear any glebiferous layer for a length of two to four millimetres. Their structure in this basal region is the usual chambered stalk structure, and in cross section they show two large chambers. Above that region, each arm becomes a simple tube, bearing on its outer wall the closely-packed processes which constitute the glebiferous layer. The diameter of the arm, which is about 3 mm. in the stalk region, is increased to 6 mm. in the glebiferous zone, the increase being due to the length of the processes. Towards the apex, the glebiferous layer ceases, and the arm is continued as a narrow simple tube. In this species, consequently, there is no "head" sharply defined from the stalk: each arm is borne on its own stalk.

In section the arms of *Lysurus Gardneri* are oval, with a narrow groove along the outer face. The groove results from the absence of the glebiferous layer, with its long processes, from a narrow longitudinal band. The stalk is composed, as a rule, of a single layer of chambers, greatly extended longitudinally, but it may have two layers.

The discussion as to the identity of *Lysurus Gardneri* and *Lysurus australiensis* has usually centred on the minor point whether the arms are united or not at the apex. In *Lysurus Gardneri*, each arm is continued as a narrow tube to the apex, where it is united with the other arms, the tube structure being continuous over the apex. This feature is constant in all the fresh specimens examined, and it is clear from the structure that any separation of the arms could only be the result of an accidental fracture. In *Lysurus australiensis*, the arms are said to be usually free at the apex, but specimens are found in which the arms are united. In one of the specimens sent me by Mr. Cheel, one of the arms is subacute and closed at the apex; the remaining four are perforate and truncate at the apex, and one of them bears at the top a short length which, from its expansion upwards, evidently belongs to one of the

other arms. In another specimen, two arms are clearly united, the wrinkled structure being continuous from one to the other. But it is surely misleading to call such a junction a "Membrane"; this one is a tube 1·75 mm. in diameter.

From the specimens submitted to me, I should deduce that in the young state, in the egg, and probably immediately after expansion, *Lysurus australiensis* has one or more arms free and others united in pairs, and that some time after the plant has expanded the junctions break. If the egg were obtained and the plant allowed to expand under a bell glass, this could easily be determined.

Fortunately, the distinction between *Lysurus Gardneri* and *Lysurus australiensis* does not depend on the question whether the arms are united or free, and we are consequently spared the trouble of discussing which characteristic should be attributed to Lysurus as a genus. But the case illustrates a point which will always bother the classifiers of phalloids, as long as they have to depend on chance collections of expanded specimens. For a phalloid is one of the most ephemeral of tropical fungi, and the collector who does not gather his specimens in the early morning cannot gain a correct knowledge of their original form.

The question which perennially arises in the study of phalloids is this: Are we to describe a phalloid from specimens which have just expanded and are therefore in the most perfect condition, or from specimens which have been expanded for some hours and have begun to collapse? It is surely incorrect to base classification and discuss affinities on details which only exist in old, broken specimens.

Setting aside Lysurus as an unsettled case, we may take Dictyophora as an example. When *Dictyophora phalloidea* first expands, its net is rigid and stands out like an old-time crinoline, but in the course of an hour or two, the net collapses into folds, after the manner of a modern (?) petticoat. But there appears to be a general agreement that the net of Dictyophora hangs in folds, and it has been suggested that a new species should be founded on Möller's figure, which shows a rigid net. Again, *Simblum periphragmoides* has a subglobose, netted head at the apex of a stout stalk. When first expanded, the head rests on the top of the stalk like a ball on a stick, but, after a few hours, the basal bars of the net weaken and collapse, and the head sits down on the stalk and sags over the edge. The collapsed form has been made a new species. As an extreme example, *Clathrus crispatus* may be cited. This is a large Clathrus, 20 cm. diameter, with massive arms and small meshes. Half an hour after expansion, it breaks up spon-

taneously into fragments. Is *Clathrus crispatus* to be described as a heap of fragments? It would appear self-evident that if classification is to be based on the general shape of phalloids, it must be on the perfect shape, immediately after expansion, before they have collapsed or broken.

The type species of the genus Lysurus, *L. Mokusin*, appears from the available figures and descriptions to be so different from the other species assigned to Lysurus, that it would seem preferable to confine the genus to it alone. From the photograph of *Lysurus borealis* in Lloyd, Myco. Notes, p. 513, it appears clear that that species has wrinkled arms similar to those of *Lysurus australiensis*. From Fischer's description, and Möller's figure as reproduced by Lloyd, *Lysurus Clarazianus* has the same wrinkled arms. Of the remaining species enumerated by Lloyd, *Lysurus Woodii* (MacOwan), *L. Sanctae-catharinae* (Ed. Fischer), and *Lysurus cruciatus*, there does not appear to be any definite information regarding the structure of the arms.

The type species of the genus Colus is *Colus hirudinosus* Cav. & Sech. Its short stalk divides above into several stalk-like arms, which support a netted head. Hence Fischer was justified in comparing *Lysurus Gardneri* to a Colus in which the apical meshes had disappeared. Its arms appear to be transversely wrinkled.

The genus Pseudocolus is attributed, in Saccardo, xxi., to Fischer, but it was apparently established by Lloyd, Phalloids of Australia (1907), p. 18, for the reception of *Colus Rothae* Fischer, *Colus javanicus* Penz., *Colus Garciae* Möll., *Colus fusiformis* Fischer, and *Pseudocolus rugulosus*. These species have a short stalk which bears three arms, united at the apex. It may be noted that unless the genus Pseudocolus is confined to species which have only three arms, *Lysurus Gardneri* should, if the general shape of the plant alone is considered, have been included in it; Fischer, indeed, grouped *Colus* (*Lysurus*) *Gardneri* with *Colus javanicus* and *Colus Garciae*. Length of stalk can scarcely be regarded as a generic difference.

Pseudocolus Rothae is insufficiently known; its arms are described by Fischer as wrinkled, but Cleland and Cheel state that the species they attribute to this has arms which are alveolar on their inner surface. *Pseudocolus Garciae*, from Möller's figure and description, has coarsely wrinkled arms. *Pseudocolus javanicus* is described and figured by Penzig as having lamellae in groups on the arms. *Pseudocolus fusiformis* and *Pseudocolus rugulosus* have not been adequately described or figured.

On the available evidence, none of the species of the genera

Lysurus, Colus, and Pseudocolus, except *Lysurus Gardneri*, has a glebiferous layer composed of closely-packed processes and plates, such as occurs in *Clautriavia irpicina*. I therefore propose to establish a new genus Pharus for *Lysurus Gardneri*, its distinguishing characters being the division of the stalk into arms, and the structure of the glebiferous layer.

Pharus, gen. nov. Receptaculum stalked: stalk dividing above into arms which normally unite at the apex: glebiferous layer borne solely on the arms, and consisting of numerous plicate processes and plates, perpendicular to the arm, closely packed together, and presenting a granular outer surface, similar to that of Clautriavia.

Pharus Gardneri (Berk.). *Lysurus Gardneri* Berk., in Hooker's Lond. Jour. Bot. v. (1846) p. 535 and vi. (1847) p. 512. *Lysurus* (*Desmaturus*) *Gardneri* Schlecht., in Linnaea, 31 (1861–62), p. 180. *Colus Gardneri* (Berk.) Ed. Fischer, Vers. e. Syst. Uebers. p. 77 (1886), and Sacc., Sylloge, vii. p. 21. *Lysurus Gardneri* Berk., of Lloyd, Synopsis of the known Phalloids. Not *Lysurus Gardneri* Berk., of Cleland and Cheel, Notes on Australian Fungi, No. 2, Jour. Proc. Roy. Soc. N.S.W., xlix. p. 204; li. p. 364.

Hab. Ceylon only.

EXPLANATION OF PLATE V.

Fig.

1. *Pharus Gardneri*, natural size. Specimen with five arms, united at the apex. The gleba has been removed as far as possible, but traces remain between the ends of the processes and give the glebiferous layer a dark appearance.
2. *Pharus Gardneri*, upper part, natural size. Specimen with six arms, the junction of the arms produced into an apical appendage. This abnormality has been met with only once.
3. *Pharus Gardneri*. An arm viewed from the inner side, after removal of the gleba. × 4.
4. *Pharus Gardneri*. Cross section of an arm through the glebiferous region. × 4. The furrow is on the outer side of the arm.
5. *Pharus Gardneri*. Cross section of the egg, through the region of the arms, slightly enlarged. The separate gleba masses surround the arms almost completely, being interrupted only by the umbilical plates which are united to the arms along the dorsal furrow.

Fig.

6. *Lysurus australiensis.* Copy of Brittlebank's figure in Lloyd (loc. cit.). Note the continuation of the glebiferous layer from arm to arm, and the constriction of the stalk (represented by the double line) below the head.
7. *Lysurus australiensis.* The lateral surface of an arm. × 4.
8. *Lysurus australiensis.* Cross section of an arm. × 4.

NEW BRITISH FUNGI.

By E. M. Wakefield, F.L.S.

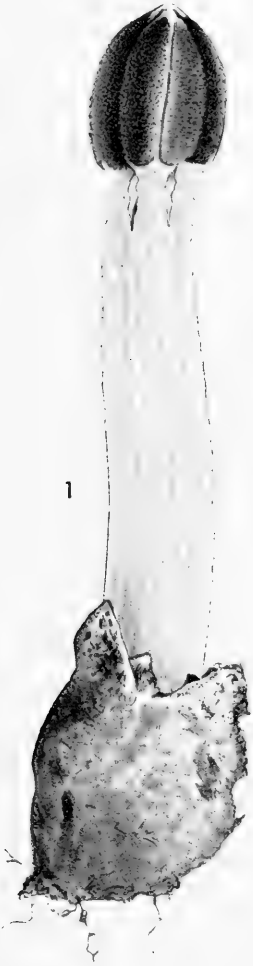
Hypochnus umbrinus (Fr.) Quél., Flore Myc. 1888, p. 2.

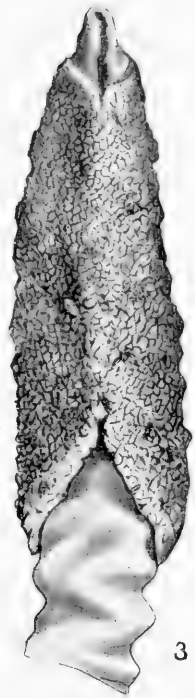
Thelephora umbrina Fr., Elench. Fung. i, 1823, p. 199; non *T. umbrina* A. & S., Consp. Fung. 1805, p. 281; *Corticium umbrinum* Fr., Hym. Eur. 1874, p. 658; *Thelephora biennis* Fr., Hym. Eur. p. 636, non Syst. Myc. i, p. 449; *Hypochnus tristis* Karst. in Soc. pro Faun. et Flor. Fenn. Med. ix, 1883, p. 71; *Hypochnopsis fuscata* Karst., Finl. Basidsv. 1889, p. 443; *Hypochnus fuscatus* Karst. in Sacc. Syll. ix, p. 244; *Tomentella tristis* von Hoehn. & Litsch. in K. Akad. Wiss. Wien, Sitzungsber. cxv, 1906, p. 1572; *Hypochnus sitnensis* Bres. in I. R. Accad. Agiati Atti, iii, 3, 1897, p. 115.

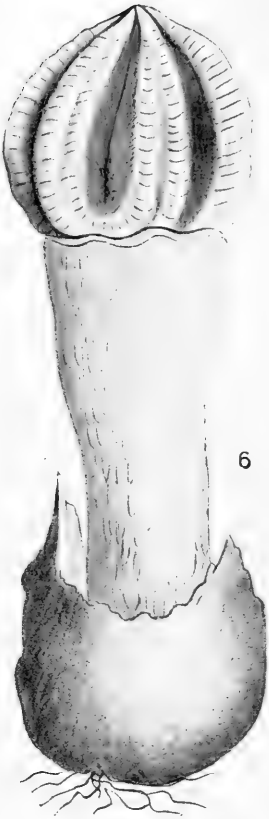
Effused, thick, soft, separable. Hymenium compact, membranaceous, brown with more or less of a vinaceous tint (varying from drab or deep brownish drab to dusky drab or Chaetura drab of Ridgway). Subiculum villose, warm sepia in colour. Hyphae brown, thick-walled, frequently septate, without clamp-connections, 4–5μ in diameter. Basidia clavate, brownish, with four sterigmata. Spores dark brown, globose or subglobose, coarsely warted, 7–8μ in diameter or 6–8μ × 6–7μ.

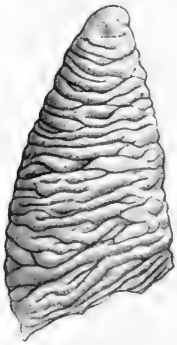
Hab. On rotten wood, Escrick, Yorks. Coll. Miss A. Lorrain Smith, Sept. 1918; on fallen twigs, leaves, etc., Weybridge, E.M.W. and A.A.P., Nov. 1918.

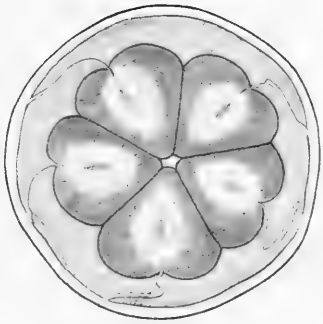
Readily distinguished by the dark, compact hymenium, the rather rigid hyphae without clamp-connections, and the

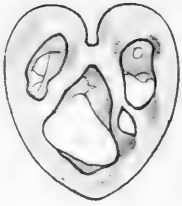












T. Petch del.

coarsely tuberculate spores. A solution of potassium hydrate dissolves some of the colouring matter from the sections. The specimen agrees with an authentic specimen from Fries in the Kew Herbarium.

Hypochnus isabellinus Fr., Obs. Myc. ii, 1818, p. 281.
Corticium isabellinum Fr., Hym. Eur. 1874, p. 660.
Hypochnus argillaceus Karst., in Soc. pro Faun. et Flor. Fenn. Med. vi, 1881, p. 13.

Effused, thin, following the inequalities of the matrix, inseparable, tomentose, pale Isabella colour (of Ridgway). Hymenium loose, pulverulent. Hyphae pale isabelline, branched at right angles, septate, without clamp-connections, 10–14μ in diameter. Basidia with four sterigmata. Spores isabelline, globose, aculeate, with fairly long spines (2–2·5μ), spore-body 7–9μ in diameter.

Hab. On the inner side of decaying bark, Staynor Wood, near Selby, Sept. 1918.

Among the hitherto recorded British species of Hypochnus this one is easily distinguished by its isabelline colour. An American species, *H. pannosus* Burt (= *Zygodesmus pannosus* Berk. & Curt.) resembles it in habit and colour, but is distinguished by the smaller hyphae with clamp-connections.

Galactinia Howsei Boud., Discomyc. d'Eur., 1907, p. 48.
Peziza Howsei Boud., in Bull. Soc. Bot. Fr., xxvi, 1879, p. lxxv, tab. 3, fig. 3; Bres., Fung. Trid. i, p. 91, tab. 103.

Ascophore sessile, cup-shaped, 3 cm. wide, whitish-tomentose at the base, smooth or slightly furfuraceous towards the margin; hymenium violet, tinged with yellow. Paraphyses septate, slightly clavate, 5–6μ wide above, contents guttulate, more or less tinged violet. Asci cylindrical, 8-spored, apex operculate and becoming blue with iodine, 200–300μ × 12–14μ. Spores almost hyaline or slightly tinted yellowish, narrowly oblong-elliptic, epispore granular, 20–22μ × 8–9μ, 2-guttulate.

Hab. On the ground, Byram Park, Yorks. Coll. C. Rea, Sept. 1918.

This species closely resembles *G. ampelina* Boud. and *G. praetervisa* (Bres.) Boud. in colour, but is distinguished from both by its spores. In *G. ampelina* the spores are smooth, while in *G. praetervisa* they are considerably smaller than in the present species. The spore-size in the present specimen is slightly greater than that given in the original description (17–19μ × 7–8μ).

Helotium ciliatosporum Boud., Discomyc. d'Eur., p. 114.
Belonioscypha ciliatospora Rehm, in Rabenh. Krypt. Flor. I, Abt. iii, p. 744; ? *Ciboria ciliatospora* Fuck., Symb. Myc. p. 311.

Apothecia stalked, ochraceous, gregarious, 1–3 mm. high. Disk 1–2 mm. in diameter, at length plane, with a distinct involute margin, externally slightly paler, with minute adpressed longitudinal fibrils. Stalk slender, pale yellow, smooth or slightly strigose, 1–2 mm. in length. Asci elongated, clavate, 135–150μ × 10–12μ. Spores somewhat "torpedo" shaped (pointed at each end, but more distinctly narrowed towards the base), with a short cilium, 5μ long, at one or both ends, 20–27μ × 4–5μ without cilia. Paraphyses filiform, unbranched, not at all or only slightly thickened towards the apex.

Hab. On the vascular skeleton of a herbaceous stem, Weybridge, A. A. Pearson, Oct. 19, 1918.

The Weybridge specimens are evidently the same species as the plant described by Rehm. As pointed out by the latter, however, this plant differs somewhat from that originally described by Fuckel. The latter gives the size as up to one inch high, and states that the margin is not distinct, whereas in these specimens there is always a distinct, erect or involute margin.

Gloeosporium inconspicuum Cav., Fung. Longobard. Exs. v, No. 249; Sacc. Syll. xiv, p. 1010.

Spots large, more or less circular, but without a definite margin, yellow to brown. Acervuli exceedingly minute, scarcely visible even with a lens, developing beneath the epidermis. Conidiophores hyaline, crowded, filiform, springing from a thin basal stratum. Conidia minute, bacilliform, hyaline, 1–2μ long.

Hab. On fading leaves of elm, Southampton, J. F. Rayner, Oct. 1918.

Ramularia Barbaraeae Peck, in 40th Ann. Rep. State Mus. New York, 1888, p. 63.

Spots rounded, white, becoming dry and thin, with a definite margin. Acervuli amphigenous, white, forming a fairly compact felted layer over the whole surface of the spores. Conidiophores fasciculate, simple or slightly branched, up to 70μ long, 4μ thick. Conidia hyaline, cylindrical, unseptate, 18–20 (–30)μ × 3–4μ.

Hab. On living leaves of *Barbaraea vulgaris*, Bungay, Col. C. Theodore Green, Jan. 1919.

A NEW MYCENA.

By A. A. Pearson, F.L.S.

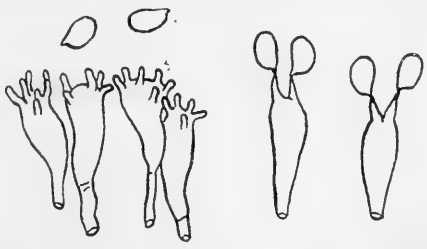
MYCENA EPIPTERYGIOIDES n.s.

Macroscopic features. Cap membranaceous, greenish yellow, depressed in centre, which is usually a little darker; persistently hemispherical, striate or sulcate, edge sometimes crenate, pellicle separable, viscid, average dia. 10 to 15 mm. sometimes much larger. Gills white at first, then a delicate greenish yellow, adnate with a decurrent tooth, rather distant, alternate long and short. Stem cylindrical or compressed, viscid, hollow, greenish, usually with reddish stains at base. Average length about 6 cm., dia. about 2 mm. Spore print white.

Microscopic characters. Basidia about 30 × $6\frac{1}{2}\mu$ with two sterigmata only which are very prominent. Spores hyaline, broadly elliptical 9–10 × $7\frac{1}{2}$–8μ, contents granular. Gill edge with finely ciliated brush-like cystidia; on gill face there are no cystidia.

Habitat. In damp places among moss in pine woods. Common in late autumn in the pine woods of Oxshott and St. George's Hill, Surrey. Usually growing in groups, but not fasciculate.

Doubtless this common species is familiar to many mycologists, who may have listed it as a green variety of *Mycena epipterygia* (Scop.) Fr., to which it is closely related. It will, however, be found quite distinct in many features. The microscopic characters are especially interesting. At first it seemed that the cystidia might be due to the puckering of the viscid thread on the gill edge. This edge can easily be removed with a needle, and then there are no cystidia visible, the 2-spored basidia being clearly defined on what might be thought to be the real gill edge. Specimens were submitted to Miss



Mycena epipterygioides. Basidia, spores, and cells from removable edge of gill

E. M. Wakefield, and she found on examining the viscid thread by itself that the cystidia did exist, and were clearly seen springing from the loosely woven hyphae of which the viscid thread is composed. The brush-like sculpturing was especially distinct when the preparations were stained with methylene blue. We are much indebted to her for this observation and for the accompanying figure.

Latin diagnosis. Mycena epipterygioides Pearson. Hygrophana. Pileo 1–2 cm. lato. hemisphaerico, membranaceo, viridi-citrino, disco obscuriore et depresso striato vel sulcato, margine saepe crenato, pellicula secernibili viscida tecto. Lamellis ex albido citrinescentibus, adnatis, dente decurrentibus, sub-distantibus. Stipite aequali, fistuloso 5–8 × 0·1–0·2 cm. viscido, citrino, basi rufescente. Sporis in cumulo albis breviter ellipsoideis 9–10 × $7\frac{1}{2}$–8μ hyalinis levibus. Basidiis 2-sporis fere 30 × $6\frac{1}{2}\mu$. In margine cystidiis globosis cum pilis tenuibus. Habitat in pinetis locis humidis inter muscos.

ADDITIONAL RESUPINATE HYMENOMYCETES FROM THE WEYBRIDGE DISTRICT.

By E. M. Wakefield, F.L.S., and A. A. Pearson, F.L.S.

In the last number of these transactions we gave a list of resupinate Basidiomycetes found in the neighbourhood of Weybridge. The list, which represented the results of field work during the winter of 1917–18, included fifty-two species.

The work was continued the following winter and we are able to make many interesting additions. Some of these were found before, but could not be determined to our satisfaction. It is perhaps needless to say that every specimen we have handled has not been given a name. A good deal of work remains to be done before the possibilities of this richly wooded neighbourhood are exhausted—if indeed such a term should ever be used when we are dealing with so protean a subject as mycology. Most of the species recorded in the first list reappeared the next year. Many were found throughout the

autumn and winter, but others shew a decided preference for the later months of the year. For instance, we did not meet with *Peniophora pallidula* before late November and December, when it cropped up everywhere.

The species which appeared with the greatest frequency were the following:

Corticium laeve (Pers.) Quél., *Sambuci* (Pers.) Fr., *arachnoideum* Berk., *botryosum* Bres., *subcoronatum* von Höhnel et Litsch., *confluens* Fr., *sulphureum* (Pers.) Bres., *echinosporum* Ellis (pink form), *comedens* Fr., *praetermissum* (Karst.) Bres.

Peniophora pallidula Bres., *cremea* Bres., *velutina* (DC.) Cooke, *setigera* (Fr.) Bres., *gigantea* (Fr.) Mass., *cinerea* (Fr.) Cooke, *quercina* (Pers.) Cooke.

Hypochnus fuscus (Pers.) Karst., *roseo-griseus* Wakef. et Pearson.

Coniophora puteana Fr., *arida* Fr.

Stereum rugosum (Pers.) Fr., *sanguinolentem* (A. & S.) Fr., *hirsutum* Fr., *purpureum* (Pers.) Fr.

Odontia farinacea (Pers.) Quél.

Caldesiella ferruginosa (Fr.) Sacc.

Merulius tremellosus (Schrad.) Fr.

Phlebia merismoides Fr.

Irpex obliquus (Schrad.) Fr.

The soil in this neighbourhood is mostly gravel and sand. There are extensive pine woods, a good sprinkling of oak, birch and sweet chestnut; also a little beech. We shall hope later to be in a position to compare this list of common species with a similar list for other soils.

An observation which may again be brought forward relates to the genus *Radulum*. Numerous specimens were gathered and some could be connected with known species of other genera. *Corticium bombycinum* shewed gradations from a smooth typical *Corticium* to a well-defined blunt-toothed Raduloid form. A cream coloured *Radulum* grew near the common *Merulius tremellosus* and was found to have an identical spore. It was growing on birch, which is the favourite habitat of this species, and was probably only an abnormal form.

Radulum molare Fr. (*R. membranaceum* Bres.) appears to be a form of *Corticium confluens*. Raduloid forms have been recorded of other species of *Corticium*, etc., and similar relations may be found to exist between many forms hitherto recorded as separate entities.

This variability is a common enough feature in many groups of fungi and renders all the more important the study of their microscopic features, which would seem, on the whole, to be constant. The spore is a most valuable indication, but it is necessary to point out that the spore alone is rarely sufficient, and must be taken in conjunction with other characters.

The following species now have to be added to the list given in the last Transactions:

PLATYGLOEA Schroet.

Receptacle homogeneous, waxy, gelatinous, or coriaceous gelatinous, effused, or more or less rugulose. Hymenium continuous. Basidia cylindrical, erect, transversely septate, sterigmata long. Spores uncoloured, smooth, obtuse or apiculate, straight or curved, producing sporidiola on germination. Growing on wood.

Platygloea effusa Schroet., Pilz. Schles. I, p. 384.

×550

Platygloea effusa.

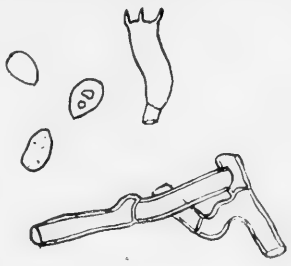
Effused, thin, somewhat gelatinous but firm and greyish when fresh, when dry whitish, closely adherent, hymenium pulverulent under the lens. Basidia elongated, cylindrical, wavy, apex frequently incurved and almost circinate, transversely 4-septate, 40–50 × 4–5μ. Spores hyaline, smooth, elliptical or ovate, with oblique apiculus, 7–8 (–10) × 4–5μ. Subhymenial hyphae fine, guttulate, 1–2μ in diameter, arising erect and parallel from a compact, pseudoparenchymatous basal stratum, made up of broader (4–5μ) hyphae.

On bark of a fallen branch, St. George's College, Weybridge, June, 1918, A.A.P. The habit of this plant is like that of a *Corticium* or *Sebacina*, but the transversely septate basidia at once distinguish it when looked at under the microscope.

Corticium bombycinum (Sommerf.) Bres., Hymen. Hung. Kmet. p. 47. *Thelephora bombycina* Sommerf., Flor. Lapp. Suppl. p. 284.

Irregularly effused, thick, soft, rather separable, often assuming hydnoid forms, margin and subiculum floccose.

Hymenium when perfect waxy, at first white then deep cream or pale alutaceous, pulverulent under the lens. Basidia cylindrical to clavate, with four sterigmata. Spores hyaline, smooth, elliptical or ovate, somewhat irregular, 9–12 × 6–8μ, guttulate. Hyphae rather thick-walled, branched, frequently septate, with clamp-connections, 4–6μ in diameter.



× 550

Corticium bombycinum.

On living pollarded willow, St. George's College, Weybridge, Nov. 1918, A.A.P. and Rev. P. Alexander; on heads of willow, near Worcester, Nov. 1918, C. Rea; on a stump (not named), Marston Green, near Birmingham, Nov. 1918, W. B. Grove.

This species would appear to have a preference for living trees, as it is recorded by Bourdot also on living trunks of various trees. There is however at present no evidence that it is a parasite. Raduloid forms occur frequently intermixed with the typical *Corticium* form. The soft, thick texture and large, somewhat irregular spores are characteristic of the species.

Corticium Sambuci Fr., *vellereum* Ell. & Cragin, *echinosporum* Ellis (yellow form), *confine* Bourd. & Galz.

Corticium atro-virens Fr., Epicr. p. 562.

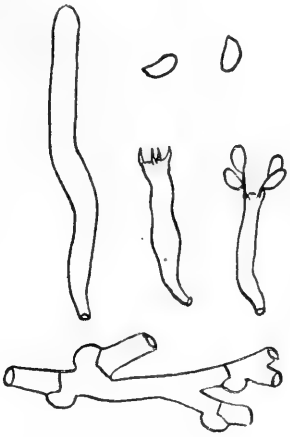
The spores of this specimen are regularly globose, 5μ in diameter, hence slightly larger than those described by Bourdot (3–4 × 3–3·5μ) and figured by Rea (Trans. Brit. Myc. Soc. III, Plate 16). Hyphae, basidia and spores are all pale grey-blue by transmitted light. The colour of the fungus when fresh is in Ridgway's nomenclature "Deep bluish gray-green" to "Russian green."

On dead leaves and twigs lying on the ground, Weybridge, Nov. 1918, A.A.P. & E.M.W. In habit suggesting a Hyphomycete.

Corticium (*Gloeocystidium*) *coroniferum* von Hoehn. et Litsch. in Sitzungsber. K. Akad. Wiss. Wien, CXVI, 1907, p. 825.

Effused, pure white then cream, very thin, following the inequalities of the matrix, fragile and pulverulent, easily separable as a delicate pellicle; margin indeterminate, gradually thinning out to a cobweb-like film. Gloeocystidia rare, sometimes lacking, cylindrical, obtuse, very thin-walled, 45–50 × 5–6μ, contents more or less yellowish. Basidia cylindric-

clavate, wavy, 3·5–4μ wide, when mature elongated and projecting from the hymenium, apex truncate, sterigmata 4–8, in British specimens usually 4, rather long. Spores narrowly elliptical, with oblique basal apiculus, variable in size, 4·5–6 (–8) × 2–3 (–5)μ. Basal hyphae frequently septate, with clamp-connections, 4–5μ in diameter.



× 850

Corticium coroniferum.

On bark and rotten wood, and often spreading on to the surrounding soil, etc., Kew, Jan. 1911 (E.M.W.); Cusworth, near Doncaster, Sept. 1914 (E.M.W.); Weybridge, Dec. 1917 (A.A.P.).

In this species the walls of all the elements are very thin and delicate, so that it is difficult to observe the structure from dried specimens. The gloeocystidia are sometimes lacking, hence the species might be looked for amongst white Corticia of the section Urnigera. The peculiar basidium which is found in *C. coroniferum* is characteristic of the section Urnigera (see Bourdot in Bull. Soc. Myc. Fr. 1911, p. 243), and in fact this species forms a connecting link with that group. The shape of the mature basidium is most easily described as like that of an extended *Hydra*.

Corticium lactescens Berk.

Peniophora pubera (Fr.) Sacc., *glebulosa* Bres. (type form), *longispora* (Pat.) von Hoehn.

Peniophora accedens Bourd. et Galz., in Bull. Soc. Myc. Fr. XXVIII, 1912, p. 386.

×850

Peniophora accedens.

Very thin, effused, greyish-white, becoming cracked on drying; hymenium glistening with the cystidia when viewed with a lens. Cystidia of similar type to those of *P. glebulosa*, smooth and thick-walled except at the apex, but here the apex is swollen into a globose head, about 10–11μ in diameter. Hyphae indistinct, 1·5–2μ in diameter. Basidia 4-spored, 5μ wide. Spores elliptical, with lateral apiculus, 4·5 (–5) × 3μ.

On wet, rotten, decorticated branch, Weybridge, Nov. 1918, A.A.P.

Distinguished from *P. glebulosa* by the capitate cystidia and the different spores. It appears to be sufficiently distinct to be regarded as a separate species.

Hypochnus zygodesmoides (Ell.) Burt, *umbrinus* (Fr.) Burt*, *ferrugineus* (Pers.) Fr.

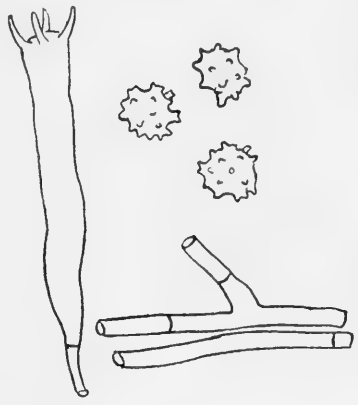
Hypochnus roseo-griseus Wakef. et Pearson, sp. nov.

Fungus effusus, mollis, tenuis, pelliculosus vel membranaceus, facile secedens, ambitu subradiato griseo, hymenio pulverulento, pallide griseo-vinaceo. Hyphae subhymeniales subhyalinae; hyphae basales dilute griseae, vix ramosae, septatae, non nodosae, 2·5–3μ diametro.

Basidia clavata, subhyalina, 40–55 × 7–10μ; sterigmata 2–4, 7–9μ longae. Sporae angulato-subglobosae, hyalinae vel pallide stramineae, crasse verrucosae, 7–9μ diametro, saepe 1-guttulatae.

Hab. On bark, wood, etc., especially of pine, Weybridge, 1917–18, A.A.P.

This is the commonest *Hypochnus* in the pine woods of this district, and is especially abundant on old pine roots.



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Hypochnus roseo-griseus.

The colour of old specimens recalls that of *H. fuscus*, but is paler, with a greyish bloom. When fresh it is between "light vinaceous fawn" and "cinnamon drab" of Ridgway, with a paler, "drab-grey" margin. Young specimens are greyish-white to dirty buff. The species is marked off from all other species of *Hypochnus* with which it might otherwise be confused by the very fine hyphae, without clamp-connections. The almost hyaline spores at once distinguish it from *H. fuscus*.

Grandinia helvetica (Pers.) Fr.

Odontia fusco-atra (Fr.) Bres.

Radulum laetum Fr. Apparently a form of *Peniophora incarnata*.

* See p. 132

Radulum mucidum Bourd. et Galz., in Bull. Soc. Myc. Fr. XXX, 1914, p. 247.

Hydnum mucidum Pers. sensu Bres., Fung. Hung. Kmet., non *H. mucidum* Fr.

Effused, soft, separable, yellow, more or less nodular, teeth short, scattered, awl-shaped, or when growing on an upright surface taking on elongated forms. Basidia clavate, 7μ wide, with 4 sterigmata. Spores elliptical to subglobose, with a lateral apiculus, 4–5 × 3·5–4μ, very pale yellow, 1-guttulate. Hyphae thin-walled, frequently septate, with clamp-connections, 4–7μ in diameter.

Inside a hollow stump, extending for some distance over bark and living stems of ivy, St. George's College, Weybridge, Nov. 1918, A. A. P. and Rev. P. Alexander.

Easily distinguished by the small subglobose spores. As the Weybridge specimen was more distinctly yellow than is indicated in the description given by Bourdot (loc. cit.), material was sent to him for confirmation. He states that he had also received from Mr. Romell a specimen which was said to be "pale sulphur or straw-coloured" when fresh. He had only once seen it fresh himself, and thinks the yellow colour may be fugacious.

It seems very doubtful whether this is Persoon's *Hydnum mucidum*, as Bresadola believes. Persoon describes his plant as pure white, and does not mention any variation to yellow.

Radulum molare Fr., Elenchus I, 1828, p. 151. *Radulum membranaceum* (Bull.) Bres., Fung. Hung. Kmet. p. 39.

An irregular form growing on a fallen branch was identified for us by M. Bourdot as a "forme tomenteuse" of this species. In texture, colour and in the large broadly elliptical spores *R. molare* resembles *Corticium confluens*, of which it may be a form. The hyphae, however, are slightly larger and more distinct. Bresadola considers this to be the true *Hydnum membranaceum* of Bulliard, and not the brown species to which Fries attached the name.

Merulius pinastri (Fr.) Burt.

On decaying sticks in the grounds of St. George's College, Weybridge, A. A. P.

This species was recorded in the Kew Bulletin, No. 7, 1918, p. 230.

Merulius tremellosus (Schrad.) Fr.

Solenia poriaeformis Fuck., Symb. Myc., Nachtr. I, 1871, p. 2. *Peziza poriaeformis* (DC.) Fr., Syst. Myc. II, p. 106.

Cups minute, very crowded, forming a compact, effused layer, the whole having the appearance of a grey *Poria*, the separate cups scarcely visible to the naked eye. Each cup about 5 mm. in diameter, externally whitish or tinged ochraceous, minutely hairy, hymenium grey. Basidia clavate, 20–25 × 6–7μ. Spores subglobose, 5–6 × 4–4·5μ.

On rotten wood, Weybridge, Sept. 1918, Rev. P. Alexander, O.J.

The minute, crowded, greyish cups, and the globose spores distinguish this from the other British species of Solenia.

Solenia anomala Fr.

Poria hymenocystis Berk. et Br.

OBSERVATIONS ON THE FUNGI OF THE LANCASHIRE AND CHESHIRE SAND-DUNES.

By Harold J. Wheldon, F.C.I.S.

The vegetation of the sand-dunes presents a remarkable range of species of fungi for the study of systematists and biologists and to both affords unique problems, and as I have had the opportunity of observing the fungi of the dunes on the coast of Lancashire and Cheshire during a period of about seven years I thought some account of them would be of further interest as affording additional information to, and for comparison with, the observations made by Miss Wakefield* last year on the dune fungi of the Gower Coast, South Wales.

The dunes referred to border the Wirrall Coast in Cheshire between the estuaries of the Dee and Mersey, and in Lancashire extend from the mouth of the Mersey, at Seaforth, to Southport, continuing again on the north side of the Ribble estuary from Lytham and St. Annes to Blackpool.

The Wirrall dunes, once damp and supporting a paludal vegetation in the hollows, either have been drained with the encroachment of verdant golf courses and urban extensions,

* Brit. Myc. Transactions, VI. (i), p. 33, 1917.

or in places have been filled up above the level of the water-table by inward drifts of fresh sand-deposits with a result that many of those rare treasures prized by botanists have succumbed. The same thing has happened to even a greater extent at Lytham and St. Annes, but happily those in South Lancashire have been spared this fate.

The Lancashire sand-dunes are the most extensive on the English coast, having a depth of nearly four miles at Formby, and they constitute a remarkable example of active dune formation, whilst to mycologists they present unique associations of fungi.

To appreciate properly the extraordinary conditions prevailing it is necessary to explain that, because the sea is receding here, these dunes are still in process of formation, and that there are three distinct ranges of dunes, between which lie rather wide flat hollows, or "slacks," which are damp, and in places swampy. The third range of sand-dunes has been planted extensively in places with young conifers, interspersed with various deciduous trees, such as Alnus, Populus, Betula, Hippophae and several species of Salix.

It would seem impossible, one would think, for fungi to develop on the loose blown sand above the line of tidal drift and on the first barren tract of dunes, yet here specimens of *Volvaria speciosa* are not infrequently found partially buried, and occasionally *Volvaria gloiocephala*, although the latter prefers the inner grass-grown parts. Similarly, growing in the bare sand near the shore at Wallasey, the late Dr. Ellis found *Geoglossum glabrum* (Pers.) several years in succession. The only other species found in the loose sand nearest the sea are *Tubaria furfuracea* var. *trigonophylla* and *Marasmius graminum*, and in these instances it has been found that the mycelial threads sprang from buried leaves and stems of the grasses *Agropyron junceum* or *Ammophila arenaria*; although the *Tubaria* often proved to be growing from buried pieces of drift wood and debris washed up by the tide. Further nutrition would be afforded by the many remains of minute algae which the sands contain in this zone.

On the slopes of the loose sandhills which face inland occurs that curious stalked Gasteromycete, *Tulostoma mammosa* accompanied by scattered specimens of *Inocybe rimosa* and others of this genus and less commonly by *Naucoria arvalis*, but these are found only with difficulty, being almost completely buried. I am of opinion that the roots and buried remains of *Agropyron* and *Ammophila* provide the means of sustenance.

Behind the outer sandhills lies the first wide, flat valley

or "dune slack" extending for several miles parallel with the sea. It is apparently in a transitional stage to a fixed dune association, being more stable and richer in humus. It is carpeted with many rare byrophytes amongst which occur here and there several species of *Carex*, *Erythraea*, *Juncus* and some grasses, such as *Agrostis vulgaris*. The old *Brya* capsules become infested with *Phoma muscicola* A. L. Sm., and the carpet of mosses is broken by extensive greyish white patches of the lichen *Arthopyrenia areniseda* A. L. Sm., this being the original station in which Mr. J. A. Wheldon found both these species. Here occur troops of the very interesting discomycetes *Cyathipodia corium* (Weberb.) Boud., *Galactinia brunneoatra* (Desm.) Boud., *Pseudoplectania nigrella* (Pers.) Fck. and *Ciliaria trechispora* var. *paludicola* Boud., and it is not unusual to find great numbers of these four growing in close proximity, sustenance and moisture for them being maintained by the mosses, hepatics and algae amongst which they grow. *Sepultaria arenicola* (Lév.) Mass., which is plentiful here, is entirely buried in the sand whilst young and spherical, and it is not until the cup commences to open, its margin throwing back the covering sand, that the presence of the fungus is apparent. At first glance it conveys the idea of holes made by a walking stick or umbrella. These remarks also apply to the rather larger *Sepultaria sepulta* (Fr.) Mass., although the disk of this becomes more exposed than in *S. arenicola*. With both these species there is usually a large mass of mycelial threads binding together a large ball of sand, and in many cases they do not appear to depend upon other plants for nutrition, but occasionally when near *Ammophila* the mycelium has been found attached firmly to its roots; probably also they find sustenance in the numerous decaying underground stems and buried decomposing leaves of dwarf willow (*Salix repens*), or even from decaying nostoc, diatoms, etc., which abound in the damp sand. Dr. Ellis records *Melanospora zobelii* (Corda) Fck. on *S. arenicola*, and on this and *S. sepulta* there frequently appears another species, *Sphaeroderma sepultariae* Wheldon. Here in the spring *Gyromitra esculenta* sometimes appears in confined areas in troops or singly, and later in the year *Inocybe rimosa* and *Psilocybe ammophila* are frequent, the latter principally after rain in summer. The mycelial threads of these can be traced to the *Ammophila*. *Geaster striatus* DC. and *Geaster Bryantii* Berk. occur here occasionally, and on the Wallasey coast Higgins recorded *Battarrea phalloides* Pers. as growing on a bare sandy bank, but neither the late Dr. Ellis nor I have met with this treasure. It is a striking fact that there is a great preponderance of brown spored fungi on the open dunes principally

represented by *Hebeloma, Inocybe, Cortinarius, Tubaria* and several Gasteromycetes.

The genus *Inocybe* is particularly prevalent on the sand-dunes, especially in the hollows clothed with *Salix repens,* and the long mycelial threads ramify among the roots of the *Salix* and grasses in the vicinity. It should be noticed that the underground stems and roots of the dwarf willow are densely packed beneath the surface and, as they decay, afford unlimited food for saprophytic fungi. The dominant species are *Inocybe rimosa, I. eutheles* and *I. dulcamara* which are plentiful during a long season, and other species not infrequently met with are *I. scaber* Mull., *I. mutica* Fr., *I. cervicolor, I. asterospora,* and *I. duriuscula* Rea. Specimens of the last-named were submitted to Mr. Rea for confirmation by our late friend Dr. Ellis. In September and October *Armillaria ramentacea* occurs in considerable abundance in association with the dwarf willow.

In similar places *Cortinarius* (*Myxacium*) *collinitus* is also very frequent, and less commonly *Cortinarius* (*Dermocybe*) *caninus, C.* (*Telamonia*) *hinnulius, C.* (*Tel.*) *limonius, C.* (*Tel.*) *lucorum, C.* (*Tel.*) *rigidus* and *C.* (*Tel.*) *injucundus.* In late summer *Hebeloma mesophaeum* var. *minor* Cke. appears in great troops in the flats between the sandhill ranges, and in fact it is in these moist *Salix*-covered slacks that fungi are most frequent, and the majority of those already mentioned occur in them. In the spring time, about May, *Verpa digitaliformis* may be found in damp places among the dwarf willow, and our member Miss Blackwell informs me that she has traced the mycelium to the roots of *Luzula* and *Salix repens. Morcehella esculenta* occurs, but rather sporadically.

Further inland the dunes are better clothed with more mixed vegetation in which *Pyrola, Parnassia* and Orchids are conspicuous, and in places large areas covered with the creeping *Rubus caesius.* Here we find a greater variety of fungi. Uredinales are numerous, especially interesting being *Ustilago hypodytes* on *Elymus arenarius,* and the Caeoma stage of *Melampsora Orchidi-repentis* on several kinds of orchid especially *Orchis incarnata* and *Listera ovata*; but in spite of the abundance of *Parnassia* I have never found *Uromyces* on its leaves, although at Mr. W. B. Grove's suggestion I have searched frequently for it. The following agarics make their appearance here in addition to those already mentioned: *Clitocybe dealbata, C. aggregata, C. ericetorum, Hygrophorus conicus* and several other common species of this genus, *Tricholoma nudum, Lepiota cristata, Entoloma sericeum, Entoloma nigrocinnamomeum, Clitopolus prunulus, Bolbitius fragilis, B. tener, Galera rubiginosa, Hebeloma mesophaeum, H. strophosum.* The "puff-

balls" are well represented, often in considerable abundance, by *Lycoperdon caelatum, L. perlatum, L. Cookei, Bovista plumbea* and *B. cepaeformis.* On the golf links there is an abundance of *Marasmius oreades.* Miss E. M. Blackwell has sent me *Lepiota erminea* and *Armillaria haematites* from this locality.

I have mentioned that the inner dunes have been extensively planted with conifers, and I feel I cannot conclude without referring to the most interesting variety of fungi which has been introduced with these trees, particularly those species usually confined to old-established pine woods. It is remarkable to find so many fungi which are usually associated with pine woods thriving in such abundance in so unexpected a locality. In view of the meagre nourishment there must be in the loose sand in which they grow, one can come to no other conclusion than that sustenance is provided by buried pine needles, cones and twigs, and possibly in some cases the mycelial hyphae absorb nutrition from the root-fibres of the trees. Also, it must not be overlooked that the enormous quantity of pollen shed by the conifers must contribute considerably to the food supply of the fungi. It would be an interesting work to investigate and record the fungi occurring in the numerous recognised plant associations. In this direction it is noteworthy that if the fungi occurring in the young conifer plantations on the sand-dunes be compared with those of established pine woods, the similarity of species is strikingly apparent, and when it is considered that before the conifers were planted in this locality, the dunes were practically devoid of vegetation, the entity of the pine wood association would appear to be demonstrated practically. The following fungi appear in numbers: *Lepiota procera, Armillaria ramentacea, Collybia conigena, C. tenacella, Gomphidius viscidus, Gomphidius gracilis, Tricholoma terreum, Paxillus lepista, Russula purpurea, R. integra, Lactarius vellereus, L. deliciosus, L. piperatus, L. torminosus, L. controversus, Clitocybe fragrans, C. ditopus, C. cerrusata, Boletus flavus, Boletus badius* in addition to a number of discomycetes and pyrenomycetes on fallen twigs, cones and leaves. *Hydnum auriscalpium* is frequent on old cones.

Particularly interesting is the abundant growth of *Thelephora caryophyllea* in the loose sand about the roots of young sallows and other young shrubs especially where these have been cut down to the base, which is sometimes done to promote bushy growth. *Thelephora laciniata* is plentiful in the older pine plantations amongst the covering of fallen pine needles.

Generalising on the growth of fungi on the sand-dunes, naturally the most favourable places are the damp hollows dominated by *Salix repens* or the tree-planted areas, and here

fungi appear in great abundance during a long season extending throughout summer and autumn. The "Marram dunes" are the least productive but, as I have stated before, a number flourish well on these dry loose sand-hills. Existence on the latter is apparently only possible owing to the moisture and nutrition provided by the planted star grass (*Ammophila arenaria*), of which the roots frequently extend to a great depth in the sand in search of moisture, and also the stems constantly climb upwards to overcome burial in the mobile sand.

On the outermost hills, the fungi favour the slopes with orientation towards the land, and it would seem that they do not flourish well in the face of the direct sea winds although on the other hand in the sheltered hollows both fungi and lichens thrive in the pure atmosphere which exists there.

It is worthy of note also that the Inocybes which are so prevalent in the open dunes do not favour the parts planted with conifers to the same extent. The number of species in the Salix-dunes is really remarkable and the quantities even more so, equalling as they do those of old woodlands. The fungus association of the open dunes is quite distinct from that of the planted areas.

Considerable attention has been devoted to the Oecology of sand-dune plants, but the observations do not seem to have been extended to the fungi. My own work in this direction was interrupted before even the first preliminary floristic survey was completed, and no doubt many species remain to be discovered peculiar to such situations; these are sure to reward careful workers. A general survey of the fungus flora of the dune tracts having been obtained, it is hoped an attempt may be made to follow up the life-history of the numerous curious and interesting species which, at least in Lancashire, appear to be restricted to this formation.

As a preliminary to continuing investigations outlined above, I published in 1914 an account of "The Fungi of the Sand-dune Formation of the Lancashire Coast" in which were defined several distinct associations of plants occurring on the dunes, with special reference to the fungi occurring in them, and a list of species was also included. Unfortunately my own removal from the district and the regrettable death of Dr. Ellis suspended active work for a time, but we have recently welcomed new recruits to the Society who are now continuing the exploration of these dunes, and it is to be hoped their researches will provide matter of interest for some of our future meetings.

N.B. Water colour drawings of many of the fungi referred to were exhibited during the Foray.

NEW OR RARE MICROFUNGI.

By A. Lorrain Smith, F.L.S.

Mr. J. Ramsbottom who usually shares in the preparation of the paper on Microfungi has until recently been engaged on R.A.M.C. work in Salonica and has therefore been unable to collaborate in the present contribution. Mr. W. B. Grove has been publishing lists of Sphaeropsideae (Phoma, Phomopsis, etc.) in preparation for a complete work on that group of British Fungi. In view of its early publication, it has not seemed to be necessary to publish here his new combinations, etc.

Thanks are cordially given to Miss Roper and others who have sent the records of new finds and especially to Mr. D. A. Boyd who has as usual contributed much interesting material.

PYRENOMYCETES.

Nectria magnusiana Rehm ex Sacc. in Mich. i. p. 294, 1878.

The conidial stage (*Tremella aurantiaca*) was found parasitic on the tubercles of *Diatrypella favacea*, on dead branches of *Betula alba*: Great Bear Park. Grove in Journ. Bot. lvi. p. 286, 1918.

Gnomonia Rosae Fuck. Sym. p. 122, 1869.

Perithecia thickly scattered over the underside of the leaves, covered by the epidermis, rather flat and round, about 300μ in diam., the beak slender, black, about 1 mm. long. Asci somewhat fusiform, tapering down to a narrow stalk, about 40–45μ long, 6–8μ thick, 8-spored; spores narrowly cylindrical about 18–20μ long, 1–2μ thick, not visibly septate, containing minute guttulae.

On decaying leaves of *Rosa tomentosa* and on petioles of *R. spinosissima*, Ardrossan and Stevenston, Ayrshire, and on leaves of *Fragaria vesca*, Largs, Ayrshire; D. A. Boyd, Feb. 1918.

Didymosphaeria conoidea Niessl in Oest. Bot. Zeitschr. 1875, p. 202.

Perithecia scattered, becoming free, rather large, conoid with a flat base, slightly depressed at the apex, shining-black, leathery, the ostiole papillate or conoid. Asci cylindrical, stalked, 8-spored,

60–79μ × 5–7μ; spores monostichous, obovate, 1-septate, slightly constricted, pale brown, 6–9μ × 5μ; paraphyses slender, simple.

On stems of the larger herbaceous plants. On dead stems of *Senecio saracenicus*, Kilwinning, Ayrshire; D. A. Boyd, Aug. 1917.

Mr. Boyd's plant corresponds exactly with the published description except in the ascus which has frequently a long stalk and measures up to 105μ in length. The same type of ascus is present in Krieger's specimen of "Fungi Saxonici."

Leptosphaeria galiorum Sacc. f. *Dipsaci*, Grove in Journ. Bot. lvi. p. 286 (pl. 550, fig. 2), 1918.

On dead stems of *Dipsacus sylvestris*, Salwarpe, near Droitwich, July.

Melogramma spiniferum de Not. Sferiac. Ital. p. 53, 1863.

Stromata generally numerous and crowded, hemispherical and cushion-like, 2–3 mm. wide, hard, horny-carbonaceous, rough, black. Perithecia mostly about 4 to 10 in each stroma, irregular, globose or flask-shaped, greyish-black, with more or less bent shortly projecting ostioles; asci cylindrical subclavate or subfusiform, sessile, 190–210μ × 17–18μ, 8-spored; spores cylindrical, rounded at the ends, slightly bent, 7-septate, brown, but the end cells hyaline, 54–70μ × 8μ; paraphyses delicate, sparsely septate, about 7μ thick.

On dead bark of *Fagus sylvatica*; D. A. Boyd, Stevenston, Ayrshire, March 1918.

In the specimen sent the spore cells are occupied by large guttulae.

MELOGRAMMA ELONGATUM n. sp.

Peritheciis subglobosis in stromata, elongata, angusta, congregatis vel solitariis, immersis vel prominulis, ca. 300μ lat., ad apicem poro pertusis; paraphysibus filiformibus; ascis elongatis, 8-sporis; sporis uniseriatis, oblongo-ellipsoideis, apiculatis, plerumque rectis, fuligineis, 18–30μ × 5–10μ, 2–3 (inaequaliter)—locularibus, cellulo hyalino minutissimo, ad unum vel utrinque extremum, praeditis.

In ramis putridis: C. McIntosh, Perthshire, 1893.

The stromata grow in parallel lines along the blackened wood. The species is distinguished chiefly by the very variable spore cells, usually unequally divided; from the longer cell a minute colourless cell is cut off; at the opposite end septation is less evident but there is usually present a colourless apiculus. Some of the spores are divided into three equal cells, one of the end cells being only faintly coloured.

Mycosphaerella Cydoniae Grove, in Journ. Bot. lvi. p. 285 (pl. 550, fig. 1), 1918.

On dead dry leaves of *Cydonia vulgaris*, on a heap of humus. Hereford, May, etc., 1917 and 1918. The genus name *Mycosphaerella* has been substituted for that of *Sphaerella* as the latter was originally that of a genus of green algae. Some authorities have limited *Mycosphaerella* to species with many-spored asci. Grove does not indicate the number of spores, presumably he accepts the broader interpretation of the genus.

Pleospora hydrophila Karst. in Hedwigia, xxii. p. 178, 1883.

Perithecia scattered, innate, spheroid, smooth, black, 0·2 mm. wide; ostiole papillate, emergent; asci oblong, subsessile, 80μ × 22μ, 8-spored; spores tristichous, oblong-fusiform, unequal-sided or slightly curved, 5-septate, slightly constricted at the septa, the third cell protuberant and with a longitudinal septum, yellow-brown, 22–30μ × 6–10μ.

On leaves of *Acorus calamus* in Fennica; on stems of *Alisma plantago-aquatica*, Kilwinning, Ayrshire: D. A. Boyd, Jan. 1914.

In Mr. Boyd's plant the perithecia are larger (350μ), the ostiole about 50μ across. The spores vary from monostichous to tristichous; coloration and size of asci and spores very similar.

Sphaerulina Alni n. sp.

Peritheciis laxe gregariis, nigris, sublentiformibus, ostiolatis, immersis, ostiolis epidermidem perrumpentibus, ca. 1 mm. diam.; ascis aparaphysatis, dense confertis, haud vel vix rosulatis, clavato-cylindraceis, rectis vel leniter curvatis, apice rotundatis, ad basim in stipitem ca. 15μ long. attenuatis; sporidiis inaequaliter distichiis, oblongo-ellipsoideis, rectis, vel interdum curvulis, 3-septatis, 22–30μ × 8μ, hyalinis, guttulatis.

In cortice suberoso emortui Alni: D. A. Boyd, West Kilbride, Ayrshire, April 1918.

Boydia gen. nov.

Perithecia nigro-brunnea, submersa, globoso-lenticularia, ostiolo breviter papillato pertusa. Ascis elongato-clavatis, octosporis aparaphysatis; sporis elongatis, curvulis, utrinque clavatis, medio sensim attenuatis, 1-septatis, hyalinis.

Evidently a member of the Sphaerellaceae, but unique in the peculiar spores.

B. remuliformis n. sp. Fig. 1.

Perithecia solitaria, numerosa, cortice subvelata, nigro-brunnea; contextu tenuiter membranacea, ca. 400μ diam.; ascis oblongis, ca. 155μ long., 25μ lat., apice rotundatis, basi

leniter attenuatis, sporis elongatis ca. 100μ long. in medio 3–4μ, apicem versus 7–8μ lat.

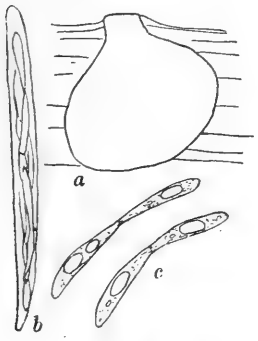

Fig. 1. *Boydia remuliformis* A. L. Sm.
a. Outline of perithecium. × 50.
b. Ascus (immature). × 270.
c. Spores. × 270.

In caulibus emortuis *Ilicis angustifoliae*, West Kilbride, Ayrshire: D. A. Boyd, Sept. 1918.

There is no discoloration of the twigs by the fungus but the internal tissues are permeated by a strong brown mycelium. The ostioles are prominent but are thinly covered by the epidermis which gives them a pruinose appearance.

Phyllachora Pastinacae Rostr. Plantepatalogie, p. 511; Cotton, in Kew Bull. 1918, p. 15.

The conidial stage (*Cylindrosporium*) was found attacking the parsnip in a market garden at Mickleton (Glos.).

HYSTERIACEAE.

Hypoderma Desmazieri Duby, Hyst. p. 42, 1862; Grove in Journ. Bot. lvi. p. 286, 1918.

On dead leaves of *Pinus Strobus*, Bagley Wood, Oxon., April (A. D. Cotton). Previously recorded from Crediton, Devon, in Trans. B.M.S. ii. p. 128, 1905.

Colpoma degenerans Mass. Fungus Flora, iv. p. 63, 1895.

Recorded by D. A. Boyd on dead branches of *Vaccinium uliginosum* from Glen Falloch, Perthshire, July 1907. The species is somewhat rare.

DISCOMYCETES.

Lachnea coprinaria var. *minima* Grove, in Journ. Bot. lvi. p. 286, 1918.

Grove reports that better specimens prove this variety to be a stage growth of *Ascobolus barbatus*. He refers to note in Trans. B.M.S. iv. p. 367 as "impossible."*

SPHAEROPSIDEAE.

Phyllosticta Camelliae Westend. ex Kickx, Fl. Crypt. Fland. i. p. 416, 1867; *Phoma camelliaecola* Brun., in Act. Soc. Linn. Bord. xliv. p. 243, 1890.

On living leaves of *Camellia japonica*, Ward End Hall, near Birmingham, Dec. 1885: Grove in Journ. Bot. lvi. p. 287, 1918. Brunaud gives the habitat as dead branches.

* Not so impossible as the error in identifying an Ascobolus as a Lachnea! C.R.

Ph. Coryli Westend., in Bull. Acad. Belg. xix. 3, p. 121, 1852.

On living leaves of *Corylus Avellana*, West Kilbride, Ayrshire, D. A. Boyd: Grove (l.c.) considers this to be an early stage of *Labrella Coryli* Sacc.

Ph. Ericae Allesch. ex Sydow in Hedw. xxxvi. Beibl. p. 158, 1897; Grove, loc. cit. p. 288.

On dead leaves of *Erica tetralix*, West Kilbride, Ayrshire: D. A. Boyd, Jan. 1918.

Phyllosticta Hydrocotyles n. sp.

Maculis amphigenis, irregularibus, amplis; pycnidiis hypophyllis, sparsis, immersis, flavo-brunneis, ca. 250μ lat., poro rotundo, 50μ lat., praeditis; sporis hyalinis, oblongis, utrinque guttulatis, 5μ × 2μ.

In foliis *Hydrocotyles vulgaris*. West Kilbride, Ayrshire: D. A. Boyd, Aug. 1915.

Phomopsis Sacc. in Ann. Mycol. iii. p. 166, 1905. *Phoma* subgen. *Phomopsis* Sacc. Syll. iii. p. 66, 1884.

A full account of the British species of this genus has been published by W. B. Grove in the Kew Bulletin, 1917, no. 2, pp. 49–73 (2 pls.). He lists 76 British species with descriptions. As a volume on Sphaeropsideae is promised for an early date it is unnecessary to deal with the species here. The following however are recent discoveries:

Phomopsis alnea Died. Krypt. Fl. Mark Brand. ix. p. 244, 1912.

On twigs of *Alnus glutinosa*, Cheshire; Chatsworth (Ellis), May, June: Grove in Journ. Bot. lvi. p. 290, 1918.

Phomopsis pustulata (Sacc.) Grove in tom. cit. p. 291.

On dead branchlets of *Acer Pseudoplatanus*. Stewarton, Ayrshire (D. A. Boyd), Dec.

Phomopsis subordinaria (Desm.) Trav.

Parasitic on *Plantago lanceolata* at Earlswood Lakes station; Grove in tom. cit. p. 292.

Phomopsis vepris (Sacc.) v. Höhn. in S. B. K. Acad. Wiss. Wien, 1906, p. 681; Grove, tom. cit.

On dead stems of *Rubus*, Eastham Lake, Cheshire (Ellis); Grove, loc. cit.

Phomopsis corticis (Fuck.) Grove in tom. cit. p. 291.

On dead stems of *Rubus*, Meols, Cheshire (Ellis).

Phomopsis Eres (Sacc.) Grove, tom. cit.

On dead twigs of elm, West Kilbride, Ayrshire (D. A. Boyd). Grove states that "Cooke's specimens under this head are incorrectly named."

Phoma anceps Sacc. in Mich. ii. p. 273, 1880. Var. *Polygoni* Grove, in Journ. Bot. lvi. p. 289, 1918.

On stems of *Polygonum cuspidatum* in the Botanical Garden, Birmingham.

Phoma santonensis Sacc. et Syd., Syll. Fung. xiv. p. 868, 1890.

On dead twigs of *Ilex Aquifolium*. Quinton, Worcestershire, March; Grove, tom. cit. p. 290.

Ph. lychnidina Grove tom. cit.

On living leaves of *Lychnis dioica*. West Kilbride, Ayrshire (D. A. Boyd), July 1918.

Ph. Platanoidis Sacc. in Mich. i. p. 360, 1878.

On fading leaves of *Acer Pseudoplatanus*. West Kilbride, Ayrshire (D. A. Boyd), July 1918. Grove (loc. cit.) records the identity of this fungus with *Leptothyrium Platanoidis* Pass. collected in Staffordshire. The latter represents a less developed stage. In both cases *Phleospora Aceris* was present often on the same spot and may be genetically connected.

Phyllosticta punctiformis (Desm.) Allesch. Rabenh. Krypt. Fl. i. 6, p. 129, 1898; Grove, tom. cit. p. 289.

On fading leaves of *Lychnis dioica*. Largs, Ayrshire (D. A. Boyd), Sept.

Sclerophoma von Hoehn., in S. B. K. Akad. Wiss. Wien, Math.-Nat. Kl. cxviii. Abt. 1, p. 1232, 1909; Diedecke in Krypt. Fl. Mark Brandenb. ix. p. 277, 1912; Grove in Journ. Bot. lvi. p. 292, 1918.

A genus resembling *Phoma* but without an ostiole and the lower part of the pycnidium filled with a well-developed stroma, etc. Students are referred again to the forthcoming volume on Sphaeropsideae.

Scl. pithya Died., tom. cit. p. 280; Grove in tom. cit. p. 293.

On small dead branches of *Pinus sylvestris*, King's Lynn (Plowright); Cheshire (Ellis).

Edgbaston Bot. Gard., Birmingham, Mar., Apr.

Dothiorella Fraxinea Sacc. & Roum. Syll. iii. p. 236, 1884; Grove, tom. cit. p. 294.

On bark of ash, Lichfield, Feb. 1887.

Cytospora Myrtilli Grove in tom. cit. p. 294, 1918.

On dead branches of *Vaccinium Myrtillus*, West Kilbride, Ayrshire (D. A. Boyd), March 1918.

Camarosporium Stephensii B. & Br.

Further specimens of this fungus have been collected by D. A. Boyd at Ardrossan, Ayrshire. The stems of the bracken on which the fungus grows bear a number of elongate swellings splitting above, the interior of which are occupied by a line of pycnidia of somewhat irregular form about $225\mu \times 150\mu$ and with thin brown walls. The large muriform spores are borne on short sporophores as already described in Trans. B. M. S. vi. p. 50, 1918.

NECTRIOIDEAE.

Zythia Mercurialis Kickx Fl. Crypt. Fland. i. p. 449, 1867.

Pycnidia scattered or congregate, dull yellow then rust-coloured at length brownish-black, almost globose, with a pore at the apex; spores elongate or ovate, very small.

On leaves, petioles and stalks of *Mercurialis perennis*, Garforth, Yorkshire. No measurements have been recorded but there is no reason to consider the specimens collected as different from the above; the minute yellow pycnidia measure from 100–125μ, the ostiole 25μ in diam. The spores are mostly small, varying from ovoid to ellipsoid, usually about $5\mu \times 2$–$2{\cdot}5\mu$; mixed with these are a few spores almost double in length, and occasionally constricted and septate, $10\mu \times 3\mu$.

LEPTOSTROMATACEAE.

Leptothyrium Fragariae n. sp.

Maculis testaceo-brunneis, parvis vel latis, non limitatis. Pycnidiis epiphyllis, numerosis, sparsis vel gregariis, punctiformibus, convexo-dimidiatis, atris, nitidis, minutis, ad 120μ latis; contextu fuliginoso radiante; centro irregulariter pertuso; sporis cylindraceis, rectis, continuis, hyalinis, 3–6μ long, 1–1·5μ lat.

In foliis langusecentibus *Fragariae vescae*: D. A. Boyd, Largs, Ayrshire, Feb. 1918. The pycnidia cover large areas of the leaf. *Gnomonia Rosae* was also present along the veins on the under surface.

MELANCONIEAE.

Melanconium zonatum Ellis & Ever. in Peck, 44th Rep. N. York State Mus. p. 136, 1890; W. B. Grove in Kew Bull. 1918, p. 164, fig. 3.

Considered by Grove to be British. It has turned up on birch at Byram Park, Selby; the spores agree in size and form with Grove's measurements and drawing.

Myxosporium Polygoni W. B. Grove in Journ. Bot. lvi. p. 340, 1918.

On stems of *Polygonum cuspidatum* in Botanical Garden, Birmingham, associated with *Phoma anceps* var. *Polygoni*.

Marssonia Omphalodis W. B. Grove, loc. cit. p. 342.

On decaying leaves of *Omphalodes verna*, Saltcoats, Ayrshire (D. A. Boyd), July.

HYPHOMYCETES.

Ovularia Doronici Sacc. in Mich. ii. p. 638, 1882.

Spots hypophyllous, spreading, whitish. Conidiophores in tufts, non-septate, shortly branched above or denticulate, 30–40 μ long, 3 μ thick, colourless; conidia elongate sometimes subfusiform, occasionally in chains, 12–15 $\mu \times$ 4–5 μ, colourless.

On the underside of the leaves of *Doronicum Pardalianches*, Flax Bourton, Somerset. Comm. T. M. Roper, Bristol, Feb. 1919.

COREMIUM SWANTONII n. sp.

Stroma simplex albo-ochraceum usque ad 15 mm. alt., 1 mm. lat. vel tenuis ca. 5 mm. × 0·2 mm. Hyphae fertiles capitula singula, 2–3 mm. diam. vel plura coalescentia, sporis pulvereis obtecta, formantes. Hyphae longae, septatae ca. 2 μ lat. irregulariter ramosae; verticilli fertiles sparsi ca. 10 μ long, pluribus sterigmatibus praediti; sporae minutae ellipsoideae vel globosae, simplices, catenulatae, 3 $\mu \times$ 2 μ vel 2 μ diam., hyalinae.

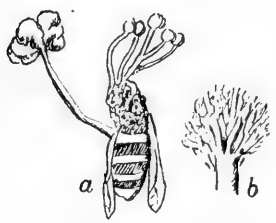

Fig. 2. *Coremium Swantonii* A. L. Sm.

a. Wasp with fungus. Nat. size.

b. Head of Coremium. × 5.

In vespa emortua. Blackdown, Haslemere, Surrey: E. W. Swanton.

The fungus is probably saprophytic on the wasp (*V. sylvestris*) which was lying entangled in moss.

Acrostalagmus albus Preuss.

This species was recorded from Cambridge in Trans. B. M. S. i. p. 71, 1897. It has recently turned up in a chemical solution from Coventry. In the solution there was a dense mass of felted hyphae; a culture on glucose agar grew freely producing dense clusters of yeast spores and a vigorous growth of *Acrostalagmus*.

Ramularia Lysimachiarum Lindroth in Acta Soc. Faun. Fl. Fenn. xxiii. p. 28, 1902.

Leaf-spots brown, then dark-green, at length yellowish, often covering complete portions of the leaf from the margin inwards, without a margin. Tufts on both sides of the leaf (mostly under surface), very small, white; conidiophores, 5 to 15 emerging

from the stomata, unbranched, straight, cylindrical, non-septate, slightly unequal-sided, about 18–22μ × 3–4·5μ; conidia, one or two at the tips of the conidiophores, cylindrical, slightly pointed, 2-celled, colourless, 8–30μ × 2–3μ.

On leaves of *Lysimachia Nummularia*, Lochwinnoch, Renfrewshire; D. A. Boyd, July 1918.

The spores are non-septate for a considerable time.

R. Pastinacae Bubák in Sitzb. böhm. Ges. Wiss. Prag. 1903, Sep. p. 19; Cotton in Kew Bull. 1918, p. 18, fig. 1.

On leaves and petioles of parsnip in Worcs., Glos. and Cambs.

Dactylella ellipsospora Grove in Journ. Bot. xxiv. p. 200 (pl. 266, fig. 9), 1886.

A mould somewhat similar to this species was collected on dead wood during the Selby Foray. The stalks are longer and narrower, 130–230μ × 2–3μ, and the spores are narrower, measuring about 40μ × 10–12μ; but the differences do not seem to be specific and Grove's drawings even more truly represent the Selby fungus than do his measurements.

Torula convoluta Harz, in Bull. Soc. Imp. Nat. Moskow (separate), p. 47 (pl. 1, fig. 6), 1871.

Mycelium creeping, richly branched, septate; conidiophores upright, very short, branched or unbranched, septate, terminating in long chains which roll up at the ends; conidia globose, black, transparent, 2·5–3μ in diam.

On decaying and dry potatoes, also on decaying leaves. Found by F. T. Brooks on potatoes in the Isle of Wight, summer, 1918.

Cercosporella Pastinacae Karst. in Hedwigia, xxiii, p. 63, 1884; Cotton in Kew Bull. 1918, p. 19, fig. 2.

On leaves and petioles of parsnip in Worcs., Glos. and Cambs.

Dendryphium curtum B. & Br. Collected at Parlington Park, Selby, Yorkshire.

The fungus developed on branches kept under observation. It agrees with the above species in every respect except in the spores which in the Selby specimen are catenulate, but this is probably due to the very sheltered laboratory conditions.

Cercospora Myrti Erikss., in Bidr. till Känned. odl. växt sjukdomar, Stockholm, p. 79, 1885.

Leaf spots amphigenous, roundish, red-purple. Tufts mostly hypophyllous, the conidiophores in groups; conidia gradually tapering upwards, bent, 3–6 septate, 60–100μ × 2–4μ, brown.

On the leaves of cultivated myrtle. West Kilbride, Ayrshire, Sept. 1918. Comm. D. A. Boyd.

A FLUORESCENT COLOURING MATTER FROM LEPTONIA INCANA GILL.

By Harold Wager, D.Sc., F.R.S.

During the summer of 1917 I found a number of beautiful specimens of *Leptonia incana* in a limestone pasture at Hawkswick, Skipton-in-Craven, about 800 ft. above sea level. The Fungus commonly occurs amongst short grass in woods and pastures and on lawns and downs. Mr. Carleton Rea informs me that he has met with it most years during the months of August and September, and that it has often been found at the Fungus Forays of the British Mycological Society, and Mr. A. E. Peck informs me that it has been recorded many times in various parts of Yorkshire. The pileus is of a beautiful bronze or olive green tint, yellowish bronze-green at the periphery, darker green to bronze in the middle, and striated from the disc to the periphery with dark yellowish green lines on a light yellow ground. The flesh of the stem, pileus, and trama of the gills is light yellow to yellowish-green in colour; all parts of the flesh turn green when bruised, and, when pressed between sheets of paper, the paper is stained greenish-yellow.

Fresh specimens of the Fungus placed in 95 per cent. alcohol give a green solution which shows a brilliant green or green-blue fluorescence. Fresh specimens in distilled water give an opalescent yellow solution with a slight green fluorescence, the colour of the Fungus becoming pale green-blue. If the water is changed several times until no further colour comes out, and the specimens are then drained and placed in absolute alcohol, a blue-green colouring matter is extracted and the solution shows a brilliant dark green-blue fluorescence. If the Fungus is first dried and then placed in alcohol the colour does not come out, but if soaked for a few seconds in water, and then in alcohol, the colour comes out at once. On adding ether to a watery alcoholic solution of the fresh Fungus a small quantity of a yellow colouring matter comes out into the ether; this shows no fluorescence, but the alcoholic green solution below remains fluorescent.

These experiments indicate that there are in this Fungus at least two fluorescent colouring matters, yellow and blue,

and that the green colour is therefore probably due to a combination of these. The yellow pigment is soluble in water; the blue pigment is soluble in alcohol in the presence of a small quantity of water. The two colours can be separated by capillary analysis on a strip of filter paper, by suspending the strip of paper with one end dipping into the alcoholic solution. As diffusion takes place the paper becomes coloured yellow below, and blue-green above.

The green alcoholic solution if allowed to remain in contact with the Fungus soon becomes yellow, but still retains for some time its green fluorescence. The blue pigment apparently becomes changed, in the presence of the Fungus, to a yellow one. This may be due to the action of an oxidase. A similar change takes place in the air dried Fungus. This retains its green colour for some time, but gradually becomes brown. When the dry, brown Fungus is soaked in water a dark yellow solution with a green fluorescence is obtained. Water extracts nearly all the colour, and if, after standing for some time in water, the solution is poured off, and alcohol added, the alcohol remains colourless.

The green alcoholic solution is much more strongly fluorescent than the yellow watery solution, and if the green alcoholic solution is decanted from the Fungus it retains its green colour and strong fluorescence for a long time. After the lapse of some months the solution becomes yellower, but the strong fluorescence is maintained, and after two years is practically as strong as at the beginning. The addition of a little sodium hydrate, ammonium hydrate or hydrochloric acid to the green solution changes it at once to yellow, but the green fluorescence persists. Hydrogen peroxide brings about a slow change in the colour of the green solution to yellowish green but the fluorescence remains.

On evaporating the green alcoholic solution to dryness a yellow amorphous pigment is left which gives when taken up with water or dilute alcohol a yellow fluorescent solution, but in absolute alcohol or ether gives only a faint yellow non-fluorescent solution.

Fluorescent pigments are widely distributed among the Fungi, and they are also formed in many bacteria. Dr. A. Weiss states that the majority of Fungi give a more or less fluorescent pigment in alcohol*, but I find that in many species no fluorescence is visible, and in many others is only very slight. Thus the coloured species of *Hygrophorus* (yellow, green, red) all give a bright orange coloured solution in alcohol with a very slight green fluorescence. The bright green

* S. B. K. Akad. Wiss. Wien, 1885.

Chlorosplenium aeruginosum gives a light yellow-green solution with a very slight green fluorescence. The pink or red Russulas on the other hand usually give red or yellowish solutions with a brilliant blue fluorescence. The yellow or greenish Russulas give yellow solutions with a green or green-blue fluorescence. Rostrup has described the greenish fluorescence of the yellow alcoholic solutions of *Pleurotus serotinus**. A. Ling has observed a greenish fluorescence in beer due to a *Torula*†. A. Kløcker has found that under certain conditions *Aspergillus glaucus* gives a faint green fluorescing pigment to wort in which it is grown. This is soluble in ether and then gives a blue fluorescence. If the ether is evaporated to dryness a yellow residue remains, easily soluble in water to a slightly fluorescent solution‡.

The green fluorescence due to certain bacteria has long been known. Thus *Bacillus fluorescens liquefaciens*, which is very widely distributed, especially in soil and polluted water, shows in ordinary bouillon culture a beautiful green fluorescence§. Several other green fluorescent bacteria have been described. According to Thumm‖ all fluorescing bacteria, when cultivated in alkaline media, produce first a blue fluorescence which afterwards becomes green.

It is of considerable interest to note that in all bacteria, and in all except very few Fungi, the fluorescence should be in the more refrangible, green or blue, part of the spectrum, whereas in chlorophyll solutions, and in solutions of carotin and xanthophyll, the fluorescence is in the red or less refrangible part of the spectrum. In a few Fungi which I have examined the fluorescence is slightly red, and in *Tubaria inquilina* red violet. This may be due to the presence of a carotinoid colouring matter. The colouring matters of the Fungi usually occur in the cell membrane, and it is to these that the green or blue fluorescence is due, but the yellow and dark orange or red colours of many Fungi, *Pilobolus*, spores of *Chytridineae*, many Pezizas and *Uredineae*, *Sphaerobolus*, *Stereum*, etc., are associated with fatty bodies contained in the cells. They give a blue or green reaction with strong sulphuric acid or iodine, and are probably of the nature of carotin and xanthophyll. The yellow and red colouring matters of *Hygrophorus*, *Clavaria* and *Amanita muscaria* are not of this type. They are contained in the cell membranes, and give a green fluorescence. The spore

* Mykologiske Meddelelser, Bot. Tidskr. 1889.
† Jour. Inst. of Brewing, 1915.
‡ C. R. des travaux du Laboratoire de Carlsberg, 1917.
§ See Ellis, Outlines of Bacteriology, 1909.
‖ See Centrbl. f. Bakt. 2nd Abt. 1895.

coloration of the Fungi is also due in the main to colouring matters in the spore membrane, but these are apparently very slightly soluble in alcohol, and so far as I have been able to observe do not give fluorescent solutions. None of these pigments has any resemblance, except colour, to the well-known anthocyan pigments of flowers. Their behaviour with reagents is totally different, and their physical characteristics are not the same. We have very little knowledge of the chemical nature of these fluorescing pigments, or of the conditions under which they are formed. The yellow fluorescent pigment of *Leptonia incana* resembles in some respects the well-known colouring matter fluorescein; both pigments are soluble in dilute alcohol to a yellowish solution, and both give a brilliant green fluorescence. When heated strongly they both give off fumes of volatile matter and carbon is left; the fumes given off by the Leptonia pigment have much the same odour as those given off by the fluorescein. It is not improbable therefore that the fluorescent pigments of the Fungi may be related to that group of colours to which fluorescein belongs, but further investigation is necessary before any satisfactory conclusion can be reached.

The following is a list of the Fungi I have examined which give fluorescent solutions in alcohol*:

Name of fungus	Colour of alcoholic solution	Fluorescence
Amanita muscaria	Yellow-orange	Green
,, *rubescens*	Light yellow-brown	Very slight green
Amanitopsis vaginata var. *fulva*	Light yellow	Light blue
Russula lilacea	Light yellow	Blue
,, *aurata*	Yellow	Blue or blue-green
,, *ochroleuca*	Yellow	Blue or blue-green
,, *xerampelina*	Yellow-red	Blue
,, *emetica*	Yellow-red	Blue
,, *cyanoxantha*	Yellow	Green
,, *vesca*	Red	Bright green-blue
,, *alutacea*	Yellow-red	Brilliant blue
,, *citrina*	Yellow-red	Bright green-blue
,, *virescens*	Orange-red	Blue-green
Leptonia incana	Green or yellow-green	Brilliant blue-green
,, *lampropus*	Yellow-brown	Blue-green
Hygrophorus (yellow, red or green species)	Orange	Slight green
Lepiota granulosa	Light yellow	Very slight green
Laccaria laccata	Light yellow-brown	Light blue-green
Agaricus campestris	Light yellow	Very slight blue-green
Thelephora laciniata	Light brownish-red	Very slight green
Inocybe Godeyi	Light yellow-brown	Very slight green-blue
Stropharia aeruginosa	Yellow	Light blue or green
Hypholoma fasciculare	Yellow-green	Light green

* Cf. Weiss, loc. cit.

Name of fungus	Colour of alcoholic solution	Fluorescence
Coprinus micaceus	Light yellow	Light reddish
Mycena haematopus	Red	Slight green
Entoloma rhodopolium	Yellow-brown	Light blue
Lactarius quietus	Light yellow-brown	Slight green-blue
Tubaria inquilina	Yellow-red	Red-violet
Naucoria temulenta	Dark brown	Very slight yellow-red
Boletus pruinatus	Light yellow	Very slight yellow-green
,, *elegans*	Yellow	Green
,, *chrysenteron*	Yellow	Very slight red
,, *badius*	Dark yellow	Very slight green
Polyporus nidulans	Yellow (in dilute solution)	Very slight blue-green
Tremella mesenterica	Yellow	Light blue
Nectria cinnabarina	Yellow-red	Very slight green
Cordyceps militaris	Yellow	Slight green
Chlorosplenium aeruginosum	Light yellow-green	Very slight green
Clavaria inaequalis	Orange-yellow	Very slight green

The colouring matters vary much in solubility, and it is necessary, when they are easily soluble and give a dark coloured solution, to dilute the solution considerably before the fluorescence becomes clearly visible. The colours of the alcoholic solutions given in the above table are those of solutions diluted sufficiently to show the fluorescence most clearly. I have not attempted to give the results obtained with other solvents than alcohol, for although better solutions were sometimes obtainable with alcohol and hydrochloric acid, or dilute ammonia, the fluorescence remained much the same. Thus *Leptonia lampropus* gave in methylated spirit a light grey-blue solution with a light blue fluorescence, in water a yellowish solution with slight blue fluorescence, in 70 per cent. alcohol a yellow-brown solution with blue-green fluorescence, and in dilute ammonia a reddish violet solution with a green or green-blue fluorescence.

Not all the colouring matters found in any given species of Fungus are fluorescent. Much of the colouring matter which may be extracted in water or alcohol, especially on heating, shows no fluorescence. But with the exception of the carotinoid colouring matters they all occur, along with the fluorescent pigments, in the cell membrane or in the gelatinous or mucilaginous layers of the cell membranes. In many Fungi the characteristic colouring, as in *Amanita muscaria*, appears to be due to pigments contained in the mucilaginous layers, although, as de Bary points out, it is not easy to determine with certainty how the colour is distributed. We have very little knowledge of the functional significance of the colouring matters of the Fungi. From the fact that they are found mainly in the cell membranes and not in the cell contents, and that they

absorb the more refrangible, blue and violet, rays of the spectrum, which have a deleterious action upon protoplasm, they may exercise a protective function against a too intense light*.

The light energy absorbed by the pigments may also be of use in maintaining the tissues at a suitable temperature in order that the metabolic activities of the Fungus may be carried on satisfactorily.

One of the important functions of the Fungus pigments appears to be to render the tissues more resistant. The coloration of the non-gelatinous cell membranes is accompanied with increased firmness, and in most cases with exceptional power of resisting the action of concentrated sulphuric acid, phenomena which recall the similar behaviour of the sclerosed, lignified and suberised membranes of the higher plants†. This is well seen in coloured spores the membranes of which, as compared with those of colourless spores, are very resistant to the action of concentrated sulphuric acid.

No physiological or biological explanation of the fluorescent pigments can be given. Nor can any explanation be given of phosphorescence which also occurs in some Fungi. Both phosphorescence and fluorescence are now classed together as photo-luminescence, and both are due to the stimulus of the light absorbed. Phosphorescent substances are those which continue to emit light for some time after the stimulus is withdrawn; fluorescent substances only emit light during the time the stimulus is acting.

A light yellow alcoholic solution of the pigment of *Leptonia incana* shows a beautiful green colour when a beam of sunlight is passed through it. If, instead of white light, a beam of violet or blue light is allowed to pass through, the same green colour is observed, and the invisible ultra-violet rays are also able to produce the same effect. The blue, violet or ultra-violet rays on being absorbed by the solution at once set up disturbances in the colouring matter by which light of a different wave-length is emitted. Stokes stated that the wave-length of the fluorescent radiation is always longer than that of the radiation which excites fluorescence. Recent investigations have however shown that this is not always the case, and according to Nichols the absorption band, to which fluorescence is due, and the fluorescent spectrum overlap, and all the waves included in the absorption band can produce the excitation. The yellow fluorescent solution of *Leptonia incana* shows a strong absorption at the more refrangible end of the spectrum extending from the extreme violet to about the line *E* and

* Cf. Buller, Researches on Fungi.

† De Bary, Comparative Morphology and Biology, etc., of the Fungi.

including the violet, blue and green rays. The exciting rays capable of bringing about fluorescence extend from the ultra-violet to the blue-green part of the spectrum up to about the line *F* and the spectrum of the fluorescent radiation includes the blue-green, green and yellow-green part of the spectrum. There is here therefore some overlapping of the absorption band and the emission spectrum.

According to the views at present held by physicists the light absorbed, both in phosphorescent and in fluorescent substances, brings about a partial or complete separation of electrons from the atoms of the substances acted upon. Both fluorescence and phosphorescence are therefore to be regarded as photo-electric phenomena*.

In the Fungi phosphorescence appears to be due to the activities of living cells, but fluorescence is only visible in solutions of the colouring matter extracted from the plant by solvents.

A REVISION OF THE BRITISH CLAVARIAE.

By A. D. Cotton, F.L.S., and E. M. Wakefield, F.L.S.

INTRODUCTION.

The work on which the present revision is based was begun in 1905. It was originally intended to include in the study all the described species of Clavaria, numbering now about 400, and to publish a systematic monograph of the whole genus. As the work progressed however it became apparent that, before any attempt could be made to monograph the genus, it was essential to clear up the confusion which existed with regard to the old European species.

Microscopic structure had shown new ways of distinguishing species and also that several undescribed species occurred even in Britain. It was obvious, therefore, that it was only by prolonged and careful field work, coupled with an investigation of the micro-characters, that a true understanding of the genus could be obtained and the old descriptions and original specimens be correctly interpreted.

As a result of this preliminary work it was decided to limit the revision in the first place to the British species, but to include during the investigation as many continental and extra-European species as came to hand, with a view to publishing

* Allen, Photo-electricity.

a monograph at a later date. The present revision does not profess to furnish a complete list of the British species. Indeed it is clearly preliminary, since many specimens had to be left unidentified, and species apparently new continue to appear every season. We feel confident however that the interpretation here given of the old and doubtful species is in the main correct and that, though new species may be added, little fundamental alteration will be necessary. As it has not been possible to pay detailed attention to the subject since 1914, and as there is no prospect of doing so in the immediate future, it seems advisable to publish without further delay the results so far obtained.

With regard to the diagnostic characters adopted, we have used micro-characters in conjunction with field characters. The form and size of the spore, except in the ochraceous-spored section where they are singularly uniform, proved surprisingly varied and useful. But although so invaluable we have never used micro-characters in separating one species from another unless the plant was also amply distinct in form, colour, or other field character. The spores in some cases afford a more accurate and precise means of expressing the difference between allied species than form or colour. This is well seen in the yellow unbranched section and especially in the case of the two species *C. inaequalis* and *C. persimilis*. To the trained eye these are usually distinguishable in the field, but at times the colour is identical. If examined with the microscope, however, the oblong spore of the latter with its marked lateral apiculus immediately separates it from the globose spinose spore of the former, and if the specimens are sorted out by this method the separation is confirmed by the difference in colour which is assumed on drying.

The variation of the spore both in form and size, and hence the difficulty in gauging its value as a diagnostic character, has been commented on by several writers, both systematists and experimentalists, e.g. Sherbakoff in the case of Fusarium, Brierley in Botrytis, and by Thom to a lesser extent in the case of Penicillium. The present study has not revealed any marked variation in the genus Clavaria, but merely that which any systematist would consider normal for the Hymenomycetes and indeed for the larger fungi generally. The spores of all species of Clavaria vary within certain limits, and those of some species much more so than others; indeed the tendency to great variation may be regarded as characteristic of certain species. In connection with spore-measurements two points must be borne in mind, (1) the necessity of dealing with mature spores and (2) the possibility of the existence of strains or races which

may differ in several respects from the typical species. With regard to the former, for ordinary systematic purposes the use of the usual spore-cast provides a sufficiently good safeguard, although the possibility of obtaining exceptional spores is not excluded by this method (see, for instance, these Trans. vol. iv. pp. 298–300). With reference to strains, the existence of these in many parasitic species has been definitely proved, and though perhaps less general it occurs also amongst the Hymenomycetes, as has been shown with respect to the formation of fruit-bodies in *Schizophyllum commune* and *Stereum purpureum* (Naturwiss. Zeitschr., 1909, p. 521). It will be noted that the fungi alluded to above (Fusarium, etc.) are Hyphomycetes and it would appear that, owing perhaps to the great diversity of substrata on which they exist, they are more liable to vary than the Hymenomycetes.

The list as given in the present revision consists of 37 species. Two of these, *C. Broomei* and *C. Invalii*, we have been compelled to describe as new, and four other novelties were described during the progress of the work, viz., *C. gigaspora*, *C. Crosslandii*, *C. straminea* and *C. persimilis*. In two cases only has it been necessary by following the International Rules of Nomenclature to change a name. *C. muscoides* Linn. becomes *C. corniculata* Fr., and *C. conchyliata* Allen becomes *C. Bizzozeriana* Sacc. One plant usually listed in British works as a species, *C. fastigiata*, is reduced to the rank of a variety (*C. corniculata* var. *pratensis*) and 22 names have been excluded from the British list as synonyms or indeterminable.

With regard to the citation of synonyms and illustrations the list, though fairly full, does not profess to be completely exhaustive. Well-known names have in all cases been cited, but doubtful names have been omitted. Of illustrations, those occurring in British works have been quoted, and a selection has been made from other works, choosing those which are well known and best represent the species in question.

Before closing this introduction we would acknowledge our indebtedness to all who have helped the work by forwarding specimens. Many of the species are so rare in this country that but for their aid there would have been little chance of examining fresh material. As practically every working member of the British Mycological Society has helped in this way, it is impossible to mention each one individually. The late Mr. G. Massee suggested the work and liberally handed over a number of notes and drawings. Mr. Carleton Rea's help was invaluable, and we are indebted to Mrs. Rea for the loan of her matchless collection of paintings together with notes. Amongst other members of the Society who have

whole-heartedly helped mention may be made of Mr. C. Crossland, the Rev. W. L. W. Eyre, Miss A. Fry, Mr. C. H. Spencer Perceval, and Mr. E. W. Swanton. We have also received specimens from American, French, Swiss and German botanists, whilst the Abbé G. Bresadola was always ready to supply specimens and notes from the Austrian Tyrol. For a collection of specimens from the classical ground near Upsala we are indebted to Mr. C. G. Lloyd. To these mycologists and to all others not mentioned by name we record our sincere thanks.

In the case of certain rare species we have indicated the localities. These are limited to Britain and include only those from which material has been received during the preparation of this revision. No attempt has been made to investigate the specimens contained in the public and private herbaria of this country.

KEY TO THE BRITISH SPECIES OF CLAVARIA.

A. Plants branched.

1. Plants when mature more or less yellowish, spores ochraceous.

(*a*) Plants large, up to 10 or 15 cm. high; spores 9–20μ long.

Plant fragile, pale when dry; spores pale ochraceous, minutely granular, 11–14 × 4–5μ ... ... 1. *C. flava*

Plant somewhat fragile, dark when dry; spores deep ochraceous, echinulate, 15–16 × 6–7μ ... ... 2. *C. Broomei*

Plant white to ochraceous, tips of branches rosy; spores striate or reticulate ... ... 3. *C. botrytis*

Plant buff-pink, tips of branches yellow; spores minutely granular ... 4. *C. formosa*

(*b*) Plants medium-sized, up to 5 cm. high; spores 6–10μ long.

Growing on wood, vinous to brownish yellow ... ... 5. *C. stricta*

Growing on the ground in coniferous woods

Plant turning green when bruised 6. *C. abietina*

Plant not turning green when bruised

Plant slender, flaccid; spores 6–7 × 3μ ... ... 7. *C. flaccida*

Plant stout, rigid; spores 7–9× 4μ 8. *C. Invalii*

2. Plants variously coloured, spores hyaline.

(*a*) Plants white.

Branches cristate; spores large, subglobose, 9–12 × 6–8μ ... ... 9. *C. cristata*

Branches not cristate; spores small, globose, 3–5μ ... ... 10. *C. Kunzei*

(*b*) Plants greyish.

Spores subglobose, 7–10 × 6–8μ ... 11. *C. cinerea*

Spores very large, pip-shaped, 12–16 × 7·5–8μ ... ... 12. *C. gigaspora*

(*c*) Plants violet.
- Plant medium sized, fleshy; spores subglobose, 5–7μ ... ... 13. *C. amethystina*
- Plant very small, slender; spores globose, 2·5–3·5μ ... ... 14. *C. Bizzozeriana*

(*d*) Plants clear yellow; spores subglobose, 6–7μ ... ... 15. *C. corniculata*

(*e*) Plants pale umber, spores pip-shaped, 5–6 × 3–4μ ... ... 16. *C. umbrinella*

B. Plants simple (occasionally branched in 21).

1. Plants tufted.
- Plant white; spores subglobose, 3–5 × 3–4μ 17. *C. vermicularis*
- Plant grey; spores elliptical or pip-shaped, 6–8 × 3–4μ ... ... 18. *C. fumosa*
- Plant yellow; spores globose, 5–7μ ... ... 19. *C. fusiformis*

2. Plants solitary or in small groups.

(*a*) Plants white.
- Plant very slender, smooth; spores subglobose, 8–9 × 7–8μ ... ... 20. *C. acuta*
- Plant stout, rugose, sometimes branched; spores subglobose, 9–11 × 8–9μ ... ... 21. *C. rugosa*
- Plant small, slender; spores aculeate, globose, 7–8μ (without spines) ... 22. *C. asterospora*

(*b*) Plants drab or greyish.
- Plant with a distinct stalk, thickened above; spores ovoid, 8 × 4μ ... 23. *C. tenuipes*
- Plant slender, brittle, without a distinct stalk; spores small, pip-shaped, 4–5 × 2–3μ ... ... 24. *C. Crosslandii*

(*c*) Plants reddish or purple.
- Plant bright rose-pink ... ... 25. *C. rosea*
- Plant purplish-brown ... ... 26. *C. purpurea*
- Plant dingy flesh-colour or pale chocolate ... ... 27. *C. incarnata*

(*d*) Plants yellow.
- Spores aculeate ... ... 28. *C. inaequalis*
- Spores smooth.
  - Plant straw-coloured, becoming brownish when bruised, apex usually acute; spores globose, 5–7μ 29. *C. straminea*
  - Plant greenish-yellow, not becoming brownish when bruised, apex usually blunt; spores 10–11 × 5–6μ ... ... 30. *C. argillacea*
  - Plant apricot-yellow, pale buff when dry; spores ovoid, 6–7 × 3μ 31. *C. luteo-alba*
  - Plant orange-yellow, darker when dry; spores subglobose to oblong, 5–6 × 4μ ... ... 32. *C. persimilis*

(*e*) Plants ochraceous to brownish.
- Plant very large and stout, clavate, dingy yellow to brown ... ... 33. *C. pistillaris*
- Plant medium sized, up to 1·25 cm. thick, ochraceous ... ... 34. *C. ligula*
- Plant very long, subulate, pale yellow to rusty, growing on branches; spores 10–17 × 7–9μ ... ... 35. *C. fistulosa*
- Plant short, contorted, erumpent, on branches of Alder; spores 17–23 × 8–10μ ... ... 36. *C. contorta*
- Plant filiform, rusty to brownish; spores 8–11 × 4–5μ ... ... 37. *C. juncea*

A. Plants Branched.

1. *Plants when mature more or less yellowish, spores ochraceous.*

(*a*) Plants large, up to 10 or 15 cm. high; spores 9–20 μ long.

1. Clavaria flava *Fr.*, Syst. Myc. i. p. 467; Maire in Bull. Soc. Myc. Fr. xxvii. 1911, p. 450.

C. flava Pers., Comment. p. 43; *Ramaria coralloides flava* seu *lutea* Holmsk., Beata ruris, 1790, p. 117; *C. sanguinea* Pers., Obs. Myc. ii. 1799, p. 61, tab. 3, fig. 3; *C. lutea* Venturi, Mic. Bresc. tab. 41, fig. 4.

Illustrations: Holmsk., Fung. Dan. i. tab. 31; Pers., Obs. Myc. ii. tab. 3, fig. 3; Schaeff., Icon. Fung. tab. 175; Barla, Champ. Nice, tab. 40, fig. 5; Bres., Fung. Mang. tab. 100; Fries, Sver. Atl. Svamp. tab. 26; Schaeff., Icon. Fung. tab. 175; Vittadini, Fung. Mang. tab. 29, figs. 2, 3; Venturi, loc. cit.

Plants large, branched, 8–13 cm. high, fleshy, fragile, ochraceous, becoming paler on drying and reddish when bruised; smell pleasant, taste mild. *Stem* thick, white or tinged reddish. *Branching* irregular or irregularly dichotomous, repeated, axils acute, not flattened; branches slender, cylindrical, erect, solid, smooth or slightly wrinkled, apices blunt or pointed. *Flesh* white, soft. *Internal structure* of slightly interwoven hyphae, 8–12 μ in diameter, sub-parenchymatous in transverse section. *Basidia* 45 × 10 μ, finely granular; sterigmata 4, erect. *Spores* pale ochraceous in the mass, almost hyaline by transmitted light, narrowly elliptical, incurved at the base, walls slightly granular, 11–14 (–15) × 4–5 μ.

Habitat. On the ground, in both coniferous and frondose woods.

Rare. Specimens from Morpeth (C. H. Spencer Perceval, 1906, 1909); Bodmin (A. D. C., 1906); Tobermoray, Isle of Mull (A. D. C., 1910); New Forest (G. Massee, 1903, and [Lyndhurst] A. D. C., 1916).

Of the three large species of Clavaria found in Britain this is the least rare. It appears to be not infrequent also on the Continent, at all events in France and Switzerland. It is found in both coniferous and frondose woods (especially beech), where it occurs either isolated or in groups as a pale fragile plant, with a marked tendency to become reddish at the base or when bruised. The colour is pale ochraceous, paler and yellower than in *C. formosa*, which has a tendency to become dull pink.

The correct identity of the three species, *C. flava* Pers., *C. formosa* Pers., and *C. aurea* Fr. is a very perplexing problem,

and one which owing to the scarcity of authentic material and meagreness of the original descriptions it is perhaps impossible to solve. There can be little doubt that the plant here referred to as *C. flava* is the same as that described by Persoon under the same name, and in this view we have the support of Maire (loc. cit.). In this country it has been usually referred to as *C. aurea*, an error which arose largely as the result of Fries' statement that *C. aurea* differed from *C. flava* in its ochraceous spores. This was incorrect, as in all the species of this section the spores are coloured, though in some species more so than in others.

With regard to *C. aurea* it is difficult to dogmatise as to its identity. The English specimens so named consist as stated above for the most part of *C. flava*, but a few which as far as can be seen from herbarium material only differ in possessing shorter spores may be distinct also in other characters, and these may possibly represent the *C. aurea* of Fries. Until the Swedish species of Clavaria have been critically worked out it is advisable not to attempt to describe the plant or list the species for Britain.

2. C. Broomei *Cotton et Wakefield*, sp. nov.

Sporophorum ramosum, circa 5–8 cm. altum, 2–4 cm. diametro, haud fragile, ochraceo-aurantiacum, apicibus aurantiacis, tactu brunnescens, basi albidum. *Stipes* brevis, albidus, tactu rubescens, vix radicans. *Ramuli* subdichotomi, cylindrici vel compressi, breves, solidi, erecti, laeves vel rugulosi, apicibus compressis. *Caro* solida, alba, demum vinosa. *Hyphae* 3–6μ diametro, dense aggregatae. *Basidia* 40–50 × 8–9μ, granulosa, 2-sterigmatica. *Sporae* copiosae, fulvo-ochraceae, oblique fusiformes, aculeatae, 14–20 × 6–8μ.

Habitat. Ad terram in silvis. Warleigh Common, near Bath, C. E. Broome, 1866; Batheaston, C. E. Broome; Meathop Fell, near Grange, Westmorland, chiefly under Holly, collected by J. Wilfrid Jackson, and forwarded by Harold Murray, 1909 and 1911.

Plants somewhat branched, medium to large, 5–8 cm. high, 2–4 cm. across, rather tough, ochraceous orange, tips darker orange, turning brown easily on bruising, base white or pinkish; smell slight, not pleasant, taste bitter. *Stem* short, not swollen, white, becoming pinkish on bruising; rooting base small. *Branching* irregular or somewhat dichotomous, slight below, more frequent above, axils not rounded; branches cylindrical or flattened, short, solid, fairly erect, smooth, or the larger branches much wrinkled, tips flattened. *Flesh* solid, white, becoming vinous later, especially below. *Internal structure*

composed of fine filaments, densely packed, slightly interwoven, 3–6μ in diameter, with vesicular ends 10–12μ in diameter, not pseudoparenchymatous in transverse section; large crystals present in abundance in the tissue. *Basidia* not conspicuous, 40–50 × 8–9μ, contents granular; sterigmata 2. *Spores* deep ochraceous or even orange in the mass, copious, obliquely fusiform or pip-shaped, markedly aculeate, 14–20 × 6–8μ (average 15–16 × 6–7μ).

This species is clearly allied to *C. formosa*, but it is distinguished from it and still more from *C. flava* by its darker hue, and by the deeply coloured and distinctly aculeate spores. On drying it becomes nearly black in colour, whereas *C. formosa* and *C. flava* remain pale, and are somewhat more brittle. It is not possible to identify this species with Fries' *C. aurea*, the spores being quite different from those of an authentic specimen of *C. aurea* in the Kew Herbarium: moreover among all the specimens so named from the Continent not one has been found agreeing with *C. Broomei*.

There can be no question that the specimens forwarded by Mr. Harold Murray agree with those collected by Broome in 1866. These latter were named *C. formosa* by Berkeley, and were distributed under this name by M. C. Cooke in Fungi Britannici Exsiccati (No. 230 and Ed. 2, No. 411). The first record of *C. formosa* as British was made by Berkeley and Broome in 1865 (Ann. and Mag. of Nat. Hist. ser. iii. 15, 1865, p. 321, No. 1031). It was based on specimens collected by Broome at Bathford Down, but although these specimens have not been found, from the description of the spores as "buff, broadly fusiform, granulated," there is little doubt that the species in question was *C. Broomei* and not *C. formosa*.

C. Bataillei Maire (Ann. Myc. xi. 1913, p. 351) has also verrucose spores, but they are smaller and paler than those of the present species, and the plant differs in the violet colour of the branches. *C. testacco-flava* Bres. is distinguished by the smaller basidia and spores, and by the fact that the spores are minutely granular, not distinctly aculeate.

3. C. BOTRYTIS *Fr.*, Syst. Myc. i. p. 466; Bourdot & Galzin in Bull. Soc. Myc. Fr. xxvi. 1910, p. 213; Maire in Bull. Soc. Myc. Fr. xxvii. 1911, p. 449.

C. botrytis Pers., Comment. p. 42; *C. plebeja* Wulf., in Jacq. Misc. Aust. 2, p. 101, tab. 13; *Ramaria coralloides apicibus purpureis* Holmsk., Beata ruris, 1790, p. 117; *C. acroporphyria* Schaeff., Icon. Fung. tab. 176; *C. rufescens* Schaeff., ibid. tab. 288; *C. purpurascens* Paulet, Traité des champ. tab. 194, fig. 6.

Illustrations: Pers., loc. cit. tab. 3, fig. 3; Atkinson,

Mushrooms, p. 201, fig. 202; Badham, Esc. Fung. tab. 16, fig. 2 (*C. coralloides*); Barla, Champ. Nice, tab. 40, figs. 1–3; Bres., Fung. Mang. tab. 101; Fries, Sverig. Atl. Svamp. tab. 35; Gillet, Champ. Fr. tab. 507; Holmsk., Fung. Dan. i. 1799, tab. 32, fig. *b*; Krombh., Abbild. u. Beschreib. tab. 53, figs. 1–3; Paulet, loc. cit.; Schaeff., loc. cit.; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24D, figs. 2, 3 (but spores not correct); Vittadini, Fung. Mang. tab. 29, fig. 1; Weberbauer, Pilze, tab. 10, fig. 1.

Plants large, 10–12 cm. across and 7–12 cm. high, forming fleshy rounded masses, with a short stout base, densely branched above, white to buff, the tips of the branches reddish; smell slight, pleasant, taste pleasant. *Stem* short, stout, white tapering below. *Branching* irregular, primary branches few and stout (2–3 cm.), ultimate branches slender (2–3 mm.), more or less dichotomous; branches cylindrical, somewhat erect, smooth, pruinose, apices pointed or toothed. *Flesh* solid, white. *Internal structure* of parallel septate hyphae, cells 100–150 × 10μ in the centre, smaller towards the margin, scarcely parenchymatous in transverse section. *Basidia* long, conspicuous, 60–70 × 8–10μ, contents very granular; sterigmata 2–4. *Spores* dull ochraceous in the mass, copious, obliquely elliptical, apiculate, smooth, but with fine longitudinal or oblique striations often anastomosing to form a network, 12–16 × 4–5μ.

Habitat. On the ground amongst leaves in woods. Very rare. Specimens from Haslemere (E. W. Swanton, 1905, 1906, 1913); Byfleet (Lady Davy, 1912); Effingham, under beech and holly (A. D. C., 1913); Lyndhurst (A. D. C., 1916).

As remarked by Persoon, the habit of this species is very variable. The typical form is white or pale, and has short, densely crowded, rose-tipped branches, forming a compact rounded mass. With age it becomes more yellowish in colour, and under certain conditions the branches may become much elongated, as figured by Barla, tab. cit. fig. 3, and Vittadini. It would seem that such elongated specimens have been sometimes referred to *C. formosa*, whence has arisen the idea amongst some recent writers that *C. formosa* has red-tipped branches.

Even when old, however, *C. botrytis* may always be recognised by its characteristic, striate spores, as was noted by us and pointed out by Maire (loc. cit.). Maire suggests that *C. Rielii* Boud. (Bull. Soc. Myc. Fr. xiii. 1897, p. 14) and *C. sculpta* Beck (Verh. k. zool.-bot. Ges. Wien, 39, 1889, p. 603) may have been old specimens of *C. botrytis* from which the branches had been for the most part broken off. The fact that the striations of the spore wall are not mentioned by these authors may merely

be due to the fact that they did not examine the spores with a sufficiently high magnification.

4. C. FORMOSA *Fr.*, Syst. Myc. i. p. 466.

C. formosa Pers., Comm. p. 41; ? *C. fastigiata* Batsch, Elench. tab. 11, fig. 48; *C. coralloides purpurea* Holmsk., Fung. Dan. i. 1799, p. 116, tab. 30, p.p.; *Clavariella formosa* Karst., Hattsv. ii. 1882, p. 185.

Illustrations: Pers., Ic. et Descr. i. tab. 3, fig. 6; Gillet, Champ. Fr. Hymen. tab. 511; Holmsk., Fung. Dan. i. 1799, tab. 30 (*b* and *c*); Krombh., Abb. u. Beschreib. tab. 54, figs. 21–22; Rolland in Bull. Soc. Myc. Fr. ix. 1893, tab. 4, fig. 8; Weberbauer, Pilze, tab. 10, fig. 2.

Plants large, about 15 cm. in diameter, gregarious, much branched, very fragile, colour pinkish buff, pale at first but deeper later, the tips of the branches yellowish or very slightly tinged with pink, every part turning violet and finally black when bruised; taste slight, smell none. *Stem* white at first, then deep pinkish buff, rooting base absent. *Branching* irregular or irregularly dichotomous, axils slightly flattened; branches erect, cylindrical or flattened, elongated, distinctly grooved, 1 cm. thick below, 2 mm. above, apices blunt. *Flesh* white, solid. *Internal structure* of frequently septate irregular hyphae, loosely interwoven in the centre, 6–8 (–10)μ wide, occasionally swollen up to 14μ at the septa, more slender and more closely interwoven towards the margin, somewhat parenchymatous in transverse section. A few latex hyphae present. *Basidia* not conspicuous, 30–40 × 6–8μ; sterigmata 4, erect. *Spores* pale-coloured, ochraceous in the mass, elliptical, apiculate, minutely granular, almost smooth, 9–11 × 5μ.

Habitat. On the ground under trees (beech). Lyndhurst, Sept. 1916, growing in a large semicircle.

Very rare in Britain. The above description is drawn up from the Lyndhurst specimens, which on the whole appear to agree better with the older descriptions of *C. formosa* than some of the British plants which have been so referred.

As here understood, *C. formosa* is a large, very fragile plant, differing from *C. botrytis* in the fact that the apices of the branches are yellowish, or at most slightly tinged pinkish, and in the granular, not striate spores. It is distinguished from *C. flava* and *C. aurea* by the pinkish buff colour, which is somewhat like that of *C. stricta*. The original record of *C. formosa* in Britain, by Berkeley and Broome (Ann. Nat. Hist. ser. 3, vol. xv. 1865, p. 321), appears to have been based on a plant which was distinct from any of these species, and which is here described as a new species (*C. Broomei*), while some of the later

records, such as the Haslemere specimens, have been old specimens of *C. botrytis*, as is pointed out in the notes on that species.

(*b*) Plants medium-sized, up to 5 cm. high; spores 6–10μ long.

5. C. STRICTA *Fr.*, Syst. Myc. i. p. 468.

C. stricta Pers., in Ust. Annal. xv. 1795, p. 33; Comment. p. 45; *Clavariella stricta* Karst., Hattsv. ii. 1882, p. 188; *Clavaria Kewensis* Mass., in Journ. Bot. 34, 1896, p. 470.

Illustrations: Pers., Comment. tab. 4, fig. 1; Berk., Outl. tab. 18, fig. 5; Bull., tab. 358, figs. A, B (*C. crispula* Fr.); Weberbauer, Pilze, tab. 10, fig. 3; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 23, fig. 2.

Plants branched, 3–5 cm. high, gregarious, tough, ochraceous, tinged with vinous (or pale pinky buff), apices pale yellow; smell strong, spicy, taste bitter. *Stem* distinct, thick, short, tough, with root-like strands of white mycelium at base. *Branching* irregularly dichotomous, axils acute; branches slender, cylindrical or sometimes compressed, erect, attenuated, apices somewhat pointed, slightly incurved, solid. *Flesh* concolorous. *Internal structure* of interwoven hyphae, 4–10μ in diameter, not parenchymatous in transverse section; central hyphae often rather thick-walled. *Basidia* distinct, 30–40 × 7–9μ, contents granular; sterigmata 4, erect. *Spores* ochraceous in the mass, almost hyaline by transmitted light, pip-shaped, almost smooth, 7–10 × 3–5μ (average 8–9 × 4μ), guttulate or granular.

Habitat. On rotten wood, stumps, etc., or on the ground in the vicinity of logs. Rather common.

Distinguished by its lignicolous habitat, the white cord-like mycelium, and the bitter taste. The branches are unusually parallel to each other and form a compact fascicle.

C. STRICTA var. ALBA, var. nov.

Apparently an albino form which resembles the type form in all respects, except that the colour is entirely creamy-white.

Habitat. On the ground amongst fallen leaves, twigs, etc. Drumnadrochit, N.B. (Angus Grant, 1908, 1912).

6. C. ABIETINA *Fr.*, Syst. Myc. i. p. 469.

C. abietina Pers., Comm. p. 46; *Clavariella abietina* Karst., Hattsv. ii. 1882, p. 185.

Illustrations: Cooke, Handb. p. 330, fig. 88; Flor. Dan. tab. 2030, fig. 2; Greville, Scott. Crypt. Flor. tab. 117; Massee, Brit. Fung. Flor. i. p. 74, figs. 2–3; Pat., Tab. Anal. fig. 566.

Plants much branched, forming spherical tufts, 3–5 cm. high, tough, deep dull ochraceous in colour, becoming greenish when bruised; smell strong, taste bitter. *Stem* short, thick, whitish, downy, with a slightly rooting base, becoming greenish. *Branches* slender, 1–2 mm. thick, erect, repeatedly forked, cylindrical or compressed, longitudinally wrinkled when dry, apices pointed or bifid, axils acute. *Flesh* white. *Internal structure* filamentous, hyphae loosely interwoven, 4–10μ (average 5–7μ), slightly septate. *Basidia* small, 35–40 × 7–8μ, contents uniform, finely granular, sterigmata 4, erect. *Spores* deep ochraceous in the mass, copious, finely rough, pip-shaped, 7–10 × 3–5μ (average 7–8 × 3–5μ).

Habitat. On the ground in fir woods. Fairly common.

Easily distinguished from all other British species by becoming green when bruised. It is allied to *C. flaccida* and *C. Invalii*, and occurs in similar localities. The spores are larger than those of *C. flaccida*, and more like those of *C. Invalii*.

7. C. FLACCIDA *Fr.*, Syst. Myc. i. p. 471.

Clavariella flaccida Karst., Hattsv. ii. 1882, p. 186.

Illustrations: Fries, Icon. Hymen. tab. 199, fig. 4; Karsten, Finl. Basidsv. tab. 9, fig. 139; Pat., Tab. Anal. fig. 39.

Plants branched, small, 3–4 cm. high, gregarious, rather tough, but flaccid, bright ochraceous in colour, tips paler, base whitish, does not turn green on bruising; smell and taste slight, pleasant. *Main stem* very short, white, with white, floccose mycelium. *Branches* very crowded, repeatedly forked, erect, upper axils rounded, the pointed terminal branches usually curving inwards towards each other, solid. *Flesh* white. *Internal structure* composed of loosely interwoven, slightly septate filaments, 7–10μ in diameter, not parenchymatous in transverse section and more densely arranged towards the periphery. *Basidia* small, conspicuous, 30 × 7–9μ, contents finely granular; sterigmata 4. *Spores* not copious, ochraceous, very finely punctate, pip-shaped, 6–8 × 3–5μ (av. 6–7 × 3μ), sometimes with a hyaline basal tip.

Habitat. Amongst moss and leaves in coniferous woods. Not common.

Specimens from Alresford, Hants. (C. Rea, 1904, and W. L. W. Eyre, 1911); Midhurst (E. M. W., 1913); Lyndhurst (A. D. C., 1916). Recorded at the Rothiemurchus (1900), Exeter (1901), and Savernake Forest (1903) forays.

Somewhat resembling *C. abietina*, but the whole fungus is more flaccid, and does not turn green when bruised. Stem sometimes up to 1·75 cm. long, at others almost obsolete. Mycelium whitish, creeping over leaves, etc.

8. C. Invalii *Cotton et Wakefield*, sp. nov.

Fungus dense ramosus, 4–5 cm. altus, rigidus, ochraceus. *Stipes* brevis, albido-tomentosus, basi radiculis mycelialibus albis vel flavidis instructus. *Rami* tenues, breves, cylindrici, erecti, laeves, apicibus acutis, intus solidi, albido. *Hyphae* irregulares 5–10μ diametro, laxe intertextae. *Basidia* 30–40 × 7–9μ, intus granulosa; sterigmata 4, erecta. *Sporae* copiosae, ochraceae, obovatae, basi leviter incurvatae, echinulatae, 7–9 × 4μ.

Habitat. On the ground amongst leaves in thick plantations of spruce, larch, etc. Inval, Haslemere, E. W. Swanton, 1905–1908.

Plants solitary or gregarious, branched, forming dense compact, almost spherical tufts, 4–5 cm. high, tough, rather rigid, deep ochre in colour; smell slightly pungent, taste faint, hardly bitter. *Stem* more or less distinct, short, often woolly, with white or yellowish rooting strands. *Branching* irregular, frequent, axils acute; branches slender, short, uneven, cylindrical, erect, smooth, solid, apices attenuated and pointed. *Flesh* white. *Internal structure* of irregular, wavy filamentous hyphae, 5–10μ in diameter, loosely interwoven and running equally in each direction. *Basidia* conspicuous, 30–40 × 7–9μ, contents finely granular; sterigmata 4, erect. *Spores* abundant, yellow, pip-shaped, slightly incurved at the base, echinulate, 7–9 × 4μ (average 8 × 4μ).

This species, which is obviously very rare in Britain, has been sent to us repeatedly from the spruce plantations at Inval, near Haslemere, by Mr. E. W. Swanton. It is perfectly distinct from all other species we have received and being unable to place it with certainty in any Continental species we have been compelled to describe it as new. The plant is closely allied to *C. abietina* and *C. flaccida*. From the former it differs in not turning green when bruised and retaining its deep bright colour when dried, and from the latter in its stouter form, more rigid habit, and larger and more deeply coloured spores.

2. *Plants variously coloured, spores hyaline.*

(*a*) Plants white.

9. C. cristata *Fr.*, Syst. Myc. i. p. 473.

C. cristata Pers., Syn. p. 591; *Ramaria cristata* Holmsk., Beata ruris, 1790, p. 92; *Ramaria ornithopodioides* Holmsk., ibid. p. 26; *Clavaria fallax* Pers., Comment. p. 48; *C. fallax* var. *cristata* Pers., ibid.; *C. trichopus* Pers., Comment. p. 50; *C. albida* Schaeff., Icon. Fung. tab. 170; *Clavulina cristata* Schroet., Pilz. Schles. i. p. 442.

Illustrations: Pers., Comment. tab. 2, fig. 4, and tab. 4, fig. 3; Berk. in Ann. Nat. Hist. i. 1838, tab. 5, fig. 46 (hymen.); Fries, Sver. Atl. Svamp. tab. 92, figs. 1–5; Greville, Scott. Crypt. Flor. tab. 190; Holmsk., Fung. Dan. i. 1799, tabs. 20, 23; Pat., Tab. Anal. figs. 37, 261; Quélet, loc. cit.; Weberbauer, Pilze, tab. 10, fig. 4.

Plants branched, 3–8 cm. high, gregarious, fragile, pure white, pinkish white, or with a tinge of mouse-grey; smell none, taste distinct. *Stem* short, slender or stout. *Branches* numerous, irregular, flattened upwards, and divided at the tips into sharp-pointed branchlets; axils rounded. *Flesh* white. *Internal structure* composed of loosely interwoven, more or less parallel filaments, fairly regular, frequently septate, segments 35–40 × 5–6μ, in the centre 50–70 × 6–9μ. *Basidia* small, 25 × 6–7μ, contents densely granular; sterigmata 2. *Spores* smooth, hyaline, subglobose, apiculate, 9–12 × 6–8μ (av. 9 × 7μ or 7–8μ diam.), with a large conspicuous oil-globule.

Habitat. On the ground in woods, etc. Very common.

We have retained this species in the sense in which it is usually understood, but not without some misgivings. It is obviously nearly allied to *C. cinerea*, and small crested forms of the latter are difficult to distinguish from certain forms of *C. cristata*. It is noteworthy also that *C. cristata* usually occurs in more shaded spots, and frequently covered with leaves or screened by logs of wood.

The black parasitic mould *Scoletotrichum Clavariarum* occurs perhaps more frequently on this species than on any other.

10. C. Kunzei *Fr.*, Syst. Myc. i. p. 474; Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 180.

C. chionea Pers., Myc. Eur. i. 1822, p. 167; *Clavulina Kunzei* Schroet., Pilz. Schles. i. p. 442; *Clavaria Krombholzii* Fr., Epicr. 1836–38, p. 572.

Illustrations: Quélet, Ch. Vosges, 3, tab. 2, fig. 11; Weberbauer, Pilze, tab. 10, fig. 5.

Plants medium-sized, 5–12 cm. high, branched, isolated or gregarious, brittle, ivory to creamy white, base sometimes pink; smell none, taste pleasant. *Stem* usually distinct, 1–2 cm. long, 3–5 mm. thick, but sometimes absent. *Branching* irregularly dichotomous, or irregular, loose or rarely compact; branches erect or spreading, cylindrical or slightly compressed, often elongated, 2–5 mm. thick, even, solid, axils lunate, apices blunt or pointed. *Internal structure* pseudoparenchymatous in transverse section, cells long, 100–300 × 5–8μ. *Basidia* small, 30–35 × 5–6μ; sterigmata 4. *Spores* smooth, hyaline,

globose, minutely apiculate, very small, 3·5–4·5μ in diameter, one-guttulate.

Habitat. In long grass in woods and pastures. Uncommon, but in certain seasons frequent.

This species is very distinct in its beautiful ivory-white colour and loosely branched habit. When well grown it may form tufts 4 to 5 inches high and as much across, but average plants are decidedly smaller. From *C. rugosa* it is distinguished by being branched from the base and by the slender, even (not rugose) branches, and from *C. cristata* by the loose habit, lunate axils, and non-cristate apices. From both it differs in the very small spores.

The type specimens of *C. chionea* are in the Persoon herbarium at Leyden, and Dr. Goethart reported that they agreed in form and size with British specimens of *C. Kunzei* which were submitted to him.

With regard to *C. Krombholzii*, this species was based by Fries on Krombholz, tab. 53, figs. 15, 16, and tab. 54, figs. 18–20, which the latter had referred to *C. Kunzei*. It differed principally in being less branched and in the branches being somewhat flattened. *C. Kunzei* however is well known to be a very variable plant, and it sometimes assumes forms which correspond with the description given for *C. Krombholzii*. No plants have been seen under the latter name which were specifically distinct from *C. Kunzei* or *C. rugosa*.

(*b*) Plants greyish.

11. C. CINEREA *Fr.*, Syst. Myc. i. p. 468; see also Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 184.

C. cinerea Bull., Ch. Fr. p. 204, tab. 354; *C. grisea* Pers., Comment. p. 44; *C. fuliginea* Pers., Myc. Eur. i. 1822, p. 166; *Clavulina cinerea* Schroet., Pilz. Schles. i. p. 443.

Illustrations: Bulliard, loc. cit.; Badham, Esc. Fung. tab. 15, fig. 5; Bolton, Hist. Fung. tab. 113 (*C. coralloides*, poor); Cooke, Plain and Easy Acc. Brit. Fung. Ed. i, 1862, tab. 17, fig. 1; Ed. iii, 1876, tab. 10, fig. 2; Greville, Scott. Crypt. Flor. tabs. 64, 321 (vars.); Pat., Tab. Anal. fig. 154; Stevenson, Hymen. ii. p. 290; Weberbauer, Pilze, tab. 11, fig. 2 (*C. grisea*).

Plants branched, very variable in habit, usually 3–5 cm. in height, but sometimes more, solitary or gregarious, greyish or with a faint tinge of purple, rather brittle; smell none, taste mild. *Stem* more or less distinct, thick, short. *Branching* irregular, repeated, uneven, axils usually acute; branches thick or slender, cylindrical or compressed, short, stuffed, erect, wrinkled, apices often toothed. *Flesh* white. *Internal*

structure composed of hyphae 8–10 (–12)μ in diameter, with occasional inflations, slightly septate, loosely filamentous, irregular in transverse section. *Basidia* long, conspicuous, 35–50 (–70) × 6–10μ, contents finely granular; sterigmata 2. *Spores* copious, smooth, hyaline, subglobose or obovate, apiculate at the base, 7–10 × 6–8μ, with one large oil-globule.

Habitat. On the ground in woods, etc. Common and edible.

Very variable in form but known by its grey colour and large spores, the former however being variable in tint. See also the notes under *C. cristata*.

C. CINEREA var. GRACILIS *Rea*, in Trans. Brit. Myc. Soc. vi. 1917, p. 62.

Distinguished from the type form by its larger size, longer and more slender stem, with numerous slender branches and branchlets. Spores 9 × 8μ, with a large central gutta.

Habitat. On bare soil in woods. Caughley, Salop, and Shrawley, Worcestershire.

12. C. GIGASPORA *Cotton*, in Naturalist, 1907, pp. 97–98.

Illustrations: None published.

Plants branched, caespitose but distinct at the base, or solitary, small, up to 3 cm. high, tough, greyish with a tinge of yellow, whitish at base of stem, smell and taste absent. *Stem* slender, not very distinct, 1 cm. long or shorter. *Branching* irregular, sometimes almost palmate, branches erect, occasionally forked, often wrinkled, solid, terete or compressed, much compressed at the acute axils, ultimate branches attenuated, apices blunt. *Internal structure* of densely packed hyphae 4–4·5μ in diameter, forming a firm tough tissue, rather horny when dry. *Basidia* large, 60–70 × 15μ, contents finely granular; sterigmata 4, rather stout, 8–10μ long. *Spores* smooth, hyaline, somewhat pip-shaped, very variable in size, 10–20 × 7–9μ (average 12–16 × 7·5–8μ), contents guttulate, then granular.

Habitat. Amongst moss on a rocky, heathy slope. Only known from the type locality, near Cullingworth, Yorks.

A small, dingy, yellowish-white plant, scarcely overtopping the moss in which it grows. It resembles certain forms of *C. cinerea* and *C. cristata*, but is readily distinguished from either by the exceedingly large spores. The structure also is somewhat exceptional, being composed of very fine, densely matted hyphae, which give rise to unusually large basidia.

(*c*) Plants violet.

13. C. AMETHYSTINA *Fr.*, Syst. Myc. i. p. 472.

Clavaria amethystina Pers., Comment. p. 46; *Coralloides amethystina* Batt., Fung. Agr. Arim. Hist. 1759, p. 22, tab. 1, fig. C; *Ramaria amethystina* Holmsk., Beata ruris, 1790, p. 110; *Clavaria amethystea* Bull., Champ. Fr. tab. 496, fig. 2.

Illustrations: Bulliard, loc. cit.; Badham, Esc. Fung. tab. 5, fig. 2; Berk., Outl. tab. 18, fig. 2; Cooke, Plain and Easy Acc. Brit. Fungi, Ed. i, tab. 17, fig. 2; Ed. iii, tab. 11, fig. 3; Cooke, Brit. Edible Fungi, tab. 1, fig. 4; Holmsk., Fung. Dan. i. tab. 28.

Plants branched, 3–4 cm. high, forming small, very compact tufts, lilac or mauve, turning rapidly to yellowish on drying, rather brittle; smell strong, taste tallowy. *Stem* very short, scarcely distinct. *Branching* irregular, axils not flattened; branches thick, 3–5 mm. in diameter, short, cylindrical, not attenuated, erect, smooth, solid, apices blunt. *Flesh* uniform. *Internal structure* of densely interwoven hyphae, frequently septate, cells 50–100 × 8–12μ, not pseudoparenchymatous in transverse section. *Basidia* rather large, 50–60 × 7–10μ, sterigmata 2–4. *Spores* smooth, hyaline, globose, with minute basal apiculus, 5–7μ in diameter.

Habitat. Among grass in woods and pastures. Rare.

Specimens from Rothiemurchus (1900); Alresford, Hants. (W. L. W. Eyre, 1905, 1909); Clare Island (H. C. Hawley, 1910); Dolgelley (C. Th. Green, 1910).

C. amethystina has somewhat the habit of a short thick form of *C. cinerea*, with the deep-coloured forms of which it has by some authors been confused. When once the true plant has been seen, however, there is no difficulty in distinguishing it by its beautiful violet colour (almost as deep as that of *Laccaria laccata* var. *amethystina*), and by its much smaller spores. It is usually much branched, but sometimes almost simple. The only other violet species in Britain, *C. Bizzozeriana*, is very much more slender, and in no way related.

14. C. BIZZOZERIANA *Sacc.*, Syll. vi. 1888, p. 693.

C. tenuissima Sacc., Michelia, i. 1878, p. 436 (*non* Lév.); *C. conchyliata* Allen, in Trans. Brit. Myc. Soc. iii. 1908, p. 92.

Illustrations: Trans. Brit. Myc. Soc. iii. 1908, tab. 8.

Plants branched, very small, not more than 1 cm. in height, solitary or in groups, at first violet, becoming discoloured with age. *Stem* reddish-yellow, pubescent below, with rooting base. *Branching* irregular, dichotomous, the axils of the branches patent; branches very slender, 0·5 mm. thick, erect, apices

blunt. *Flesh* white. *Internal structure* filamentous, filaments 3–4μ in diameter. *Basidia* 15–18 × 3–4μ; sterigmata 2–4. *Spores* hyaline, smooth, globose or subglobose, 2·4–3·5μ in diameter, 1-guttulate.

Habitat. On the ground, under hazel. Rare.

Easily recognised by the very small size and the violet colour of the branches, which are "irregular and divaricate with somewhat digitate ends."

It is regrettable that the name *C. conchyliata* must be dropped in favour of *C. Bizzozeriana*. Mr. Allen submitted specimens of his plant to Kew in 1907, and was informed that it was apparently an undescribed species. Specimens of the same species were received from Switzerland in 1912 and it was subsequently discovered that the plant was *C. Bizzozeriana*, a species described by Saccardo in 1888.

The species is very rare in Britain, but material has been forwarded on two occasions by Dr. J. S. Bayliss Elliott.

(*d*) Plants clear yellow.

15. C. CORNICULATA *Fr.*, Syst. Myc. i. p. 471.

C. corniculata Schaeff., Icon. Fung. tab. 173; *C. muscoides* Linn., Spec. Plant. 1753, p. 1183; *Ramaria muscoides* Holmsk., Beata ruris, 1790, p. 87; *Clavaria furcata* Pers., Comment. p. 52.

Illustrations: Bolton, Hist. Fung. tab. 114 (poor); Fl. Dan. tab. 775, fig. 3; Holmsk., Fung. Dan. i. tab. 21; Pat., Tab. Anal. fig. 564; Schaeff., tab. cit.

Plant branched, 3–4 cm. high, gregarious, tough, clear egg-yellow; smell none, taste mild. *Stem* short, downy at the base. *Branches* slender, two or three times forked, erect, even, solid, axils lunate or acute, often compressed, apices attenuated, not pointed. *Flesh* slightly paler than the exterior. *Internal structure* composed of filaments running parallel to the axis, not interwoven but very easily separating and becoming twisted, 4–8μ thick (average 5–7μ), fairly frequently septate with cells 100–200μ long, not pseudoparenchymatous in transverse section. *Basidia* distinct, about 50μ long, vacuolate or clear; sterigmata 4, 10μ long, fairly erect. *Spores* white in the mass, smooth, subglobose, apiculate, hyaline, 6–7μ in diameter, guttulate.

Habitat. Amongst grass, especially in fields. Common.

This is the commonest of the branched yellow species. It varies in form in accordance with its surroundings, but the clear yellow colour and beautiful globose spores, 6–7μ in diameter, clearly separate it from other species. The height

of the plant is determined by the nature of the surrounding vegetation and conditions of exposure. In long damp grass it grows loosely and is frequently four inches in height, whereas in shorter grass and more open surroundings it is shorter and more compact; whilst on exposed hills and downs the dwarf form, var. *pratensis*, is produced. The latter is a very common plant, and may occasionally be found in vast quantities.

C. corniculata was formerly known in all British works as *C. muscoides*. The change in name is necessitated by the International Rules of Nomenclature. It was agreed that the starting-point for the nomenclature of the Hymenomycetes should be Fries' Systema Mycologicum, 1821–1832, and as Fries there adopts the names *C. corniculata* and *C. pratensis* these stand, in spite of the fact that he later changed his mind and adopted the Linnaean names *C. muscoides* and *C. fastigiata*.

C. CORNICULATA *Fr.* var. PRATENSIS *Cotton et Wakef.*

Clavaria pratensis Fr., Syst. Myc. i. p. 471; Pers., Comment. p. 51; *C. fastigiata* Linn., Spec. Plant., 1753, p. 118; *Ramaria fastigiata* Holmsk., Beata ruris, 1790, p. 90; *Clavaria muscoides* var. *fastigiata* Cotton, in Trans. Brit. Myc. Soc. iii. 1909, p. 181.

Illustrations: Bolton, Hist. Fung. tab. 112, fig. 2 (poor); Bull., Champ. Fr. tab. 358, figs. D, E; Holmsk., Fung. Dan. i. tab. 22; Flor. Dan. tab. 836, fig. 2; Pers., Comment. tab. 4, fig. 5.

Plants tough, very much branched, branches crowded, of equal length and forming a level top. Colour the same as that of the typical form.

Habitat. In short grass in exposed situations.

This plant was formerly known as *C. muscoides* var. *fastigiata* (= *C. fastigiata* L.). For remarks as to habitat, etc., see notes under typical form.

(*e*) Plants pale umber.

16. C. UMBRINELLA *Sacc.*, Syll. vi. 1888, p. 695; Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 181.

C. umbrina Berk., Outlines, 1860, p. 279.

Illustrations: Berk., loc. cit. tab. 18, fig. 4 (very poor); Cotton, loc. cit. tab. 11, fig. E (spores).

Plants slightly branched, small, 2–2·5 cm. high, isolated or caespitose, pale brown; smell none, taste pleasant. *Stem* sometimes thick and minutely velvety, but often absent, a number of slender branches arising close together from the base. *Branching* irregularly dichotomous, axils somewhat flattened; branches slender, erect, cylindrical, 1–2 mm. thick,

even, solid. *Internal structure* composed of loosely and slightly interwoven filaments, 5–10μ in diameter (average 7–8μ). *Basidia* small, 35–40 × 6–7μ, contents finely granular; sterigmata 4. *Spores* hyaline, smooth, pip-shaped, laterally apiculate, 4–5 × 4μ or 5–6 × 3–4μ, usually guttulate.

Habitat. On lawns. Uncommon.

C. umbrinella is a well-marked and somewhat uncommon species. It is distinguished by its short branched habit, like that of *C. corniculata* var. *pratensis*, and by its pale brown colour.

Owing partly to the poorness of Berkeley's figure a good deal of uncertainty has existed as to its identity. Part of the original gathering which exists at Kew, however, shows the characteristic pip-shaped spores. The specimens taken together with Berkeley's description and his rider that "The habit is that of *C. fastigiata*" leave no doubt as to the plant he had in view.

B. Plants Simple.

1. *Plants tufted.*

17. C. VERMICULARIS *Fr.*, Syst. Myc. i. p. 484; Cotton in Trans. Brit. Myc. Soc. iii. 1907, p. 32.

C. fragilis Holmsk. p.p., Beata ruris, 1790, p. 7; *C. vermiculata* Scop., Flor. Carniol. ii. 1772, p. 483.

Illustrations: Cooke, Plain and Easy Acc. Brit. Fungi, Ed. i, 1862, tab. 17, fig. 4; Ed. iii, 1876, tab. 6, fig. 3; Cooke, Brit. Edible Fungi, tab. 4, fig. 15; Holmsk., Fung. Dan. i. tab. 2, fig. *f*; Stevenson, Hymenomyc. ii. p. 298.

Plants unbranched, densely tufted, somewhat flexuous, brittle, white, about 4–6 cm. high. *Clubs* cylindrical, sometimes twisted and compressed, apex acute, smooth, fragile, becoming hollow. *Stem* not distinct. *Internal structure* of parallel, septate hyphae, with rather long cells, pseudoparenchymatous in transverse section, central cells 10–15μ in diameter, with smaller cells intermixed. *Basidia* small, 30 × 6–7μ; sterigmata 4. *Spores* smooth, hyaline, subglobose, minutely apiculate at the base, 3–5 × 3–4μ.

Habitat. In meadows, etc. Common, especially early in the autumn.

Easily distinguished among the white species by the densely tufted habit, very fragile clubs and small spores.

18. C. FUMOSA *Fr.*, Syst. Myc. i. p. 483.

C. fumosa Pers., Obs. Myc. i. p. 31; Comment. p. 76.

Illustrations: Krombholz, Abb. und Beschreib. tab. 53, fig. 18.

Plants unbranched, tufted, very brittle, 4–8 cm. high; smell none; taste marked, pleasant. *Clubs* white when young, later pale mouse-grey, tips brown, base whitish, cylindrical or clavate, sometimes furrowed, surface smooth or slightly furrowed, becoming hollow with age, apex blunt or acute. *Stem* not at all or scarcely distinct from club. *Flesh* white, the hymenial layer easily peeling off. *Internal structure* of short cylindrical cells, 30–50 × 10–15μ, parallel to the long axis of the club; structure in transverse section pseudo-parenchymatous, like that of *C. vermicularis*. *Basidia* inconspicuous, 35 × 6–7μ; sterigmata 2–4, short. *Spores* smooth, hyaline, cylindric-ellipsoid or somewhat pip-shaped with minute oblique apiculus, 6–8 × 3–4μ, contents often guttulate or granular.

Habitat. Amongst grass in fields. Not common.

This species has the dense tufted habit of *C. vermicularis* and occurs in similar situations, but is grey in colour. If there is any doubt the much larger spores at once distinguish it.

19. C. FUSIFORMIS *Fr.*, Syst. Myc. i. p. 480.

C. fusiformis Sow., Col. Fig. tab. 234; *C. fasciculata* Pers., Comment. p. 72; *C. ceranoides* Pers., Syn. p. 594.

Illustrations: Bolton, Hist. Fung. tab. 110 (as *C. pistillaris*); Cotton in Trans. Brit. Myc. Soc. iii. 1909, tab. 11, fig. A; Hussey, Illustr. Brit. Mycol. i. tab. 18; Pat., Tab. Anal. fig. 565; Sowerby, loc. cit. tabs. 234, 235 (the latter figure the basis of *C. ceranoides* Pers.).

Plants simple or very rarely branched, densely tufted, connate at the base, 5–8 cm. high, clear canary-yellow; smell none when fresh, taste bitter. *Clubs* elongated, spindle-shaped, tips acute, often becoming hollow and compressed. *Stem* not distinct. *Flesh* whitish, as in *C. inaequalis*. *Internal structure* of fine filaments, 4–6μ thick, more or less interwoven, walls sometimes rough; occasional hyphae with dark yellow contents. Mature *basidia* hyaline, 35–40 × 6·8μ; sterigmata 4, slightly curved. *Spores* globose, smooth, minutely apiculate, 5–7 (–8)μ in diameter, at first yellow, then colourless.

Habitat. Amongst grass in the open and in woods. Common.

Known amongst the simple yellow species by the densely tufted habit, the canary-yellow colour and the bitter taste.

2. *Plants solitary or in small groups.*

(*a*) Plants white.

20. C. ACUTA *Fr.*, Syst. Myc. i. p. 485; Cotton in Trans. Brit. Myc. Soc. iii. 1907, p. 31.

C. acuta Sow., Col. Fig. tab. 333; ? *C. falcata* Pers., Comment. p. 81, tab. 1, fig. 3.

Illustrations: Sowerby, loc. cit.

Plants unbranched, solitary or in small groups, 3–7 cm. high, glistening white; smell none, taste distinct, pleasant. *Clubs* slender, about 2–3 mm. wide, cylindrical or compressed, smooth, becoming hollow, very brittle, apex acute or obtuse. *Stem* more or less distinct from the club, variable in length, 1–2 cm., white. *Internal structure* of frequently septate hyphae, running parallel to the long axis of the club, 5–12 (–30) μ in diameter, average 10μ, pseudoparenchymatous in transverse section. *Basidia* conspicuous, small, 30–35 × 7–8μ, contents granular; sterigmata 2–4, slightly divergent. *Spores* subglobose, smooth, hyaline, minutely apiculate, 7–10 × 6–9μ (average 8–9 × 7–8μ), contents granular, guttulate when young.

Habitat. Amongst grass in woods, on shady lawns, etc., and often on the soil of plant pots in greenhouses. Not common.

Clavaria acuta has probably often been referred to *C. fragilis*, which is however in part a synonym of *C. vermicularis*. This species is distinguished from *C. vermicularis* by its solitary habit of growth, distinct stem, and large spores. Its frequent occurrence in greenhouses has been noted by several writers.

21. C. RUGOSA *Fr.*, Syst. Myc. i. p. 473.

C. rugosa Bull., Ch. Fr. p. 206, tab. 448, fig. 2; *C. damicornis* Schrank, Baiersche Flor. ii. 1789, p. 666; *C. elegans* Bolt., Hist. Fung. tab. 115; *C. laciniata* Schaeff., Icon. Fung. tab. 291; *C. canaliculata* Fr., Obs. Myc. ii. p. 294; *Clavulina rugosa* Schroet., Pilz. Schles. i. p. 442.

Illustrations: Bulliard, loc. cit.; Badham, Esc. Fung. tab. 15, fig. 4; Berk., Outlines, tab. 18, fig. 3; Bolton, loc. cit.; Cooke, Plain and Easy Acc. Brit. Fung. Ed. i, tab. 17, fig. 3; Ed. iii, tab. 6, fig. 2; Cooke, Brit. Edible Fung. tab. 9, fig. 32; Greville, Scott. Crypt. Flor. tab. 328; Pers., loc. cit.; Sowerby, Col. Fig. tab. 278, lower figs. (as *C. coralloides*).

Plants simple or slightly irregularly branched, solitary or grégarious, 5–10 cm. high, white or pallid, rather tough. *Clubs* thickened upwards, up to 1 cm. thick, longitudinally wrinkled, solid, apex blunt. *Stem* not distinct. *Internal structure*

uniform, somewhat dense, but looser in centre, of much interwoven, frequently septate hyphae, 8–10μ in diameter. *Basidia* long, conspicuous, up to 60μ long, 5–6μ wide, contents granular; sterigmata 2. *Spores* subglobose, smooth, hyaline, with basal apiculus, and a large guttule, 9–11 × 8–9μ (or 9–10μ in diameter).

Habitat. In woods and shady spots. Common.

This species varies in habit from simple to very branched forms, and the surface may be exceedingly rugose to almost smooth. It is generally recognisable, however, by the distinct, irregular, longitudinal wrinkles, and the large spores.

C. RUGOSA var. FULIGINEA *Fr.*, Hym. Eur. p. 669; Rea in Trans. Brit. Myc. Soc. vi. 1917, p. 62.

This variety is unknown to us, it is said to differ from the type in the dark, sooty colour of the clubs and flesh. It has been collected recently in England by Mr. Carleton Rea.

Habitat. On the ground, Caughley Wood, Salop, 1917.

22. C. ASTEROSPORA *Pat.*, Tab. Anal. ser. 2, 1886, p. 28, fig. 568.

Illustration: Pat., loc. cit.

Plants simple, slender, gregarious, 2–3 cm. high, pure white. *Clubs* cylindrical, fragile, smooth, hollow, apex blunt or pointed. *Stem* slender, greenish at the base, not markedly distinct from the club. *Internal structure* pseudoparenchymatous in transverse section. *Basidia* clavate, 30–40 × 8μ; sterigmata 4. *Spores* hyaline, globose, with long, scattered spines, spore-body 7–8μ in diameter.

Habitat. On bare soil, rare. Specimens from Haslemere (A. D. C., 1905; E. M. W., 1913).

This species is distinguished from other white simple forms by the globose, distinctly spiny spores. *C. tenerrima* Mass. et Crossl. is similar in habit, but the spores are described as granular. The latter has not been met with since it was described, and is therefore listed here among the doubtful species.

(*b*) Plants drab or greyish.

23. C. TENUIPES *Berk. et Br.*, in Ann. Nat. Hist. ser. 2, ii. 1848, p. 266, No. 369; Cotton in Trans. Brit. Myc. Soc. iii. 1909, p. 182.

Pistillaria tenuipes Mass., Brit. Fung. Flor. i. p. 91.

Illustrations: Berk. et Br., loc. cit. tab. 9, fig. 2; Cooke, Handbook Brit. Fung. i. p. 336; Mass., Brit. Fung. Flor. i. p. 74, figs. 6, 7.

Plants simple, isolated or in small groups, small, pale grey to drab in colour; smell none; taste "mushroom-like." *Clubs* 3–6 cm. high, 2–10 mm. wide, clavate or cylindrical, often compressed, smooth or slightly rugulose, hollow when old, apex blunt. *Stem* more or less distinct, slender, 1–2 cm. long, 2–3 mm. wide. *Flesh* uniform in colour. *Internal structure* of loosely packed, unbranched hyphae, 8–10μ (rarely 15–20μ) in diameter, cells 50–150μ long. *Basidia* rather small, 30–40 $\times$ 7–9μ, contents granular; sterigmata 4, erect. *Spores* smooth, hyaline, ovoid, with a minute oblique basal apiculus, 7–9 $\times$ 4–5μ (average 8 $\times$ 4μ), contents guttulate, then granular.

Habitat. Amongst short grass, especially in heathy places.

The plant is readily recognised by its greyish or drab colour, and by the more or less thickened, fleshy club and slender stem. The name has been formerly often wrongly applied to *C. acuta*, which differs in its slender, very fragile, snow-white sporophores. The stem in some specimens is sharply separated from the spore-bearing surface; in others the transition is not so abrupt. On account of the somewhat tough texture and distinct stem the plant has been placed in Pistillaria, a genus of minute, epiphytic plants. It is however a genuine Clavaria.

24. C. Crosslandii *Cotton*, in Naturalist, 1912, p. 86.

Illustrations: None published.

Plants small, unbranched, isolated or fasciculate, greyish-white or grey, becoming darker with age; smell and taste slight, pleasant. *Clubs* very slender, brittle, 2–3 cm. high, 1–3 mm. thick, pruinose, cylindrical, apex usually pointed. *Stem* hardly distinct. *Flesh* somewhat darker than the hymenium. *Internal structure* pseudoparenchymatous in transverse section, cells 5–8μ in diameter. *Basidia* 20–25 $\times$ 4–5μ, contents granular; sterigmata 4, erect. *Spores* hyaline, smooth, pip-shaped, 4–5 $\times$ 2·5–3μ.

Habitat. In short grass. Known only from the type locality, Mulgrave Woods, Yorks. (C. Crossland and W. N. Cheesman, 1910–1911).

The grey colour and small size are good field characters by which to recognise the present species. From the drab-coloured *C. tenuipes* it is distinguished by its slender, brittle clubs, and from *C. fumosa* by its fasciculate instead of densely tufted habit. *C. acuta*, which is similar in size, habit, and texture, differs in the complete absence of the grey tinge. Furthermore the small basidia and spores mark off *C. Crosslandii* from allied species. It approaches *C. affinis* Pat. et

Doass., but the latter differs, according to the published description (no type is preserved), (i) in the distinct stem; (ii) in becoming yellow on drying; (iii) in the slightly larger, punctulate spores.

(*c*) Plants reddish or purple.

25. C. ROSEA *Fr.*, Syst. Myc. i. p. 482.

C. rosea Dalman, in Vet. Acad. Handl. 1811, p. 157.

Illustrations: Fries, Obs. Myc. ii. tab. 5, fig. 2; Krombh., Abbild. u. Beschreib. tab. 53, fig. 21.

Plants simple, solitary or in groups of 3–7, 2–4 cm. high, fragile, bright rose-pink; taste and smell none. *Clubs* slender, cylindrical or compressed, equal or tapering upwards, smooth, solid, 2–5 mm. thick, apex blunt or pointed. *Stem* fairly distinct, paler, sometimes yellowish. *Flesh* whitish, deep rose beneath the hymenium. *Internal structure* of frequently septate, irregular hyphae, 7–12μ in diameter, semi-parenchymatous in transverse section; crystals sometimes present. *Basidia* conspicuous, 35–40 × 7–10μ, granular or guttulate, sterigmata 4, erect. *Spores* copious, smooth, hyaline, ovoid or broadly elliptical, 7–10 × 5–6μ.

Habitat. Amongst grass, moss, etc. Rare. Specimens from near Hebden Bridge (C. Crossland, 1895–97); Morpeth (C. H. Spencer Perceval, 1908, 1909, 1910); Halifax (C. Crossland, 1908); Forres (1912); Selby (1918).

Easily distinguished from other British species by the bright, rose-pink colour.

26. C. PURPUREA *Fr.*, Syst. Myc. i. p. 480.

C. purpurea Müller, in Flor. Dan. tab. 837, fig. 2.

Illustrations: Flor. Dan. tab. cit.

Plants unbranched, caespitose, up to 12 cm. high, somewhat tough, purplish brown or dark chocolate; smell none. *Clubs* slender, 1–2 mm. thick, flattened, smooth, solid, apex acute, paler. *Stem* hardly distinct, whitish at the base. *Flesh* not distinct. *Internal structure* of irregular hyphae, cells 50–60μ long, 3–5μ in diameter, or 7–9μ towards the centre of the club, pseudoparenchymatous in transverse section. *Basidia* small 25–30 × 7–8μ, guttulate; sterigmata 4, erect. *Spores* hyaline, smooth, oval, 7–8 × 4–5μ, contents granular.

Habitat. Amongst grass. Very rare. Small specimen from Mulgrave Woods, Yorkshire (C. Crossland, 1910).

Distinguished by its dark, purplish-brown colour.

27. C. INCARNATA *Weinm.*, Hymeno- et Gasteromycetes, 1836, p. 510.

Illustrations: None published.

Plants simple, solitary or gregarious, fragile, 2–3·5 cm. high, flesh-coloured to pale chocolate; smell slight, pleasant. *Clubs* slender, 2–2·5 mm. thick, cylindrical or compressed, even or slightly rugose, hollow, apex blunt. *Stem* more or less distinct. *Flesh* coloured, pale or darker than the club. *Internal structure* of frequently septate hyphae, loosely interwoven, with trumpet-shaped expansions in the sub-hymenial layer, cells 50–100 × 5–10μ, pseudoparenchymatous in transverse section. *Basidia* 35–40 × 7–8 (–10)μ, contents finely granular; sterigmata 4, erect. *Spores* abundant, hyaline, smooth, ovoid, 7–10 × 6–8μ (average 8 × 5μ), contents granular.

Habitat. On the ground. Very rare. Specimens from Whitby and Halifax (C. Crossland, 1908); ? Haslemere (E. M. W., 1913).

Distinguished from *C. purpurea* by the paler colour, smaller size, and slightly larger spores. *C. rosea* differs in its brighter, rose-pink colour.

(*d*) Plants yellow.

28. C. INAEQUALIS *Fr.*, Syst. Myc. i. p. 481; Cotton in Trans. Brit. Myc. Soc. ii. 1906, pp. 163–165, and iii. 1907, p. 33.

C. inaequalis Müller, Fl. Dan. tab. 836, fig. 1; *C. polymorpha rufa* Müll. Fl. Dan. tab. 775, fig. 1; *C. rufa* Pers., Comment. p. 71; *C. fasciculata* Villars, Hist. Pl. Dauph. iv. 1789, p. 1052; *C. bifurca* Bull., Ch. Fr. tab. 264; *C. angustata* Pers., Comment. p. 72; *C. vermiculata* Sow., Col. Fig. tab. 253, p.p.; *C. dissipabilis* Britz., Hymenomycet. aus Südbayern, 1885, p. 289; *C. similis* Boud. et Pat., Journ. de Bot. ii. 1888, p. 446.

Illustrations: Flor. Dan. tab. 836, fig. 1; Boud. et Pat., loc. cit. tab. 8, fig. 1; Britzelmayr, loc. cit. fig. 28; Bulliard, loc. cit.; Cotton in Trans. Brit. Myc. Soc. iii. tab. 11, fig. B (spores); Greville, Scott. Crypt. Flor. i. tab. 37 (*C. fragilis*); Massee, Brit. Fung. Flor. i. p. 74, fig. 4; Pers., Comm. tab. 1, fig. 3 *bis* (*C. angustata*); Sowerby, Col. Fig. tab. 253 (lower figs.).

Plants simple, or very rarely with one or two branchlets, 4–7·5 cm. high, usually in small groups but occasionally single. *Clubs* cylindrical or flattened, smooth or with one or more furrows, bright yellow to rich orange, apex obtuse or pointed. *Stem* not distinct. *Flesh* whitish, fibrous. *Basidia* conspicuous,

clavate, yellowish, 30–40 × 6–8μ; sterigmata 4, more or less erect. *Spores* hyaline, white or slightly ochraceous in the mass, subglobose, sharply warted, 5–6 (–8)μ in diameter.

Habitat. Amongst grass in woods, parks, lawns, etc. Common.

This is by far the most frequent of the yellow simple Clavarias, being found in short grass in a variety of situations every season. It may be distinguished at once from all other yellow species by its subglobose, spiny spores.

As pointed out in the notes in Trans. Brit. Myc. Soc. ii. p. 163, *C. dissipabilis* Britz. is merely a synonym of *C. inaequalis*. The only justification for Britzelmayr's describing his plant as a new species was Karsten's statement that the spores of *C. inaequalis* were smooth and elliptical. This was an error, as the examination of material in herbaria, including Karsten's own specimens, clearly shows. It is possible that a species with smooth elliptical spores occurs on the Continent, but if so it is obviously very rare and cannot be regarded as representing the old and well-known *C. inaequalis*.

Dark forms of this species, almost orange in colour, sometimes occur, and these represent the *C. polymorpha rufa* (= *C. rufa* Pers.) of the Flora Danica. (See Trans. Brit. Myc. Soc. iii. p. 33.)

29. C. STRAMINEA *Cotton*, in Trans. Brit. Myc. Soc. iii. 1910, p. 265.

Illustrations: Cotton, loc. cit. tab. 11, fig. D (given in error as *C. persimilis*).

Plants small, unbranched, isolated or caespitose, straw-coloured, becoming brownish with age; smell and taste not marked. *Clubs* slender, 3–5 cm. high, 3–4 mm. thick, cylindrical or somewhat compressed, smooth, brittle, apex usually acute. *Stem* usually very distinct, cinnamon-yellow. *Flesh* somewhat darker than the hymenium. *Internal structure* pseudoparenchymatous in transverse section. *Basidia* rather large, 40–60 × 7–9μ, contents granular, sterigmata 4. *Spores* hyaline, smooth, globose, with a minute basal apiculus, 5–7μ in diameter, contents granular.

Habitat. In short grass. Rare. Specimens from Erringden, near Halifax (C. Crossland, 1905); Carlisle (Miss D. Graham, 1908–1909); Chatsworth (A. D. C., 1909); Broseley, Salop (G. Potts, 1909); Clare Island (A. D. C., 1910); Sandsend, Yorks. (C. Crossland, 1912); Haslemere (E. M. W., 1913).

C. straminea differs from *C. argillacea* in its smaller size, and pointed cylindrical clubs, and also in its globose spores. In both species the spore-bearing surface is paler in colour than

the stem, and is more or less clearly separated from it. In *C. argillacea* the stem is yellow or greenish-yellow, whereas in *C. straminea* it becomes a brownish-red or cinnamon, and this colour is liable, especially on handling, to spread over the whole surface of the club.

C. flavipes Pers., in Fries, Syst. Myc. i. p. 483, might possibly refer to this species, but no specimen exists, and its identity cannot be determined from the description and figures quoted.

30. C. ARGILLACEA *Fr.*, Syst. Myc. i. p. 482.

C. argillacea Pers., Comment. p. 74; *C. ericetorum* Pers., Obs. Myc. ii. 1799, p. 60.

Illustrations: Boudier, Icon. Mycol. i. tab. 175; Fries, Obs. Myc. ii. tab. 5, fig. 3; Pat., Tab. Anal. fig. 585, *non* 587.

Plants simple, gregarious, 2–5 cm. high, pale greenish-yellow, fragile; smell none, taste like tallow. *Clubs* cylindrical or flattened, with one or more grooves, surface often minutely channelled, apex blunt. *Stem* distinct, yellowish. *Internal structure* almost pseudoparenchymatous in transverse section, even when old; cells regular, 10–14μ in diameter, with small narrow filaments (4–5μ in diameter) between; segments 50–70μ long towards the margin, but up to 200–300μ in the centre. *Basidia* conspicuous, about 70μ long, contents granular, sterigmata 4. *Spores* smooth, hyaline, cylindric to elliptical with a minute lateral basal apiculus, 10–11 × 5–6μ (or sometimes 10–14 × 6–7μ), contents granular.

Habitat. In heathy places. Not uncommon.

This species is a typical plant of heather moors and similar heathy places, on which it at times occurs in profusion and occasionally in company with *C. tenuipes*. The only species with which it is likely to be confused is *C. straminea*, which as stated in the remarks under that species differs in its globose spores and other characters.

31. C. LUTEO-ALBA *Rea*, in Trans. Brit. Myc. Soc. ii. 1903, p. 66; Cotton, ibid. iii. 1907, pp. 30–31, 183.

Illustrations: Trans. Brit. Myc. Soc. ii. 1903, tab. 3, fig. B; Ibid. iii. 1907, tab. 11, fig. C (spores).

Plants simple, isolated or in two's or three's, small, 3–5 cm. high; smell none, taste like tallow. *Clubs* very slender, 1·5–3 mm. thick, apricot-yellow with apex whitish, cylindrical or slightly compressed, smooth, solid, usually attenuated, apex acute or obtuse. *Stem* not sharply marked, often becoming more distinct on drying. *Flesh* orange-yellow. *Internal structure* not pseudoparenchymatous in transverse section, but composed of loosely packed longitudinally running fila-

ments, 5–6μ in diameter, containing orange-coloured granules. *Basidia* small, 25–30 × 5–7μ, contents slightly granular; sterigmata 4, erect. *Spores* hyaline, smooth, ovoid or slightly pip-shaped, not apiculate, 6–8 × 3–4μ (average 6–7 × 3μ).

Habitat. In short grass, on mossy banks, etc. Not uncommon.

The species is distinguished from *C. inaequalis* by its small size and apricot-yellow clubs, with the apex not infrequently white. The flesh also is practically identical in colour with the exterior of the club, whereas in *C. inaequalis* the flesh is whitish. The smooth ovoid spores moreover distinguish it. On drying the plant rapidly loses its apricot hue, and finally becomes pale ochraceous, the stem usually retaining the colour longer than the club, and becoming twisted. The white apex from which the plant takes its name is more marked in some cases than in others, and may be altogether absent; it appears to be more obvious in the field, and disappears on drying.

Some remarkably large specimens were found growing amongst holly leaves at Haslemere. These plants grew in clusters or singly, with the habit and markings of *C. rugosa*. The spores were 7–10 × 4–5μ (average 8 × 4μ), slightly larger than those of typical *C. luteo-alba*, but the colour of the clubs and flesh was normal.

32. C. PERSIMILIS *Cotton*, in Trans. Brit. Myc. Soc. iii. 1909, p. 182.

Illustrations: None published.

Plants small unbranched, isolated or fasciculate, orange-yellow to orange, becoming darker on drying. *Clubs* slender, 3–5 cm. high, 2–3 mm. thick, cylindrical or somewhat compressed, apex usually acute. *Stem* not sharply defined. *Flesh* pale. *Internal structure* composed of loosely packed, longitudinally running filaments 3–6μ in diameter, not pseudoparenchymatous in transverse section. *Basidia* small, 30–35 × 7–8μ, contents granular; sterigmata 4, erect. *Spores* smooth, hyaline, subglobose to oblong, with a conspicuous lateral oblique apiculus, 5–6 × 4μ, guttulate.

Habitat. In short grass. Not uncommon.

The present species is very similar to *C. luteo-alba* Rea, and difficult to distinguish from it in the field. An unfailing character is found in the spore, which is subglobose to oblong with a very well-marked oblique apiculus, and not ovoid and non-apiculate as in *C. luteo-alba*. It differs also in other characters, namely, in the different shade of colour when fresh, the absence of a white tip, and in becoming dark orange on drying.

(*c*) Plants ochraceous to brownish.

33. C. PISTILLARIS *Fr.*, Syst. Myc. i. p. 477.

C. pistillaris Linn., Flor. Suec. p. 456, No. 1266 (1755); *Fungus clavatus* Bocc. ex Fries, loc. cit.; *C. major* Mich., Gen. Plant. tab. 87, fig. 1; *C. herculeana* Lightfoot, Fl. Scot. ii. 1777, p. 1056; Pers., Comment. p. 63; *C. pulvinata* Pers., Comment. p. 65.

Illustrations: Numerous. Atkinson, Mushrooms, p. 202, fig. 203; Bulliard, Ch. Fr. tab. 244; Hussey, Illustr. Brit. Mycol. i. tab. 62; Massee, Brit. Fung. Flor. i. p. 74, fig. 8; Sowerby, Col. Fig. tab. 277; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24; Weberbauer, Pilze, tab. 11, fig. 3.

Plants simple, solitary, clavate or obovate, variable in size, 10–30 cm. high, 2·5–5 cm. thick at the widest part. *Clubs* minutely velvety, whitish then dingy ochraceous, finally dusky brown, stuffed. *Stem* not distinct. *Flesh* whitish, loose and cottony in the centre. *Basidia* about 70μ long, with 2–4 sterigmata. *Spores* smooth, ochraceous in the mass, almost hyaline by transmitted light, elliptic-oblong, with oblique basal apiculus, 12–16 × 7–8μ.

Habitat. On the ground in woods. Rather rare and sporadic.

Easily distinguished by the large, thick, club-shaped sporophores.

34. C. LIGULA *Fr.*, Syst. Myc. i. p. 477.

C. ligula Schaeff., Icon. Fung. tab. 171; *C. caespitosa* Wulf., in Jacq. Misc. 2, 1781, p. 98, tab. 12, fig. 2; *C. pulvinata* Pers., Comment. p. 65; *C. luteola* Pers., Comment. p. 66.

Illustrations: Flor. Dan. tab. 837, fig. 1; Schaeff., loc. cit.; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24 B, fig. 1; Weberbauer, Pilze, tab. 11, fig. 4.

Plants simple, clavate, 5–10 cm. high, up to 1·25 cm. thick above, much narrowed and downy towards the base, ochraceous with a rufescent tinge, fragile, apex rounded. *Stem* not distinct from the club. *Flesh* solid. *Basidia* conspicuous, 40 × 6–8μ; sterigmata 4. *Spores* smooth, hyaline, cylindrical or very narrowly elliptical, with a curved basal apiculus, 11–14 × 4μ.

Habitat. Attached by the downy base to leaves, twigs, etc., lying on the ground in woods. Very rare. Specimen from Duncombe Park near Helmsley (Y. N. U. Foray, Sept. 1903).

This species is allied to *C. pistillaris*, but differs in the flattened and much smaller clubs and pale colour. It is apparently very rare in Britain as no specimens have been received during

the past 15 years. Specimens, however, were forwarded by Mr. C. G. Lloyd from Sweden and Mr. W. B. Allen from Germany.

35. C. FISTULOSA *Fr.*, Syst. Myc. i. p. 479; Lind in Ann. Myc. v. 1907, p. 272.

C. fistulosa Holmsk., Beata ruris, 1790, p. 15, tab. 6; *C. pilipes* Müll., Flor. Dan. tab. 1076, fig. 1; *C. Ardenia* Sow., Col. Fig. tab. 215; *C. strigosa* Schum., Enum. Pl. Saell. 1801, p. 403; *C. macrorhiza* Sw., Vet. Ak. Handl. 1811, tab. 6, fig. 1.

Illustrations: Holmskiold, Fung. Dan. i. 1799, tab. 6; Harper in Mycologia, x. 1918, tabs. 3, 4, figs. A, B; Flora Danica, tab. 1076, fig. 1, tab. 1256; Sowerby, loc. cit.; Migula in Thomé, Flora von Deutschl. iii. 2, 1, tab. 24 B, fig. 2.

Plants simple, solitary or two to three together, erect, tough, narrowly clavate, 5–8 cm. high or more; smell and taste none. *Clubs* at first yellowish, then date-brown, cylindrical or clavate, often twisted, smooth, hollow with age, occasionally branching at the apex. *Stem* with whitish fibrils. *Flesh* not distinct in colour. *Internal structure* characterised by possessing a system of laticiferous hyphae, unseptate, frequently branched, 6μ in diameter, contents granular. *Basidia* conspicuous, about 40μ long, contents finely granular; sterigmata 4, erect. *Spores* hyaline, smooth, pip-shaped, with often irregular outline, 10–17 × 7–9μ (average 13–15 × 8μ), contents guttulate or granular.

Habitat. On fallen branches lying amongst dead leaves. Rare.

According to Lind, in Denmark this species occurs chiefly on branches of beech, whereas *C. contorta* is usually on alder. Harper, however, finds *C. fistulosa* always on sticks buried amongst leaves in coniferous woods. Both writers agree that the spores of *C. fistulosa* are smaller than those of *C. contorta*, and this observation is borne out in the British specimens examined.

36. C. CONTORTA *Fr.*, Syst. Myc. i. p. 478; Lind in Ann. Myc. v. 1907, p. 272; Cotton in Trans. Brit. Myc. Soc. ii. 1906, p. 165, and iii. 1910, p. 266.

C. contorta Holmsk., Beata ruris, 1790, p. 29, tab. 12; *Tremella ferruginea* Schum., Enum. Pl. Saell. 1801, p. 443.

Illustrations: Holmskiold, loc. cit. tab. 12; Flora Danica, tab. 1852, fig. 1; Harper in Mycologia, x. 1918, tab. 4, fig. C; Boudier in Bull. Soc. Myc. Fr. xxxiii. 1917, tab. 1, fig. 5.

Plants erumpent, 2–3 cm. high, contorted, irregularly branched; smell and taste none. *Clubs* pale yellowish-drab,

darker when moist, fairly tough; branches 4–6 mm. thick, short, blunt, wrinkled, not attenuated, at length hollow. *Stem* not distinct. *Internal structure* in longitudinal section of long cells 10–15μ wide, with narrower elements on either side; latex-tubes present. *Basidia* rather large, very distinct, 50 × 10μ, contents finely granular; sterigmata 4. *Spores* hyaline, smooth, ovate or pip-shaped, pointed at the base, 17–23 × 8–10μ (average 19 × 9μ), contents vacuolate.

Habitat. On branches of *Alnus*. Rare.

As pointed out in the notes in these Transactions referred to above, von Höhnel regards *C. contorta* as a morbid form of *C. fistulosa*, but this statement has been criticised by Lind. Lind's arguments appear to be confirmed by what is known of British specimens. In the paper quoted he gives a tabular comparison of the differences between *C. contorta* and *C. fistulosa*, stating that he knows both species well and finds no intermediate forms. The chief points of distinction in *C. contorta*, besides its dwarf, fasciculate habit, are its paler, more greyish colour, entirely smooth club, covered everywhere with the hymenium, its occurrence on dead branches still remaining on the tree, as well as on fallen ones, preference for *Alnus incana*, and larger spores.

37. C. JUNCEA *Fr.*, Syst. Myc. i. p. 479; Harper in Mycologia, x. 1918, p. 56.

C. juncea Fr., Obs. ii. p. 291; *C. cylindrica* Tode, in Schrift. Naturf. Freund. Berl. iv. 1783, p. 166; *C. triuncialis* Pers., Comment. p. 82; *C. triuncialis* f. *juncea* Alb. et Schw., Consp. Fung. p. 289; *C. hirta* Vahl, Flor. Dan. tab. 1257; *Typhula juncea* Schroet., Pilz. Schles. i. p. 441.

Illustrations: Boudier, Icon. Mycol. i. tab. 176; Harper, loc. cit. tab. 5.

Plants filiform, simple, in groups of two or three, dirty yellow, then tinged rusty, or brownish-drab; smell none; taste distinctly acrid. *Clubs* slender, weak, wavy, not brittle, 8–12·5 cm. high, 0·5–1·5 mm. thick, apex pointed. *Stem* long, up to 2 mm. thick, woolly. *Flesh* uniform. *Internal structure* in transverse section pseudoparenchymatous throughout, with occasional large air-spaces. *Basidia* small, 30–35 × 6–7 (–8)μ, slightly vacuolar; sterigmata 4. *Spores* smooth, hyaline, elliptical and slightly curved, or pip-shaped, with oblique apiculus, 8-11 × 4–5μ.

Habitat. On dead, fallen leaves, etc. Rare. Specimens from Broseley, Salop (W. B. Allen and G. Potts, 1909); Louisburgh (H. C. Hawley, 1910); Mulgrave Woods, Yorks. (Y.N.U. Foray, 1912).

This species is related to *C. fistulosa*, but differs in the very much more slender habit.

SPECIES NOBIS INCOGNITAE.

CLAVARIA MICHELII *Rea*, in Trans. Brit. Myc. Soc. ii. 1902, p. 39.

C. fragilis Holmsk. var. *C. gracilis* Pers., Fr. Hym. Eur. p. 675.

On ground, Dinmore, C. Rea, 1902.

This is a simple yellow species, said to have subglobose spores, $3 \times 2\mu$. It differs in this respect from any of the yellow species with which we are familiar.

C. SUBTILIS (*Pers.*) *Fr.*, Syst. Myc. i. p. 475; Rea in Trans. Brit. Myc. Soc. ii. 1902, p. 39.

Tough, thin, white, becoming yellowish, glabrous at the base, of equal thickness throughout (1 mm.), branches few, dichotomously forked and somewhat fastigiate. Spores white, elliptical, $6 \times 3\mu$. The whole plant is 2–2·5 cm. high.

Amongst grass, Moseley Green, Forest of Dean, C. Rea, 1902. Distinguished from allied species by its small size, equality of thickness, toughness and few branches.

The above is the description given by Rea. Amongst the as yet unidentified material which has come into our hands there is a slender whitish or pale yellow branched species, sent by Miss Lister from Theydon Forest, which would pass very well for this species as regards habit, but the spores are subglobose, 3μ, hence it cannot be regarded as identical.

C. TENERRIMA *Mass. et Crossland*, in Naturalist, 1904, p. 2.

Gregaria subtenax farcta candida; clavis simplicibus cylindricis flexuosis apice subattenuatis; sporis hyalinis subglobosis apiculatis verrucosis, 8–9μ

Sporophores entirely shining white, gregarious but quite distinct at the base, cylindrical, smooth, apex slightly attenuated but by no means acute, base not narrowed, 2·5–4 cm. high, 1·5–2 mm. thick. Basidia bearing four spores.

Said to be characterised by the slender, cylindrical, flexuous sporophore, and more especially by the subglobose spores having the epispore densely covered by minute rounded warts.

Unfortunately the type specimen does not appear to have been kept. The only white species with rough spores seen by the authors has spores with quite distinct, comparatively long spines, and is obviously *C. asterospora* Pat. The suspicion arises that *C. tenerrima* may have been really *C. acuta*, the

spores of which have granular contents, and might have appeared to be rough.

SPECIES EXCLUDENDAE.

C. Ardenia Sow., Col. Fig. tab. 215. = *C. fistulosa.*

C. aurea Fr., Epicr. p. 574. None of the British specimens seen can be satisfactorily distinguished from *C. flava.* The statement by Fries that *C. aurea* differs from *C. flava* in its coloured spores cannot be maintained, since as already pointed out the spores of all in this section are coloured. The further distinction of habitat is of no value, as *C. flava* occurs in both coniferous and frondose woods.

C. canaliculata Fr., Obs. 2, p. 294. = *C. rugosa.*

C. chionea Pers., Myc. Eur. i. p. 167. = *C. Kunzei.*

C. ceranoides Pers., Syn. p. 594. This was founded on Sowerby, tab. 235, which is obviously a form of *C. fusiformis.*

C. coralloides Linn., Flor. Suec., ed. 2, 1755, p. 457. At first applied to various branched species, but the name appears to have been used by Fries and others for large forms of *C. cristata.*

C. condensata Fr., Epicr. p. 575. Indeterminable.

C. crassa Britz., Hymenomycet. aus Südbayern, 1885, p. 286. Has the form and spores of *C. rugosa,* but was said to be tinged violet. Probably = *C. rugosa.*

C. crispula Fr., Syst. Myc. i. p. 470. Indeterminable.

C. crocea Pers., Icon. et Descr. p. 36, tab. 11, fig. 6. Indeterminable.

C. curta Fr., Monogr. ii. p. 281. Indeterminable.

C. dissipabilis Britz., Hymenomycet. aus Südbayern, 1885, p. 289. = *C. inaequalis.*

C. falcata Pers., Comment. p. 81. = *C. acuta*? (See these Trans. iii. p. 32.)

C. filicina Sacc. et Syd., Syll. xiv. p. 238; *C. cervina* W. G. Smith, in Journ. of Bot. 1873, p. 66. Apparently a good species, but doubtless an introduced plant, and therefore not included in this account of British forms.

C. flavipes Pers., Comment. p. 75. Indeterminable. (See these Trans. iii. p. 266.)

C. fragilis Holmsk., Beata ruris, p. 7, tabs. 2 and 3. The right-hand figure of tab. 2 is *C. vermicularis.* The other simple white forms in tab. 2 and the yellow forms in tab. 3 are not identifiable with certainty from the figures alone, and the name should be dropped.

C. grisea Pers., Comment. p. 44. = *C. cinerea.* (See these Trans. iii. 1909, p. 184.)

C. Kewensis Mass., in Journ. Bot. 34, 1896, p. 470. = *C. stricta.*

C. Krombholzii Fr., Epicr. p. 572. The figures of Krombholz on which this species was founded may have been forms of either *C. Kunzei* or *C. rugosa*, possibly both. No species distinct from either that would answer to *C. Krombholzii* has been seen by the authors.

C. pyxidata Pers., Comment. p. 47, tab. 1, fig. 1. Possibly an abnormal form of *C. stricta*, since it occurred on wood.

C. rufa Pers., Comment. p. 71. = *C. inaequalis.* (See these Trans. iii. p. 33.)

C. rufescens Schaeff., Icon. Fung. tab. 288. = *C. botrytis.*

C. spinulosa Pers., Obs. Myc. 2, p. 59, tab. 8, fig. 1. Indeterminable.

C. striata Pers.; Persoon's figure suggests a discoloured *C. vermicularis.*

C. tuberosa Sow., Col. Fig. tab. 199. The figure suggests an abnormal form of *C. fistulosa*, but was referred by Fries and Quélet to the genus *Calocera.* Probably not determinable.

C. uncialis Grev. = *Pistillaria.*

THE OCCURRENCE OF OAK MILDEW ON BEECH IN BRITAIN.

By A. D. Cotton, F.L.S.

The fungus which now so generally occurs on coppiced oak in this country was first noticed in Europe in 1907 and was probably introduced from America. Its spread in Europe was remarkably rapid and by 1909 it was known from almost every European country and had moreover spread through Turkey into Asia Minor.

The fungus for a time remained unnamed since, owing to the absence of perithecia, it was impossible to determine its generic position. In 1910 Griffon and Maublanc named the conidial stage *Oidium alphitoides*, and the following year Arnaud and Foëx recorded the occurrence of occasional perithecia production from which it was apparent that the fungus was a *Microsphaera*, and was regarded by them as a form of *M. Alni.* This view has in the main received acceptance and is endorsed

by Mr. E. S. Salmon, the author of the monograph of the Erysiphaceae. Some difference of opinion, however, exists as to whether the fungus should be regarded as species, variety, or biologic form, and a number of papers bearing on this subject, especially in French journals, have been published. Griffon and Maublanc regard it as a distinct species and have published the name *Microsphaera alphitoides*.

The method of over-wintering of the Oak Mildew fungus is the same as that which occurs in the fungi causing Apple Mildew and Hawthorn Mildew, namely by the hibernation of mycelium. The latter penetrates the buds in autumn, remains dormant during winter, and develops again in spring with the unfolding of the leaves. It would seem that only a very few buds are infected in this way but it is obvious that a sufficient number occur to provide a copious supply of conidiospores and general infection each season. The production of perithecia is therefore not required.

A considerable amount of work on the biology of the fungus has been carried out on the Continent and one of the fullest accounts of such work is that by Neger (Naturwiss. Zeitschrift. für Land- und Forstwirtschaft. xiii). With regard to its occurrence on Beech, several workers have recorded this phenomenon, e.g. Griffon and Maublanc 1908, Ferraris 1909, Forneti 1910, Müller 1911, Hauck and Kölpin Ravn 1913, and Neger 1915, but apparently the last-named alone clinched the matter by means of artificial cultures. The occurrence of the mildew on Beech is therefore not new but a record of its occasional appearance in this country is none the less of interest.

The mildew was observed on this host by the writer near Sevenoaks, Kent, on several occasions in July 1918. It occurred on shoots springing from the stumps of old trees which had been cut down and in some instances it was quite clear that the Beech was being infected directly from spores produced on the Oak. In one case some half-dozen stumps in the immediate neighbourhood of badly mildewed oak shoots possessed young shoots most of which were more or less mildewed, whilst the shoots of other stumps not in close proximity to mildewed oak were clean. Closer inspection showed that young beech shoots growing immediately under infected oak were developing a slight growth of mildew, whereas the other shoots of the same age not beneath the oak shoots were free from attack. The affected shoots were so close to the oak that a copious supply of spores must have fallen upon them, and the young leaves must have received a constant new supply of spores during the whole period of their development. When infected directly from

the oak it would appear that only very young leaves are susceptible, but it is possible that conidia produced by the beech might give a higher percentage of successful infections. It should perhaps be added that these observations were confirmed by microscopic examination, and that at the time Neger's experiments were unknown to the writer.

One of the most interesting features connected with the above phenomenon is its comparative infrequency. The occurrence of Oak Mildew on Beech was recorded ten years ago by Griffon and Maublanc, yet the Beech remains as generally immune from attack to-day as it did then. On the Oak the mildew is found specially on closely cut hedges, coppiced plants, and on the young summer growth on the lower parts of trees. Although the Beech is not coppiced and makes little secondary growth, closely trimmed Beech hedges are general throughout the country but in no case have these been observed attacked by the mildew.

ENTOMOGENOUS FUNGI NEW TO BRITAIN.

By A. D. Cotton, F.L.S.

Very few observations have been made in this country on entomogenous fungi and the occurrence of any species not hitherto recorded is worthy of a special note. Of the following species the three on Aphides were discovered by Miss D. J. Jackson in the course of research carried on by her on the distribution of these insects in Scotland. They were forwarded to the Pathological Laboratory at Kew for determination and I am indebted to her for permission to publish the records. The fourth species *Empusa sphaerosperma* was collected by Mr. W. Watson and determined by Miss E. M. Wakefield. The three species of Empusae appear to be new records for Britain, but it is probable that they are not uncommon.

Since the descriptions of these three fungi are not readily accessible to all workers, the diagnoses as given in Thaxter's excellent monograph "The Entomophthoreae of the United States" are added to each.

EMPUSA (ENTOMOPHTHORA) APHIDIS Hoffman, in Fresenius, Ueber die Pilzgattung Entomophthora, p. 84; Thaxter, Entomoph. United States, pp. 175–177, Pl. 18, figs. 220–240; Jackson, Notes on the Aphides of Ross-shire, p. 82.

Conidia ovoid to elliptical or subfusiform; commonly asymmetrical and very variable, with papillate base and containing numerous oil globules. Average measurements 25 × 12μ, maximum 16 × 40μ. *Conidiophores* digitate, often simple. Hyphal bodies spherical, germinating in all directions and giving rise to numerous contorted hyphae which grow into conidiophores. *Cystidia* rather slender and tapering at their extremities. *Secondary conidia* like the primary, or short ovoid with a single large oil globule. *Resting spores* "spherical, 33–45μ in diameter and borne terminally or laterally on hyphae" (Fresenius and Sorokin). Host attached to substratum by rhizoids, few in number, and usually terminating in a disc-like expansion.

Habitat. In *Macrosiphum lactucae* Schrank., on gooseberry, Swordale, Evanton, Ross-shire, September 18, 1917; in *Macrosiphum allii* Jackson, on *Allium Porrum*, Swordale, Aug. 12, 1918; in *Rhopalosiphum lactucae* Kalt., on gooseberry, Swordale, Aug. 12, 1918. Coll. D. J. Jackson, Sept. 1917, and Aug. 1918.

In alluding to this species Miss Jackson makes the following notes in her paper referred to above: The species is very common and many Aphides are killed by it. Individuals in which the fungus is present are easily distinguished by the dull ochreous colour and opaque appearance, which is quite different from the shining look of healthy specimens. They possess also a rough appearance due to the skin being distended all over into numbers of small elevations, each elevation being caused by a spherical spore-cluster (of which the body is entirely made up) pushing the skin outwards. Aphides killed by this fungus remained adhering to the under side of the gooseberry leaves.

EMPUSA (TRIPLOSPORIUM) FRESENII, Nowakowski, Entomoph. p. 171, Pl. xii. figs. 115–125; Thaxter, Entomoph. United States, pp. 167–169, Pl. 16, figs. 106–140.

Conidia nearly spherical to short-ovoid, often with a short, truncate or commonly slightly papillate base; with granular contents; without large fat globules, and slightly smoky in colour; 15 × 18—18 × 20μ. *Conidiophores* simple, arising directly from small, spherical hyphal bodies of a yellowish colour. *Cystidia* not observed. *Secondary conidia* of two

kinds: the first like the primary, the second almond-shaped and borne obliquely on capillary conidiophores. *Resting spores*, zygospores, elliptical or subovoid, yellowish, becoming often smoky and opaque, formed by the conjugation of two small, spherical hyphal bodies by means of slender gametes, above the point of junction of which the spore rises as a bud; average measurements 30 × 19μ. Host attached to substratum by the insertion of its proboscis.

Habitat. In *Rhopalosiphum lactucae* Kalt. and *Myzus Whitei* Theobald, on gooseberry, Swordale, Evanton, August 1918; *R. persicae* on potato, Stirkoke, Wick, Sept. 9, 1918. Coll. D. J. Jackson, Aug. 1918. Apparently not uncommon in eastern states of America, being recorded from several localities by Thaxter.

"Several apterous viviparous females of *R. persicae* found adhering to the underside of potato leaves were covered with this fungus. Other specimens developed the fungus when in captivity. The fungus was ochreous white on some specimens and pale pinkish in others." D. J. J.

EMPUSA (ENTOMOPHTHORA) SPHAEROSPERMA, Fresenius, Notiz, p. 883; Thaxter, Entomoph. United States, pp. 172–175, Pl. 17, figs. 200–219.

Conidia long-elliptical to nearly cylindrical, papillate at base and tapering very slightly near the rounded apex; 15–26 × 5–8μ, average 20 × 5·5μ; usually with a fine granular contents and a central oval nuclear body. *Conidiophores* digitate, much branched and confluent over the body of the host, forming usually a mass the upper surface of which is flattened. Colour of the fungus as a whole white, varying to bright pea green. *Cystidia* slender, tapering, not abundant. *Secondary conidia* like the primary, or long almond-shaped and borne on a capillary conidiophore. *Resting spores*, azygospores or zygospores (?), borne laterally or terminally from hyphae, 20–35μ, average 25μ, spherical, hyaline or very slightly yellowish. Host attached to substratum by rhizoids.

Habitat. In a small green caterpillar on grass. Rushton, Somerset. Coll. W. Watson, May 1918.

A widely distributed and common species and one remarkable for the great diversity of its hosts, being known to occur on Lepidoptera, Hymenoptera, Diptera, Coleoptera, Hemiptera, Neuroptera, Thripidae. Thaxter notes that it produces epidemics of considerable proportions and mentions clover weevils and certain small flies being killed in large numbers. In a third case a severe epidemic occurred on the leafhoppers of roses and apples

(*Typhlocyba rosae* and *T. mali*); and in an apple orchard in Maine tens of thousands of leafhoppers were killed, a dozen or more being often found fastened to a single leaf.

Cladosporium aphidis Thüm., in Oesterr. Bot. Ztschr. xxvii. p. 12 (1877).

Habitat. On dead body of a late viviparous female of *Macrosiphum dirhodum* Walker, on rose leaf, Balconie, Evanton, Ross-shire. Coll. D. J. Jackson, Oct. 1917.

Though usually listed as a distinct species it is probable that this fungus is merely a form of *C. herbarum*. Miss Jackson remarks that the fungus was found on a dead specimen and there was no evidence as to whether the aphide had been killed by Cladosporium or not.

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SOME CONCEPTS IN MYCOLOGY—AN ATTEMPT AT SYNTHESIS.

By William B. Brierley.

In every branch of Science there are a number of observations and ideas, which, sometimes in their original form, sometimes modified or augmented, are handed on from one generation of students to the next, from one writer of text-books to another writer of text-books. In course of time many of these fade into oblivion, but others are retained and become an integral part of the Science. One learns them of one's early teachers, imbibing them almost unquestioningly, and they form part of one's ideational system.

An example—not the best that could be given, but one personally interesting—may perhaps serve to make this more evident. Every student knows that growth in dicotyledons takes place in the cambial layer. The nuclei of cambial cells ought therefore to be in a constant state of division, and yet how many botanists have ever seen a mitotic figure in a cambial cell? For some time, when opportunity has permitted, an inquiry has been made, and up to the present not one of many well-known workers has answered in the affirmative. Granted that it is in the highest degree probable that dicotyledonary growth does take place in a cambial layer, and that the nuclei of these cells do shew mitotic figures: that the concept of cambial dicotyledonary growth is a true one: nevertheless it surely would be advantageous that such a fundamental process should be more frequently observed, and that the published figures should be more numerous and representative of modern cytological technique.

There is no reason to doubt that many concepts in biological science correspond to reality; but one may perhaps be forgiven for wondering occasionally how many others gain continued allegiance mainly by sheer conservatism and inertia. It could only serve a useful purpose if, periodically, certain of these concepts were revised in the light of more recent knowledge, were weighed in the balance, and if found wanting, neither

high authority nor ancient status and respectability were allowed to preserve them save as interesting historical relics.

In this note I wish to draw attention to certain concepts, of importance in mycology and possessing many wider applications, which would perhaps appear to merit some reconsideration in the light of present knowledge. If the result of such consideration be confirmatory, mycologists will hold and elaborate their theses with the greater surety and profit. If the outcome be to throw doubt upon accepted beliefs, that also is good, for we shall no longer bow down before false idols.

I. *The Species Concept.*

When a number of specimens are examined and the statement is made that this organism is *Ustilago Cardui*, and that organism *Ustilago violacea*, and so on, what is the connotation of these terms? At first sight, perhaps, such a question may seem pedantic and of mere academic interest; but these and other fungi are disease-producing organisms and the problem of their specific identity and recognisability is one most vital to any clear formulation and indeed essential to any true progress in mycology.

Certain morphological characters *A*, *B*, *C*, *D* are noted in a particular fungus and to it the name $\alpha\beta$ is given. Another fungus possesses the characters *A*, *B*, *C*, *E*, and receives the name $\alpha\gamma$. A third presents characters *A*, *B*, *C*, *L*, and is named $\alpha\delta$. The generic characters *A*, *B*, *C* these fungi all possess, but they differ from each other in the one or more minor characters *D*, *E*, *L*, and these serve to differentiate them as species. If the morphological difference be, however, very striking, the fungus may be given the status of a new genus, whilst if inconspicuous the fungus may be graded as a variety of some other already known species. For example, the genus *Phomopsis* has certain morphological characters and *P. hysteriola*, differing from *P. striaeformis* in certain minor ways, is graded as a variety of the latter. If now a single specimen were found with all the characters of *P. hysteriola*, save only that it possessed large dumb-bell shaped spores, this striking difference would certainly be sufficient to raise the specimen to the rank of a new genus. And so a "Sylloge Fungorum" has been evolved, the criteria of all the several ranks being confessedly arbitrary.

This creation of new fungal species and their subsequent determination from descriptive diagnoses is based on certain assumptions which may perhaps be briefly expressed as follows:

(1) The characters separating one species from another are of morphological nature.

(2) The essential specific characters are constant and hereditary ("nulla certior... quam distincta propagatio ex semine").

(3) The essential specific characters of an organism may be determined and evaluated by sight in one specimen of one generation.

Now these assumptions, and all that gigantic and rather wonderful superstructure of fact and fancy which is erected upon them and which we call systematic mycology, take origin in a philosophic concept, that of the *species*. The essential quality of a species is that the different individuals included in it be identical, and throughout all systematic mycology morphological comparison is accepted as a criterion for specific purity. The species concept therefore may perhaps be expressed as follows—a species consists of the total of individuals possessing essentially similar morphological facies. The species is thus a morphological abstraction.

Such a species concept is not of course confined to mycology but is common to and is held with varying degrees of rigidity in all branches of systematic biology.

So far as the flowering plants are concerned, however, it has long been recognised that the morphological facies of an organism may vary according to development under different environmental conditions. For example *Leontopodium alpinum* growing on a mountain summit is hardly recognisable as the same species as this plant growing in a lowland meadow. *Polygonum amphibium* has a terrestrial variant extremely different from the aquatic or the xerophytic growth form; and so also *Ranunculus sceleratus* and many other plants. These organisms are plastic and the particular morphological facies of a specimen is clearly a resultant of two systems of interacting forces represented by the living substance of the organism and the conditions of life*. In the phanerogams, however, it is but rarely that these ecologic growth forms or "ecads," to use the name given to them by Clements(6), differ markedly in the essential morphological characters of their reproductive members, and consequently the underlying specific identity may usually be traced with ease throughout.

* As Baur says (Einführung in die Exakte Vererbungslehre Auf. 2, 1914) "Only a certain specific type of reaction to the external world is inherited, and what we perceive with our senses as external characteristics are only the result of this reaction on a chance combination of external conditions under which the individual has developed." And MacLeod (24, 2), "The so-called characteristics of each species are the product of reactions, in which there intervene on the one hand the external causes which affect the individuals during their development, and on the other hand the living substance of the species under consideration."

But even when plasticity has been recognised, the problem of systematic categorisation is not by any means rendered simple for there is still the question of specific variability. The variability of many phanerogamic species has been shewn to be due to the fact that the species group really consists of two or more elementary or Jordanian species as in the well-known cases of *Draba verna, Capsella bursa-pastoris, Solanum nigrum*, etc. Each of these little species may itself be plastic. Furthermore it is very probable that many elementary species may consist of two or more of Johannsen's(19) *pure lines* separated from each other by qualitative chemical differences, each pure line being itself plastic*. Moreover not only may external causes bring about the production of different morphological facies in specimens of the same species, but inversely the essential differences of two or more elementary species may themselves disappear under the influence of certain environmental conditions. For example, the pink colour of the corolla of certain elementary species of *Primula sinensis* may be eliminated by growing the plants at a higher temperature, and the resulting white forms may then no longer be distinguished from elementary species characterised by the possession of white corollas. The same phenomena may be brought about with the blue corolla of certain Campanulas, or the red colour of the copper beech which may be eliminated by development in deep shade. And complicating all these things is the gametic condition of the organism and the discovery of Nilsson-Ehle(31) that a pure line may be homozygous in respect to one character and heterozygous in respect to another.

In the phanerogams the different species are distinguished by many characters; units each of which may be investigated separately. And yet even this very brief indication of some of the difficulties involved in the systematic treatment of such plants will serve to shew that the prevailing morphological species-concept depending upon the "systematische blick" is far from being finally satisfactory.

When, however, we attempt to apply this concept to the already known facts of mycology and to the everyday laboratory and field experience of the experimentalist we create a total impasse.

An adequate review of the literature cognate to this subject is not feasible here. As however the most critical descriptive character in the systematic treatment of fungi is the reproductive body, attention may be drawn to a few of the more recent

* "Each animal and vegetable species differs strictly from all others by the chemical composition of its living substance." (MacLeod 24, 2.)

investigations dealing with variations in the size, shape and colouring matter of the spore.

That the essential morphological characters of fungal spores are not necessarily constant under different conditions has been shewn by Stevens and Hall(44) for species of the genera Septoria, Ascochyta, Volutella, Spermoedia, Coniothyrium, Epicoccus, Colletotrichum, Phyllosticta, Alternaria, Sclerotinia and Diplodia; by Mutto and Pollacci(29) for species of Coniothyrium and Phyllosticta; by Stakman(41, 1) for *Puccinia graminis*; by Long(22a) for *Puccinia ellisiana* and *Puccinia Andropogonis*; by Moreau(28) for *Sporodinia grandis*; by Elliott(11) for Macrosporium and Alternaria; by Gaümann(14) for Peronospora; by Beach(3) for Septoria and by numerous investigators for species of many other genera of fungi.

There is thus a considerable body of evidence to shew that the essential descriptive characters of fungal spores may largely be determined by the conditions under which the fungus develops, and that environmental changes may result in modification of spore characters. Nor is it only the morphological features of the spores which are altered: the whole structure and facies of the organism may undergo transformation.

In bacterial studies such artificially induced modifications of the organism constitute a major part of the common laboratory technique, and are utilised extensively and often exclusively in specific determinations.

In mycological studies, however, although cultural modifications are the daily experience of laboratory workers, they are still practically unrecognised by the systematist, and when recognised either neglected or regarded as abnormal or bizarre phenomena "idle to speculate upon." Innumerable instances of such morphological transformations are scattered through the literature of three decades, or could be given out of one's own experience.

Thus after a very thorough and intensive cultural study of certain species of the genus Penicillium, Thom(45) remarks "In experimental cultures changes in the chemical nature of the medium or in the conditions, or both, have been found to produce great changes in the morphology of the fungi studied. With the exception of a few fundamental group or generic characters nearly every attribute used in specific description has been shewn to be a reaction to environment, hence changeable with such environment (for some species at least)." And again, "Many species differ so materially in gross characters when grown upon these different media that successive cultures, if not known to be pure transfers, might be supposed to be

different species; but when returned to the original media and conditions these forms have immediately produced the characters and reactions first found, with a large degree of uniformity."

Fifteen years ago Smith and Swingle(40) wrote of their *Fusarium oxysporum*, "...This fungus shewed a number of very striking variations. For this reason it is impossible to give a general description that will hold universally." After quoting descriptions of eleven old species of Fusarium from potatoes, the authors conclude as follows: "Judged by the above descriptions, we have had a half dozen or more species of Fusarium in our culture tubes, some of them 'new species,' and yet all were the product of a single spore. This does not mean that there have been in our cultures any very wonderful transmutations of one thing into another, but only that organisms respond to their environment, and that 'species descriptions' of the kind cited have not taken this fact into consideration, and consequently are worthless for scientific purposes. This is not a new idea, but it is a fact to which the attention of systematic mycologists might be directed profitably at frequent intervals."

A few years later Stevens and Hall(44) drew attention to this same fact and wrote "If a fungus can be easily changed as regards its essential descriptive characters by a change in substratum, density of infection or other environmental factor, these characters are worthless for descriptive purposes unless the conditions under which they develop be accurately known."

And yet mycological journals are still largely filled with these "worthless descriptions," and instead of the collecting of facts and material, mycological nomenclature is increasingly encumbered with more and more names.

From what has already been said it must surely be granted that the morphological facies of an organism is not necessarily a constant expression, but that it may vary *beyond the recognised limits of the species* under the influence of changed environmental conditions. Is such variation sporadic and irregular or does it exhibit a constant and definite relation to particular cultural factors and stimuli? In bacterial investigations of a decade and more ago this question was all important and still unanswered; but with fuller knowledge and more particularly with the ever-increasing refinement of technique it has been demonstrated that the response of bacteria to standardised factors is definite and constant.

The technique of mycology is still far from perfect for the science is but young, and we cannot as yet answer the question with an unconditional affirmation. With the exception, however, of some few doubtful results such as those of Shear

and Wood(38) on the genus Glomerella, evidence is rapidly accumulating to shew that under recurrent identical conditions the morphological variation of a particular fungus is definite and constant.

Many detailed examples could be given but perhaps two or three from one's own experience may suffice.

If *Fusarium arcuosporum* and *Fusarium angustum* be grown on Czapek's medium with five per cent. glucose, the former is pink and the latter is colourless. If, however, the same medium contain thirty per cent. of glucose, the former is clay-coloured whilst the latter assumes a bright-purplish vinaceous hue. In a neutral Czapek medium *Fusarium sclerotioides* possesses a greyish-white aerial mycelium, but in a like medium plus 0·4 per cent. by weight of citric acid the aerial mycelium is pink-vinaceous. These and many similar colour reactions may be obtained with the most perfect constancy. Again in certain fungi which have been investigated the expectation of identity of reaction under constant conditions is fulfilled with mathematical accuracy. Thus a certain pedigree pure line strain of *Botrytis cinerea* growing under rigidly standardised conditions on the media—steamed sugar-beet root, fresh onion bulb scales and potato agar has the following respective values of its mode spore: $9{\cdot}3\mu \times 6{\cdot}6\mu$; $9{\cdot}3\mu \times 6\mu$; and $9{\cdot}3\mu \times 4{\cdot}6\mu$. These are extremely slight differences, but they are mathematic constants.

All the more recent and accurate work indicates that the fungi like the bacteria respond to particular environmental conditions in definite and characteristic ways; and the present position of this question may fairly be summarised by the following quotation from Thom(45). "The question at issue was not whether or how variations could be produced, but whether a particular variation is constantly produced by a species in a particular environment." "In those species most thoroughly studied both the physiological and morphological reactions have appeared to be very reliable."

A further development of the fact of plasticity and constancy of response to definite environmental conditions, is the phenomenon of morphological *convergence* or *divergence* of two or more organisms under the influence of external factors. This may perhaps most clearly be illustrated by the diagram on p. 211.

The numbers 1, 2, 3, 4 represent distinct organisms growing under the influence of environmental conditions represented by the capital letters *A, B, C, D, E*. The small letters shew the growth forms or morphological variations of the organisms under the differing conditions. Thus organism 2 under external factors *C* exhibits the morphological facies represented by "*n*."

Now it may happen that organisms 1 and 2 under the influence of like conditions (*A*) will produce growth forms having similar essential descriptive characters. Under environmental factors represented by *B*, *C* and *D*, however, the morphological characters of the growth forms may be very divergent. On the other hand organisms 2 and 3 may converge under the influence of *D* and the former may also exhibit a similar "ecad" when stimulated by *C*. Thus 1*A* and 2*A* would on the basis of morphological comparison be regarded as a single species, as would also 2*C*, 2*D*, and 3*D*. The constitutional distinctness of the three organisms would however be clearly visible were

	A	*B*	*C*	*D*	*E*
1	*k*	*a*	*l*	*a*	
2	*k*	*m*	*n*	*n*	
3	*f*	*d*	*y*	*n*	
4					

the morphological response to two or more environmental systems observed. As Thom(45) states, "Two species closely similar when grown parallel in one environment may differ characteristically when transferred to a different medium or a different set of conditions."

Before continuing further the discussion of plasticity attention may briefly be drawn to a factor very seriously complicating all systematic treatment of fungi, in which the criterion of specific purity is morphological comparison. This is the undoubted fact that very many accepted fungal species are aggregates of two or more elementary species each of which is plastic, the ecads or growth forms converging or diverging in constant and definite relation to the adjustment of the physico-chemical factors of the environment.

Furthermore as stated by Dox(9), "While various species of these two genera may be closely related morphologically, they often shew wide chemical differences." To such chemical species perhaps belong the so-called "biologic races" of *Puccinia graminis*, Erysiphe, Monilia, etc.

The foregoing facts may be the more explicit if expressed briefly in concrete terms. Let us take, by way of illustration,

a tomato fruit which has been attacked by *Botrytis cinerea* and of which a large portion of the surface is covered by the smoke-grey conidiophores of the fungus. The following possibilities are present:

(i) The growth may consist of a single "chemical species."

(ii) The growth may consist of two or more "chemical species" growing mixed together. These would present no morphological distinctions but would be separable on culture media by their chemical reactions.

(iii) The growth may consist of a single elementary species.

(iv) The growth may consist of two or more elementary species.

(*a*) The species may be such as diverge on the medium. An examination of the morphological characters of the growth would shew considerable variations and the curves might be multimodal or the separate curves might associate to form one regular variation curve. With suitable cultural and mechanical technique the different elementary species could be isolated. Such a growth would correspond to a mixture, for example of "*a*" and "*m*," representing organisms 1 and 2 developing under environment *B*.

(*b*) The species may be such as converge on the medium. The morphological variation would be comparatively small and the curves would be unimodal. By transplanting the growth to a series of media the components would diverge and could then be isolated. Such a growth would correspond to a mixture of for example "*k*" and "*k*," representing organisms 1 and 2 developing under environment *A*.

Accepting morphological comparison as a criterion of specific purity, the growth would, in all the above cases, have been regarded as a single species.

Finally there is the case not illustrated in the foregoing summary where the same morphological facies is presented by two different elementary species growing under different conditions—for example, "*n*" and "*n*" representing organism 2 under conditions *C*, and 3 under conditions *D*.

It does not necessarily follow therefore that two fungal organisms presenting identical morphological characters and growing under either like or unlike conditions necessarily belong to the same fungal "species"—that a Stysanus growing upon a potato tuber is necessarily the same "species" as a morphologically identical Stysanus also growing upon the tuber or upon a decaying tree stump.

This being so it must be obvious that the morphological species concept—the total of individuals possessing essentially similar morphological facies—is a false concept; and not only

so, but that even as a temporary working hypothesis it is valueless and only increases the existing confusion in mycology. The utmost that may be achieved by the practical application of such a concept, and this is the systematic mycology of to-day, is the minute description of ecologic variants and growth forms, the "ecads" of Clements(6). The true species implying identity of constitution has no existence in such a concept.

It would be a profitable and fascinating study to examine in some considerable detail the philosophic bases for a species concept, beginning from the known facts of mycology, but the most that is feasible here is merely to indicate certain of the main directions in which such a consideration would perhaps progress.

At the present time we have no knowledge of living organisms apart from some particular environment, such environment varying from a stump in a tropical forest to a standardised synthetic medium in a laboratory. The visible organism is a morphological entity which may as we have said shew a different morphological facies under other environmental conditions. Each individual is therefore a growth form or "ecad," and every ecad may be regarded as being the morphological expression of the resultant of two interacting series of forces. One of these force systems is the living matter or the organic individual which itself is an almost infinite complex of metabolic reactions in a colloid substratum. The other force system is the infinite complex of physico-chemical reactions which constitutes any particular environment. Thus the morphological expression of the resultant of the interaction of two force systems represented by a certain organic individual and an aqueous environment, is that growth form which we term the aquatic variant of *Ranunculus aquatilis*. The same force system which is the organic individual, interacting with a second force system which is certain conditions of development on land, gives a resultant the morphological expression of which is the terrestrial variant of *Ranunculus aquatilis*. One may draw illustrations from chemical phenomena and the analogies may have far greater significance than merely an illustrative value. The force system copper, interacting with the force system nitric acid, produces a resultant having the facies of copper nitrate, but the resultant of the interaction of copper with a different environment, sulphuric acid, is expressed by the substance copper sulphate. From the phenomena of crystallisation one could adduce much more exact analogies.

But the existing organic entity is far greater than the morphological structure which is its visible expression. Much more

truly the organism is to be regarded as the physiological equilibration, the complex of reactions in the colloid substratum; while the colloid substratum and the morphological structure of the organism represent the "residue" from the metabolic processes, the excess of intake over outgo. Nearly seventy years ago Huxley(18) wrote of the cells, the structural components: "They are no more the producers of the vital phenomena than the shells scattered along the sea beach are the instruments by which the gravitative force of the moon acts upon the ocean. Like these the cells mark only where the vital tides have been and how they have acted." It will be evident that any chemical substance which can be completely utilised by the metabolic processes will not appear as a visible part of the body of the organism. The body, the structure and morphology of the organism, is a by-product of the metabolic reactions. As such by-product can only escape from the cell by decomposition, it constitutes therefore the more permanent matter of the cell and appears as a visible substratum. It may be regarded as residue left behind by the metabolic tides, shewing how they have acted.

Under identical conditions the structural substratum of different organisms differs because the physiological constitution of the living matter of the organic individuals differs. Thus the morphological distinctions between two species are produced; but these divergent morphological facies are merely the expressions of the differing physiological constitutions, and have no permanent value or even existence apart from the particular environmental conditions under whose influence they are created. Under varying conditions the same physiological constitution will give rise to different morphological expressions and so one finds growth forms or "ecads." Under recurrent identical conditions the same resultant will be produced by the same physiological constitution giving constancy of reaction in like environments.

But just as, for example, a resultant of sixteen may be the expression of various interacting factors such as four and four or eight and two or sixteen and one, so, differing physiological constitutions may under the influence of certain different external stimuli produce the same resultant or "ecad." Moreover the force system representing the environment is infinitely complex and it may often happen that two or more different physiological constitutions may react with different smaller force systems within the same environmental complex, so that similar resultants ensue. Thus two distinct species may under apparently identical conditions give rise to "ecads" morphologically indistinguishable from each other.

The primary conception to which all these indications lead is that of an organism as a physiological equilibration functioning about a constant point, and of the environment as a complex of forces with infinite capacity for adjustment. The resultant of the interaction of the metabolic entity and the environment is the growth form or "ecad." The constant or specific function is the metabolic entity or physiological constitution and not the morphological individual which is merely the visible expression of the reactions of the physiological constitution under particular conditions.

It follows therefore that the *morphological* species concept—the total of individuals possessing *essentially similar morphological facies*—must be abrogated and in lieu thereof be substituted the *physiological* species concept—the total of individuals possessing *essentially similar physiological constitutions.*

The morphological concept regards the species as an entity in *space*: the physiological concept regards it as an entity in *space* and in *time.* In other words the species is a dynamic relation and not a static figure; it is an event and not a thing.

Before concluding this brief consideration of the species concept attention may be drawn to certain minor issues which arise directly from it. Once having substituted the physiological concept for the morphological one, and having accepted the implications which such a viewpoint involves, it is recognised that the systematic categorisation of fungi must coincide with and take fully into account the known facts of their *behaviour.* It is clear that many, perhaps most of the Linnean species of fungi have no constant existence in fact; they are merely aggregates of growth forms or "ecads." Many of them are aggregates of elementary species, themselves plastic; many elementary species are aggregates of physiological or chemical species, producing constant variations under recurrent conditions.

The only exact method of species creation and specific determination is by means of quantitative data derived from cultural treatment under standardised physico-chemical conditions, for this method alone reveals the physiological constitution of the organism. To-day, merely to describe the essential morphological characters of a particular growth form of a fungus, and so create a new species—*if that organism can be grown in pure culture*—exhibits not only a complete ignorance of the philosophy of mycology, but a total inaptitude to appreciate the developments of the subject and to apply to it the elementary principles of scientific methodology.

Certain fungi, however, cannot yet be grown *in tubus*, but here surely the imperative need is not increase in the already bewildering accumulation of binomial terms applicable largely

to evanescent morphological facies, but the concentration of energy in the discovery of suitable breeding technique. The results obtained in the cultural treatment of organisms pathogenic to man must here be an inspiration.

Attention is most usually drawn to the Hymenomycetes and the application of a physiological concept of species in their systematic treatment derided; the opinion being expressed that although the lower fungi may be plastic, such groups as the Agaricineae, Polyporeae, etc. contain species well defined and constant, whose specific purity may be determined by morphological comparison alone. It is extremely improbable that this is true. In the Agaricineae are a very great number of growth forms which have been studied so minutely and patiently and their essential descriptive characters placed on record so fully, that few possible permutations or combinations of morphological characters can remain unreported. This huge assemblage of forms has been arranged by certain artificial criteria so that whenever a growth form is examined it may be relegated to one or other of the almost innumerable diagnoses in existence. These diagnoses are regarded as distinctive of species but their true value is that of "ecad" descriptions. If reference be made to the diagram, the diagnoses do not apply to the species 1, 2, 3, 4 and so on, but to the growth forms *k*, *m*, *l*, *a*, etc. Any one of the species 1, 2, 3 under certain conditions will produce growth forms fitting a particular diagnosis. If, however, species 2 under environmental conditions *E* gives rise to a growth form which has not already been described, a new diagnosis is drawn up fitting the new "species."

If, however, the particular growth form is the morphological expression of the resultant of the interaction of the physiological constitution of the organic individual, and the special environmental conditions, and it is extremely difficult with the evidence at our disposal to conceive what else it can be, then it follows that under certain conditions, like resultants may be produced by unlike physiological constitutions. Thus even in the higher fungi there is no reason to suppose that under the influence of the infinitely variable environmental conditions the phenomena of morphological convergence and divergence are not operative. In such case it does not necessarily follow that two similar morphological entities which may receive the name *Hydnum repandum* or *Agaricus melleus* might not possess totally different physiological constitutions which under other conditions of growth would diverge characteristically. While therefore it is interesting to possess the detailed knowledge which has been accumulated regarding the growth forms of the higher fungi, it must always be realised that the so-called

"species" here are merely "ecads," and in no wise comparable with species of Penicillia as described by Thom(45) or species of Fusaria as diagnosed by Appel and Wollenweber(1) or more recently by Sherbakoff(39). The "species" of Agaricus like the "species" of most other genera of fungi correspond to the morphological variants or "ecads" obtained by the experimentalist when a particular pure line organism is cultivated under different environmental conditions.

It would be advantageous if there could be introduced into systematic mycology some such terminology as that proposed by Lotsy(23) for the phanerogams. Perhaps the main features of this as they apply to fungi may briefly be noted here.

The term *Linneon* is suggested to replace the term species in the Linnean sense, and to designate a group of individuals which resemble one another morphologically more than they do any other individuals. To establish a Linneon consequently requires careful morphological comparison only.

The name *Jordanon* to replace the term species in the Jordanian sense, viz., microspecies, elementary species, subspecies, etc., and to designate a group of individuals externally alike which all propagate their kind faithfully as far as these external characters are concerned, with the only exception of non-inheritable modifications of these characters, caused by the influence of the surroundings in the widest sense, to which these individuals or those composing the progeny may be exposed. To establish a Jordanon, morphological comparison alone does not suffice; the transmittability of the characters by which the form was distinguished must be proved by experimental breeding.

The name *Species* to designate a group of individuals of identical constitution. To establish a species neither morphological comparison alone, nor comparison of the morphological facies of the organisms on standardised series of culture media is sufficient. Analysis of physiological reaction to standardised conditions is required in addition.

The term *Modification* to designate the non-transmittable effect of external circumstances.

The continuance of the present system, or lack of system, in mycological terminology can only add to the existing confusion, and make still deeper and more unbridgeable that ever-widening gulf between the work of the systematist and that of the laboratory and field experimentalist. The adoption of the terminology suggested by Lotsy, which involves the acceptance of the physiological species concept, would not only co-ordinate the systematic treatment of fungi with that of the other great groups in the vegetable kingdom—and surely there is not a

philosophy of mycology different in nature from a philosophy of phanerogams—but it would prove the means of evaluating the herbarium in terms of the laboratory and field, the rigid formalities of an artificial system in terms of the living organism.

Finally attention may be drawn to the fact that the substitution of the physiological in lieu of the morphological species concept implies not only a complete re-orientation of mental attitude, but the unqualified acceptance and unceasing application of a new technique; the quantitative method in place of the qualitative method. One's opinion of the latter may perhaps be better expressed by the following quotation from the recent most suggestive and valuable book of MacLeod(24), "The systematists, confined in an antiquated routine, are the first victims of their deplorable method. Since the great majority of the existing specific and even generic descriptions are superficial and unfinished to such a degree that the exact identification of a specimen is simply impossible, the systematists *discover* continually and describe under new names so-called *new* species, which have already been described either once or even several times." "Moreover, the existing descriptions are ordinarily very incomplete. Only a few characters are mentioned, according to a sort of conventional scheme, which would possibly have been sufficient (or thereabout) a century ago, when the number of known species was comparatively small, but which does not answer the needs of modern science." "The almost incredible imperfection of many well-known works on *fungi* and the deplorable disorder which prevails in this department of descriptive botany," has been illustrated in a very entertaining manner by Lloyd(21) in his "Myths of Mycology."

"The aim of the quantitative method in descriptive science is not only to describe exactly the properties of the species and to make an inventory of the forms of life. *This is important enough in itself,* but there is more. It is difficult to obtain exact data about the development and the anatomy of animals and plants as long as the observed facts are described by means of mere terms. It is still more difficult to discover the origin of species and their phyletic relations without an exact knowledge of the investigated species. This can only be obtained by comparing their characteristic figures with the figures of other species. The object of the quantitative method is, in general, the exact description of the living objects."

Recent workers such as Thom(45), Sherbakoff(39) and others have to a certain extent adopted the quantitative method, but have refrained from doing so entirely, attempting to combine a quantitative with a qualitative technique.

Weidemann(49) and a few more recent investigators have gone further and followed the bacteriologists in giving formulae for a considerable number of media and detailed notes as to reactions upon such media.

In bacterial studies any particular organism may be represented by a number which defines exactly its physiological constitution. If the species concept as described by Lotsy, which is the physiological interpretation put forward in this paper, be accepted, one may anticipate the elaboration of some similar numerical system for recording the salient physiological characters of an organism which will be applicable in mycology. This is the final ideal of the quantitative method, and the development of this method is imperative if order is to appear from chaos.

II. *Educability of Fungi.*

A second concept to which attention may with profit be directed is that of the "educability of fungi" or the induction by suitable treatment of permanent modifications in their biochemical, morphological or other properties. The concept of the educability of the lower organisms is almost universally held either explicitly or implicitly by microbiologists, but rarely is it formulated as a general principle, and even more rarely expressed in concrete terms. A survey of the literature, however, and still more, personal contact with those investigators interested in the behaviour of the lower organisms, clearly shews that this concept permeates all thought and all consideration of the problems involved, and that the validity of many far-reaching conclusions is bound up with its truth. Every day bacteriologists attenuate or augment the virulence of cultures of pathogenic organisms by well-known technique, observe the fermentation of sugars by cultures which before treatment were unable to form the requisite enzymes, find pigment produced where no colour was originally. "Systematic cultivation of colon and typhoid bacilli in the hands of Twort, Penfold and others seems to have shewn that agglutination as well as fermentation characteristics can be artificially changed. Furthermore, colour producing organisms like the prodigiosus can be artificially changed to colourless strains, and it is well known that certain micro-organisms rapidly lose their virulence when cultivated, and that the virulence can only be brought back by passage through animals. Rosenow claims recently to have converted hemolytic streptococci into typical streptococcus viridans, pneumococcus mucosus, and pneumococcus-like organisms." The foregoing passage is quoted from one of the latest and best known treatises on bacteriology(15).

And in 1915 Massee(25) wrote "That parasitism on the part of fungi is an acquired habit has been fully demonstrated and is generally accepted," and earlier, "A saprophytic fungus can be gradually educated to become an active parasite to a given host plant..."

In his recently published work on "Fungi and Disease in Plants," Butler(5) has written: "Certain saprophytes have been found at times to become 'educated' into the parasitic life; that is to say, it has been found possible to develop a parasitic strain, or race, of a normally saprophytic species, capable of living even on healthy individuals of the host plant."

Pringsheim(34), Dobell(8), Eisenberg(10) and Vaughan(47) have within recent years drawn up careful summaries of the evidence relative to this question and references to the greater part of the literature will be found in their compilations.

At first sight the weight of evidence on which the concept of the educability of micro-organisms is based appears so overwhelming as almost to preclude doubt. But first-hand acquaintance with certain of the described phenomena, and a more critical examination of the literature of the subject, raise disquieting suspicions that possibly investigators have been too facile in their interpretations of the phenomena observed and over hasty in drawing general conclusions.

In the first place it is very necessary to have sharply in focus what we mean when we speak of educating organisms or of inducing permanent changes in their characteristics. The changes which have been recorded in the lower organisms are of two essentially different kinds. One consists of those alterations which are impermanent, their expression depending upon particular factors in the environmental conditions. This category includes all the expressions of the plasticity of organisms which have already been referred to as "modifications." Such modifications are strictly comparable with the "ecads" or growth variants of for example *Polygonum amphibium* or other plastic phanerogams. If the individuals are returned to their original environmental conditions they revert strictly to type.

The second category includes all those alterations—however small they may be—which take place in an organism and are then transmitted to subsequent generations even when these are again grown under the original environmental conditions. As illustrations of such changes the work of Twort(46) and of Revis(35) may be noted. The former found that certain colityphosus organisms were able to acquire the power of fermenting certain sugars if grown in them for a sufficiently long time, the change taking place slowly. In this manner he modified

dysentery bacteria (Kruse and Flexner strains) so that they were able to ferment saccharose: and he was able to train *B. typhosus* to ferment lactose and dulcite, the power being retained permanently.

Revis(35) investigated certain coli-typhosus organisms which produce both acid and gas when cultured in peptone-broth plus certain sugars or polyhydric alcohols, and was able gradually to acclimate these organisms to a medium containing 0·1 per cent. of malachite green. When returned to the original medium the organisms were found to have lost the power of producing gas though they could still form acid.

The best known case of fungal education is that described by Massee(25). Following out certain indications given in one of Miyoshi's(27) experiments Massee sowed spores of *Tricothecium candidum* on leaves injected with sugar solution and from the growths thus obtained re-inoculated other injected leaves. This was done for several generations of the fungus, after which spores from the last growth were sown on normal leaves and infection obtained. "This means that after twelve generations of the fungus, educated to grow in living *Begonia* by means of chemotactic substance—a solution of cane sugar—the faculty of parasitism had been acquired for this particular host plant." "The period of time required in this series of experiments for the conversion of a saprophytic fungus into a true parasite was twelve weeks, and the number of generations of the fungus amounted to sixteen." "By similar means a parasitic fungus can be induced to become parasitic on a new host."

The changes illustrated in the foregoing paragraphs are induced or educative changes of which the results were transmitted to offspring. The change is therefore one of genetic constitution. The difference between the two categories is very clearly expressed by Dobell(8) as follows: "Let us suppose that a given Bacillus is coloured red under normal conditions. By growing it and its offspring upon a new medium they become —let us suppose—colourless. If the organisms and their descendants when transplanted again into the original medium are again found to be red, then the change (loss of colour) is a *modification;* if, on the other hand, they are found to be now permanently colourless, then the change is a *mutation.*" It is the induced mutation, the permanent change in genetic constitution brought about under controlled conditions and at will by certain educative treatment, which is the subject of this consideration.

The possibility of such facile genetic change carries certain corollaries, which perhaps have not been envisaged with sufficient clearness or reasoned to their logical conclusions, by

those investigators who have lightly paid allegiance to the general concept: and brief attention may profitably be given to certain of these issues.

The great mass of evidence which we have at our disposal would appear to point to the fact that the essential physiological nature of an organism is a constant. Now the physiological constitution of an organism interacting with certain physico-chemical factors in a particular environment produces a certain resultant—the visible individual—the characteristic properties of which are described in terms of colour, size, shape, etc. If the physiological constitution and the environmental factors are both constants it follows that the resultant of their interaction must also be a constant however often it may recur. But if apparently identical physiological constitutions under apparently identical conditions produce two different resultants it must follow either

(1) That the conditions are not really identical but different, for otherwise things which are equal to the same thing would not be equal to one another.

Or (2) that for a similar reason the physiological constitutions are different, i.e., that some change in the ultimate physiological nature of the organism must have occurred.

A graphic expression may be given to this as follows:

Let a = the physiological constitution of an organism,
and let b = the constant environmental conditions;
then ab = the resultant of interaction which is the visible individual.

Now if $a \times b$ on one occasion produce "ab," and on another occasion produce some other resultant such as "x," it must follow that either or both a and b have changed from their original state into some different constants such as "c" or "d."

If this change be one in the environmental conditions the resultant is merely a "modification" and outside this discussion. If, however, the change be in the physiological constitution of the organism it is a fact of incalculable import, for it would mean that the physiological constitution of an organism could be altered at will, the facility and scope of change increasing with fuller knowledge and refined technique so that theoretically there is no limit to its operation. But the only foundation which we can find for any systematic categorisation of living organisms is in the absolute constancy of their physiological constitution, this being the ultimate specific criterion. If therefore one may at will transmute one physiological constitution into another, it follows that one can change one species into another species, and this with great rapidity, merely by the simplest adjustment of the most common environmental factors.

But it is perhaps not sufficiently realised that our culture media, our test tubes and flasks are but microcosms, and that the little experiments devised in laboratories have been carried out on an infinite scale by Nature for aeons of centuries. That whereas in laboratories we merely change a medium from saccharose to dulcite and back again, or raise the temperature by ten degrees or perform some other equally trivial operation, Nature offers to micro-organisms infinite permutations and combinations of all the physico-chemical factors operative on this earth. If therefore the little endeavours of human investigators may so easily change one species into another species, Nature must surely be doing this on an infinite scale. But to admit that species in Nature are unstable and labile, one instant moving in this direction, the next instant moving in that as the world adjusts itself is surely a *reductio ad absurdum.* Were it true a science of biology would be but a Utopian dream; more, we should not exist for evolution had been impossible.

On *a priori* grounds therefore such quick and facile changes in the ultimate physiological constitutions of organisms are not only inconceivable but frankly impossible, and some other interpretation of the observed phenomena must be found. Such interpretations are not far to seek for they can only lie in two directions.

(i) Either the environmental factors are inconstant in which case the apparently induced mutation is, as already stated, merely a modification, or

(ii) The change must exist in the organism but in some other form than a change of physiological constitution.

Recent investigations throw much light on the possible nature of this change, and attention may briefly be drawn to a few of the main lines of research which bear on this question.

The crux of the problem lies principally in the initial purity of the organism which is the subject of experiment, and in perhaps the majority of those investigations, the results of which are generally accepted as phenomena of induced mutation, it is here that the interfering factor is operative.

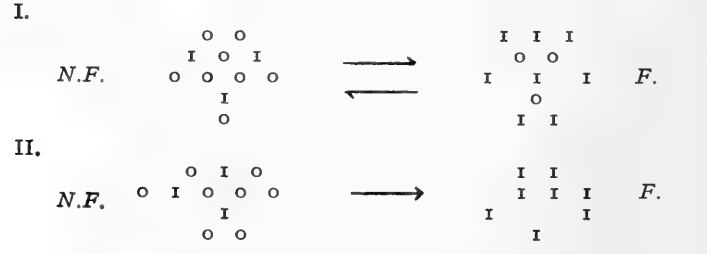
In the higher vegetable organisms, as in the fungi, there are "physiological species"—the "species" of Lotsy(23)—within the elementary species or "Jordanon"; and elementary species within the Linnean species or "Linneon." In bacterial categorisation morphological characters are but of little help and recourse is had to the physiological reactions of the organisms under standardised conditions, the bacterial species being diagnosed by means of cultural data. During the last few years it has been found that within the bacterial species there are, frequently, very nearly allied races, often only

differing in some obscure serological reaction, and extremely difficult to isolate. These correspond to the ultimate physiologically differentiated categories of fungi, and represent the "species" of Lotsy(23) which is the genotype in the phanerogams. These serological races harmonise perfectly in their growth and often exist as mixed populations. Many of the pedigree cultures which have been used in laboratories for years are such mixed populations, the component species existing side by side through numerous transplantations. It is only the recently devised and still largely neglected technique for the isolation of individual bacteria wherewith to initiate pedigree cultures, that furnishes hope of solution for this most embarrassing complication. The ordinary method of purification by dilution is practically valueless in such circumstances.

There can be little doubt that many of the "pure" cultures of organisms which have formed the basis for experimental researches on the induction of mutations, have not been absolutely pure species but mixed populations with unknown components. If therefore in these investigations the most critical factor—the initial organism—may be a mixed and unknown quantity, it does not seem wholly wise to build any fundamental and far reaching conclusions on the results obtained.

Moreover it is an elementary principle in scientific methodology that of two hypotheses, that which may be expressed in simpler terms, or in terms of more general applicability, should be chosen; and if one applies this to the phenomena in question, one finds that they may be brought within the scope of present hypotheses and paralleled by known facts.

There are few of these results which may not be explained in terms of the selection of components from a mixture, of species from a population. The classical work of Johannsen(19) on pure lines shewed the immense importance of this concept in the study of the higher organisms, and there are few aspects of biology to which the pure line concept has not made its way, although its influence is yet hardly appreciable in Mycology and Bacteriology. As applied to the lower organisms this concept may be shewn diagrammatically as follows:



III.

IV.

V.

A few words may be said about each of these conditions, which have been reduced to their simplest proportions.

In Case I a population consists of two species of which one is numerically dominant owing to the selective and favourable action of the medium. The second species may exist in almost infinitesimal numbers and therefore the characters of the colony are entirely those of the dominant form, which we may suppose to lack fermentative power. If now the conditions be gradually changed by the addition for example of lactose to the medium in increasing amount, the relative numerical proportions of the two species comprised in the colony may be reversed owing to this medium favouring the growth of the previously subordinate species. At the end of the "educative" treatment the characters of the colony will be those of the now dominant form which we may suppose to possess the power of fermenting sugars. The non-fermenting organism will still exist in the colonies but its influence will not be visible and thus the "organism" will by such treatment have acquired the power to ferment sugar. If the conditions be reversed an opposite process will occur and the original equilibrium be restored. This explanation is probably applicable to most of those instances in bacteriology and mycology where the virulence of a specific culture fluctuates, and it may explain results such as those obtained by Bernhardt and Markoff(4) in which blue colonies of *B. coli-mutabile* on Drigalski-Conradi agar gave rise to red colonies which if bred through mice and rabbits again became blue.

In Case II the population is again dominated by the non-fermenting species. By the cumulative addition of lactose however, the conditions may be so altered that the subordinate species becomes dominant and the previously dominant species dies out. Again the final result will be a colony able to ferment sugar but, whereas in Case I the action was reversible, in this

case the action may not be reversed for there is now no subordinate strain to select out. This explanation is probably common to many of those results where the change is permanent —that is the property once acquired by the race is never lost. This is well illustrated by an experiment of Horiuchi(16), who relates that he had in his possession a highly virulent, densely capsulated strain of the micrococcus tetragenus, which resisted phagocytosis *almost* entirely and killed guinea pigs in a dose of 100 organisms. When this was grown for a number of days on rather dry agar it lost its capsule-forming power permanently, became readily subject to phagocytosis, and did not affect guinea pigs even in doses of 1,000,000,000 organisms.

In Case III the non-fermenting organism is found to be absolutely ineducable by any treatment whatsoever. This is due to the fact that it is really a pure species, and not a population out of which a particular subordinate strain may be selected.

Case IV is the reversal of Case II. In the latter a character is developed by the selection from a population of a subordinate component possessing that character. In the former the population is originally fermentative but loses that capacity because the subordinate species which finally becomes dominant cannot form the necessary enzymes. As no individuals of the originally dominant species remain, the population becomes a pure line which is constant.

Case V corresponds to Case III, but the fermenting power is retained under all treatments.

In these five conditions and multiples of them, all possible educative phenomena may be included; and except in those investigations where the organism has been initially derived from a single individual, and subsequently the most rigid precautions adopted to eliminate possibility of contamination, it is more consonant with principles of scientific methodology to adopt a hypothesis stated in terms of the selection of existing species from a population, than a hypothesis which requires the introduction of such a new and fundamentally destructive idea as that of the fluidity of species.

That two or more fungal or bacterial species may grow together so harmoniously that the mixed nature of the culture cannot be detected save by the most scrupulous attention to a special technique is a fact that as yet is hardly receiving due recognition. Under most environmental conditions the two or more organisms "harmonise" perfectly in their growth but under the influence of certain other environmental factors they may "disharmonise" or shew characteristic divergencies, when the mixed character of the population becomes evident. This is the case with certain species of the "Linneon" *Botrytis*

cinerea Pers.: and experience in laboratories of medical pathology during the last two or three years has shewn that bacterial cultures which for years have been regarded as of specific purity, and regularly transplanted in the usual way, have in reality consisted of mixed populations, and that under the influence of unusual conditions the components have shewn characteristic and divergent reactions. It is absolutely imperative therefore that the experimental organism in all investigations dealing with the educability of micro-organisms should be above suspicion regarding its specific purity. Possibly in such a direction may be sought the explanation of the arresting claims of Rosenow(36) to which reference has already been made.

A second direction of research which may possibly throw a flood of light on the so-called mutations in the bacteria lies in the investigation of the life-cycles and developmental and reproductive phases of these organisms.

Since the days of Cohn(7), who established the morphological constancy of the bacteria, these organisms have been regarded as characterised by an extremely simple life-history, and although in the intervening period many observations have been put on record which have contravened this idea, the weight of dogma has been so heavy that these have not received serious consideration. There can be no doubt that progress in bacteriology has been very severely checked by the rigid adherence of all but a few investigators to a conventional conception of a very simple and constant bacterial organism. The recent researches of many workers, among whom may be particularly mentioned Hort(17) in this country, Löhnis and Smith(22) in America and de Negri(30) in Germany, indicate that the life-cycles of the bacteria may be very complex and characterised by the regular occurrence of many different forms and stages of growth connected with each other by constant relations. Under ordinary conditions simple binary fission and endospore formation are probably only two of many phases in the life-cycle which there would seem reason to believe includes an almost invisible filterable stage and a naked plasmodial or symplastic condition. According to Löhnis and Smith(22), "The life-cycle of each species of bacteria studied is composed of several sub-cycles shewing wide morphological and physiological differences. They are connected with each other by the symplastic stage. Direct changes from one sub-cycle into another occur, but they are rather rare exceptions."

The foregoing very brief sketch may give some idea of the hitherto unrealised complexities involved in investigations,

where very slight changes in morphology or biochemical properties have been acclaimed as the induction of a mutation. These mutations may be merely the expression of a developmental stage previously unrecognised; new phases may present new cultural reactions, and possess different biochemical properties. If the presence of sub-cycles within the general life-cycle be confirmed, such knowledge will go very far indeed to explain many of the phenomena hitherto regarded as evidence of mutation. Clearly until very much more is known of the full life-histories of the organisms upon which the experimental work is carried out it will, at least, be somewhat injudicious to found upon the results of such experiments any very fundamental conclusions.

Again a possible interfering factor which has received little or no attention by the bacterial mutationists is that of the genetic constitution of their organisms. In the higher animals and plants the almost bewildering complications which consideration of the gametic constitution of the individual introduce into any experimental study, where absolute specific purity is vital, render it imperative that the genetic relations of the subject to be investigated be known with the most scrupulous accuracy and in the minutest detail. If one is examining the morphological and physiological behaviour of a species of which such knowledge is totally lacking, and drawing therefrom phylogenetic deductions, those deductions, and conclusions based upon them, will tend to be unreliable.

Now the lack of information concerning the genetic behaviour of bacterial organisms is profound. Hitherto the only recognised reproductive processes have been those of binary fission and asexual spore formation. If analogies drawn from the behaviour of higher plants have any value, the recent investigations on somatic segregation may indicate that the genetic processes involved even in binary fission may have a significance greater than that with which they have been accredited. If in addition there are further possible avenues of segregation in such reproductive processes as gonidial formation and gemmation, this matter may assume a serious aspect.

Furthermore it is not inconceivable that in the bacterial life-cycle there may exist some phase more or less comparable with the sexual fusions of other organisms. Löhnis and Smith(22), for example, note a symplastic stage in which "the living matter previously inclosed in the separate cells undergoes a thorough mixing either by a complete disintegration of the cell wall, as well as cell content, or by a 'melting together' of

the contents of many cells which leave their empty cell walls behind them." In addition there was observed "another mode of interaction between the plasmatic substance in bacteria cells...consisting in the direct union of two or more individual cells. This 'conjunction' seems to be of no less general occurrence than the process first mentioned."

And these indications do not stand alone, for scattered through the literature there are many sporadic observations which point in the same direction. Without labouring this point further it may be stated that if at any time sexual phenomena be observed in the bacteria it involves the existence of heterozygous individuals with the possibility of segregation on Mendelian lines. Such segregation by the splitting up of a heterozygote might explain the so-called "reverting mutants"(50) in which the new form is described as constantly giving rise to two types of colonies one similar to the obvious parent and one like itself, the former breeding true, the latter again shewing segregation.

Whether or not these speculations contain any germs of truth, the fact remains that we are in total ignorance of the genetic constitution of a single bacterium, and this should make one hesitate before elaborating theories of great import which have their foundations in the processes of reproduction.

Finally there is the imperative need to exclude all possibility of contamination, or the "mutant" may merely represent an invading organism. If, as would appear probable, many bacteria may give rise to reproductive bodies so infinitesimally small that they will pass through a porcelain filter, it will be quite obvious that experimental technique must be very considerably more exact and nice if the results are to be worthy of serious consideration.

From the brief sketch which has been given of certain of the more important lines of research which bear upon the question of the educability of fungi and bacteria it will be clear that much of the evidence bears no relation to the point at issue, and that of the remaining investigations scarcely one may be accepted at its nominal value.

There are certain evident minimal requirements for any studies to this end which may perhaps be expressed as follows:

(1) In order to ensure specific purity the organism must be a single individual of a tested pedigree pure line.

(2) The whole life-history of the organism together with the range of its plasticity both morphological and physiological must be accurately known in the minutest detail.

(3) No organism in which sexuality exists or it is conceivable that it may exist must be used unless its gametic constitution,

and genetic behaviour under all the conditions of the experiment, be known.

(4) Possible contamination by filterable gonidia must be eliminated.

(5) Adequate control experiments must be maintained (a little matter, but one absolutely vital, which has escaped the attention of many students of the lower organisms).

Unless these five conditions are rigidly maintained in the focus of one's attention, and exactly complied with, the results obtained in experimental studies on the educability of micro-organisms can have but little value.

Much of what has been said is drawn from bacteriological investigation and few direct references to more strictly mycological studies have been made. There are two reasons for this. In the first place direct experimental work on the educability of fungi is confined to a very few investigations of which more will be said later, and the criticisms and suggestions which have been made apply equally both to bacteriological and mycological studies. In the second place the concept of the educability of micro-organisms had its birth in the laboratories of bacteriology, and largely in the phenomena of the attenuation of viruses of whose nature and organic composition nothing is known*. Thence it has been taken over by mycologists and applied to the fungi with a confidence and lack of critical evaluation which is somewhat astonishing.

Still, if this concept be true for the bacteria, it must also be true for the fungi. The whole of biological science is founded on the hypothesis that in their ultimate physiological constitution living organisms are constant, for otherwise it would be futile to attempt even the most general systematic treatment of individuals, which are the only forms in which the living organisms are known to us. This concept cannot be true for certain kinds of individuals and untrue for others, true for the bacteria and untrue for the fungi, applicable to ferns, inapplicable to liverworts. Biological science stands or falls by the truth of this concept, for without it there can be no systematised knowledge of living things.

A few words however may perhaps be said of the evidence derived from fungal studies which has been regarded as establishing this concept. The classical investigation is that of Massee(25) in 1905 to which reference has already been made. Even for that date this work was remarkable rather for what it

* Whilst this paper is passing through the press a study of acute infective polyneuritis has appeared which is noteworthy as containing a description of the minute organism composing the filterable virus causing this disease. (Bradford, J. R., Bashford, E. F. and Wilson, J. A., Quart. Journ. Med., 12, 1919.) See also the same authors in the Lancet, No. 4979, 1919.

omitted than for what it produced; and in the light of what has been said, and particularly of the minimal experimental conditions, fulfilment of which is obligatory in studies designed to elucidate this issue, this research possesses now only historical interest.

Evidence of much greater weight is the well-known work of Salmon(37) on the adaptive parasitism of *Erysiphe graminis* and the parallel results obtained for certain rust fungi by Ward(48), Freeman(12), Freeman and Johnson(13), Johnson(20), Pole Evans(33) and others. Until however this work can be carried out under conditions much more rigidly controlled, and with the nicety of technique which has been indicated as imperative to the present issue, these most interesting results must be placed on one side, and the verdict on the present question be regarded as "non-proven." Moreover it may be noted that the more recent work of Stakman(41), Stakman and Piemeisel(42), Stakman, Parker and Piemeisel(43) and Stakman, Piemeisel and Levine(43 a) has produced results which directly negative the conclusions previously reached. As a result of their investigations they state(43): "The results of the experiments with *P. graminis tritici-compacti* shew that barley which both theoretically and from the results obtained by previous investigators might be expected to increase the infection range does not do so. Even susceptible varieties of wheat do not change the parasitic capabilities of the rust so as to enable it to attack a normally resistant variety. Furthermore the rust does not acquire additional virulence when associated for a long time with a given host. Barley is moderately susceptible to the rust but the relations between host and rust are apparently the same regardless of the length of their association with each other. Wheats resistant to the rust remain resistant regardless of the previous history of the rust."

"In no case, however, was there the slightest evidence of any change in the virulence of the parasite, nor any indication that a short sojourn on a susceptible hybrid had given it any peculiar ability to cause normal infection on a heretofore resistant variety or to cause a more than usually virulent infection on a susceptible variety."

And again (43 a) "Differential hosts must be used to isolate biologic forms from mixtures before conclusive experiments can be made with bridging hosts." "No one so-called bridging host nor any combination of such hosts enabled any biologic form tried to infect naturally immune plants nor to infect a highly resistant plant more readily." "The writers have not been able to detect any mutation nor to induce perceptible evolutionary changes experimentally."

It will be evident from this very brief summary* of certain of the principal positive contributions to this subject, that the condition of knowledge and the available evidence is not such as to warrant the deducing of any, even minor, conclusions; much less the elaborating of a hypothesis so subversive of the foundations of biological science.

On the other hand there is a very great deal of evidence which shews that the properties of numerous organisms which have been investigated have remained constant under all treatment. This constancy of reaction to particular environmental conditions has been referred to in the first portion of this paper, and is the normal expectation. Conclusions such as those reached by Dox(9) from an intensive study of the intracellular enzymes of Penicillium and Aspergillus, and which are quoted below, could be multiplied almost indefinitely: "There is no evidence that enzyms not normally formed by the organism in demonstrable quantities can be developed by special methods of nutrition. The influence of adding a particular substratum to the medium is, therefore, not to develop any entirely new enzym, but to stimulate the production of the corresponding enzym, which is normally formed under all conditions."

In my own studies of *Botrytis cinerea* I have only been able to educate this fungus when the initial culture has represented a mixed population, and the extent of possible educability is equal to that of the particular component possessing the required property in the highest degree. When this strain has been selected out from the population, and is dominant, the organism or culture shews no further capacity for education. A culture of *Botrytis cinerea* which contains a single strain only, i.e., an organism which is of specific purity, cannot in my experience be educated or permanently modified in any direction.

When one considers this concept of the educability of micro-organisms, and realises how pregnant with significance it is for all aspects of biological science, how implicit is the allegiance paid to it almost universally by students of microbiology and how its far-reaching ramifications permeate all thought and influence all technique in these studies, one feels that surely its roots must lie deep in fact, and its truth be unimpeachable.

* Reference should also be made to the work of Miss E. Schiemann on mutations in *Aspergillus niger* (Zeit. f. indukt. Abstamm. v. Vererbungslehre viii. 1912). Colour modifications in this fungus may readily be produced but Miss Schiemann's work stands alone in that the induced changes were permanent. Until the circumstances obscuring the genetic constitution of this fungus are made more clear, and the results are confirmed under more rigidly controlled conditions, one must hesitate in accepting this unique work. My own repetition of these experiments has given absolutely negative results.

But if one then surveys the available evidence, critically evaluating the phenomena which have been recorded or the interpretations which only too frequently have been set down in their place, one is left with a feeling of utter dismay.

A hypothesis of little moment, merely a corollary to a well-established theory, we may accept on slight positive evidence, but acceptance of a fundamental concept of wide and subversive applicability is in a totally different category. This must be based on a great mass of critical and sifted evidence, positive, convincing and amply confirmed.

In the foregoing pages the endeavour has been to shew that the concept of the educability of micro-organisms has not arisen in such evidence, and that beyond high authority and much prestige there is little to favour its retention as a fundamental concept of microbiology, save the dead weight of convention and inertia.

In this brief discussion of the "species-concept" and the "concept of educability" in mycology, no attempt has been made to review the literature cognate to these issues, for to have outlined even the principal investigations would have rendered such a preliminary consideration as this wearisome to read and of unwieldy length. All that has been feasible here is merely to indicate certain lines of thought, largely the result of one's own observations but owing much to one's past and present colleagues, which do not appear to coincide with conventional beliefs.

The present epoch of the science of mycology had its birth about the middle of the nineteenth century in the labours of de Bary, Woronin, Berkeley, Zopf, Brefeld, Nägeli and others too numerous to mention, and in the period represented by the great treatises of de Bary and of Zopf the fundamental concepts dominating mycology were elaborated. These hold to-day, and since that time few concepts of major importance have been formulated. And yet the last three decades have seen the birth and development of the experimental attitude and the cultural technique; and in this period there has been accumulated a mass of fact greater in volume than the stores of eighteen centuries. It is a mass of analytic data which we try to interpret according to the concepts and ideas of an earlier time. And still we accumulate unco-ordinated observations and heap up an incoherent literature. In the great scientific renascence of the nineteenth century, mycologists were not content merely with unending analysis, they also synthesised. We use their syntheses to-day.

The great present need, not only of mycology, but of all biological science, is Synthesis. Let us make bricks and

mortar, but let us also build houses. We still live in the houses the giants of last century built for us; but our possessions overflow. There are great heaps of bricks lying around and instead of using them we merely pile others on the top.

Synthesis may not be the work of one man, for the labour would be too great, but if many help, a fair and useful structure may arise.

The present paper is a very tentative essay towards synthesis in mycology. Two out of many possible lines of construction have been followed and it is hoped that others may criticise and co-operate in the building.

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CHARLES OGILVIE FARQUHARSON.

By E. M. Wakefield, F.L.S.

In the list of passengers missing after the loss of the s.s. "Burutu," homeward bound from West Africa, on the night of October 3rd, 1918, occurred the name of Charles Ogilvie Farquharson, M.A., B.Sc., Mycologist to the Agricultural Department, Southern Provinces, Nigeria. C. O. Farquharson was born at Murtle, Aberdeenshire, in February, 1888, and was educated at Robert Gordon's College, Aberdeen. From there he entered the University, in 1905, and at first intended reading for the Honours Degree in Classics. At the end of his second year, however, he decided to devote himself to Natural Science. After graduating in Arts he took the Science course, and gained his degree of B.Sc. in 1911, with special distinction in Botany. Shortly afterwards he came to Kew, and worked for a few months at Mycology and Plant Pathology under the late Mr. G. Massee. He was appointed Mycologist in South Nigeria, and sailed in the beginning of 1912.

The multifarious duties which fall to the lot of officers in Colonial Agricultural Departments did not leave him much leisure for purely mycological work. He was, however, keenly interested in the subject, and in the intervals of acting as Assistant Director, Entomologist, or Agricultural Inspector, as occasion demanded, he was able to collect fungi to some extent, and accumulated a fund of information with regard to plant diseases in West Africa. In a letter to the Assistant Director at Kew, dated September 23rd, 1918 and sent by the mail following the ill-fated vessel on which he sailed, he gave a graphic summary of his work, discussing the problems to be faced, and the kind of training his experience had led him to believe best for such work. This letter, which was published in the Kew Bulletin, No. 10, 1918, is of general interest to all concerned with tropical plant pathology. His sound judgment renders his views worthy of close consideration.

The letter shows that he had a strong presentiment that he might not reach home. His botanical friends mourn the loss of a very charming personality, as well as of a mycologist who promised to have a useful and distinguished career. Unfortunately much of his detailed knowledge is lost with him, as partly through modesty and partly through lack of time he had published little. Mr. Farquharson sent home to Kew

a number of interesting fungi, with full ecological notes. Lists of these were published in the Kew Bulletin, No. 7, 1914, p. 253, and No. 3, 1917, p. 104. In the Journal of Botany, 1916, p. 121, he published in conjunction with Miss G. Lister an account of South Nigerian Mycetozoa, in which two new species, *Physarum digitatum* Lister and Farq., and *Dichaea radiata* Lister and Petch, are described. His only other published mycological work is contained in the official reports of the Mycologist for South Nigeria.

Published 19th September, 1919.

The whole of the first part of the British Mycological Society's Transactions (Season 1896–1897) has now been sold.

The other parts may be purchased at the following prices:—

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THE BASLOW FORAY.

22nd–27th September, 1919.

The twenty-third annual week's Fungus Foray was held at Baslow, Derbyshire, from September 22nd to September 27th, 1919. This first post-war meeting was attended by some thirty-two members and visitors, and was in every way a most enjoyable one. Unfortunately however, not only in Derbyshire but generally, the autumn of 1919 was a bad season for fungi, consequently the list of species numbers only three hundred and ninety-one, as compared with the 1909 list of five hundred and thirty-three. The difference is the more marked when it is remembered that the number, three hundred and ninety-one, was only attained after practically a fortnight's work on the part of various members of the party. A few enthusiasts had spent the previous week-end at Baslow, and owing to the railway strike a number of members were held up for some days after the 27th, spending their time in adding as far as possible to the records for the Foray.

The headquarters for the meeting were at the Grand Hotel and Hydro, where the manager kindly placed at our disposal a large room for the exhibition of specimens and the holding of meetings.

Here on the Monday evening various fungi of interest brought by members were placed on exhibition. Dr Adams* had brought from Keswick *Tricholoma imbricatum*, *Lactarius mitissimus*, *Cortinarius pholideus*, and *Boletus porphyrosporus*, and from Looe *Polyporus varius*. Mr Rea showed *Marasmius foetidus*, *Leptonia euchlora*, *Cortinarius caerulescens*, and *Lycoperdon velatum*, all from Tick Wood, Shropshire. Subsequently Mr N. G. Hadden sent from West Porlock *Boletus sulphureus* and *Paxillus panuoides*, both found growing on sawdust.

On Tuesday, September 23rd, the party started out through the Yeld Wood at the back of the Hotel, intending to make for some promising ground near a stream which had been noticed the previous day. Unfortunately however the way was missed, and instead we found ourselves on a high moorland, which yielded nothing but numerous specimens of *Anellaria separata*, growing on cow-dung. It was decided to attempt a short cut back to Baslow by climbing down, a proceeding which was

* Members will learn with deep regret that Dr Adams has since passed away. The Society is glad to welcome his son, Mr J. Adams, who was also present at Baslow, as a member.

found somewhat difficult, especially for the ladies, owing to the very rough nature of the ground. During this return journey the party became broken up, and various members succeeded in finding more suitable collecting ground in copses round the village, with the result that quite a fair number of species had been gathered by lunch-time. After lunch at the Hotel, a few members went out again, chiefly into the Yeld Wood, but others stayed in in order to sort and work out the specimens already collected. A piece of old sacking yielded *Botryotrichum piluliferum**, new to Britain, subsequently reported by Miss Lorrain Smith.

In the evening, the Annual General Meeting was held, the President, Dr Wager, occupying the chair. The Officers and Council for 1920 were elected (see p. 2 of cover) and the new Rules, with some slight amendments, chiefly verbal, were confirmed. Mr A. D. Cotton urged the necessity of the Society taking a more active part in the development of Plant Pathology in Great Britain, and suggested the formation of a special sub-committee to deal with questions of interest to plant pathologists. After a vigorous discussion the general opinion seemed to be that some steps should be taken to make it clear that the Society includes in its scope *all* branches of mycology, including pathology, but the details of action were left to be settled by the Council†.

After the adoption of the balance sheet for the year, the Treasurer pointed out that it may become necessary to raise the subscription in 1920, to meet the enormously increased cost of printing. Should this become necessary, due notice will be given before the next Annual General Meeting. It was resolved to publish the Transactions for the future in two half yearly parts.

Miss Lorrain Smith then showed a very interesting abnormal specimen of *Fomes ulmarius*, which had been found in a drain 30 feet below the surface of the ground.

On the following day, Sept. 24th, motors were in attendance at 10.0 a.m., and the party was taken first to Highlow Wood. This being a damp wood with much fallen timber lying about was specially productive of resupinate Hymenomycetes. Miss Wakefield collected the new species *Hypochnus roseo-griseus*, which was described for the first time last year. The Rev. C. Fynes-Clinton gathered a fine specimen of *Fomes conchatus*, and Mr Thos. Smith brought in *Dacryomitra glossoides*, which was also gathered at the 1909 Foray. Messrs Pearson and Rea

* For description see New or Rare Microfungi, to be published later.

† At a Council Meeting held December 17th, 1919, a sub-committee for plant pathology was constituted as follows: F. T. Brooks, M.A. (*Chairman*), A. D. Cotton, F.L.S. (*Secretary*), G. H. Pethybridge, B.Sc., Ph.D., J. Ramsbottom, M.A., F.L.S., together with the President and Secretary of the Society *ex officio*.

secured *Mycena dilatata*, new to the British flora, and *M. chlorantha*. The party then motored back as far as Padley Wood, where a halt was made for lunch. Here a few interesting species were obtained, notably *Naucoria Cucumis*, and *Galactinia Phillipsii*, the latter discovered by Miss Noel. It is a beautiful Discomycete, remarkable for the large sculptured violet spores. Owing to the description of the spores as hyaline in Massee's "Fungus Flora," vol. IV, there was some discussion as to whether the colour had not diffused into the epispore from other parts of the fructification. The specimens examined however left no doubt that the spores are at first hyaline, but when mature are covered by a violet-coloured warted epispore. This confirms Phillips' original description as set out in *Grevillea*, IV. 84, for *Ascobolus amethystinus**.

Stoke Wood was then visited, and here the first fungus to be found was a large and beautiful group of *Clitocybe connata*, growing close to the gate. This wood proved to be poorest in species of the three visited, and the only other find of special interest was *Nolanea araneosa*, also recorded in 1909.

In the evening, at 9 o'clock, Dr Wager delivered his Presidential address, entitled "The Sexuality of the Fungi."

On Thursday, Sept. 25th, the party was conducted over the grounds of Chatsworth by the head forester, Mr J. P. Robertson. As was natural the greater number of the Agarics collected on this day were species characteristic of pastures. *Hygrophorus clivalis, Reai*, and *russo-coriaceus* were all noted by Mr Rea. It was particularly interesting to find *H. Reai* because it was first described from this locality at the Baslow Foray of 1909. *Merulius lacrymans* var. *minor* was found by Dr Bayliss Elliott, while some other noteworthy species observed were *Hypholoma pyrotrichum, Inocybe fastigiata, I. destricta* and *Corticium botryosum* growing on dead stems of *Pteris aquilina*.

At the evening meeting Mr. A. A. Pearson, F.L.S., read a paper on "Cystidia as a Generic Character" and Mr W. B. Brierley gave an account of "Mutations among Fungi," which evoked a good deal of discussion.

On Friday, Sept. 26th, in a heavy downpour of rain, Calton Lees wood-yard was first visited, but yielded only a few fungi. Mr Robertson then conducted the party to New Piece Wood, where *Lactarius fuliginosus* and *L. theiogalus* were perhaps the most interesting finds. After lunch at the Hotel some members paid a visit to Haddon Hall, the historical and romantic interest of which eclipsed mycology, for the only record brought in was *Puccinia Malvacearum*!

* There seems to have been some confusion as to the nomenclature of this species. It is hoped to publish a note on it in the next part.

In the evening the formal meeting was brought to a close by hearty votes of thanks to the owners and factors who had given permission for their woods to be visited, to Dr Wager for presiding, and to the Treasurer and Secretary for the general management of the meeting.

For assistance in compiling the subjoined list of species the Secretary is much indebted to Mr Carleton Rea, Miss A. Lorrain Smith, Dr Bayliss Elliott, Mr A. D. Cotton and Mr C. H. Grinling.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

C. = Chatsworth; *H.* = Highlow Wood; *P.* = Padley Wood; *S.* = Stoke Wood; *N.* = New Piece Wood, Chatsworth; *B.* = neighbourhood of Burbage Brook. Where not otherwise indicated the locality is the immediate neighbourhood of Baslow.

Amanita muscaria (Linn.) Fr., *H.*, *P.*, rubescens (Pers.) Fr., pantherina (DC.) Fr., *C.*

Amanitopsis vaginata (Bull.) Roze, *H.*, strangulata (Fr.) Roze.

Lepiota procera (Scop.) Fr., *C.*, rachodes (Vitt.) Fr., cristata (A. & S.) Fr., amianthina (Scop.) Fr., *H.*

Armillaria mellea (Vahl.) Fr.

Tricholoma rutilans (Schaeff.) Fr., *C.*, imbricatum Fr., terreum (Schaeff.) Fr., *C.*, argyraceum (Bull.) Fr., cuneifolium Fr., *H.*, carneum (Bull.) Fr., *C.*, album (Schaeff.) Fr., personatum (Fr.) Berk., *C.*, cinerascens (Bull.) Quél. (Syn. Clitocybe fumosa Fr.), melaleucum (Pers.) Fr., var. phaeopodium (Bull.) Quél.

Clitocybe clavipes (Pers.) Fr., rivulosa (Pers.) Fr., phyllophila Fr., candicans (Pers.) Fr., *H.*, dealbata (Sow.) Fr., var. minor Cooke, *C.*, connata (Schum.) Fr., *S.*, infundibuliformis (Schaeff.) Fr., *C.*, brumalis Fr., *Bolehill Wood*, metachroa (Fr.) Berk., *C.*, ditopus Fr., *H.*

Laccaria laccata (Scop.) Berk. & Br.

Collybia radicata (Rehl.) Berk., *S.*, platyphylla Fr., *S.*, fusipes (Bull.) Berk., maculata (A. & S.) Fr., *H.*, *C.*, butyracea (Bull.) Fr., vertirugis Cooke, *B.*, confluens (Pers.) Fr., *C.*, tuberosa (Bull.) Fr., *P.*, xanthopus Fr., acervata Fr., *P.*, dryophila (Bull.) Fr., ambusta Fr., *B.*, clusilis Fr., *Monsal Dale.*

Mycena olivaceo-marginata Mass., *C.*, pura (Pers.) Fr., *S.*, chlorantha Fr., *H.*, lactea (Pers.) Fr., *H.*, galericulata (Scop.)

Fr., polygramma (Bull.) Fr., ammoniaca Fr., metata Fr., *C.*, amicta Fr., *C.*, Iris Berk., *B.*, vitilis Fr., *B.*, sanguinolenta (A. & S.) Fr., galopus (Pers.) Fr., var. alba Fl. Dan., var. nigra Fl. Dan. (Syn. M. leucogala Cooke), *H.*, *P.*, epipterygia (Scop.) Fr., *P.*, rorida Fr., *P.*, pelliculosa Fr., *P.*, dilatata Fr.*, *H.*, tenerrima Berk., corticola (Schum.) Fr.

Omphalia umbellifera (Linn.) Fr., *P.*, velutina Quél., *C.*, fibula (Bull.) Fr., var. Swartzii Fr.

Pleurotus ulmarius (Bull.) Fr., *Great Longstone.*

Hygrophorus pratensis (Pers.) Fr., virgineus (Wulf.) Fr., *C.*, niveus (Scop.) Fr., russo-coriaceus Berk & Br., *C.*, clivalis Fr., *C.*, ovinus (Bull.) Fr., laetus (Pers.) Fr., *B.*, ceraceus (Wulf.) Fr., *C.*, coccineus (Schaeff.) Fr., *C.*, *B.*, miniatus Fr., *P.*, conicus (Scop.) Fr., Reai Maire, *C.*, psittacinus (Schaeff.) Fr., *B.*

Lactarius pubescens Fr., turpis (Weinm.) Fr., *B.*, blennius Fr., *C.*, quietus Fr., theiogalus Fr., *N.*, rufus (Scop.) Fr., glyciosmus Fr., fuliginosus Fr., *N.*, serifluus (DC.) Fr., *C.*, mitissimus Fr., subdulcis (Pers.) Fr., *H.*

Russula nigricans (Bull.) Fr., *S.*, *N.*, adusta (Pers.) Fr., furcata (Pers.) Fr., virescens (Schaeff.) Fr., *C.*, atropurpurea (Krombh.) Maire, vesca Fr., cyanoxantha (Schaeff.) Fr., *S.*, *N.*, foetens (Pers.) Fr., *C.*, fellea Fr., *N.*, emetica (Schaeff.) Fr., ochroleuca (Pers.) Fr., *B.*, *H.*, *N.*, fragilis (Pers.) Fr., *P.*, lutea (Huds.) Fr., *B.*

Cantharellus cibarius Fr., *C.*, aurantiacus (Wulf.) Fr.

Nyctalis parasitica (Bull.) Fr., *C.*

Marasmius peronatus (Bolt.) Fr., oreades (Bolt.) Fr., *C.*, ramealis (Bull.) Fr., rotula (Scop.) Fr., androsaceus (Linn.) Fr.

Lentinus cochleatus (Pers.) Fr., *H.*

Panus stypticus (Bull.) Fr., *C.*

Lenzites betulina (Linn.) Fr., *C.*

Pluteus cervinus (Schaeff.) Fr., nanus (Pers.) Fr., *S.*

Entoloma prunuloides Fr., *C.*, rhodopolium Fr., costatum Fr., sericeum (Bull.) Fr.

Leptonia lampropus Fr., *P.*, *C.*, sericella (Fr.) Quél., *S.*

Nolanea pascua (Pers.) Fr., *B.*, proletaria Fr., papillata Bres., araneosa Quél., *S.*

Eccilia griseo-rubella (Lasch.) Fr., *C.*

Claudopus variabilis (Pers.) W.G.Sm., *P.*

Pholiota erebia Fr., *S.*, togularis (Bull.) Fr., subsquarrosa Fr., *N.*, spectabilis Fr., mutabilis (Schaeff.) Fr., *Bolehill Wood*, marginata (Batsch) Fr.

* New to Britain. For description see New or Rare British Fungi to be published later.

Bolbitius titubans (Bull.) Fr., *C.*

Inocybe cincinnata Fr., *C.*, incarnata Bres., *B.*, *C.*, obscura (Pers.) Fr., *B.*, fastigiata (Schaeff.) Fr., *C.*, rimosa (Bull.) Fr., *B.*, *C.*, asterospora Quél., *B.*, *N.*, proximella Karst., *N.*, eutheles Berk & Br., *B.*, destricta Fr., *C.*, geophylla Fr.

Hebeloma fastibile Fr., glutinosum (Lindg.) Fr., *N.*, mesophaeum Fr., crustuliniforme (Bull.) Fr.

Flammula sapinea Fr., *H.*, *N.*, flavida (Schaeff.) Fr.

Naucoria Cucumis (Pers.) Fr., *P.*, melinoides Fr., *C.*, semiorbicularis (Bull.) Fr., *Froggatt Edge*, sobria Fr., *Bolehill Wood*, escharoides Fr.

Galera tenera (Schaeff.) Fr., hypnorum (Schrank) Fr., mycenopsis Fr., *C.*

Tubaria furfuracea (Pers.) W.G.Sm., paludosa Fr., *C.*, inquilina Fr., *Bolehill Wood*.

Cortinarius (Myxacium) elatior (Pers.) Fr., *P.*, *N.*

— (Dermocybe) tabularis (Bull.) Fr., *H.*, *N.*, caninus Fr.

— (Telamonia) torvus Fr., *P.*, hinnuleus (Sow.) Fr., *P.*, iliopodius Fr., *Bolehill Wood*, hemitrichus (Pers.) Fr., *Bolehill Wood*, rigidus (Scop.) Fr.

— (Hydrocybe) castaneus (Bull.) Fr., leucopus (Bull.) Fr., *C.*, decipiens (Pers.) Fr., *Bolehill Wood*, acutus (Pers.) Fr., *C.*

Paxillus involutus (Batsch) Fr., panuoides Fr., *C.*

Psaliota xanthoderma (Genev.) W.G.Sm., campestris (Linn.) Fr., *C.*, comtula Fr., *H.*

Stropharia aeruginosa (Curt.) Fr., *C.*, albocyanea (Desm.) Fr., inuncta Fr., *C.*, squamosa (Pers.) Fr., *C.*, merdaria Fr., *Froggatt Edge*, semiglobata (Batsch) Fr.

Hypholoma capnoides Fr., *N.*, epixanthum Fr., *P.*, fasciculare (Huds.) Fr., pyrotrichum (Holmsk.) Fr., *C.*, velutinum (Pers.) Fr., *S.*, leucotephrum Berk. & Br.

Psilocybe sarcocephala Fr., *Monsal Dale*, uda (Pers.) Fr., *C.*, semilanceata Fr., *C.*, foenisecii (Pers.) Fr.

Psathyra corrugis (Pers.) Fr., *C.*, fibrillosa (Pers.) Fr., conopilea Fr., *Froggatt Edge*.

Coprinus comatus (Fl. Dan.) Fr., atramentarius (Bull.) Fr., cinereus (Schaeff.) Fr., niveus (Pers.) Fr., micaceus (Bull.) Fr., plicatilis (Curt.) Fr., *S.*, *C.*, ephemerus (Bull.) Fr., *C.*

Panaeolus sphinctrinus Fr., campanulatus (Linn.) Fr., *C.*, papilionaceus (Bull.) Fr., *C.*

Anellaria separata (Linn.) Karst.

Psathyrella gracilis (Pers.) Fr., atomata Fr., *N.*, crenata (Lasch) Fr., *Bolehill Wood*, disseminata (Pers.) Fr., *S.*, *C.*

Boletus elegans (Schum.) Fr., *B.*, granulatus (Linn.) Fr., *C.*, badius Fr., *B.*, piperatus (Bull.) Fr., *C.*, chrysenteron (Bull.) Fr., subtomentosus (Linn.) Fr., *B.*, edulis (Bull.)

Fr., *B.*, *C.*, luridus (Schaeff.) Fr., *C.*, versipellis Fr., *Bolehill Wood*, scaber (Bull.) Fr., *P.*

Fistulina hepatica (Huds.) Fr., *C.*

Polyporus squamosus (Huds.) Fr., *C.*, and f. erecta Bres., *Calton Lees*, nummularius (Fr.) Quél., sulphureus (Bull.) Fr., *C.*, dryadeus (Pers.) Fr., *C.*, betulinus (Bull.) Fr., adustus (Willd.) Fr., *S.*, lacteus Fr., fragilis Fr., *H.*

Fomes connatus Fr., *H.*, annosus Fr., conchatus (Pers.) Karst., *H.*, ferruginosus (Fr.) Mass.

Polystictus versicolor (Linn.) Fr.

Poria mollusca (Pers.) Fr., *S.*, hymenocystis Berk. & Br., *H.*, sanguinolenta (A. & S.) Fr., *H.*

Merulius lacrymans (Wulf.) Fr., var. minor Falck, *C.*

Hydnum repandum (Linn.) Fr., *C.*, rufescens (Pers.) Fr., *C.*

Caldesiella crinalis (Fr.) Bourd. & Galz.

Irpex obliquus (Schrad.) Fr.

Phlebia merismoides Fr., *S.*

Odontia alutacea (Fr.) Quél., fimbriata (Pers.) Fr., farinacea (Pers.) Quél.

Grandinia granulosa Fr.

Stereum hirsutum (Willd.) Fr., purpureum (Pers.) Fr., spadiceum (Pers.) Fr., *C.*, sanguinolentum (A. & S.) Fr., rugosum (Pers.) Fr., *H.*

Corticium Sambuci (Pers.) Fr., *S.*, botryosum Bres., *C.*, subcoronatum von Hoehn. & Litsch., *B.*, confluens Fr., *H.*, confine Bourd. & Galz., *H.*, *S.*, *N.*, sulphureum (Pers.) Bres., *H.*, praetermissum (Karst.) Bres., *B.*, *H.*, porosum Berk. & Br., albo-stramineum (Bres.) Wakef., *H.*, *N.*

Peniophora pallidula Bres., *B.*, cremea Bres., *N.*, velutina (DC.) Cooke, *H.*, setigera (Fr.) Bres., *S.*, pubera (Fr.) Mass., *H.*, gigantea (Fr.) Mass., *N.*, aurantiaca Bres., *H.*, incarnata (Pers.) Cooke, *H.*, maculaeformis (Fr.) Bourd. & Galz., *B.*, cinerea (Fr.) Cooke, quercina (Pers.) Cooke, hydnoides Cooke & Mass., *H.*

Hypochnus zygodesmoides (Ell.) Burt, *N.*, roseo-griseus Wakef. & Pears., *H.*

Coniophora arida Fr., *B.*

Cyphella capula (Holmsk.) Fr.

Solenia anomala (Pers.) Fr., *C.*

Clavaria cristata (Holmsk.) Fr., cinerea (Bull.) Fr., corniculata (Schaeff.) Fr., *C.*, and var. pratensis (Fr.) Cotton & Wakef., fusiformis (Sow.) Fr., *C.*, acuta (Sow.) Fr., rugosa (Bull.) Fr., inaequalis (Müll.) Fr.

Pistillaria quisquiliaris Fr., *C.*

Tremella mesenterica (Retz.) Fr., *S.*

Dacryomyces deliquescens (Bull.) Duby, *S.*, *N.*

Calocera viscosa (Pers.) Fr., cornea (Batsch) Fr.
Dacryomitra glossoides (Pers.) Bref., *H.*
Phallus impudicus (Linn.) Pers., *H.*
Mutinus caninus (Huds.) Fr., *H.*
Sphaerobolus stellatus (Tode) Pers.
Crucibulum vulgare Tul.
Bovista plumbea Pers.
Lycoperdon depressum Bon., pyriforme (Schaeff.) Fr., *C.*, umbrinum Pers., *P.*, *C.*, perlatum Pers., *P.*
Scleroderma vulgare Hornem.
Puccinia Lychnidearum Link, *C.*, Malvacearum Mont., *Haddon Hall*, pulverulenta Grev., on *Epilobium hirsutum, Miller's Dale*, Valantiae Pers., on *Galium cruciatum, Miller's Dale*, obtegens (Link.) Tul., *C.*, Hieracii (Schum.) Mart., *C.*, Lampsanae (Schultz) Fuck., *C.*, Leontodontis Jacky, *Miller's Dale*, Menthae Pers., *N.*, obscura Schroet., *C.*, triticina Eriks., Poarum Niels. (Aecidium on *Tussilago*).
Phragmidium Sanguisorbae (DC.) Schroet., *Stoney Middleton.*
Coleosporium Tussilaginis (Pers.) Kleb., *C.*, Sonchi-arvensis (Pers.) Lév., on *Sonchus arvensis, Miller's Dale.*
Ustilago violacea (Pers.) Wint., on *Lychnis dioica.*
Frankiella Alni (Wor.) Maire, near saw-mill, Baslow.
Erysiphe communis (Wallr.) Fr., graminis (DC.) Fr.
Nectria cinnabarina (Tode) Fr.
Hypocrea rufa (Pers.) Fr., *Bolehill Wood.*
Hypomyces torminosus on *Lactarius pubescens.*
Cordyceps militaris (Linn.) Link, with the conidial stage also.
Xylaria polymorpha (Pers.) Grev., Hypoxylon (Linn.) Grev., *S.*, *N.*
Rhopographus Pteridis (Sow.) Wint., *C.*
Helvella crispa (Scop.) Fr., *S.*
Rhizina inflata (Schaeff.) Karst., *B.*
Aleuria micropus (Pers.) Gill., *H.* (*fide* Dr Bayliss Elliott).
Galactinia Phillipsii (Cooke) Boud., *P.*
Otidea cochleata (Linn.) Fuck., *S.*
Peziza aurantia Pers., *C.*
Ciliaria scutellata (Linn.) Quél., *S.*
Coprobia granulata (Bull.) Boud.
Ascobolus Crouani Boud., *C.*, stercorarius (Bull.) Schroet.
Leotia lubrica (Scop.) Pers., *N.*
Cudoniella acicularis (Bull.) Schroet.
Coryne sarcoides (Jacq.) Tul.
Bulgaria inquinans (Pers.) Fr.
Corynella glabro-virens Boud., *B.*
Orbilia xanthostigma Fr.
Ciboria Sydowiana Rehm.

Sclerotinia Curreyana (Berk.) Karst., *N.*
Phialea firma (Pers.) Gill.
Chlorosplenium aeruginosum (Oeder.) de Not., *S.*
Helotium fructigenum (Bull.) Fuck., cyathoideum (Bull.) Karst., *C.*, scutula (Pers.) Karst., virgultorum (Wahl.) Karst.
Dasyscypha Soppittii Mass., *C.*
Trichoscypha calycina (Schum.) Boud., *H.*
Hyaloscypha hyalina (Pers.) Boud., *C.*
Urceolella puberula (Lasch) Boud.
Mollisia cinerea (Batsch) Karst., benesuada (Tul.) Phill.
Stegia Ilicis Fr., *C.*
Rhytisma acerinum (Pers.) Fr.
Empusa muscae Cohn, *N.*
Phytophthora infestans (Mont.) de Bary, *C.*
Peronospora parasitica (Pers.) Tul., *C.*
Cystopus cubicus (Strauss) de Bary, *Monsal Dale*, candidus (Pers.) de Bary, on *Arabis.*
Spinellus fusiger (Link) van Tiegh., *C.*
Pilobolus crystallinus (Wiggers) Tode.
Phoma complanata (Tode) Desm., on *Heracleum.*
Cytospora Laurocerasi Fuck.
Septoria graminum Desm.
Leptothyrium acerinum (Kze) Corda on *Acer campestre*, medium Cooke.
Oidium alphitoides Griff. & Maubl., *C.*
Cylindrium flavo-virens (Dittm.) Bon.
Trichoderma viride (Pers.) Fr.
Sporotrichum chrysospermum Harz., *C.*
Sepedonium chrysospermum (Bull.) Fr., *N.*
Ramularia calcea (Desm.) Ces.
Echinobotryum atrum Corda, *H.*
Botryotrichum piluliferum Sacc. & March.* on old sacking, *Baslow.*
Gonytrichum caesium Nees, *C.*
Cladosporium epiphyllum Mart., fulvum Cooke, on Tomato, *Baslow Hydro.*
Stysanus stemonites Corda, *H.*
Volutella nivea (Fr.) Sacc.
Epicoccum purpurascens Ehrenb., *N.*

* New to Britain. For description see New or Rare Microfungi to be published later.

MYCETOZOA FOUND DURING THE BASLOW FORAY.

By Gulielma Lister, F.L.S.

The visit of the British Mycological Society to Baslow had been arranged to take place from Monday, Sept. 22nd, to the following Saturday. Several of our party however arrived a few days earlier than the appointed time; and, owing to the railway strike, many were unable to leave at the end of the week; thus by the enforced extension of their visit a fuller opportunity was afforded for exploring the woods than had been anticipated. The weather for the previous weeks had been drier than the hunters for Mycetozoa could have wished, but on the whole a fair harvest of species was obtained.

On September 19th W. N. Cheesman searched some woods between Grindleford and Baslow, and found six species, including a good development of *Trichia verrucosa*. This species although it had been recorded from seven English counties, as well as from Wales and Scotland, is by no means common in the British Isles, and is a new record for Derbyshire. Mr Cheesman also obtained a fine gathering of *Cribraria rufa*.

On September 23rd the woods near Baslow were searched. These consisted of oak, ash, sycamore, poplar and beech, with some larch and Scots fir. Nineteen species were obtained. On fallen pine boughs *Didymium melanospermum* was abundant, and on the dead beech leaves amongst which the boughs were lying were found *Craterium minutum*, *Didymium nigripes* and *Lamproderma scintillans*. A large growth of *Craterium leucocephalum* occurred on dead oak leaves, and several gatherings of *Tubifera ferruginosa* were obtained in the rosy immature stage on old stumps.

On September 24th the party was conveyed by motor cars to explore three woods in the neighbourhood of Grindleford. In Highlow Wood the trees consisted of alder, birch, poplar, sycamore, larch and a little Scots fir; the moist peaty ground beneath was trenched with old draining ditches and rough with tussocks of *Aira caespitosa*. Thirteen species of Mycetozoa were found here, of which the most noteworthy were *Enteridium olivaceum*, forming small aethalia on dead sticks, a compact hemispherical aethalium of *Reticularia Lycoperdon* without any

enveloping cortex and showing distinctly the outlines of the component sporangia, and *Perichaena corticalis* abundant on the under surface of dead birch boughs lying among wet grass.

In Padley Wood, our lunching place, oaks clothed the steep sides of a ravine down which a stream fell in small cascades between fern-clad banks. Four species of Mycetozoa were found here, all on fallen boughs of oak: they were, *Comatricha nigra*, a minute form, *Arcyria nutans*, *A. pomiformis* and *Licea pusilla*; the sporangia of the last named species were, as usual, small and inconspicuous, matching in colour the dark decorticated wood on which they had developed. The spores proved to be unusually small, measuring 12 to 16μ, instead of 16 to 20μ, but were typical in colour and marking, being olive grey and very minutely warted all over. Stoke Wood formed a narrow strip beside the river Derwent, and consisted of sycamore and poplar with an undergrowth of dog's mercury, elder and rhododendrons. Of the three species found here the most striking was *Comatricha nigra* var. *alta* which formed conspicuous reddish brown patches extending over an area of six by twenty-four inches on the side of an old fencing plank: most of the sporangia were cylindrical on long slender stalks, but among them were globose sporangia with shorter stalks; the capillitium in all consisted of a tangle of sparingly branched flexuose threads attached chiefly to the base of the columella.

On September 25th we visited the timber yard and explored the woods and gardens of Chatsworth. Seventeen species were obtained, of which ten were found in the timber yard. Here *Fuligo septica* was very abundant on old pine trunks, and also *Arcyria nutans*. *Physarum psittacinum* and *Stemonitis ferruginea* were also found on these logs, in good condition; both are new records for Derbyshire. The fine old oaks, survivors of the giants of Sherwood Forest, scattered over grassy and bracken-covered slopes, yielded two interesting Mycetozoa, viz. *Cribraria rufa*, a species rarely found on any but coniferous wood, and a form of *Liceopsis lobata* having some sporangia stalked, globose and free, and others sessile and closely clustered.

Rough slopes of peaty soil above the Chatsworth gardens, clothed with cushion-like growths of the moss *Campylopus pyriformis*, recalled similar habitats in Epping Forest where *Colloderma oculatum* had repeatedly been obtained. No trace of this species was found at the time, but lumps of the mossy soil were brought away and kept moist; after a fortnight a sporangium of *Colloderma* made its appearance and was soon followed by others until after two months over thirty sporangia had developed.

A visit to the sawpits in the Chatsworth grounds on October 26th resulted in several additions to our list, among them being *Lindbladia effusa* found on sawdust, a species rare in England but obtained in the same locality during the visit of our society to Baslow in May, 1915.

On September 27th the woods called "New Piece" in the Chatsworth grounds were explored, when the most interesting finds were *Hemitrichia clavata*, and the conspicuous red sporangia of *Arcyria Oerstedtii*.

Two of our members visited later Calton Wood, on the Bakewell Road. Here, amongst other species, a small *Comatricha* was obtained on dead wood, agreeing on the whole with *C. elegans* in having the columella divided above to form the primary branches of the capillitium. Some of the sporangia however resemble *C. nigra* in having the columella unbranched and tapering upwards. The two species are undoubtedly very closely allied. Another interesting specimen was obtained by Mr Rea in Cheedale. He found there on a plant of *Mimulus Langsdorfii* growing in the river Wye a perfect development of *Physarum didermoides* var. *lividum*; this well-marked variety had only been recorded before with certainty from the counties of Bedfordshire, Buckinghamshire and Sussex, and always on old straw. In the present gathering we have a new record for Derbyshire and a new habitat for the species. As the plant to which the sporangia were attached was completely surrounded by running water we must infer that the plasmodium had been living under water before it crept up the Mimulus stalk to fruit. It is well known that a plasmodium can in special cases become adapted to submerged conditions, and may even thrive there, but such instances have rarely been met with in the field.

During the two previous forays at Baslow in September 1901 and May 1915, forty-four species of Mycetozoa were obtained altogether; during our recent foray forty-five species were collected, fifteen of which do not appear in the previous lists and appear to be new records for Derbyshire; they are distinguished by an asterisk in the following list.

B. refers to Baslow Woods, *C.* to Chatsworth, *Ca.* to Calton Wood, *G.* to Grindleford, *H.* to Highlow Wood, *P.* to Padley Wood, *S.* to Stoke Wood.

Ceratiomyxa fruticulosa (Müll.) Macbr., *B.*
Physarum nutans Pers., *B.*, *C.*, *H.*, subsp. *leucocephalum* Lister, *B.*
P. viride (Bull.) Pers., *H.*, *Ca.*
**P. psittacinum* Ditmar., *C.*

**P. didermoides* (Ach.) Rost., var. *lividum* Lister, *Cheedale.*
Fuligo septica (L.) Gmel., *B., C.*
Craterium minutum (Leers) Fries., *B., S.*
C. leucocephalum Ditmar., *B.*
Didymium nigripes Fries., *B., C.*
**D. melanospermum* (Pers.) Macbr., *B.*
D. squamulosum (A. & S.) Fries., *B., C.*
Mucilago spongiosa (Leyss.) Morg., *B.*
**Colloderma oculatum* (Lipp.) G. Lister, *C.*
Stemonitis fusca Roth., *B., C.*
**S. herbatica* Peck, *C.*
**S. ferruginea* Ehrenb. *C.*
Comatricha nigra (Pers.) Schroet., *B., C., G., H., P.*, var. *alta* Lister, *S.*
**C. elegans* (Rac.) Lister, *Ca.*
**C. typhoides* (Bull.) Rost., *C.*
Lamproderma scintillans (Berk. & Br.) Morg., *B., C.*
Lindbladia effusa (Ehrenb.) Rost., *C.*
Cribraria argillacea Pers., *B., Ca.*
C. rufa (Roth.) Rost., *C., G.*
C. vulgaris Schrad., *C.*
**Licea pusilla* Schrad., *P.*
Tubifera ferruginosa Gmel., *B., H.*
Enteridium olivaceum (Ehrenb.) Rost., *H.*
Reticularia Lycoperdon Bull., *C., H.*
**Liceopsis lobata* (Lister) Torr., *C.*
Lycogala epidendrum (L.) Fries., *H.*
**Trichia verrucosa* Berk., *G.*
T. affinis de Bary, *C.*
T. persimilis Karst., *B.*
T. varia Pers., *B., C., G., H.*
T. decipiens (Pers.) Macbr., *S.*
T. Botrytis Pers., *C., H.*
**Hemitrichia clavata* (Pers.) Rost., *C.*
Arcyria cinerea (Bull.) Pers., *H.*
**A. pomiformis* (Leers) Rost., *B., C., G., P.*
A. denudata (L.) Wettst., *B., C., H.*
A. incarnata Pers., *B., C., Ca.*
A. nutans (Bull.) Grev., *C., P.*
**A. Oerstedtii* Rost., *C.*
Perichaena corticalis (Batsch) Rost., *G., H.*
**P. depressa* Lib., *G., H.*

During the meeting some of our members exhibited interesting specimens which they had recently collected. From the Lake district Dr Adams brought a large growth of *Badhamia rubigi-*

nosa (Chev.) Rost. var. *globosa* Lister, on moss, a form of *Physarum globuliferum* (Bull.) Pers. showing in its pale drab tint an approach to the nearly allied *P. murinum* Lister, *Comatricha laxa* Rost., *Lachnobolus congestus* (Somm.) Lister and *Margarita metallica* (Berk. & Br.) Lister. Mr Knight exhibited a fine development of *Badhamia lilacina* (Fr.) Rost. found in the plasmodium stage on Sphagnum in a bog in North Wales.

LICHENS OF THE BASLOW FORAY.

By A. Lorrain Smith, F.L.S.

The members of the Mycological Society naturally place fungi in the first rank for collection, and districts are chosen for the annual foray in which the fields and woods are likely to yield good gatherings of these fleeting plants: lichens have therefore not been considered in the choice of locality. They flourish only in pure air, and at Selby, in the 1918 foray, their absence was very striking, and was due to the smoke-clouds from manufacturing towns near-by. Better times for lichenologists were expected from Derbyshire, but Baslow lay within the influence of Sheffield smoke and lichens again were scarce. The atmosphere seemed to be absolutely pure, but the presence of sooty impurities was amply manifested by the condition of one's hands after a few hours' collecting.

The first day's excursion, in the immediate neighbourhood of Baslow, yielded the best results. On the stone walls by the road-side, there were numerous specimens of *Placodium flavescens* and allied yellow forms. *Lecanora muralis* and *L. parella* were also found; many of the stones were coated with an undeveloped powdery white thallus. *Cetraria glauca* was curiously abundant on some of the scattered boulders. Higher up on the moor, *Sphaerophorus globosus* was collected, with various poorly developed *Cladoniae* and, on the bare soil, *Lecidea granulosa* and *L. uliginosa*. Chatsworth Park proved especially disappointing, as the trees, which in more favourable conditions would have been covered with lichen growths, were quite bare. *Lecidea fuliginea* was noted on dead timber. Other species collected and determined during the expedition were *Lecanora varia, Parmelia perlata,* with var. *ciliata, P. omphalodes, P. physodes, Cetraria aculeata, Cladonia coccifera, C. fimbriata* and *Baeomyces rufus.*

PLANT SANITATION IN FRUIT PLANTATIONS*.

By F. T. Brooks, M.A.

(University Lecturer in Botany, Cambridge.)

The ideal variety of apple or plum for growth on a commercial scale is one which crops heavily and regularly, is of good quality, and is resistant to disease. Unfortunately it is as rare in the case of fruit trees as in other cultivated plants, for all these desirable qualities to be combined together. Many of the best market varieties of apples and plums are subject to serious attacks of fungoid or insect pests, and it often happens that the most valuable commercial varieties are those which suffer most from disease. Indeed, certain diseases, e.g. canker in apples and silver-leaf in plums, may threaten the very extinction of some varieties grown on a large scale, unless measures are taken to control their ravages. Hence fruit growers must of necessity spend considerable time and money in combating disease unless they are prepared to see their plantations become derelict. Whenever a crop is grown on a large scale and is forced to its best efforts towards productivity, disease will frequently tend to increase beyond the normal unless drastic measures are taken to deal with it on its first appearance. If neglected, disease becomes cumulative and in its latest stages often assumes the character of an epidemic even though the particular malady is not one of an essentially epidemic nature.

Plant diseases, like human ailments, can be dealt with in various ways. The best means of dealing with disease, if one may so put it, is to avoid it altogether. With cultivated plants, this desirable end can usually only be achieved by obtaining varieties which are immune or very resistant to the most serious pests, whether insect or fungoid. Thus in apples, 'Bramley's Seedling' is very resistant to canker, and in plums 'Pershore' is almost entirely immune from silver-leaf. With certain human diseases, e.g. small-pox, an artificial immunity can be conferred by vaccination, but similar methods of establishing immunity in plants cannot yet be applied, chiefly because there is nothing comparable in plants to the blood stream in man with all its latent healing properties circulating rapidly through the body.

* A paper read at the Eastern Counties Fruit Growers Conference, November 1919.

It often happens that varieties of cultivated plants which are specially resistant to disease are poor in quality or in cropping power. The plant pathologist and the cultivator here look for the assistance of the expert plant breeder to make the necessary desirable combinations. As is well known, this has already been done with many annual plants, especially the cereals, with great success, and one looks forward to the time when similar developments will take place with perennial plants such as fruit trees, although success in this direction will necessarily be slower. Again, it does not follow that because a plant is immune from one disease that it escapes attack from other diseases. Thus, Lord Derby apples which are resistant to ordinary canker are liable to serious damage by blossom-wilt, and Pershore plums which are practically immune from silver-leaf are often attacked by the fungus *Fomes pomaceus*—which, however, is fortunately far less destructive than *Stereum purpureum*. It is, therefore, a counsel of perfection to advocate the selection of varieties which are not affected by disease, and so means have to be devised and set in operation for attacking fungoid and insect pests as they appear.

In human illnesses, medical means are often applied to effect a cure. Thus some drug is taken, or injected into the blood, which either exerts a stimulative action enabling the body to throw off the malady, or which, by some directly poisonous effect, kills the parasitic organisms that are the cause of the disease. In plant pathology, however, medical treatment by internal application can only rarely be applied with any hope of success, chiefly, as already stated, because the higher plants possess nothing comparable to the blood stream of animals, the movements of sap in the former being essentially different from the latter. There is, however, a mode of dealing with certain insect and fungoid pests which is of the greatest importance to fruit-growers, and which can be compared in some respects to medical treatment. I refer to spraying with insecticides and fungicides —in the use of which fruit-growers, from the time when the vine-growers of France first began to use copper compounds as a means of protection, have always been the pioneers. As is well known, insecticides are usually most potent when applied just as the pest is emerging from the resting state or at any rate before the insect is abundant in an active condition, but many fungicides must be applied before the appearance of the fungus in an infectious form in order for the leaves and stems to be protected from penetration. Certain pests and diseases, such as aphis in plums and scab in apples, can be entirely, or almost entirely, controlled by spraying. It is not proposed to deal further with the subject of spraying in the present paper, except

to say in passing that much money is sometimes wasted by spraying at the wrong time.

Finally, there are the surgical and hygienic means of dealing with plant diseases. At a time when hygienic measures are assuming increasing importance in the medical profession, it is of interest to point out that these twin phases of plant sanitation have long been the mainstay of the plant pathologist, and probably will long continue to be. Fruit trees in particular lend themselves to surgical treatment when attacked by certain diseases. It is not the case here that if one member of the plant body suffers, all the other members suffer with it, for the unruly limb of a fruit tree can be severed with nothing but benefit accruing to the remainder of the tree. Fire is the strongest weapon in the armoury of the plant pathologist, and notwithstanding that its frequent use in this connection is sometimes slightingly referred to as a primitive and unscientific weapon, and not at all in keeping with the elaboration of the twentieth century, it is undoubtedly the surest destroyer of disease that exists. In plant sanitation, one aims at the eradication of the sources of infection. This is a point of view which should be kept constantly in mind by the cultivator. It may be urged that it is impossible to eradicate completely the sources of infection in the case of the commonest plant diseases. Be that as it may, and certain human diseases such as yellow fever have been wiped out in parts of the tropics solely by the application of sanitary measures, conviction is firm that many of the most serious fungoid pests can be greatly reduced by destroying their breeding grounds which are still often left either within or near fruit plantations. It is a well known fact in medical science that in diseases of parasitic origin like malaria and tuberculosis the magnitude of the dose, so to speak, of the parasite frequently determines whether disease is established or not. If only a few germs are absorbed, the parasite may not be able to establish itself, while if many are taken in, disease will develop rapidly. The same factor operates with certain plant diseases, and many growers here must be familiar with plum orchards which, through neglect in the eradication of branches bearing *Stereum purpureum*—the cause of silver-leaf disease, succumbed in the later stages with amazing rapidity. In such cases, probably the most potent factor is the great abundance of spores shed by the fungus in the immediate vicinity.

The first principle of sanitation in fruit gardens is to avoid as completely as possible any harbourage for the breeding of insect and fungoid pests. This postulates the cutting off of branches which are dying back and their speedy destruction on the spot by fire, or removal from the plantation. If the severed

branches are allowed to remain in the plantation, the fungus which killed them will soon fructify and shed its spores around in the same way as if still attached to the standing tree. Large wood piles are often seen in fruit plantations forming excellent breeding grounds for such a destructive pest as *Stereum purpureum*. In these days of fuel shortage there should be no difficulty in disposing of wood cut out in this way. Not long ago I saw a gigantic pile of red currant prunings in the midst of a large area of red currants, the prunings being literally smothered with the pink fructifications of *Nectria cinnabarina*, which, as many fruit growers know to their cost, is becoming increasingly destructive to red currants. There is no reason why these prunings should not have been burnt as soon as collected. In cutting out diseased branches, action must be sufficiently drastic to ensure that the downward limit reached by the fungus is excised. This is particularly important with silver-leaf disease, the region penetrated by the fungus being marked by a brown discolouration in the wood, which is often a considerable distance below the silvered foliage. In this connection mention may be made of a case seen during the summer: the branches of certain silvered 'Lord Grosvenor' apple trees had been cut back, but not far enough, as the fungus *Stereum purpureum* was developing in quantity from each of the exposed extremities. We have not infrequently seen silvered trees the upper parts of which have been lopped and the trunks left standing and bearing enormous quantities of *Stereum*. Such a practice cannot be too strongly condemned. Where large branches are severed, the exposed surfaces should be made smooth and covered with tar to prevent the ingress of wound parasites. While on the subject of branch infection by silver-leaf, it may be mentioned that it is usually the wisest economy to cut out silvered branches as they appear, i.e. before they die back; there is then not the slightest opportunity of the fungus fructifying through delay in cutting out the dead wood.

With other diseases there is often no means of telling that a parasite has entered the tree until the branches begin to die back and fructifications of the fungus appear. This is particularly the case with the die-back of plums and cherries caused by the fungus *Cytospora leucostoma* and the affection of plums due to *Fomes pomaceus*. In such, drastic action can only be taken upon the appearance of the first external signs of disease, when the greater part of the trees can often be saved, if excision is effected judiciously. While dealing with the subject of excision, it is recommended that, in soft-wooded varieties such as the 'Victoria' plum, the branches of which frequently break through overcropping, broken limbs should be cut back flush

with a larger branch or main stem immediately after removal of the fruit. It is the ugly wounds of broken branches which offer special facilities for the entrance of wound parasites such as *Stereum purpureum*.

Where a tree is dying back to such an extent that its loss is inevitable, it is important that the stump should be removed if possible at the time of felling. Unlike the forester, the fruit-grower is little troubled by the action of root parasites, but nevertheless the stumps and the larger roots should be removed in order to prevent the growth of suckers and for the future convenient working of the plantation. If the stump cannot be removed, it should be covered with soil to prevent the development of dangerous fungi such as *Stereum*. In the case of plum trees removed on account of silver-leaf disease one has always hitherto hesitated to suggest the planting of other susceptible varieties of plum on the same site, but during the past summer considerable areas have been seen in which young 'Victoria' plums have been planted where older silvered trees have been removed; these young trees have remained healthy up to the present, i.e. for a period of 2 or 3 years. Although one is not in a position at present definitely to recommend this course, there seems to be no undue risk in replanting with the same variety, if this is desirable for other reasons, and provided the stumps of the diseased trees are removed.

As time proceeds, greater care will probably be devoted to the control of such diseases as brown rot of apples and plums which in certain seasons levy a heavy toll on the fruit. In the main, this trouble is carried over from season to season by fruits which, mummified by the action of the fungus, hang upon the trees during the winter or lie on the ground. Where brown rot is liable to be severe, it would be worth while to have these mummified fruits collected and destroyed during the winter. Another closely allied disease, the blossom-wilt which Wormald has shown severely affects 'Lord Derby' apples, can be dealt with by the excision of the affected spurs. It has been demonstrated that this operation of removing the diseased spurs is commercially profitable. Again, the common scab fungus, *Fusicladium dendriticum*, usually hibernates in the young twigs of the most susceptible varieties of apples, and while pruning is being done, care should be taken that all the twigs which show small pustules in the bark should be cut off. With the common canker caused by *Nectria ditissima* it is generally recognised that this disease is chiefly dependent upon the nature of the variety and the conditions of the soil. There is evidence too that the influence of the stock is not inconsiderable in this connection. The wise fruit-grower will therefore select his varieties accordingly.

Excision of cankered areas is undoubtedly profitable in some cases, particularly in young trees, as this trouble, like most others, becomes cumulative if neglected.

Care must be taken to prevent the development of dangerous fungi not only within the plantation but also in its immediate vicinity. On more than one occasion I have seen silvered sloe trees with the fungus *Stereum purpureum* developing on the dying branches, in hedges bordering plum plantations. It is obvious that such trees should be removed, as well as any other, such as laburnum, which happen to develop silver-leaf disease. The stumps of elm trees in hedgerows are a prolific source of the same species of *Stereum* and it is known that the fungus from this source is just as dangerous in causing silver-leaf as is *Stereum* taken from a dying 'Victoria' plum. Stumps of practically all broad-leaved trees with the exception of oak are liable to give rise to profuse growths of this fungus. Such stumps should be eradicated, charred, or covered with soil if they are on the borders of fruit plantations. Fruit gardens situated in the midst of agricultural land are more favourably placed as regards danger of attack by wound parasites than are plantations near woods, in which most of these fungi find an excellent harbourage. There is no excuse, however, for such a practice as that of making fences of plum wood around fruit plantations. That is simply asking for trouble. I once saw a fence, made of plum wood, separating one plum plantation from another, which was literally covered with the fructification of *Stereum purpureum*. Can it be wondered at that silver-leaf disease was rife in both these gardens? In another place, a number of half-standard plums were tied up to stakes made of birch stems on which *Stereum* was developing in abundance.

With a few diseases such as plum rust and black currant rust, the fungus completes its life on two different kinds of plants. Thus in the plum rust, the fungus lives indefinitely in the perennial parts of the commonly cultivated Anemone, *Anemone coronaria*, in the leaves of which spores are produced in the spring, which in turn affect plum leaves. Unless, therefore, the diseased anemones are eradicated, there is no means of preventing attacks of plum rust in the immediate vicinity. Some years ago, I saw a very severe attack of plum rust in fruit orchards near a florist's garden in which diseased anemones were known to be present. So severe was the plum rust that the trees were defoliated by the end of August. More recently, the florist's garden has been converted to other purposes and plum rust has been scarcely noticeable in the vicinity. One is strongly inclined to suggest cause and effect as operating here. With black currant rust, in which the effect of a bad attack is

less noticeable, the alternate stage of the fungus grows upon Weymouth pines, which it gravely injures. Here again diseased Weymouth pines should not be allowed to occur in the neighbourhood of fruit gardens. If a comprehensive system of inspection of plant diseases is ever instituted in this country, these are two of the diseases which will have to be kept under observation, for although they are not at present a menace to the fruit-grower, they have dangerous potentialities.

The remarks just made with reference to market plantations apply with even more force to nursery gardens. The nursery is the foundation of all sound fruit growing, and this country is fortunate in possessing many firms of nurserymen who have the highest possible sense of responsibility to their customers. If one imagines what might have been distributed by way of disease and by poor quality stocks by untrustworthy people, the effective manner in which the nurseries have firmly established the market fruit-growing industry in this country will be at once recognised. Nurserymen should deal even more drastically with disease than the market grower. If silver-leaf happens to appear, the affected plants should be immediately burnt. It must be recognised that some of the operations carried out in the nursery necessarily entail a risk of infection by wound parasites. Thus in budding and grafting, the exposed tissues may be penetrated by *Stereum purpureum* with the result that silver-leaf disease develops. It is sometimes the practice in budding young nursery stuff to leave a long stub belonging to the stock, to which the developing bud can be tied, thus obviating the necessity of staking. While this practice is almost entirely innocuous with apples, it is fraught with some danger to plums and peaches, especially if these are worked on the 'Brompton' stock which, it is well known, is very susceptible to silver-leaf. It would probably be a sounder practice to cut back the stub, cover the exposed end with grafting wax or with an antiseptic, and tie the developing bud to a stake. That great care is taken generally by nurserymen in eradicating silver-leaf if it happens to appear in the nursery, is evidenced by the fact that it is very rare to see silvering in plum trees under 5 years of age.

Persons who only occasionally grow stocks and work them may perhaps take less care in avoiding disease than the regular nurseryman. Statements have been made that silvered suckers are sometimes taken from diseased plum plantations to be used as stocks, and although reputable nurserymen would not countenance such a practice, provision should certainly be made to prevent the possibility of silvered suckers being used as stocks. If any wide system of nursery inspection is contemplated

in the future, care must be taken, in fairness to the established firms, that those persons who grow stocks for a year or two spasmodically are also subject to its provisions.

There remains to be discussed the best time for carrying out these operations. Whenever a disease is seen, the motto "Do it now" applies with great force to whatever measures may be contemplated. If labour conditions permit, the best time for action on the above lines is during the summer when there is a clear differentiation between healthy and diseased branches. Furthermore, the wounds made by severing branches then have a chance of partly healing before the winter. Action during the early summer is specially important in dealing with silver-leaf, because it is well known that the fructifications of *Stereum purpureum* are produced in greatest abundance on the dead wood during the latter part of the summer and autumn. While pruning and thinning out are taking place during the winter a second opportunity is afforded of dealing with some of the pests which have been briefly mentioned. If, however, labour conditions do not permit of cutting out dead wood during the summer, excision must be left until the autumn and winter.

In large areas of fruit there is a great deal to be said for placing the operations of plant sanitation, spraying, and pruning in the hands of an expert with a gang of men under him. The expert is often anathema to the practical man, but the time seems to have come in large market fruit-gardens, when there is a great deal to be said in favour of a division of labour, the respective portions of the work being in charge of men of special training. In districts where small fruit plantations are the rule, much might be done in the same way by co-operative effort. In the case of the rubber plantations of the East—of which I happen to have some knowledge—there is upon every estate of importance what is known as a pest gang whose sole duty is to watch for and treat disease as soon as it appears. This pest gang is either officered or supervised by a European under whom are one or more intelligent natives who direct the coolies as to what is to be done. In the tropics, sanitary measures of the same kind as those outlined above, are considered of the greatest possible importance, and one of the chief anxieties of the managers of these estates is in seeing that the pest gang is adequately doing its work. Of course most of these rubber estates are much larger than fruit gardens in this country—many of them exceed 1000 acres, but so important is the question of combating disease now considered to be, that some of the largest estates employ a fully trained plant pathologist in an advisory capacity, in addition to the Government staff which is always available. As stated above, there is much

reason in the fruit-growing industry for placing spraying, pruning, and sanitary measures in the hands of a separate labour unit controlled by a man with special knowledge.

Although particular stress has been laid upon certain sanitary measures in controlling some of the diseases that attack fruit plantations, other measures such as winter washing, and grease banding, are of equal importance in diminishing the activities of certain pests, but these subjects have often been dealt with and there is no time for their consideration now. Of primary importance too in the well-being of fruit gardens are adequate drainage, sufficiently wide spacing of the trees to allow of the free circulation of light and air, and reasonably good cultivation of the soil. On the last topic one word may be ventured. It is known that rapidly acting nitrogenous manures induce a succulent type of growth which readily falls a prey to fungoid disease, while on the other hand slow-acting manures such as basic slag and shoddy tend to promote growth in the trees, which rapidly ripens and is less susceptible to parasitic attack.

It may be asked whether the sanitary measures dealt with in this paper are economically sound. The universal test of every commercial operation is the question whether it pays or not. It may be urged that in the long run greater profits will be made where diseases are allowed to run their course in view of the cost of the operations briefly described in this paper. But he would be a bold man to-day who ventured to assert this, and all who have seen plantations of 'Victoria' plums rendered completely derelict by neglect of silver-leaf disease will agree in stating that sanitary measures in fruit gardens are worth while and serve as the best means of insurance for the future. Progressive fruit-growers have long recognised this, but their efforts towards cleanliness in their plantations are sometimes partly discounted by apathy on the part of their neighbours. Those growers, for instance, who neglect silver-leaf disease are a menace not only to themselves, but to their fellow cultivators. The time has come when a person who allows trees killed by silver-leaf disease to remain standing and be the means of propagating the insidious fungus which causes it, will be looked upon as committing a nuisance for which there must be pains and penalties. Public opinion amongst fruit growers, however, can do more good towards introducing proper treatment for the troubles occasioned by disease than all the legislation in the world. It is a pleasure to note that a healthy public opinion in this respect is rapidly developing amongst fruit growers.

With silver-leaf disease, measures of plant sanitation can alone be used at present as a means of control. These measures are simple and easy to carry out, and I am convinced after much

experience of the disease and its treatment, that the disease can be effectively controlled in this way. Silver-leaf and similar troubles are sometimes looked upon as "Acts of God" for which there is no treatment, or else alarm is raised and some nostrum is requested in a hurry which will cause recovery in trees that are already doomed and dying. The cry has been raised that the cultivation of the valuable 'Victoria' plum will be wiped out by the spread of silver-leaf disease. Nothing of the kind—that is, if the measures advocated in this paper are effectively pursued. Where plantations of 'Victoria' plums have been killed by this disease, there has always been terrible neglect, but one hopes that such gardens will soon cease to exist in all the important fruit-growing districts of the country.

A DRAIN-BLOCKING FUNGUS.

By A. Lorrain Smith, F.L.S.

In September 1919, material was submitted to me that had been taken out of a sewer in the City of London 30 feet below ground, and under the vaults of a bank previously the site of Crosbie Hall. The whole mass weighed about ½ cwt. and had completely closed the drain-pipe. The substance was sodden with water and of a uniform brownish-yellow, but there was no difficulty in recognising its fungus nature and that it was a *Fomes*. As the fungus dried, layers of white pileus and long cinnamon-coloured tubes became visible. The specimen was exhibited a few days later to the members of the Mycological Society at their annual meeting at Baslow, and Mr Carleton Rea unhesitatingly pronounced it to be *Fomes ulmarius*, a fungus which has always been considered to grow on elms.

There is at the present date no living elm in the neighbourhood of Crosbie Square. Search was made, while tunnelling to remove the obstruction, for any material on which the fungus could have originated; the gap in the pipes was found by which the fungus had penetrated into the pipe; and near to this lay a piece of timber of coniferous wood. The wood was fairly rotten and the cells occupied by mycelium, but there was no sufficient evidence that the fungus had any connection with this wood. Mr Rea tells me that elm roots travel long distances and he has had experience of drains being blocked by the roots of an elm tree

50 or 60 yards away. It may be that remains of elm roots or timber are present in the soil. It might also be possible that the fungus had lived on the coniferous wood. The *Fomes* was found in four different places; it has now been removed at great cost and trouble.

STUDIES IN DISCOMYCETES II.

By Jessie S. Bayliss Elliott, D.Sc. (Birm.), B.Sc. (Lond).

5. *Dasyscypha conformis* (Cooke) Sacc.

During the last two years I have often found on the dead stems of rushes *Erinella apala* (B. & Br.) Sacc. growing very plentifully and also *Dasyscypha conformis* (Cooke) Sacc.; sometimes both were growing together on the same clump of rushes. Massee (British Fungi, Vol. iv. p. 334) states that the latter species was unknown to him and also that he was unable to find the type specimen in Cooke's herbarium. Both Discomycetes are very similar except in microscopic characters, but after meeting the two frequently, one recognises readily with a hand lens *D. conformis* by its larger size and its sessile or very shortly stipitate form (fig. 3). It has been suggested that *D. conformis* might be an immature form of *E. apala*: but after studying both species I find the microscopic characters of the two very distinct.

Since Cooke's description of *D. conformis* copied by Massee is very incomplete and also has inaccurate spore measurements, I think it would be useful to describe the fungus again.

D. conformis. Gregarious or scattered, sessile or very shortly stipitate, ·75–1 mm. diameter, cupulate becoming plane, fawn colour, covered with short, wide, colourless, obtuse, clavate, aseptate hairs filled with oil drops when fresh; excipulum parenchymatous, cells oblong; asci subcylindrical, 65–70 × 7μ, apex obtuse, spores slenderly lanceolate 14–20 × 1·5μ, one or two seriate, straight, sometimes slightly curved; paraphyses acerose, exceeding the asci, some narrow, others wide—5μ, filled with oil drops when fresh (figs. 3, 4, 5, 6).

E. apala is distinguished from the above by the much longer spores arranged in a fascicle, the septate paraphyses which project further above the asci than do those of *D. conformis*, and also by the long narrow tapering hairs which surround the margin and cover the excipulum, and which form a sharp contrast to the obtuse clavate marginal hairs of *D. conformis* (figs. 7, 8.)

6. *Orbilia leucostigma* Fr., v. *xanthostigma* (Fr.) Rehm.

I have found this fungus very frequently growing luxuriantly and examined many specimens, also I have had it under observation while growing for many months. The form of the spores is described as elliptical or egg-shaped by Massee, Rehm and Saccardo; this description is misleading and incomplete since they are decidedly U-shaped: when the two ends of the U are in view the spores appear as two circles (o o) and only when the curved top of the U is in focus can they be called elliptical (figs. 9, 10). In Boudier's Icones they are figured as U-shaped.

This fungus seems to me identical with *O. coccinella* (Somm.) Fr. the spores of which are said to be slightly wider, being given as 3–4 × 2μ, thus having only a trifling difference from 3–4 × 1·5μ (Massee) or 3–4 × 2–3μ (Boudier), the measurements of *O. leucostigma* v. *xanthostigma*; also the colour distinction is insignificant. *O. coccinella* is described as blood red or deep orange red while *O. leucostigma* v. *xanthostigma* is said to be yellow with sometimes a tinge of red when fresh. The specimens which I find usually vary from yellow to deep orange and often there is a sprinkling of whitish translucent forms among them while, when dry, a blood red colouration is usual, but this varies and is sometimes yellow; I have seen them just as blood red as those figured by Boudier as *O. coccinella*.

Although Boudier figures spores of *O. coccinella* as ellipsoid, in Engler and Prantl two figures of the spores are given, the one (profile view) showing a very curved, almost a U form, the other elliptical; thus all characters considered there is no real distinction between *O. leucostigma* v. *xanthostigma* and *O. coccinella*.

7. *Pyrenopeziza plicata* Rehm (= *Mollisia plicata* (Rehm) Sacc. sec. Boud.) f. *conicola*.

Ascophores scattered and crowded, $\frac{1}{2}$–$\frac{3}{4}$ mm. diameter, sessile, or when young very shortly stalked, closed and almost globose at first, becoming saucer-shaped or even repand when old; disc greyish, margin whitish, fimbriate, hairs septate and obtuse; excipulum olive brown or blackish, parenchymatous, rough with rounded hair-like outgrowths from the cortical cells, often more or less vertically wrinkled; asci cylindrical, apex somewhat narrowed, 80 × 6μ; spores oblong, fusiform, hyaline, continuous, straight, or slightly curved; two seriate; 10–12μ × 2μ; paraphyses slender, hyaline, equal, 2μ wide and same length as the asci (figs. 11, 14, 15, 17).

The apothecium is often attached to the substratum by a fringe of colourless hyphae (fig. 11*a*).

Habitat. Cones of *Pinus sylvestris*. Tanworth-in-Arden.

This is closely allied to *P. Mercurialis* (Fuck.) Boud., and also to *Mollisia atrata* (Pers.) Karst., with its numerous varieties, and allied species whose habitats are herbaceous stems.

Growing on the same cone in close relation with this Discomycete were crowds of small black pycnidia belonging to the genus Phoma and on the older specimens of these the young apothecia of the Discomycete could be seen, growing either out of the top or the sides (fig. 11); the inference seems justifiable that these pycnidia are the conidial stages of the Discomycete; the external appearance of the pycnidia even in microscopic detail resembles that of the Discomycete.

The pycnidia are erumpent and in many instances a scar similar to the one seen in connection with the pycnidium was also to be seen below the apothecium (fig. 11).

PHOMA CONICOLA. Pycnidia erumpent, gregarious or scattered spherical, ·2 mm. diameter, sessile, olive brown or black, excipulum parenchymatous, rough with round hair-like outgrowths from the cortical cells, similar to the excipulum of *Pyrenopeziza plicata* Rehm f. *conicola*, at first closed, then open, margin fringed with septate colourless hairs which converge: pycnospores colourless, oblong $3 \times 1–1{\cdot}5\mu$, some slightly bent, continuous, situated on short conidiophores, arising from the walls of the pycnidium (fig. 11*b*, 12, 13, 16, 18).

Habitat. Fallen cones of *Pinus sylvestris*. Tanworth-in-Arden.

Under very moist conditions the pycnospores ooze out and form a glistening white ball on the top of the pycnidium: this elongates, topples over and the pycnospores are dispersed in the surrounding moisture: they germinate within twenty-four hours in rain-water (fig. 18).

The pycnidia need far moister conditions for development than the apothecia, and by varying the humidity of the moist chamber containing a cone on which both of these forms were growing, either the one or the other prevailed.

Pyrenopeziza plicata Rehm has previously been found in Britain, but apparently not recorded. I have seen specimens from the herbarium of W. B. Grove collected by him at the Edge Hills on dead *Angelica* stems, 1884, and by C. B. Plowright collected at Kings Lynn on some dead herbaceous stems in 1873.

PHOMA CONICOLA n. sp.

Pycnidia gregaria vel sparsa, erumpentia, sphærica, 0·2 mm. diam., sessilia, olivaceo-brunnea vel nigrescentia, excipulo parenchymatico, vesiculis e cellulis extimis oriundis obsito, ei Pyrenopezizæ simillimo, primo clausa, dein aperta, margine pilis achrois septatis convergentibus fimbriato. Sporulæ

achroæ, oblongæ, 3 × 1–1·5μ, interdum curvulæ, continuæ, sporophoris brevibus suffultæ.

8. *Hyalinia Leightoni* (Phill.) Boud. v. *lignicola.*

Scattered or crowded, confluent, sessile, glabrous, diaphanous, translucent, depressed or almost plane 1 to 1·5 mm. diameter; when dry angularly contracted with margin sometimes raised; hymenium whitish, excipulum parenchymatous and fuscous: asci cylindrical, apex narrowed 100 ⁄ 8μ; spores 8–13 × 2·5–3μ, elliptical with blunt ends, irregularly one or two seriate; paraphyses filiform, branched, same length as asci, ·5μ wide (figs. 1, 2, 28, 29, 30).

Habitat. Decaying wood. Plowden near Shrewsbury, Sept. 1917.

This fungus seems to differ very little from *Calloria Leightoni* found by Phillips growing on a Polyporus, and which does not appear to have been seen since: it seems advisable however to consider it a variety as the substratum is very different, and the colour fuscous instead of yellow or white.

9. *Calloria extumescens* Karst.

Gregarious or often confluent, ·3 to ·5 mm. diameter, sessile, globose at first becoming plane or slightly concave, glabrous, sub-gelatinous when moist, excipulum formed of anastomosing hyphae, bright yellow when young, becoming flesh coloured or reddish brown; asci cylindrical clavate, 60 × 6μ; spores hyaline continuous or uniseptate (rarely more) 10–13 × 2μ, elliptical, ends rather acute; paraphyses filiform, 1–1·2μ (figs. 23, 24, 25, 26, 27).

Habitat. On decaying oak. Bomere near Shrewsbury, Sept. 1917.

This agrees with Karsten's description of *C. extumescens* but according to Rehm the excipulum should be parenchymatous. Karsten does not describe the excipulum.

This fungus is also near *Mollisia Mali* (Rehm) Phill. (= *Urceolella Mali* (Rehm) Boud.) but differs in the confluent apothecia, the uniseptate spores, which sometimes even have two septa, also the colour which although bright yellow when quite young becomes flesh-coloured and reddish brown later.

10. Mollisia Populi n. sp.

Gregarious, sessile, saucer-shaped, becoming plane and revolute, 1–2 mm. diameter, hymenium grey when young, pinkish or ochraceous when older; excipulum grey with an olive tinge, parenchymatous, margin fimbriate, asci cylindrical, 90–100 ⁄ 7–10μ, apex narrowed, short pedicel, spores two

seriate, hyaline, narrowly fusiform, straight or slightly curved, continuous, one septate, 20–25 × 2–3μ; paraphyses containing oily protoplasm in the terminal cell, hyaline, stout, septate, thickened upwards to 7–8μ wide, apex narrowed length not exceeding the asci.

Habitat. On dead twigs and branches of poplar. Tanworth-in-Arden.

This fungus has some points of resemblance with *M. atrata* (Pers.) Karst. v. *eupatoricola* (Phill.), including the large conspicuous paraphyses, but it grows on wood not herbaceous stems, it is a bigger fungus, and its spores are longer varying from 20–25μ, instead of 10–18μ.

It also somewhat resembles *Niptera ramealis* Karst. (= *Mollisia ramealis* Karst. sec. Boud.), but although the spores are within Karsten's wide limits of 14–30μ, they are not blunt at the ends neither are the paraphyses thread-like, being much wider than the outside limit given (3μ), being as wide as the ascus, 7–8μ.

Rehm considers *N. ramealis* Karst. the same as *Belonidium ventosum* (Karst.) Phill. (*M. ventosa* Karst. sec. Boud.); if that is so, the above fungus differs considerably since it has a parenchymatous excipulum and a fimbriate margin in contrast with the excipulum of interwoven hyphae and smooth margin of *M. ventosa*, also the spores are larger and the paraphyses very different.

This fungus was found in August 1917, growing on branches which had been pruned from a flourishing young poplar tree less than two months previously, and left lying in a heap on the ground.

MOLLISIA POPULI n. sp.

Gregaria, sessilis, patelliformis, dein plana ac revoluta, 1–2 mm. diameter; hymenium junius cinereum, senius incarnatum vel ochraceum; excipulum olivaceo-cinerascens, parenchymaticum, margine fimbriato. Asci cylindrici, 90–100 × 7–10μ, apice attenuato, pedicello brevi. Sporidia biseriata, hyalina, anguste fusiformia, recta vel leviter curvata, continua, 1-septata, 20–25 × 2–3μ; paraphyses haud ascos superantes, hyalinæ, amplæ, septatæ, superne ad 7–8μ incrassatæ, apice ipso attenuatæ.

I wish to express my thanks to Mr W. B. Grove, M.A., for useful criticism and help in various ways and also to the late Prof. G. S. West for the loan of books of reference.

DESCRIPTION OF PLATE VI

Fig.

1. *Hyalinia Leightoni* v. *lignicola*. Asci and paraphyses.
2. Parenchymatous excipulum of *H. Leightoni* v. *lignicola*.
3. *Dasyscypha conformis*. Apothecia.
4. Ascospores.
5. Clavate marginal hairs and parenchymatous excipulum.
6. Aseptate paraphyses containing oil drops and asci.
7. *Erinella apala*. Septate paraphyses and ascus containing a fascicle of ascospores.
8. Tapering marginal hairs incrusted with crystals.
9. *Orbilia leucostigma* v. *xanthostigma*. Ascospore.
10. Asci containing ascospores.

11*a*. *Pyrenopeziza plicata* f. *conicola*. Apothecia.

b. Pycnidia of *Phoma conicola*.

The apothecia are to be seen growing among and arising from the pycnidia.

12. Young pycnidium of *Phoma conicola*. The young apothecium of *P. plicata* f. *conicola* is similar in all detail.
13. Pycnospores oozing out of a pycnidium.
14. Asci and paraphyses of *P. plicata* f. *conicola*.
15. Section through young apothecium of *P. plicata* f. *conicola* showing the rounded hair-like growths on the excipulum.
16. Section through young pycnidium of *Phoma conicola*.
17. Apothecia of *P. plicata* f. *conicola* on cone.
18. Pycnidium of *Phoma conicola* with the rounded glistening mass of pycnospores imbedded in mucilage.
19. *Mollisia Populi*. Apothecia.
20. Ascospores of *M. Populi*.
21. Excipulum with fimbriate margin.
22. Paraphyses—narrow and wide varieties; also ascus containing ascospores.
23. *Calloria extumescens*. Confluent apothecia.
24. Excipulum formed of anastomosing hyphae.
25. Apothecia of *C. extumescens*.
26. Asci and paraphyses.
27. Ascospores, continuous and uniseptate.
28. *Hyalinia Leightoni* v. *lignicola*. Apothecia.
29. Apothecia, crowded and confluent.
30. Ascospores.

ON THE FORMATION OF CONIDIA AND THE GROWTH OF THE STROMA OF DALDINIA CONCENTRICA.

By Jessie S. Bayliss Elliott, D.Sc (Birm.), B.Sc. (Lond.).

The curious charcoal-like sporosphore of *Daldinia concentrica* have often attracted the attention of mycologists and several have kept it under observation for more or less lengthy periods and have also cultivated it and noted points of interest in its life history. In 1863 Tulasne* published an excellent description of the ascophore also noting the presence of conidia on it previous to the formation of perithecia. In 1901 Möller† published the results of his observations on the rapidity of growth of the stroma and the duration of spore production. He also germinated ascospores and obtained the conidial condition in his cultures. In 1904 Molliard‡ published a paper describing how he had obtained the conidial form by sowing ascospores on pieces of carrot enclosed in tubes. Again, in 1913, Brooks§ in a paper describing some culture experiments he had carried out refers to finding conidia on blocks of ash which he had infected with ascospores. Descriptions of the ascophore are also given by Rabenhorst‖, Berkeley, Cooke and others.

For more than five years I have had under observation logs of ash on which both the conidial and perithecial forms of this fungus appeared from time to time. The conidial form was to be seen during the spring, summer and autumn months as a cream-coloured incrustation (figs. 35, 36) several sq. centimeters in area both on the bark and on the sawn ends of the logs, chiefly in the damper parts where they touched the ground and in parts shaded by grass: its surface had a coarsely villose appearance (fig. 36) owing to the tendency of the conidiophores to mass together and form small stromata about 3 or 4 mm. high by 1·5 mm. broad (fig. 36). Colourless conidia were produced in great quantities giving the patches a powdery appearance; the

* Tulasne. Selecta fungorum Carpologia, T. II.

† Möller, A. Phycomycetes and Ascomycetes. In Schimper, A. F. W., Bot. Mitth. aus den Tropen, Heft 9. Jena, 1901.

‡ Molliard Marin Forme conidienne de Daldinia concentrica. Bull. Soc. Myc. de France. Tome XX, 1904, pp. 55–60.

§ Brooks. Observations on pure cultures of some Ascomycetes and Basidiomycetes. Trans. British Mycological Society, 1913.

‖ Rabenhorst. Kryptogam. Flora. Band I, Abth. 2.

conidiophores are much branched and since the branches come off in a verticillate manner and terminate in clusters of conidia (figs. 31, 33) the fungus is evidently a species of Botrytis. On one of these conidial areas small hemispherical nodules with a rich brown velvety covering appeared (fig. 36). These on being cut showed the characteristic zoning of *Daldinia concentrica*. One produced ten zones in three weeks and the cut surface examined three weeks later was found to be covered by the conidial form but on being cut again ceased to grow.

Tulasne describes the presence of conidia on the stromata previous to the formation of perithecia; I have examined many specimens while growing and have only come across traces of this except on stroma of exceedingly small diameter, 3 mm. or less; whereas the creamy conidial patches on bark (fig. 35) which appear before or at the same time as the ball-like stromata are quite common on ash logs.

During the Selby foray this year (1918) both at Byram Park and Garforth patches of conidia were very abundant in close proximity to the sporophores, and also quite apart from them, on the ash logs which lay scattered about so plentifully.

Although this conidial form is so common, it is not recognised as belonging to the perithecial stroma, nor does it appear to have been recorded as a Botrytis: as already mentioned several investigators have obtained it by infecting culture media with ascospores, and one, Molliard, recognising its systematic position has proposed to call it *Nodulisporium* (*Botrytis*) *Tulasnei*; but he considered it was unlike any described species, possibly through being grown under artificial cultural conditions.

The conidia are colourless and measure 6·5–8 × 5–6μ.

Culture experiments. Large chunks of ash after being sterilised were infected with conidia as were also small chips in tubes;—some of these chunks were placed out in the open, others were kept in the laboratory. In the laboratory a fluffy mycelium appeared on them which although white at first gradually became black; when after eighteen months these chunks were placed out in the open air on grass in the shade, the black mycelium disappeared and the characteristic villose conidial patches appeared; the cultures which from the start were out in the open within three months produced conidia but no black mycelium: the conidial patches always became brown. Large patches 10 sq. cm. or more have appeared every year on these infected blocks but as yet no perithecial stromata have been seen; the blocks are still in a very sound condition unlike the log on which the perithecial sporophores appear which is in an advanced stage of decay.

The perithecial stroma. As long as the stroma is growing the

exterior is brown in colour and it only becomes black when it ceases growth; at this stage the whole stroma is exceedingly brittle and carbonaceous especially the exterior layer, about ·5 mm. in thickness, which is so hard that it is difficult to force even a sharp needle through it, but the interior remains quite soft and has a somewhat fibrous texture. The *zoning* so characteristic of this fungus is due to the formation of successive layers of perithecia. Perithecia are continually being formed in the stroma just immediately beneath the thin hard external layer (fig. 36); they are to be seen even in stromata of 3 or 4 mm. diameter but only those of the last formed zone reach maturity; the outlines of previously formed perithecia (fig. 34) are to be observed more or less distinctly in the zones near the exterior; these are easily recognised because the hyphae forming the walls of the perithecia turn black some time before the hyphae which form the bulk of the stroma.

Although actual experiments were not carried out, from various observations there seems reason to believe that the periods of perithecial maturation correspond with periods of diminished humidity while increase in humidity brings about active growth which ultimately leads to the formation of a new perithecial zone and atrophy of the perithecia of the preceding zone.

It is quite recognisable that the fibrous nature of the interior of stromata is due to these perithecia which never attain maturity: some zones in consequence of the perithecia having attained quite an advanced stage of growth before renewed growth of the stroma occurred have quite a porous appearance owing to the numerous large sterile perithecial cavities there.

Although in section mature stromata look a smoky-brown colour, while growing the last four or five zones are seen to be zoned alternately black and white: the black zones owe the dark appearance to the abundant perithecia there, the walls of which are always nearly black (fig. 34).

The hard exterior is exceedingly protective for a stroma becomes immediately mined by slugs when cut, or after being cracked by frost: the stromata crumble away during the winter and so do not last more than one year.

Very young stages in the formation of perithecia are difficult to observe because they are formed close under the dark brittle protective outer layer of the stroma: in the youngest which could be clearly distinguished small spherical masses of hyphae (figs. 38, 39) were seen which consisted of an external covering tissue of densely woven, very narrow, thin walled hyphae, surrounding a central hyphal mass of very wide septate hyphae: the latter formed an irregular coil of several turns and doubtless functioned as ascogenous hyphae: very similar structures are

to be seen in sections of young perithecial stromata of *Xylaria polymorpha*, Ustulina and other fungi: the densely woven covering tissue eventually turns black and forms the wall of the imbedded perithecia.

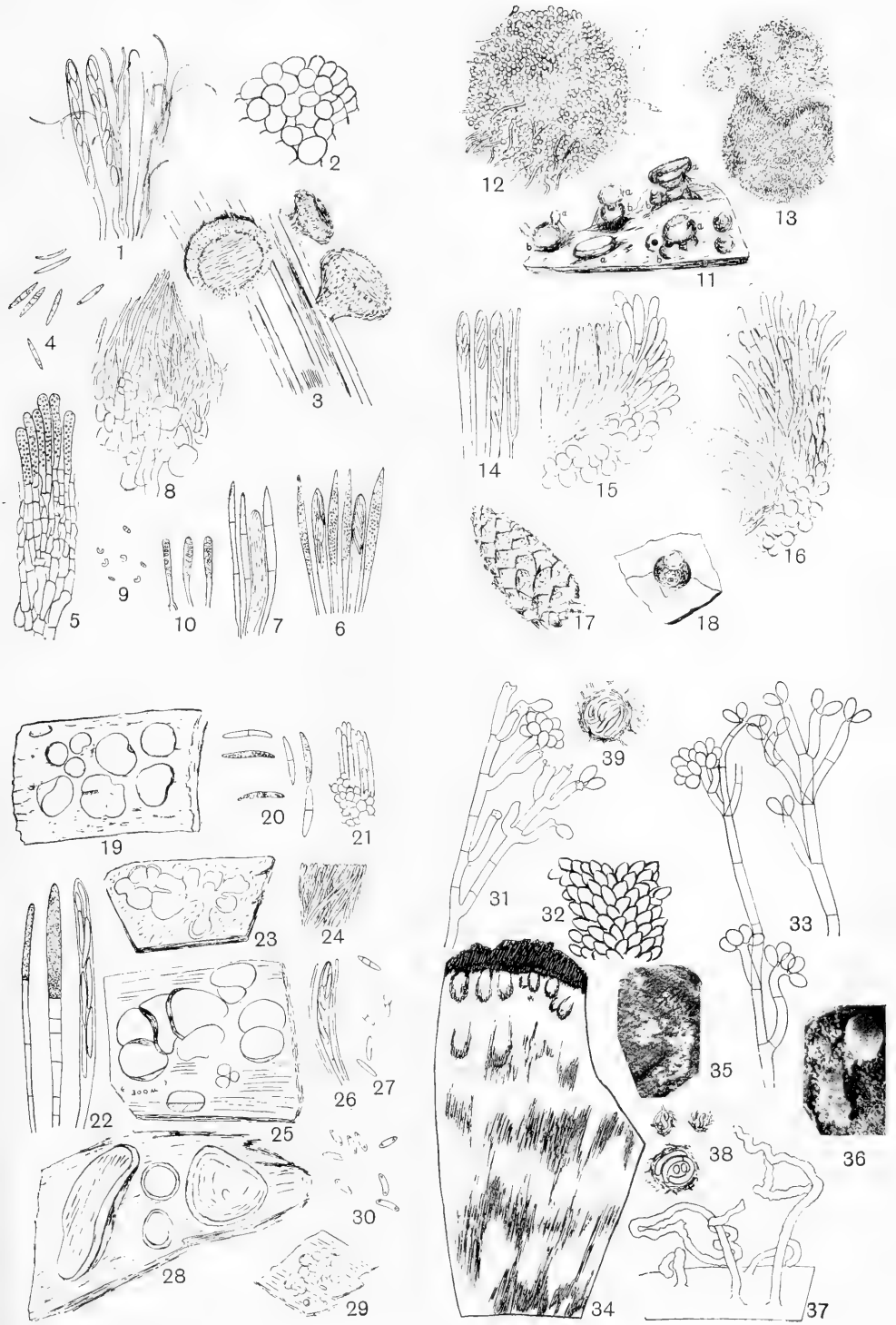
Stages of development earlier than this were somewhat indistinct, but they suggested that the coiled hypha arose from two similar very transparent hyphae (fig. 38) which stain very deeply with haematoxylin, one of which curved closely against the other and are analogous to the simple form of gametangia seen by Barker* in Monascus: at this stage the thin walled covering tissue was not yet formed.

Spore discharge extends over several weeks in detached stromata and black ascospores are produced in vast quantities. In the quiet atmosphere of a culture chamber long coiling threads of ascospores 10 or 15 mm. or longer are extruded from the mouths of the perithecia (fig. 37) which closely crowded together cover the whole exterior of the stromata. The coiled threads look very like the threads of pycnospores which are produced normally from mature pycnidia of the Sphaeropsidaceae, but they are not formed in the same way and are really abnormal. If one of these threads be observed under the microscope it will be seen to issue from the mouth in a jerky manner and on brushing aside such a thread, asci can be seen coming up to the orifice one at a time and discharging themselves one after another. The discharge goes on very rapidly and the ascospores from one ascus follow so closely on those from the preceding one that in a quiet atmosphere they stick together and a long coiling thread is produced (fig. 37), consisting of symmetrically arranged ascospores (fig. 32), for each series of eight ascospores lies parallel with another series of eight and the eight ascospores of each group can be seen adhering to one another. Sometimes an ascus appears quite a third its length above the orifice before discharging.

Under natural conditions air currents would prevent the formation of these coiled threads, for the contents of one ascus would be blown away before the discharge of the next ascus took place. Even in a quiet atmosphere the coiled threads of ascospores are not formed if the discharge of asci is taking place slowly; for by placing slips of white paper a centimeter or so above the surface of a ripe sporophore, after about an hour black ascospores will be seen spotting the white surface sometimes singly, sometimes in groups of eight.

After the asci have been discharged, numbers of ascospores remain crowded around the mouths of the perithecia; in a damp

* Barker. The Morphology and Development of the Ascocarp of Monascus. Ann. of Bot., 1903, p. 217.



J. S. Bayliss Elliott del.

atmosphere these germinate and the stroma becomes studded over with little white tufts of mycelium which appear to issue from the mouths of the perithecia: and in some instances this is the case for stromata which had apparently discharged all their ascospores were examined and some of the few ascospores which had not been set free had germinated inside the perithecia. These tufts in the course of a few days become covered with conidia; on detached ripe fruit bodies kept in a moist atmosphere under a bell jar these tufts always appear but in the open are rarely seen except on logs lying in very sheltered places.

In conclusion I wish to express my great indebtedness to the late Professor G. S. West for the loan of books of reference.

DESCRIPTION OF PLATE VI

Fig.

31. Conidia and conidiophores from bark of ash log infected with *Daldinia concentrica*.
32. Small portion of ascospore tendril which has exuded from a perithecium.
33. Conidiophores and conidia from hanging drop culture of ascospores.
34. Section through a few exterior zones of a perithecial stroma, showing an outer layer of distinctly formed perithecia, and inner zones where previously formed perithecia are seen in various stages of distinctness.
35. Conidiophores bearing conidia growing on bark.
36. Perithecial stromata appearing on a patch of conidiophores.
37. Tendrils of ascospores arising from the mouths of perithecia which were rapidly discharging their contents in a still atmosphere.
38. Sections of very young perithecia.
39. Section of perithecium somewhat older.

SOME OBSERVATIONS ON ERYSIPHE POLYGONI DC.

By G. O. Searle, B.Sc., P.A.S.I.

(Bd. of Agric. Research Scholar, Botany School, Cambridge.)

The work described in this paper was carried out by the author during 1913–14 in the Mycological Department of the South-Eastern Agricultural College, Wye.

The war caused a cessation of the work in August. 1914, and no opportunity of continuing the investigation or of publishing the results has occurred until now, except in the one instance given below. Though far from complete and though a considerable time has elapsed since they were undertaken, it was thought that these observations might contain sufficient points of interest to be worthy of publication.

My thanks are due to Mr E. S. Salmon for the many suggestions and great help he gave me.

The investigation, as originally conceived, fell under the following three heads:

(A) The Comparative Susceptibility of Varieties of Swedes and Turnips to the "Swede Mildew" (*Erysiphe Polygoni* DC.).

(B) The Specialisation of Parasitism within the Morphological Species *Erysiphe Polygoni* DC.

(C) The Method of Over-wintering of the "Swede Mildew" (*Erysiphe Polygoni* DC.).

(A) In the case of the first problem to be attacked, the result of the field trials for 1913 have already been published in full elsewhere (12), and will only be very briefly described here.

Samples of seed of thirty-three varieties of Swedes, forty-two varieties of Turnips and two varieties of Rape were obtained from five well-known seeds-merchants in England and Scotland.

These seeds were sown, on June 9th, 10th, and 12th, in small plots measuring ten links square, i.e. one-thousandth of an acre each, on old lucerne ley which had been ploughed and dunged but had received no artificials. The plots were cultivated and thinned in the usual way. On August 23rd the conidial stage of *Erysiphe Polygoni* was found on Swedes in a field situated at some distance from the plots, and on the 28th of August sufficient material was collected from this field to carry out the infection of the plots in the following manner.

A number of the infected leaves were picked and placed in a warm moist atmosphere for twenty-four hours to encourage the formation of conidia. The leaves were then washed in large cans of water until it became quite milky from the number of conidia contained. This spore suspension was then sprayed through a fine rose, as evenly as possible, over the seventy-seven plots. Previous to spraying a very careful examination was made but no mildew could be found on any plot. The weather was dull but no rain fell for three or four days after inoculation.

Examined on Sept. 2nd, a few minute patches of mildew were found on nearly every plot. From Sept. 6th to Oct. 9th the severity of attack was classified once a week in the following manner: Marks were assigned each week to each plot, these marks varying from 0–10 according to the severity of the attack; the plots marked 0 were those on which no trace of mildew could be found, and so on proportionately up to 10 assigned to the plots most severely attacked, and on which not a single leaf could be found free from mildew. By Oct. 9th the attack seemed to have attained its maximum severity, and on Nov. 3rd all the roots were pulled, topped, cleaned and weighed. On an average the plots contained fifty roots each.

The following are the salient points of the results.

No variety of Swede, Turnip or Rape was found to be wholly immune.

Only two varieties, both Turnips, were marked as low as "1" when the weekly readings were averaged at the end of the trials.

The Swedes were attacked more severely than the Turnips; the Rape came approximately midway between the two in the severity of the attack. The Turnips were attacked most on the underside of the leaf.

It was reported by nurserymen that, in the North of England at any rate, Bronze Top Swedes were more liable to mildew than Purple or Green Top varieties and that Purple Top Yellow is more susceptible than Green Top Yellow; this was not confirmed by the trial, a Green Top Swede being one of those averaging $9\frac{1}{6}$, whilst another Green Top averaged only $2\frac{1}{3}$, two Bronze Top varieties averaged 8.

The plots being so small, too great an experimental error was introduced to allow any reliable comparison of yields with severity of mildew attack, though it is of interest to note that the two highest yields, each 106 lbs. per plot, averaged in marking 2 in one case and $2\frac{2}{3}$ in the other; these were both Turnips.

In 1914 one hundred and four varieties were obtained, including all those previously tested, but owing to the outbreak of war the trials came to an end.

My thanks are due to the firms of Messrs Sutton & Sons, Austin & McAslan, Drummond, Little & Ballantyne and Carter for kindly providing me with the seed free.

(B) As has been conclusively proved by the work of several investigators including Neger (2), Marchal (3), Salmon (4, 5, 6) and Reed(11), many species of Erysiphaceae show that specialisation of parasitism which results in the evolution of "biologic forms," forms morphologically identical but totally distinct in their infection powers, being, in most cases that have been investigated, confined to a single species or to a few closely related species of host plants and seldom having powers of infection outside the genus.

The experiments described in this paper were undertaken with a view to extending the knowledge of this specialisation as far as the morphological species *Erysiphe Polygoni* was concerned, more especially in the case of the conidial form of that species found on cultivated Brassicae.

It may be stated here that throughout the whole investigation the perithecial stage was never found on any Brassicae, so that the oidium used in inoculations was only identified as *Erysiphe Polygoni* by its host, no other species of Erysiphaceae having, so far as I know, been reported on the genus *Brassica*.

The method of inoculation was the usual one of drawing the edge of a sterile scalpel through the patch of mildew from which the conidia were to be taken and then, after placing a drop of water on the leaf to be inoculated, drawing the edge of the scalpel through the drop thus leaving the conidia floating in it. The whole plant was then kept under a bell-jar for twenty-four hours after which the bell-jar was removed completely or raised enough for ventilation.

There was always a chance of a certain amount of natural infection taking place especially towards the end of September, although all the plants used were kept in a separate greenhouse as soon as inoculated, so only those results were accepted as positive where infection occurred at the exact spot inoculated and the remainder of the leaf was entirely free from mildew; if the remainder of the leaf showed any mildew the experiment was discarded, whether there was infection at the inoculated spot or not.

All the plants used were grown from seed in pots in a greenhouse. In each case the first sign of infection (when this occurred), was noticeable in about six days, when a small powdery patch of mycelium, visible to the naked eye, appeared.

A few general observations will first be given.

The late summer and early autumn of 1913 were characterised

by a particular abundance of mildew in the Wye district, but little was noticed earlier in the year. A very careful search for the conidial stage of *Erysiphe Polygoni* on some of its commoner hosts was made during July and August, but it was not found out of doors until August 19th on *Polygonum aviculare* and August 23rd on Swedes. On the other hand it appeared spontaneously in the greenhouse on Swedes on July 23rd and on *Polygonum aviculare* on August 2nd.

This same phenomenon was noted in other cases, the conidial stage on Turnip, Rape, *Sonchus arvensis*, *Linum usitatissimum*, *Pisum sativum*, *Trifolium pratense*, *Onobrychis sativa*, *Trifolium dubium*, *T. hybridum*, *T. repens*, *Capsella Bursa-pastoris*, and *Brassica Sinapis*, all appeared in the greenhouse at least a fortnight before they could be found out of doors even though careful daily search was made; this will be referred to later.

The first series of inoculations were with the conidia from the Swede, with a view to investigating how far the oidium on Swede was specialised in relation to other hosts of *Erysiphe Polygoni*, especially other cultivated Brassicae.

In the following tables the sign + signifies a full infection powdery with conidia and fully visible to the naked eye; the sign 0 signifies no visible infection; the sign ? signifies that a "subinfection" resulted, consisting of a few hyphae and a very few conidia visible only with a lens. The significance of subinfections will be discussed later. The sign — signifies that the experiment was discarded owing to infection appearing naturally on other spots than those inoculated.

TABLE I.

Inoculations with conidia from Swede.

Hosts inoculated	No. of inoculations	No. of infections
Swede	8	+ 8
Swede (cotyledons)	41	+37
Swede (first leaves)	6	+ 6
Turnip	13	+10
Turnip (cotyledons)	9	—
Cabbage	32	? 31
Kohl-rabi	10	? 7
Rape	26	+23
Broccoli	10	? 9
Kale (Thousand Head) ...	33	? 28
Charlock (*B. Sinapis*)		
(*a*) Under cloches out of doors	10	0
(*b*) In greenhouse	18	—
(*c*) In greenhouse	10	+5 ? 5
Geranium molle	6	0
Ranunculus arvensis	7	0
Polygonum aviculare	7	0
Trifolium pratense	6	0
Cnicus lanceolatus	3	0

The above results are interesting in that they indicate that the "biologic form" of *Erysiphe Polygoni* on the Swede is able to cause a full infection on the Turnip and Rape, all three being cultivated forms of the same aggregate species *Brassica campestris* Linn., whilst it is only capable of forming a "subinfection" on Cabbage, Kohl-rabi, Broccoli and Kale, which are cultivated forms of the aggregate species *Brassica oleracea* Linn. Further, that in the case of Charlock (*B. Sinapis*) the position is very obscure as in five instances full infections resulted, in five other instances "subinfections" only appeared and in a further ten cases no infection at all took place which seems to indicate, either that there was some physiological difference between the Charlock plants used—in one case the plants used were those raised in the greenhouse from seed and in the other were plants found growing wild and simply covered with a cloche—or that some temperature or moisture factor enters into the problem.

Further it will be seen that in no case did an infection result on any of the hosts used belonging to other families.

Though no opportunity occurred of repeating and confirming these series the following year, the results indicate that the "biologic form" on Swede is confined to the aggregate species *Brassica campestris* with powers of slight infection on *B. oleracea* and probably under certain conditions on *B. Sinapis*.

TABLE II.

Inoculations with conidia from *Polygonum aviculare*.

Host inoculated	No. of inoculations	No. of infections
Polygonum aviculare	8	+6
Swede	22	0
Swede (cotyledons)	8	0
Trifolium pratense	3	0
Swede (first leaves)	3	0
Turnip (cotyledons)	15	0

These results go to confirm the indications of Table I that the forms of *Erysiphe Polygoni* on *Polygonum aviculare* and *Brassica campestris* are distinct "biologic forms."

TABLE III.

Inoculations with conidia from *Trifolium pratense*.

Hosts inoculated	No. of inoculations	No. of infections
Trifolium pratense	4	+4
T. hybridum	3	0
T. repens	6	0
Vicia Faba	8	0
Onobrychis sativa	4	0

This table indicates that the form of *Erysiphe Polygoni* on *Trifolium pratense* is specialised on that species and is unable to infect other species of the same genus or other genera of the same family, thus, as far as the experiment was carried, confirming the more extensive series carried out with the oidium on *T. pratense* by Salmon (4).

Two further experiments with clovers were tried, in one of which conidia from *Trifolium minus* were found unable to infect *T. pratense* or *Onobrychis sativa*, and in the other conidia from *Trifolium hybridum* were found unable to infect *T. repens*.

A short series was then tried with the form on *Pisum sativum*.

TABLE IV.

Inoculations with conidia from *Pisum sativum*.

Hosts inoculated	No. of inoculations	No. of infections
Pisum sativum	5	—
,, ,, ...	15	+10
Onobrychis sativa	10	0
Vicia Faba	24	0
Trifolium pratense	4	0

This table confirms the fact, already noted by Salmon, that the oidium on *Pisum sativum* should rank as a "biologic form."

A single experiment with the oidium on *Capsella Bursa-pastoris* showed that the conidia, though able to infect fully *Capsella Bursa-pastoris* (six inoculations), were unable to infect the Swede (six inoculations).

In confirmation of Table I a further experiment with the conidia from Rape was tried; in this case eight inoculations on Turnip caused six full infections, but ten inoculations on Kohl-rabi produced no infections, whereas one would have expected that "subinfections" would have resulted.

All the above inoculations were carried out between July 29th and Sept. 26th after which date the spread of natural infection in the greenhouse was so general that further trials were entirely vitiated.

A number of series was then commenced in the laboratory employing excised leaves placed on moist filter paper in Petri dishes, and pieces of stem placed in larger dishes. These experiments gave some interesting results especially in their bearing on the growth of species of the Erysiphaceae on internal tissues of plants in contradistinction to their usual ectoparasitic existence. This phenomenon had already been noted by Salmon (10) when working with *Erysiphe graminis*.

Before describing these series it will be necessary to deal

briefly with the question of "subinfections." Salmon (4) (pp. 270–271) in his work on *Erysiphe graminis* and the Bromes found that in some inoculations the only result was a few minute flecks of mycelium and a few scattered conidiophores; in some cases these minute infections disappeared within a few days and in others small flecks of mycelium persisted. He came to the conclusion that a faint infection does actually occur and that the flecks of mycelium and few conidiophores are not merely the production of a conidium germinating and living independently for a short time. He called these slight infections "subinfections."

In the work described here the phenomenon of "subinfections" was encountered early. As will be seen from Table I above, inoculation of conidia from Swede on to cultivated species of *Brassica oleracea* invariably produced "subinfections" only. However in these particular cases of "subinfections" there is another detail to be taken into account and that is the distinct discolouration of the epidermis of the host which takes place. Superficially the epidermis at a point where a "subinfection" is present shows a series of minute black spots giving the appearance of local death of the cells. In section it was found that in some cases only an epidermal cell or a small group of cells were affected, the walls being very dark brown and the cells being filled with a dark brown disorganised content so dense that it was impossible to determine if normal haustoria had been formed or not; in other cases the discolouration radiated into the subepidermal cells changing the cell walls to a dark brown colour and sometimes the cell content also.

The discolouration of the epidermis by species of Erysiphaceae has been noted by several investigators and was discussed by Grant Smith (1), but the discolouration noted by him did not seem to be of such an extreme nature as that under consideration now, as Grant Smith says it was not noticeable in sections when cut and stained and seemingly normal haustoria were visible. In fact the discolouration was so distinct in the present instance that by its means the phenomenon of "subinfection" was later discovered in the field. Salmon ((4) p. 270) says, "It may be that, in some cases under certain favourable conditions the fungus could exist permanently and increase on such a host plant." That this is the case at any rate with "subinfections" on cultivated *Brassica oleracea* is confirmed by the following field observations.

Oct. 1913. After long search a Rape plant severely infected with the oidium of *Erysiphe Polygoni* was discovered in the centre of a large field of Kohl-rabi. An investigation of the Kohl-rabi plants showed that all those plants within a few yards

of the Rape plant had their leaves and stems covered with minute black spots, which, examined microscopically, were found to be wherever minute flecks of mycelium were present. This mycelium was quite easy to trace to the large numbers of conidia to be distinctly seen scattered over the surface. The area of infection was quite local as Kohl-rabi plants at more than five to six yards from the Rape plant only showed very few "subinfections." Under the circumstances it seemed to be a permissible conclusion to take the Rape plant as the centre of infection.

A few days later the same effect was seen in the case of Cabbages, again round a chance plant of Rape growing amongst them. The appearance in this case was exactly similar to the "subinfection" on the Kohl-rabi plants and again the Cabbages further away from the Rape plant were unaffected.

Then the phenomenon was noted on Brussels Sprouts; in this case they were some plants growing near the Swede plots used in the first investigation (A). Here the "subinfections" were much more distinct and generally, though not entirely, confined to the petioles; they showed up distinctly to the naked eye as patches, $\frac{1}{8}$ to $\frac{1}{2}$ inch across, of minute black spots, the patches being rather symmetrical in shape as though the overlying mycelium was formed by the growth from a single conidium. In every case a few conidiophores and conidia could be seen.

The last case noted was on the cultivated Brassica known as Marrow-stemmed Kale. In this case the appearance was very distinctive as under the microscope the black spots were found to follow the course of the hyphae at regular intervals giving a dendritic appearance and making it look almost certain that the spots were formed wherever a haustorium had entered or endeavoured to enter the epidermal cells.

Nov. 27th. The weather had been exceptionally warm and moist. "Subinfections" on Marrow-stemmed Kale became much more vigorous and such a large number of conidia had been formed that the characteristic discolouration could hardly be seen. However the mycelium had not spread beyond its former limits. The same happened to a slighter extent on the Brussels Sprouts.

Dec. 6th. Weather decidedly colder. Some "subinfections" on Marrow-stemmed Kale had spread $\frac{1}{4}$ inch beyond the discoloured patch without further discolouration being formed, but very few conidia were to be found on the new mycelium. Some "subinfections" on Brussels Sprouts had now developed into full infections, in this case also without further discolouration.

Dec. 10th. "Subinfections" on Marrow-stemmed Kale were observed on specimens exhibited at Messrs Garton's stand at

Smithfield Show. On enquiry it was found that the Kale had been grown in Norfolk.

Dec. 15th. After several hard frosts it was noted that the "subinfections" were still present on Marrow-stemmed Kale but only very few conidia could be seen. The infections on Brussels Sprouts were quite vigorous with a number of young conidiophores and conidia. On Rape fresh looking powdery patches of mildew were numerous. On Swede it was now difficult to find any mildew except on the lower surface of the leaves.

Dec. 17th. A number of fresh spots of mildew were found on the under surface of Swede leaves, all of them were quite powdery with conidia. "Subinfections" were very numerous on Thousand Head Kale.

Jan. 6th. During the previous fortnight the temperature dropped at times to 17° F. and there had been several inches of snow. "Subinfections" on Thousand Head Kale were found to be in a quite healthy condition. Small patches of mycelium were found on Swedes but without conidia.

Jan. 13th. Thousand Head Kale leaves, covered with snow, were collected, and under the snow were found seemingly healthy patches of mycelium. These leaves were brought into a warm laboratory and in a few days developed a large number of conidia on the patches of mycelium.

Jan. 26th. Temperature during previous week at times dropped to 12° F.

March 7th. Thousand Head Kale observed with small "subinfections" still alive and a few conidia.

Early May. "Subinfections" on Thousand Head Kale and Marrow-stemmed Kale in the same dormant condition.

Mid-May. "Subinfections" on a Thousand Head Kale plant commenced to spread first on to the lower leaves and then on to the new upper leaves. Infections then appeared on a Rape plant and a Swede plant standing next to the Kale.

It would appear therefore from the above observations that an actual infection of the plant does occur in the case of "subinfections" and that it is quite possible in Nature for a "subinfection" to continue existence as such and later grow out into a full infection.

As these "subinfections" have been found to occur quite naturally in the field, it shows that they are not merely a phenomenon caused by carrying out inoculations under cultural conditions, nor do they depend on a large number of conidia being sown on one spot as suggested by Salmon (7), though that may be the cause in certain cases, noted with artificial inoculations.

It would seem possible that "subinfections" are the pre-

liminary stages of the spread of the fungus on to a new host, especially since, as it is shown later, the conidia formed on the "subinfection" are fully viable.

The first series undertaken in the laboratory was one using conidia from the Swede and Rape. Inoculations were performed on leaves in water under a bell-jar.

TABLE V.

Conidia from Swede.

Date	Host used	No. of inoculations	No. of infections	Remarks
Nov. 21	Swede ...	4	+4	
,,	Turnip ...	2	+2	
,,	Rape ...	2	+2	
,,	Kohl-rabi	2	—	Leaf died
Nov. 29	Swede ...	4	+4	
,,	Kohl-rabi	8	? 7	With discolouration

Conidia from Rape.

Nov. 21	Rape ...	2	+2	
,,	Kohl-rabi	2	? 2	

This table shows the typical results already noted in Table I.

Two experiments with conidia from "subinfections" on Marrow-stemmed Kale were then tried; four inoculations on to Kohl-rabi leaves gave four "subinfections" but with no visible discolouration of the epidermis; four inoculations on to Swede leaves gave four full infections. These two experiments prove the viability of conidia formed on "subinfections."

It was now decided to carry out several series to test how far the fungus could adapt itself to continued life on the internal tissues of various hosts and to observe if any differences in infective power took place under such conditions. These series were carried out in large Petri dishes lined with moist filter paper, and kept at a temperature varying between 50–60° F.

The following abbreviations are used:

"Cut M.S.K." = A piece of stem of Marrow-stemmed Kale approx. 3 inches long and $1\frac{1}{2}$ inches diam. cut in half lengthwise, so that it is about $\frac{3}{4}$ inch thick and then a sloping cut made in the upper uninjured surface to remove a wedge-shaped piece of tissue, leaving the internal tissue exposed to about $\frac{1}{8}$ inch deep. Conidia were then sown on the internal surface thus exposed. This was found to be a convenient size to use in large Petri dishes and kept fresh a long time.

"Cut ... petiole" = A piece of petiole, of host used, about $2\frac{1}{2}$ inches long with a wedge-shaped piece cut out leaving internal tissue exposed to $\frac{1}{8}$ inch deep.

SERIES A. Commenced Dec. 9th. Conidia from sources shown.

One inoculation in each experiment.

No. of Expt.	Source of conidia	Host used	Result	Remarks
A 1.	Swede ...	Inner surface of $\frac{1}{16}$" thick strip of M.S.K. stem	Full infection	Grew very slowly at first only a few hyphae by Dec. 17. Full inf. Jan. 6th
A 2.	Brussels Sprout (subinfection)	,, ,,	Full infection	,, ,,
A 3.	Swede ...	Outer surface ditto.	—	Overrun by mould
A 4.	Brussels Sprout	,, ,,	—	Conidia germinated but overrun with mould
A 5.	Swede ...	,, ,,	Full infection	Strong mycelium and many conidia by Dec. 17th
A 6.	Brussels Sprout	,, ,,	Full infection	Strong mycelium by Dec. 17th
A 7.	Swede ...	"Cut M.S.K."	Full infection	Both showed strong mycelium and many conidia Dec. 15th.
A 8.	Brussels Sprout	,, ,,	Full infection	Both showed a discolouration of the host cells
A 9.	Swede ...	B. Sprout petiole epidermis removed	—	Slight mycelium Dec. 17th then died out
A 10.	Brussels Sprout	,, ,,	Full infection	
A 11.	Swede ...	M.S.K. petiole, epidermis removed	Full infection	Strong mycelium with many conidia by Dec. 15th. Later spread to uninjured surface where it discoloured the cells
A 12.	Brussels Sprout	,, ,,	Full infection	
A 13.	Swede ...	"Cut M.S.K." $\frac{1}{32}$ inch deep	—	Strong mycelium and many conidia Dec. 17th but died by Jan. 6th
A 14.	Brussels Sprout	,, ,,	—	Very weak mycelium Dec. 17th then died out
A 15.	Rape ...	"Cut M.S.K. petiole"	Full infection	Strong growth with conidia Dec. 17th. Later spread to and discoloured the cells of uninjured surface
A 16.	Swede ...	B. Sprout petiole small piece of epidermis removed	Full infection	Spread without discolouration
A 17.	Brussels Sprout	,, ,,	Full infection	Spread on to uninjured surface without discolouration
A 18.	Swede ...	"Cut B. Sprout petiole"	Full infection	Spread without discolouration to uninjured surface

SERIES A. Commenced Dec. 9th. Conidia from sources shown (contd.)

One inoculation in each experiment.

No. of Expt.	Source of conidia	Host used	Result	Remarks
A 19.	Swede ...	Uninjured surface M.S.K. stem	Full infection	
A 20.	Swede ...	,, ,,	—	Few hyphae formed then died out
A 21.	Rape ...	,, ,,	0	
A 22.	Brussels Sprout	,, ,,	0	
A 23.	Brussels Sprout	,, ,,	—	Few hyphae formed then died out

The above results show that the "biologic form" of *Erysiphe Polygoni* on cultivated Brassicae is able to live and produce conidia when sown on the internal tissue of its host instead of the epidermis. Further that when the form on varieties of *Brassica campestris* was sown on varieties of *B. oleracea*, which had been injured by cutting, full infections resulted instead of the usual "subinfections." It is also of interest to note that in some cases (e.g. A 7 and A 15) the cells of the host underwent the typical discolouration even though a full infection finally resulted; this discolouration was more notable however when the mycelium spread to the uninjured epidermal cells.

In view of the difficulty of keeping cultures of species of Erysiphe for any length of time owing to its obligate parasitism, it is worthy of note how useful the cut stem of Marrow-stemmed Kale was found to be. This material kept remarkably fresh in a large Petri dish on wet filter paper and, on the whole, remarkably free from saprophytic fungi. As an instance it may be noted that a piece of cut Marrow-stemmed Kale stem after fifty-nine days in a Petri dish showed a perfectly healthy patch of new mycelium with numerous chains of ripe conidia.

By carrying out the inoculations in December, taking pieces of Marrow-stemmed Kale from plants distant from those carrying subinfections, and by sterilising Petri dishes, it was possible to reduce the chances of natural infection to a negligible quantity, especially as the inoculations were carried out on freshly cut surfaces.

The second series (B) was carried out in extension of the first and also to test the viability of the conidia produced in series A.

This series shows the full viability of conidia produced by mycelium on cut surfaces; also that the distinctive discolouration cannot be entirely correlated with the source of the conidia in the first generation.

As in Series A the inoculations on uninjured Marrow-stemmed Kale seemed to fail under cultural conditions and Brussels

Sprout petiole was found much less satisfactory to keep in Petri dishes than Marrow-stemmed Kale, since it very quickly became attacked by various bacteria and moulds and rotted.

SERIES B. Started Dec. 20th. Conidia from sources shown. One inoculation in each case.

No. of Expt.	Source of conidia	Host used	Result	Remarks
B 1.	A 7	"Cut M.S.K."	Nearly full infection	A number of conidia. Medium discolouration
B 2.	A 12	,, ,,	Full infection	Powdery patches of conidia. Very little discolouration
B 3.	A 11	,, ,,	Full infection	Powdery patches of conidia. Great discolouration
B 4.	A 8	,, ,,	Full infection	Powdery patches just visible. Very strong discolouration
B 5.	Swede	,, ,,	Slight infection	Healthy mycelium. Few conidia. Slight discolouration
B 6.	Marrow-stemmed Kale	,, ,,	Full infection	Powdery patches of conidia. Very slight discolouration
B 7.	,, ,,	M.S.K. stem uninjured surface	o	
B 8.	Brussels Sprout	,, ,,	o	
B 9.	Marrow-stemmed Kale	"Cut B. Sprout petiole"	—	
B 10.	Swede ...	,, ,,	—	Slight mycelium and young conidia. Then rotted
B 11.	Brussels Sprout	,, ,,	o	
B 12.	Brussels Sprout	B. Sprout petiole uninjured surface	o	

Series C was undertaken to test the viability of the conidia when carried to the third generation on cut surfaces.

SERIES C. Started Jan. 22nd. Conidia from sources shown. One inoculation in each case.

No. of Expt.	Source of conidia	Host used	Result	Remarks
C 1.	B 6	"Cut M.S.K."	Full infection	Large powdery patches. Very numerous conidia. Strong discolouration
C 2.	B 1	,, ,,	Slight infection	Few conidia. Wound being overgrown by callus
C 3.	B 2	,, ,,	Full infection	
C 4.	Thousand Head Kale	,, ,,	Full infection	Powdery patches. Very numerous conidia. Slight discolouration

The next series (D) carried on the fungus to the fourth generation on cut surfaces.

SERIES D. Started Feb. 12th. Conidia from sources shown.

One inoculation in each case.

No. of Expt.	Source of conidia	Host used	Result	Remarks
D 1.	C 1	"Cut M.S.K."	Full infection	Patches powdery with conidia. Very distinct discolouration
D 2.	C 3	,, ,,	Medium infection	Fairly numerous conidia. Very distinct discolouration
D 3.	C 4	,, ,,	Medium infection	,, ,,

An attempt was made on March 6th to carry on to the fifth generation on cut Marrow-stemmed Kale stem but the Kale was by this time too old and all the pieces used soon died and rotted.

However the above series show that it is possible to carry on cultures of an Erysiphe on the exposed internal tissues of its host over four generations in three months.

An experiment was then tried to demonstrate whether infection would take place on the internal tissue of the swollen hypocotyl ("root") of the Swede in the same way as on the stem of the Marrow-stemmed Kale.

SERIES 1 S 1. Started Jan. 28th. Conidia from sources shown.

One inoculation in each case.

No. of Expt.	Source of conidia	Host used	Result	Remarks
1 S 1.	Swede	"Cut surface Swede root"	Full infection	Large number young conidia Feb. 12th
1 S 2.	B 3	,, ,,	,, ,,	One or two patches powdery with conidia Feb. 12th
1 S 3.	B 6	,, ,,	,, ,,	,, ,,
1 S 4.	Thousand Head Kale (subinfection)	,, ,,	,, ,,	Large patch powdery with conidia Feb. 12th
1 S 5.	Marrow-stemmed Kale (subinfection)	,, ,,	,, ,,	Large patch powdery with conidia Feb. 12th

This series shows that infection took place quite successfully on the internal tissue of Swede "root." In no case was there any discolouration shown.

An attempt was made to carry this series on to another

generation but in each case the Swede rotted before any result could be obtained.

The internal tissue of an epicotyl, in this case the swollen epicotyl of the Kohl-rabi, was used in the next series.

SERIES 2 K. Started Feb. 12th. Conidia from sources shown.

One inoculation in each case.

No. of Expt.	Source of conidia	Host used	Results	Remarks
2 K 1.	Rape	"Cut surface Kohl-rabi epicotyl"	Slight infection	A few young conidia. Slight discolouration
2 K 2.	Brussels Sprout	,, ,,	0	—
2 K 3.	Swede	,, ,,	Medium infection	Fairly numerous conidia. Very slight discolouration
2 K 4.	1 S 5	,, ,,	0	—
2 K 5.	C 1	,, ,,	Medium infection	,, ,,

The last two series certainly indicate that, however far species of Erysiphe may be specialised as to their hosts, the infection powers are always constant within that host whatever part is used for inoculation. This is specially noticeable if one traces the genealogy of 2 K 5, which, starting as conidia from a "subinfection" on Marrow-stemmed Kale, passed two successive generations on the internal tissues of Marrow-stemmed Kale and finally produced conidia again on the internal tissue of the epicotyl of Kohl-rabi; or the example of 1 S 2, which started as conidia from a full infection on the uninjured epidermis of a Swede leaf, spent one generation on the outermost cells of the cortex of the Marrow-stemmed Kale stem, one generation on the innermost layers of cortex and vascular tissues of the same, and finally successfully produced a full infection on the internal tissue of a Swede hypocotyl. In the latter case conidia from 1 S 2 were, on Feb. 12th, inoculated on to "cut M.S.K." again and by Feb. 23rd gave a slight infection showing a few conidia and distinct discolouration.

The last series to be undertaken was to demonstrate the infection powers of conidia from "subinfections" when inoculated on to the uninjured surface of various hosts usually only bearing "subinfections," i.e. cultivated varieties of *Brassica oleracea*. A few inoculations on to varieties of *B. campestris* were included as controls.

In each case uninjured leaves in water under bell-jars were used as hosts.

The signs used have the following significance: — = Experi-

ment discarded, usually through death of leaf; 0 = No infection; ? = Subinfection; :– = Medium infection, rather more than subinfection; + = Full infection.

Table VI.

Conidia from sources shown.

Date	Source of conidia	Host used	No. of inoculations		Result
Jan. 20	B. Sprout ?	M. S. Kale	4	:–4	Distinct discolouration
,,	,, ,,	Thousand Head Kale	4	+4	Very slight discolouration
,,	,, ,,	B. Sprout	4	+4	
,,	Marrow-stemmed Kale ?	B. Sprout	4	+4	
,,	,, ,,	Thousand Head Kale	4	? 2	+2
,,	,, ,,	M. S. Kale	4	? 4	Slight discolouration
,,	,, ,,	Swede	4	—	Leaf died
,,	A 5	M. S. Kale	4	? 4	Leaf died early
Jan. 26	Marrow-stemmed Kale ?	Turnip	4	+4	
,,	,, ,,	Rape	4	+4	
,,	,, ,,	M. S. Kale	4	? 4	
,,	B. Sprout ?	Turnip	4	+4	
,,	,, ,,	B. Sprout	4	:–2 +2	Distinct discolouration
,,	Thousand Head Kale ?	B. Sprout	4	:–4	
,,	,, ,,	M. S. Kale	4	? 4	Very slight
,,	,, ,,	Thousand Head Kale	4	? 4	
Feb. 26	B. Sprout ?	B. Sprout	2	:–2	Fair amount mycelium. Few conidia. Some discolouration
,,	,, ,,	M. S. Kale	2	:–2	Fair amount mycelium. Few conidia. Distinct discolouration
,,	,, ,,	Thousand Head Kale	2	? 2	
,,	Marrow-stemmed Kale ?	B. Sprout	2	:–2	No discolouration
,,	,, ,,	M. S. Kale	2	:–2	Few conidia. Some discolouration
,,	,, ,,	Thousand Head Kale	2	? 2	Some discolouration
,,	Swede +	Rape	4	+4	Large quantity mycelium. Few conidia
,,	,, ,,	Turnip	4	+3	One leaf died

These results show that, under cultural conditions,

1. Conidia from "subinfections" on varieties of *Brassica oleracea* are quite capable of giving full infections on varieties of *B. campestris.*

2. Conidia from "subinfections" on varieties of *Brassica oleracea* when sown on *B. oleracea* sometimes give full infections, though more usually they give "subinfections" or medium infections which cannot quite be classed as full infections.

It is hoped to be able to carry out soon a much longer series of similar inoculations, including also hybrids between *Brassica campestris* and *B. oleracea,* so that definite conclusions may be drawn as to the relative infection powers of conidia taken from "subinfections" on *B. oleracea* and full infections on *B. campestris.*

(C) In the case of *Erysiphe Polygoni* on cultivated Brassicae the method of over-wintering must be restricted to one or more of the following:

1. Perithecia.
2. Persistent mycelium.
3. Re-infection in the spring direct from other hosts of *Erysiphe Polygoni,* or by spores from "bridging species."
4. "Subinfections" within the genus Brassica.

The perithecial stage of the fungus is very seldom found on the cultivated Brassicae. In fact the writer, though making constant search, failed to discover perithecia on these hosts during the whole course of the investigation. Of course this does not imply that they never occur, but they are of such rare occurrence that alternative No. 1 above can be ruled out as a negligible method for the fungus of over-wintering.

In face of the experiments described in this paper and the large number of other experiments which have been carried out with other species of Erysiphe, all of which go to prove the extreme specialisation of parasitism of this genus of fungi, it seems permissible to lay down definitely that alternative No. 3 is also highly improbable; even though one takes into consideration the possibility of "biologic forms" breaking down, either under certain climatic conditions which, as far as the writer knows, has not been shown to occur by any investigator, or of their breaking down by reason of various injuries to the host, as has been demonstrated by Salmon (8, 9).

Even in the case of such a very closely related species as *Brassica Sinapis* there is a certain amount of doubt as to the free transference of the mildew to the species *B. campestris* and *B. oleracea* though it is possible that Charlock does help in a small degree in the reinfection of varieties of the cultivated

Brassicae in spring, though in this case again perithecia are equally rare.

It would therefore seem more probable from the experiments and field observations already described (although they are far from complete) that alternatives No. 2 and No. 4 are the most likely methods by which the mildew exists over the winter.

One or more of the cultivated Brassicae are always to be found in leaf at all seasons of the year on a farm, and above it has been shown that the conidial stage of the mildew was successfully kept under observation out-of-doors on one or other cultivated Brassica during the autumn, winter and round to the middle of the following May, and that, even after heavy frosts, viable conidia were formed.

As Swedes and Turnips are not often present on the farm in the spring, it is probable that infection is carried on mainly by "subinfections" on varieties of *Brassica oleracea* (which are generally to be found throughout the early spring in the form of Cabbage or Kale), aided by persistent mycelium on "volunteer" plants of Swede, Turnip or Rape.

It may be argued that it is difficult to understand why, if the mildew is able to attack Swedes and Turnips in the cotyledon stage as has been shown to be the case, it is not usual to find a bad attack before July when the plants are well advanced, but it would seem that this depends largely on climatic conditions, which have not yet been fully investigated. It will be remembered that the "subinfections" on Thousand Head Kale did not develop into distinct visible full infections until the middle of May and it is quite possible that infection may take place but the mildew remain in an undeveloped form invisible to the naked eye, until climatic conditions are suitable. Such an explanation would account for the fact, mentioned early in this paper, that numerous forms of *Erysiphe Polygoni* appeared spontaneously in the greenhouse some time before they could be found out-of-doors, presumably because the temperature of the greenhouse was more suitable for the full development of the fungus.

Summary.

1. In field trials in 1913 no variety, out of seventy-seven varieties of Swedes, Turnips and Rape, was found to be immune to *Erysiphe Polygoni* DC. Swedes were attacked more severely than Turnips.

2. In inoculation experiments with cultivated varieties of *Brassica campestris* and *B. oleracea*, the form of *Erysiphe Polygoni* infecting these varieties was found to be a "biologic form" with this additional distinction that inoculations from

B. campestris to *B. oleracea* invariably gave "subinfections" as the result.

3. "Biologic forms" on *Polygonum aviculare, Trifolium pratense* and *Pisum sativum* were indicated.

4. "Subinfections" on varieties of *B. oleracea* were observed in the field and found to exist over the winter and in some cases grow into full infections.

5. Inoculations were undertaken in the laboratory and were successful both on uninjured leaves and on the internal tissues of stems; these latter were carried as far as the fourth generation.

6. Inoculations with conidia from "subinfections" were carried out and the conidia shown to be viable.

7. It is suggested that the most probable method of overwintering of the "biologic form" of *Erysiphe Polygoni* on the cultivated Brassicae is by means of "subinfections" on varieties of *B. oleracea* aided by persistent mycelium on varieties of *B. campestris*.

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UPON THE VISIBILITY OF SPORE DISSEMINATION IN FOMES PINICOLA (SWARTZ.) FR.

By R. E. Stone, Ph.D.
(Department of Botany, Ontario Agricultural College.)

The larger fungi liberate millions of spores and yet the dissemination of the spores has not often been directly seen. Buller* has observed this phenomenon probably in more species than any one else, and he has devised a number of methods for detecting it. With the naked eye he saw spore clouds leaving the under surface of a fruit-body of *Polyporus squamosus* for thirteen days in succession†. The following observations were made by myself upon a fruit-body of *Fomes pinicola* in a wood near Guelph, Ontario, and I am recording them at Professor Buller's suggestion.

In May, 1917, I was collecting fungi in a dense poplar and white spruce swamp. Having become tired I sat down on a fence a short distance from a large stump from which was protruding a fruit-body of *Fomes pinicola*. The fungus was directly between myself and the sun and it was brightly illuminated by rays of light penetrating through the dense foliage. I distinctly saw clouds of spores streaming from the under side of the fruit-body and drifting away in the very slight air currents that were moving between the trees.

* A. H. R. Buller, Researches on Fungi. London, 1909, pp. 89–101, 133–147.
† *Ibid.* p. 90.

UPON THE AUDIBILITY OF SPORE DISCHARGE IN HELVELLA ELASTICA (BULL.).

By R. E. Stone, Ph.D.

(Department of Botany, Ontario Agricultural College.)

The forcible discharge of spores has been observed in a great many Ascomycetes. The spore-discharging organs or asci of these fungi are very minute. Hence it is that the sound which they emit when they explode has been heard only in the case of a few species with large fruit-bodies.

Buller* has confirmed the observations of Grove that the discharge of the sporangium in *Pilobolus* is accompanied by a distinct sound. De Bary† reports hearing a hissing sound accompanying the puffing of *Peziza acetabulum* and *Helvella crispa*, thus substantiating the earlier report of Desmazières. In this connection some observations of my own on the audibility of spore discharge in *Helvella elastica* may prove of interest.

In June, 1915, the Ascomycete *Helvella elastica* was very abundant in the neighbourhood of the Agricultural College at Guelph, Ontario. On June 21 I collected many fruit-bodies of this fungus and brought them into the laboratory where I left them in a closed basket. The next day, while I was identifying species in the laboratory, my attention was attracted by an intermittent hissing sound apparently coming from the direction of the basket containing the fungi. The basket was five to six feet away from me. The room was very quiet and the sound was quite distinct. My curiosity having been aroused, I took the trouble to locate the source of the sound. All sources were soon eliminated except the basket containing the Helvella. Upon lifting the cover of the basket I clearly saw a spore-puff and at the same time heard a distinct hiss, louder than any I had heard before. In the course of half an hour I observed at least six puffs; and each puff was accompanied by a distinct hiss. The more pronounced the puff, the more audible, the more distinct, and the more prolonged were the accompanying hissing sounds.

The above observations have convinced me that at least for some of the larger Ascomycetes there can be no doubt whatever that the discharge of the spores is audible.

In conclusion I wish to thank Professor Buller for suggesting that I should write this brief communication.

* A. H. R. Buller, Researches on Fungi. London, 1909, p. 259.

† De Bary, Comparative Morphology and Biology of the Fungi, etc. Oxford, 1887, p. 92.

PIMINA PARASITICA GROVE.

By A. Lorrain Smith, F.L.S.

This peculiar fungus which was discovered by Greenwood Pim growing on the hyphae of *Botrytis* sp. was described by Grove as gen. and nov. sp. in Journ. Bot. XXVI. p. 206, 1888. Pim himself published a photographic plate of the fungus with a description in the second number of the Trans. Brit. Mycol. Soc., Vol. I. p. 65, 1898. A microscopic preparation was placed in the herbarium of the British Museum.

In more recent years a fungus occurring among moulds on the cork of a bottle of preserved fruits has been described at length by P. Vuillemin as *Urophiala* gen. and nov. sp. (Bull. Soc. Sci. Nancy, Sér. 3, XI. p. 158 (pls. 4–5), 1910). The description and figures leave absolutely no doubt that he was dealing with the same genus if not the same species.

The genus is of particular interest as Vuillemin has given it an important place in his scheme of classification of the Hyphales or Hyphomycetes. In this scheme, he insists on the systematic importance of the insertion of the spore or conidium. He distinguishes four different types of insertion: the conidia may be borne (1) directly on the hyphae; (2) at the top of a conidiophore; (3) on a specialised cell or sterigma which he terms a phialide to distinguish it from the sterigma of the Basidiomycetes, or (4) on a phialide which rises from a specialised cell or prophialide. These he groups as four orders:

I. Sporotricheae: spores borne directly on the hyphae, ex. *Sporotrichum.*

II. Sporophoreae: spores borne directly on a sporophore, ex. *Acremonium.*

III. Phialideae: spores borne on a sterigma or phialide, ex. *Spicaria.*

IV. Prophialideae: phialide rising from a prophialide, ex. *Urophiala* (*Pimina*).

In the last order Vuillemin places three families each containing one genus, I. Urophialaceae, II. Coemansiaceae, III. Coronellaceae.

His descriptions of *Urophiala* are as follows:
Urophiala Vuill. nov. gen.

Mycelium creeping, subhyaline; fertile hyphae erect, dark-coloured septate, simple, always of three parts: (1) a continuous or uni-septate stalk; (2) the head (or prophialide) brown, incurved bearing three, rarely two, spore bearing phialides; (3) apical filaments faintly coloured. Phialides ventricose, the apex curved, beaked, soft, soon evanescent, rarely rigid. Conidia solitary, acrogenous, hyaline, round or oblong, smooth.

Urophiala mycophila nov. spec.

Mycelium effuse, creeping, ca. 1μ thick; fertile hyphae fuliginous, 20–34μ high; stalk 4–17 × 2·5–4μ; prophialide 9–11μ high, 4μ thick, to 7–7·5μ wide, with apical filament 6–8 × 1·75–2μ; phialide subhyaline, ascending, 4 × 3–3·5μ; conidia ovoid, 5–7 × 4–5μ.

On cork among Mucedineae. Cultivated in a test-tube on carrot. Beyond stating that the fungus grows in association with moulds, Vuillemin does not say that it is parasitic, and there is also no clear evidence that our British species is parasitic on the *Botrytis*. The microscopic preparation is somewhat imperfect, but the prophialides correspond exactly in form with the French specimens. *Pimina* is closely associated with *Botrytis* conidiophores and may be parasitic but it also grows outside the "host" filament. Vuillemin to whom the matter has been submitted recognises the generic resemblance of the plants but considers them specifically distinct as Grove's plant is on the whole larger. It seems impossible to be absolutely sure until fresh specimens are found. Vuillemin is of opinion that Grove's genus should rank as a *nomen nudum* on account of the very imperfect description which applies more nearly to *Urobasidium*.

If Vuillemin's contention be accepted, the British species would become *Urophiala parasitica*, but if as unfortunately seems probable *Pimina* should be held to have true priority then the French species would become *P. mycophila*.

JAMES WILLIAM HELENUS TRAIL.

(1851—1919.)

By J. Ramsbottom.

James William Helenus Trail, Professor of Botany at Aberdeen, died on Sept. 18th last. He was born at Orkney and was the son of a parish minister who afterwards became Professor of Systematic Theology at Aberdeen. As, in addition, his maternal grandfather was a Professor of Moral Philosophy it is not to be wondered at that his early training was all on the side of the humanities. But, even in his schoolboy days Trail began that systematic collecting which he was to carry on until his death. In spite of lack of encouragement, when he graduated in arts at Aberdeen in 1870 he did so with honours in natural science. He then entered the medical faculty not apparently with any idea of eventually practising, but for the purpose of further scientific training. However, having an opportunity of visiting Brazil as botanist to an expedition organised by the Amazon Steam Navigation Company he left his medical studies for a couple of years.

His work on his botanical and zoological collections brought him into notice and in 1876 he was appointed government botanist to British Guiana. Before he sailed, however, Professor Dickie who was in failing health resigned from the botanical chair and Trail, at the age of twenty-six, was appointed by the Crown to fill the vacancy. From the year 1870 onwards Trail contributed a series of papers and notes on various natural history subjects. He early became interested in systematic mycology being first attracted by parasitic microfungi probably because of his intensive work on phanerogams and on galls. He published valuable revisions of the Scottish species of Peronosporeae, Sphaeropsideae and Melanconieae, Discomycetes, Uredineae and Ustilagineae, and Perisporiaceae, in all of which he made noteworthy additions to the British fungus flora. He contributed to the Scottish Naturalist from its foundation in 1871 and became its Editor from 1883 until 1892 when it was incorporated in the Annals of Scottish Natural History of which he was botanical editor until 1911.

A hint as to his all-round knowledge is given by the fact that when he was a medical student he acted as assistant to the

Professors of Botany, Chemistry and Natural History: and when Professor Nicol retired from the Chair of Natural History in 1878 he held the professorship until a new appointment was made.

The present writer knew of Trail's personality chiefly through meeting his students: it is not usual in these days to encounter such whole-hearted enthusiasm as to a professor's stores of knowledge long after removal from his direct influence. One had only to converse with him on systematic mycology—facts and philosophies—to understand to some extent the admiration in which he was held by those who received their botanical training from him.

One characteristic of Trail was his generosity in the cause of natural science. In 1902 he endowed the Nicol prize in Zoology and the Dickie prizes in Botany at Aberdeen "for the purpose of encouraging students to undertake research in the fauna and flora of Scotland": in 1907 the Helen Scott fund in memory of his mother for the benefit of students in any faculty showing marked ability in botany or zoology who might require assistance to enable them to follow out their studies at the University: in 1909 the Trail fund of the Linnean Society for the presentation of a medal every five years for research during the interval throwing light upon the nature of protoplasm or the physical basis of life.

Trail was elected F.R.S. in 1893 and was president of Section K at the British Association in 1910. He was president of our Society for 1902. I am indebted to an obituary notice by Sir David Prain in Kew Bulletin (1919) for much information. A list of Professor Trail's publications is appended to the notice.

Published 1st April, 1920.

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THE PAINSWICK FORAY.

21st–25th May, 1920.

For the first time since 1915 it was found practicable this year to hold a Spring Foray. This took place during the Whitsun holidays, May 21st to 25th, at Painswick, Gloucestershire, the headquarters being at the Falcon Hotel, Painswick, where a large, well-lighted room was secured for the exhibition of specimens.

Some twenty-five members and friends attended, and a most enjoyable week-end was spent, favoured by glorious weather. From the mycological point of view the Foray was disappointing, owing to the dry weather, which is fatal to fungus growth in these hilly districts. Although fungi were scarce, however, there was a wide field in other directions, and as the party included lichenologists, bryologists and conchologists, as well as phanerogamic botanists, there was plenty of varied interest.

Larger fungi were of course very few. The most outstanding species was *Sarcosphaera coronaria*, which was fairly common in all the beech woods, and of which some very large specimens were gathered. On the Sunday at Sheepscombe several of the party collected *Aleuria umbrina*, a rather unusual Discomycete, and at Birdlip Mr Pearson secured a single specimen of *Acetabula vulgaris*. *Trametes suaveolens* was found by Mr Rea at Sheepscombe.

Of the microfungi perhaps the most interesting was *Chrysomyxa Pyrolae*, found in two localities. *Dichaena faginea* was abundant on the beeches, but only in the conidial stage.

In Pope's Wood Mr Grinling came across a single specimen of *Eichleriella spinulosa*. This is the first time it has been collected in the South—the only previous collections known to me being from Forres, Glamis, and Mulgrave Woods. This is an interesting plant, which has had a varied history as regards its nomenclature. Bresadola, who first noted its large septate basidia, placed it in a new genus *Eichleriella*, calling it *E. Kmetii*. Then it was found that English records of *Stereum rufum* were based on this plant, and further that *Radulum deglubens* B. & Br. was the same species, so the name became *E. deglubens*. Now Burt has shown that *Radulum spinulosum* B. & C. is also the same, and as this is a still earlier specific name the combination *E. spinulosa* Burt must stand. It is to be hoped no one will find yet an earlier name than this.

On the Saturday evening a short meeting was held, at which the Secretary read on behalf of Mr A. D. Cotton, who was unable to be present, some notes on "Black Rust on Wheat."

In view of the serious outbreak of this disease in South-West Wales (Pembrokeshire, Cardiganshire, and Carmarthenshire), Mr Cotton appealed to members of the Society to assist in collecting data as to the incidence of rust fungi on cereals in the western counties, and particularly in Devon and Cornwall.

At the request of the Essex Field Club a resolution was passed deploring the attempt being made to infringe the Epping Forest rights by making the war-time allotments permanent, but a rider was added that alternative arrangements should be made to safeguard the interests of allotment-holders. The Secretary of the Essex Field Club has since written that further action is at present unnecessary, as the Conservators are taking action to safeguard the Forest rights.

Mr Pearson announced that Dr Paul had very kindly marked in his copy of Cooke's "Catalogue of British Basidiomycetes" the correct accentuation of fungus names, and that this list was at the disposal of any member who was interested. A cordial vote of thanks to Dr Paul for his trouble was carried by acclamation.

During the Foray Mr Hadden exhibited the following from West Porlock: *Puccinia Umbilici*, *P. variabilis*, *Uromyces sparsus*, *Exoascus Pruni*, *Mitrula phalloides*, *Arachnopeziza aurelia*, and *Elaphomyces granulatus*. Miss Collins showed the rare subterranean fungus, *Melanogaster ambiguus*, which was dug up at Clapham, near Worthing.

For assistance in compiling the subjoined list the Secretary is indebted to Mr Carleton Rea and Mr A. A. Pearson. The Mycetozoa were worked out by Dr W. T Elliott and Mr N. G. Hadden, who forwarded the list appended.

COMPLETE LIST OF FUNGI GATHERED DURING THE FORAY.

B. = Birdlip; *C.* = Cranham; *S.* = Sheepscombe. Where not otherwise indicated the species was found in the near neighbourhood of Painswick.

Tricholoma terreum (Schaeff.) Fr., gambosum Fr., *Dursley*, personatum Fr., *S.*, melaleucum (Pers.) Fr., var. polioleucum Fr.

Collybia esculenta (Wulf.) Fr., *S.*, dryophila (Bull.) Fr.

Clitocybe rivulosa (Pers.) Fr., *S.*

Pluteus cervinus (Schaeff.) Fr., *B.*, nanus (Pers.) Fr., var. lutescens Fr., *C.*

Pholiota mutabilis (Schaeff.) Fr., *B.*, marginata (Batsch) Fr., *B.*

Tubaria furfuracea (Pers.) W. G. Sm.

Stropharia semiglobata (Batsch) Fr.
Hypholoma fasciculare (Huds.) Fr.
Psathyra corrugis (Pers.) Fr., *S.*
Coprinus niveus (Pers.) Fr., micaceus (Bull.) Fr., radiatus Fr., *B.*
Panaeolus sphinctrinus Fr., campanulatus (Linn.) Fr.
Psathyrella disseminata (Pers.) Fr.
Boletus elegans (Schum.) Fr., badius Fr., laricinus Berk.
Polyporus adustus (Willd.) Fr., *B.*
Fomes annosus Fr., *B.*
Polystictus versicolor (Linn.) Fr.
Trametes gibbosa (Pers.) Fr., suaveolens Fr., *S.*, rubescens (A. & S.) Fr., mollis (Somm.) Fr.
Hydnum udum Fr.
Irpex obliquus (Schrad.) Fr.
Odontia fimbriata (Pers.) Fr., farinacea (Pers.) Quél.
Corticium laeve (Pers.) Fr., Sambuci (Pers.) Fr., botryosum Bres., subcoronatum von Hoehn. & Litsch., confine Bourd. & Galz., sulphureum (Pers.) Bres., praetermissum (Karst.) Bres.
Peniophora longispora (Pat.) von Hoehn. & Litsch., velutina (DC.) Cooke, cremea Bres., cinerea (Fr.) Cooke, hydnoides Cooke & Mass.
Auricularia auricula-Judae (Linn.) Schroet.
Dacryomyces deliquescens (Bull.) Duby.
Calocera cornea (Batsch) Fr.
Eichleriella spinulosa (B. & C.) Burt.
Uromyces Scillarum (Grev.) Wint.
Puccinia Violae (Schum.) DC., Aegopodii (Schum.) Mart., fusca (Relh.) Wint., Heraclei Grev., *S.*, Saniculae Grev., *S.*, obtegens (Link) Tul., Hieracii (Schum.) Mart., *S.*, Hypochaeridis Oud., Chondrillae Corda on *Lactuca muralis*, Lampsanae (Schultz.) Fuck., variabilis Grev., *S.*, Vincae (DC.) Berk., Betonicae (A. & S.) DC., Caricis (Schum.) Rebent., on *Urtica*, Poarum Niels., on *Tussilago*, *S.*
Phragmidium Sanguisorbae (DC.) Schroet., *B.*
Coleosporium Senecionis (Pers.) Fr., on *Pinus*.
Ochropsora Sorbi (Oud.) Diet. (=Aecidium leucospermum DC.), *S.*
Endophyllum Euphorbiae-silvaticae (DC.) Wint., *S.*
Chrysomyxa Pyrolae (DC.) Rostr., *C.*, *S.*
Melampsora Rostrupii Wagn., on *Mercurialis perennis*, *B.*
Melampsorella Symphyti (DC.) Bubak.
Urocystis Anemones (Pers.) Wint., *B.*
Cystopus candidus (Pers.) de Bary, cubicus (Strauss) de Bary, *B.*
Peronospora calotheca de Bary, on *Asperula odorata*, Ficariae Tul, *S.*
Plasmopara nivea (Ung.) Schroet., on *Anthriscus*, *S.*

Pilobolus crystallinus (Wigg.) Tode.
Protomyces macrosporus Ung.
Sphaerotheca pannosa (Wallr.) Lév.
Microsphaera Alni (DC.) Wint., on *Rhamnus catharticus.*
Erysiphe graminis (DC.) Fr.
Hypomyces aurantius (Pers.) Fuck., on *Polystictus versicolor.*
Chaetomium elatum Kunze.
Rosellinia aquila (Fr.) de Not.
Diatrype Stigma (Hoffm.) de Not., disciformis (Hoffm.) Fr.
Hypoxylon fuscum (Pers.) Fr., coccineum (Bull.) Fuck., rubiginosum (Pers.) Fr.
Ustulina vulgaris Tul.
Xylaria polymorpha (Pers.) Grev., Hypoxylon (Linn.) Grev.
Rhytisma acerinum (Pers.) Fr.
Dichaena faginea (Pers.) Fr.
Acetabula vulgaris Fuck., *B.*
Aleuria umbrina Boud., *S.*
Sarcosphaera coronaria (Jacq.) Boud.
Cheilymenia stercorea (Pers.) Boud.
Coprobia granulata (Bull.) Boud.
Ascobolus stercorarius (Bull.) Schroet.
Ascophanus ochraceus (Cr.) Boud.
Polydesmia pruinosa (B. et Br.) Boud., on *Diatrype Stigma.*
Hyalinia inflatula (Karst.) Boud.
Dasyscypha virginea (Batsch) Fuck., bicolor (Bull.) Fuck., cerina (Pers.) Fuck.
Trichoscypha calycina (Schum.) Boud.
Hyaloscypha hyalina (Pers.) Boud.
Mollisia cinerea (Batsch) Karst.
Pseudopeziza Trifolii (Biv.-Bern) Fuck.
Ovularia obliqua (Cooke) Oud., on *Rumex.*

Mycetozoa.

Ceratiomyxa fruticulosa (Muell.) Macbr., *B.*
Physarum nutans Pers., *B.*, *C.*
Craterium minutum (Leers) Fr., *B.*
Diderma spumarioides Fr., *B.*
Didymium difforme (Pers.) Duby., *S.*
D. squamulosum (Alb. & Schw.) Fr., *B.*
Stemonitis fusca Roth.
Enteridium olivaceum Ehrenb.
Reticularia Lycoperdon Bull.
Lycogala epidendrum (L.) Fr., *C.*, *S.*
Trichia persimilis Karst., *B.*
T. decipiens (Pers.) Macbr., *B.*
Arcyria denudata (L.) Sheldon, *B.*

LICHENS FOUND NEAR PAINSWICK.

22nd–25th May, 1920.

By Robert Paulson, F.L.S., F.R.M.S.

In so short a period as three days it was only possible to search over a very circumscribed area of the higher ground to the north-west of Painswick. A few species were, however, seen upon the larger trees, beech and ash, in the woods near Birdlip.

A noticeable feature of the lichen flora of this district is the paucity of corticolous and terricolous species. Those that were gathered proved to be very poorly developed specimens belonging to the Pertusariaceae, Cladoniaceae and Graphidiaceae. This feature cannot be explained by saying that it is simply due to the low light-intensity within the wood, for shade lichens of the Graphidiaceae are equally rare and stunted in growth as are those belonging to the Parmeliaceae. On the outer borders of the woods, towards the south and south-west, where the light-intensity is considerably higher than it is some distance within the wood, corticolous lichens rarely occur.

This area is not adversely affected by a great smoke drift, for the trunks and branches of the trees are not begrimed with soot as they would be if subjected to such a baneful influence.

The only suggestion that can at present be offered to explain the absence of the corticolous species in the woods around Painswick, is, that such absence may be due to some edaphic factor of the soil which is as yet unknown to us, for it is highly probable that edaphic factors are occasionally inimical to lichen growth within a wood.

There is a comparatively rich harvest of saxicolous species, shown by the accompanying list, to be gathered on the sunny side of the field oolitic-stone walls and from the rocks projecting through the soil, when these are sufficiently remote from the clouds of dust that are raised by the heavy motor traffic upon the main roads. The species of the walls are for the most part crustose; there are very few foliose species upon them.

Tichothecium pygmaeum Koerb., a fungus parasite, was abundant on the thallus of *Placodium rupestre*.

LIST.

w., on walls; r., rocks; t., on trees; s., on soil; f., fertile.

Placynthium nigrum S. F. Gray, w., f.
Parmelia physodes Ach., very poorly developed, t.
P. caperata Ach., t., *P. sulcata* Ach., t.
P. dubia Schaer., t., *P. fuliginosa*, var. *laetevirens* Nyl., t.
Evernia prunastri Ach., t., *Xanthoria parietina* Th. Fr., w., f.
Placodium callopismum Mér., w., f., *P. murorum* DC., w., f.
P. variabile Nyl., w., f., *P. rupestre* Branth & Rostr., w., f., and var. *calvum* A. L. Sm., w., f., *Physcia pulverulenta* Nyl., t., f.
P. hispida Tuckerm., t., r., *Lecanora subfusca*, var. *chlarona* Ach., t., f., *L. allophana* Ach., t., f.
L. campestris B. de Lesd., w., f., *L. galactina* Ach., w., f.
L. conizaea Nyl., t., f., *L. calcarea* Sommerf., w., f.
Pertusaria faginea Leight., t.
P. pertusa Dalla Torre & Sarnth., t., *P. leioplaca* Schaer., t., f.
Cladonia furcata Schrad., s., and var. *spinosa* Leight., s.
Gyalecta exanthematica Fr., r., f.
Lecidea Metzleri Th. Fr., w., f., *L. parasema* Ach. t., f.
Biatorella pruinosa Mudd, r., f., *Biatorina lenticularis* Koerb., w., f.
Bilimbia sabuletorum Branth & Rostr., moss, w., f.
B. aromatica Jatta, w., f.
Buellia myriocarpa Mudd, on yew trees in the church-yard, f.
Rhizocarpon alboatrum Th. Fr., var. *epipolia* A. L. Sm., w., f.
Arthonia radiata Ach., var. *Swartziana* Sydow., t., f.
Opegrapha Leightonii Cromb., w., f.
Dermatocarpon hepaticum Th. Fr., s., f.
Verrucaria rupestris Schrad., w., f.
Thelidium immersum Mudd, w., f., *T. incavatum* Mudd, w., f.
Acrocordia gemmata Koerb., t., f., *A. epipolaea* A. L. Sm , w., f.

PRESIDENTIAL ADDRESS.

By Harold Wager, D.Sc., F.R.S., F.L.S.

On this the first annual meeting of the Society since its reorganisation, it is appropriate that I should devote a few minutes of the time at my disposal to consider briefly the progress made in Mycology during the time the Society has been in existence, a period covering nearly a quarter of a century.

During this period our knowledge of the life-histories of the Fungi, especially the Phycomycetes, Ascomycetes, and Basidiomycetes (Uredineae and Hymenomycetes) has been completely revolutionised. The perfection of the microscope, and the introduction of more refined methods of investigation, have enabled us to elucidate the cell structure or cytology of the Fungi to such a degree of completeness that in this respect they are almost as well known as the more highly developed plants.

In Physiology, Pathology and in the biological relationships of parasitic forms to their hosts very important contributions, of interest, not only to the mycologist and biologist, but to investigators in various other branches of science, have been made. The progress which has taken place in our knowledge of fertilisation in the Fungi, and the discovery of endokaryogamy, a process of nuclear fusion entirely unknown before either in plant or animals, have led to various new conceptions of the significance of sex and nuclear fusions.

Many new systems of classification have been proposed, and some of them have been very favourably received, but in this country the system devised by Fries is, for all practical purposes, still maintained. The difficulties which are confronted in the attempt to devise a more natural classification are very great. Although much has been done to elucidate the life-histories of the Fungi, we are still unacquainted with the complete life-histories of the vast majority of the Fungi, and the list of Fungi Imperfecti—Fungi which are supposed to be stages in the life-histories of other Fungi—is still so vast that anything like a reasonably natural classification is out of the question. Something however might be done to introduce a more natural arrangement of the British Fungi than that at present in use. Probably the most serviceable classification available is that given by Engler and Gilg in the Syllabus der Pflanzenfamilien.

This is based upon the fuller classifications in Engler and Prantl's Pflanzenfamilien and although it leaves much to be desired, especially in the classification of the Basidiomycetes, may be very well taken as a basis for further improvements and emendations.

The study of ecological problems arising out of the distribution of the Fungi is almost an untouched field. Many of these problems are most difficult and perplexing, and will demand most patient and laborious investigation both in the field and in the laboratory. We may hope that the committee appointed by the British Association to report upon the possibilities of the investigation of the ecology of the Fungi may very shortly indicate profitable lines of study along which our energies may be directed.

The British Mycological Society has played an important part in the progress of Mycology during the period under review; many of the most striking discoveries made during the last twenty-five years, which have completely modified our views and conceptions of Mycology, have been made by members of our Society. Our most grateful thanks are due to Mr Carleton Rea, and, may I add, to Mrs Rea also, for the splendid services they have rendered during all these years in the organisation and development of the work of the Society. Not the least important effect of the success of the Society has been the possibility of its reconstitution upon a wider basis, and with a more elaborate organisation. We look forward with confidence to a highly successful and prosperous future for the Society, and to increased activity and usefulness in all departments of Mycology in which we hope that both amateur and professional mycologists will play their part.

Before I pass on to the main subject of my address I wish to refer briefly to the losses we have sustained by death during the year.

The death of Thomas Gibbs, who had been a member of our Society from its foundation, leaves us the poorer by a charming personality, and an indefatigable worker in the realm of systematic mycology. Although leading the busy life of a professional man he found time to contribute to various scientific journals no less than forty papers on Natural History topics of which rather more than half are on Fungi.

By the death of Sir Charles Thomas Dyke Acland, Bart., who joined the Society in 1899, we have lost a member who always took a friendly and sympathetic interest in our work.

Two promising young mycologists died during the last year, Dr Arthur Eckley Lechmere and Mr Charles Ogilvie Farquharson; the former would have been a member of our Society had not

the great European War prevented it, and I am quite sure therefore that you would wish me to mention them here.

The tragic death of Dr Arthur Eckley Lechmere, on February 14th of this year, which occurred soon after his return to England after a period of four years as a prisoner of war in Ruhleben, deprives mycological science of an unusually gifted and versatile investigator. The story of his life at Ruhleben and of his setting up under most difficult and primitive conditions, of a well-equipped biological laboratory, in which teaching and research were carried on, savours of the romantic and will not easily be forgotten. By his unflagging industry and enthusiasm he aroused a genuine interest in natural science which not only alleviated the rigours of the prison camp, but gave to many an impetus to scientific study. Surely such a piece of work will take its place among the honourable records of distinguished service rendered during the war.

Mr Charles Ogilvie Farquharson whose untimely death occurred through the collision at sea of the homeward bound SS. Burutu on October 3rd 1918, was a promising tropical mycologist whose work had already shown distinction and originality.

By the death of Mr Anthony Wallis we have lost a mycologist of high attainments and ability. As a member of the Yorkshire Mycological Committee he had done excellent service to Mycology, and he was also engaged in a special study of the Fungi of Cumberland. Had he lived he would have been proposed as a member of our Society at this meeting.

THE SIGNIFICANCE OF SEX AND NUCLEAR FUSIONS IN THE FUNGI.

In his Presidential Address at the first annual meeting of the Society at Worksop in 1897 Mr George Massee gave some account of mycological progress during the sixty years from 1837 to 1897, a period within which practically all the knowledge we possessed of Fungi as living organisms had been acquired.

The very considerable progress made however, during the last decade of that period, in our knowledge of the sexuality and reproduction of the Fungi was only slightly touched upon by Massee, and it has seemed to me, therefore, that a brief discussion of some of the aspects of the problems of sex and nuclear fusions in the Fungi which have come to light during the last thirty years might usefully occupy the time that remains to me.

In one of his interesting essays on "Problems of Life and Reproduction" my friend Professor Hartog has taken me to task for the use of the word sexuality in connection with the

Fungi where "no differentiation of male or female exists in some of the most important and, indeed, primitive types." As Professor Hartog points out the term sex "originally implied a binary differentiation of pairing cells into categories of distinct size and habit." But the more we know of the physiology of sex the more we see that this difference in size and habit is only a morphological indication of profound internal differences. Such differences may exist in fusing cells which are morphologically identical, and there is no good reason why they should not be regarded as sexual. Among the Mucors for example, as Blakeslee has shown, isogamy is only morphological. "Sexually the two (morphologically identical) gametes which unite have diametrically opposite characters."

The idea of sex may be thus extended, and quite justifiably so, I think, to cell fusions which take place between cells of the same size if they result in the production of a zygote, and are characterised by similar phenomena to that of binary fusions. Such cells although not morphologically heterogamous are physiologically heterogamous, and the difference between male and female is thus at bottom a physiological one and not morphological.

Sexual fusion or fertilisation involves not only the fusion of two cells, but also the fusion of their nuclei. This latter fact was not definitely established until 1875 when O. Hertwig and Hermann Fol independently discovered the fusion of the egg nucleus with the sperm nucleus in the egg of the sea urchin. These observations were soon confirmed and extended both in animals and plants, but it was not until 1889 that any satisfactory indication of the fusion of a male with a female nucleus was observed in the Fungi, and it was not until 1896 that it was definitely established.

At that time the existence of sexual organs in the Fungi was well known. Oogonia and antheridia had been seen in many forms of the Peronosporeae, and the formation of zygospores by the fusion of two equivalent cells, or two unequal cells had been definitely observed in the Mucorineae. There were indications of sexuality in the Ascomycetes, and already it had been surmised that the aecidium of the Uredineae might be the seat of sexual organs. The passage of the protoplasm of a male cell into a female cell had been clearly observed in *Pythium de Baryanum* by Marshall Ward and de Bary. No fusion of nuclei had however been seen. This is not surprising for at that date it was not known whether the majority of the Fungi possessed true nuclei. Strasburger (1884) had observed the presence of true nuclei in *Trichia fallax* but, except for some deeply stainable granules which had been seen in various species of Fungi,

and which, simply on account of their staining properties, were regarded as nuclei, the presence of true nuclei in the majority of Fungi had not been established.

De Bary remarks for example (1887, Comparative Morphology and Biology of the Fungi, etc.), "The satisfactory discrimination of true nuclei from other small bodies contained in the protoplasm, and like them perhaps rendered more distinct by colouring reagents, is extremely difficult, and can only be obtained after renewed investigation." The determination of the nuclear nature of these granules depends not on their stainable properties, but upon their structure and mode of division. Where this is accompanied by mitosis the nuclear nature of any given body is unmistakable.

Evidence of mitotic nuclear division had been obtained in 1883 by Sadebeck in Asci of *Exoascus*, by Strasburger in 1884 in *Trichia fallax*, by Fisch in 1885 in Ascomycetes, and by Eidam in 1887 in *Basidiobolus*.

In 1889 I described the nuclei of *Peronospora parasitica* and showed that they possessed a normal nuclear structure, nuclear membrane, nuclear net-work and nucleolus, and further that the process of division was karyokinetic in that chromosomes were formed, a nuclear spindle produced, and the separation of the chromosomes along the spindle to form two daughter nuclei. The nuclei of *Peronospora parasitica* in fact differ in no essential particular from the nuclei of higher plants and animals.

Hartog in 1889 and 1895 saw some mitotic stages in *Saprolegnia*, Rosen in 1892 thought he had obtained some indications of nuclear division in Basidiomycetes, but he mistook stages of the resting nucleus for these, Gjurasin in 1893 described mitosis in the nucleus of the ascus in *Peziza vesiculosa*, Lister in 1893 mitosis in Mycetozoa, Wager in 1891–4 mitosis in Basidiomycetes, in which spindle figure, equatorial plate and centrosomes were seen, and Harper in 1895 obtained beautiful figures of mitosis in asci.

Since then our knowledge of the nuclei of Fungi has been extended to all the groups of Fungi, and we know that the nuclei of the Fungi do not differ in any essential feature from the nuclei of higher plants and animals.

Side by side with our knowledge of their nuclei our knowledge of the sexual phenomena in the Fungi has been developed and the importance of the nuclei in the process has been demonstrated.

All that we know definitely of the behaviour of the nuclei in the formation of the sexual organs and in the subsequent fertilisation which takes place has been discovered during the last thirty years, but all the essential features of this fertilisation were

definitely established in the first ten years of this period, that is between 1889 and 1900.

Thus in 1889 the chief stages of nuclear behaviour in the maturation of the zygote of *Peronospora* were described. It was shown that the oogonium contained over 100 nuclei, each of which divided at least once, so that the oogonium contained some 200 nuclei or more, that the fully formed oosphere contained only one nucleus, that a branching tube from the antheridium carrying one nucleus penetrated the oosphere, that subsequently an empty antheridial tube was seen, that the oosphere then was found to contain two nuclei presumably male and female, and that at a later stage only one nucleus was visible. The conclusion was arrived at therefore that a male nucleus passes over from the antheridial tube into the oosphere, and finally fuses with the central nucleus. That this is what actually takes place was definitely proved in 1896 for *Cystopus candidus*, and in 1900 for *Peronospora parasitica*, and has been abundantly confirmed by many observers. Here, then, we have a definite sexuality, viz. the fusion of morphologically differentiated male and female organs. The female organ is a large egg cell, containing abundance of cytoplasm, the male organ is a smaller cell containing several nuclei and protoplasm, but only one of the nuclei, with probably no cytoplasm, or only a very minute quantity, migrates from the male organ into the egg cell. Morphologically then this sexual fusion differs in no essential respect from what takes place in higher plants and animals. But this well-marked sexuality is not maintained throughout the other groups of Fungi, and subsequent investigations show that profound modifications of the sexual process occur. The first indication of this was discovered in 1891 (Report of the British Association, 1891) in the Hymenomycetes, in which no sexual differentiation had so far been observed. It was found that two nuclei were present in the young basidium, and that these two nuclei fused together before the formation of the basidiospores. The structure of the nuclei was found to be similar to that of the nuclei in the higher plants: each "consists of a nuclear membrane enclosing a dense nucleolus and a thread-like network." In a later paper, 1893, the fusion of the nuclei was described in detail, and the subsequent division of the fusion nucleus was also described; a spindle figure, chromosomes and centrosomes were observed, and the extrusion of the nucleolus into the cytoplasm. The number of chromosomes could not be determined exactly, but all the figures published show eight or ten chromosomes in the division of the fusion nucleus, and four or five in the daughter nuclei. In later papers it was shown that the number of chromosomes in the vegetative nuclei was four, in

the fusion nucleus eight, and that the result of the reducing division was the separation of these eight chromosomes into two groups of four each for the two daughter nuclei. Maire's statement that the vegetative nuclei contain only two chromosomes, and the fusion nucleus four, is quite incorrect.

My original investigations gave some indications of the fusion of three or four nuclei in the basidium, and Maire also stated that he had found three or four nuclei in young basidia, but the subsequent researches of Harper, Dangeard, Maire and myself showed quite clearly that this was abnormal and that the basidium normally contains two nuclei only.

Concerning this discovery of two nuclei in the basidium, and their subsequent fusion, Professor Harper remarks: "The most striking discovery as to fusion in the fungi and the one which preceded and led the way to very many of the most important later results was the observation by Wager of paired nuclei and the subsequent fusion of these nuclei in the young basidium." This was "the first proof of the existence of an endokaryogamy —the fusion of nuclei not derived from separate and independent gametes as in ordinary fertilisations, but having had a similar if not identical history in the cells from which the basidium arose. Such a process was entirely unknown before in either plants or animals (American Naturalist, Sept. 1910).

Subsequently in 1893 (Comptes rendus, Acad. des. Sc. Feb. 1893) Dangeard and Sappin-Trouffy announced the discovery of a binucleate condition in the aecidiospores and teleutospores of the Uredineae, and in Le Botaniste (ser. IV. 1894–5) Dangeard announced the discovery of two nuclei in the ascus, and their fusion. Dangeard regards the fusion of nuclei in the basidium, ascus and teleutospore as sexual in the ordinary sense of the term, the nuclei which fuse being equivalent to gametes, and the resulting uninucleate cell in each case as equivalent to an oospore or egg. Harper's observations on the true sexual organs of the Ascomycetes, and the discovery of binucleate cells in the vegetative stages of the Basidiomycetes and the cell fusion discovered by Blackman at the base of the aecidium in the Uredineae all tend to show however that the problem of the sexuality of the higher Fungi is an extremely difficult one to solve.

Whatever sexuality may be intrinsically, whatever may be its function physiologically or in heredity, it is essentially characterised by the association of two cells, each with its nucleus, and their fusion to form a zygote. The production of this zygote or egg takes place at a definite period in the life-history of any plant or animal in which it occurs, marking the close of a definite cycle in the life-history, and the beginning of another. Within this egg are contained all the essential charac-

teristics of the organisms from which it is derived, and from it a new individual arises. From the fact that, in the higher animals, this fusion of cells and nuclei is always necessary before any reproduction can take place, the sexual fusion was regarded as an act of reproduction.

But fertilisation is not an essential factor in reproduction. It has been shown that eggs which under normal conditions are fertilised can also develop without fertilisation if the male gamete is replaced by some other agent capable of effecting the necessary stimulation. Already in 1785, long before the morphological characteristics of fertilisation had been established, Spallanzani had tried to make use of such agents as electricity, extracts of various organs of the body, dilute acids, alcohol, etc., to stimulate the development of the egg in place of the seminal fluid. His experiments were however unsuccessful, but in recent studies of fertilisation on some of the lower forms of life it has been found possible to induce at least the earlier stages of development of the egg by other agents than that of the male organ, and it is now well known that fertilisation may be in certain cases replaced by stimuli of various kinds.

Tichomiroff (1886) found that the unfertilised ova of the silk moth could be stimulated to develop by rubbing them with a brush, or dipping them for two minutes in sulphuric acid and then washing them, and Loeb especially has given us since 1892 numerous examples of substances, hypertonic sea-water, solutions of magnesium chloride, sugar, potassium salts, inorganic acids, calcium salts, fatty acids, etc.—all of which are capable of effecting division in non-fertilised eggs.

In the conjugation of one of the Protozoa—*Paramoecium*—which has been very carefully studied by numerous observers it has been found that although under normal conditions rejuvenescence is brought about only after conjugation, it has been found that rejuvenescence may be brought about by changes in the culture fluids (Calkins), or may even be brought about spontaneously, without conjugation (Woodruff).

The observations of Woodruff are extremely interesting from the point of view of the Fungi. He showed (1914, Jour. Exp. Zool.) that the explanation of this spontaneous rejuvenation without conjugation in *Paramoecium aurelia* is due to a nuclear reorganisation in the individual cells which may be compared to the nuclear reorganisation which takes place in conjugation. The macronucleus breaks up and disappears, the micronuclei divide twice, but the third division, which normally occurs in conjugation, does not take place, a new macronucleus being formed from the micronuclei, with ultimately a restoration of the normal nuclear organisation. We have thus a nuclear re-

organisation which takes place, in the absence of fertilisation, at regular periods, and is sufficient for the continual development of the organisms.

These observations clearly indicate therefore that, although nuclear fusion is necessary for the blending of hereditary characters, it is not essential for growth and development, since the developmental stimulus under certain conditions can be effected by other agencies.

The observations which have recently been made on the binucleate cells in the vegetative tissues of the higher plants by Prankerd (Ann. Bot. 1915), and Beer and Arber (Ann. Bot. 1915; Proc. R. Soc. 1919), have an important bearing on the rejuvenation function of sexual and other nuclear fusions. It appears that multinuclear cells are very widely distributed and that they are characteristic of young tissues which are actively carrying on the processes of life. Most frequently the cells are binucleate, but three, four or even more may occur, and the paired nuclei often become surrounded by a differentiated shell of cytoplasm, "phragmosphere," which gradually expands until it merges in the peripheral cytoplasm. Professor R. C. McLean considers that there is also evidence of nuclear fusions taking place in these cells. The multinucleate stage reaches its most characteristic expression just previous to the maximum period of growth, when metabolic activity is running high. There appears to be in fact a definite cytoplasmic and nuclear reorganisation in the cells of young tissues just at a time when vigorous growth and development are taking place, and this may "conceivably afford the organism a distinct advantage in carrying out the chemical processes associated with growth, and might tend to become perpetuated as a definite physiological phase in the history of growing members."

A normal sexual fusion includes at least two distinct phenomena, (1) the blending of the parental characters derived from two distinct lines of descent, and (2) rejuvenescence of the reproductive cell by means of which it receives a new stimulus to growth and division. This exogamic binary sexual fusion is found at the present day, so far as we know, in a few fungi only, although formerly it may have been of more frequent occurrence. In the majority of fungi in which binary sexual fusion occurs (*e.g.* fusion of differentiated gametes) this fusion is endogamous (*e.g.* the gametes are produced on the same individual). Here it is obvious that, since there can be no blending of two lines of descent, the only purpose of this sexual fusion is rejuvenescence.

The production of distinct male and female organs on the bisexual thalli of such forms as Cystopus and Peronospora indi-

cates, however, that a definite physiological differentiation takes place at the time the sexual organs are formed. We do not know what this differentiation may be. It is not necessarily associated with a difference in the amount of food present in the respective male and female organs, for the same physiological differentiation obtains, as Blakeslee has shown, in the bisexual morphologically isogamous mucors. We may perhaps conceive it as something of the nature of a chemical difference in the nuclei brought about by their reactions to cytoplasmic influence, or possibly to some differentiation or segregation of hereditary factors. In the subsequent fusion of the male and female nuclei in the zygote, we have therefore no blending of two lines of descent but simply a recombination of nuclei which had become more or less differentiated in the individual. This recombination restores the vigour necessary for further development, and is sufficient to enable the fungus to continue its development by a prolonged period of vegetative reproduction during which vast numbers of asexual spores are formed without any further nuclear fusion, until the stage is reached when reinvigoration again becomes necessary and sexual organs are once more formed.

In the higher Fungi this normal type of sexual nuclear fusion has disappeared or is disappearing and is being replaced by a simpler type of nuclear fusion — endokaryogamy — the purpose of which is to provide for the nuclear reorganisation and reinvigoration of the individual reproductive cells just at the time when large numbers of spores are about to be formed.

In the Hymenomycetes and Uredineae this appears to be the only type of nuclear fusion that remains. The basidium of the Hymenomycetes, with its two nuclei, is the last term in a long series of binucleated cells which appears to extend back to a period prior to the formation of the carpophore. How this binucleate condition comes about we do not know, although suggestions have been made that it may arise as the result of fusions taking place between the cells of the primary mycelium by which plasmogamy is effected and cells with two nuclei are produced. It has also been stated that the binucleate condition is brought about by means of the clamp connections, but this requires confirmation. On the evidence at present available the most satisfactory explanation is that the binucleate condition occurs simply by differentiation during the formation of the cells of the primary mycelium which, at the beginning of their development, may contain from one to many nuclei.

In the Uredineae the origin of the binucleate cells has been more clearly determined. In those forms which possess an

aecidium it takes place in the cells at the base of the young aecidium. Maire described in some species a re-duplication of the nuclei by the division of the single nucleus of uninucleate terminal cells of hyphae below the aecidia. But this has not been confirmed and is, no doubt, from the evidence afforded by more recent observations, incorrect. Blackman found that cells become binucleate by the migration of a nucleus from one cell to another, and Christman showed that it might also be effected by the fusion of two cells. In the absence of an aecidial stage cell fusion may take place in the vegetative cells at the base of the uredospores or teleutospores. In *Uromyces Scillarum* (Grev.) Madame Moreau believes it may take place somewhere in the vegetative mycelium.

The cellular fusion at the base of the aecidium probably takes the place of an ancestral fusion of normal sexually differentiated gametes. Blackman suggests that this may be characterised as a vegetative fertilisation. After a more or less prolonged period of vegetative growth, during which the cells maintain their binucleate condition, large numbers of teleutospores are formed, each of which receives two nuclei; these ultimately fuse, and this is held to be the final stage in a sexual fusion which began by the fusion of cells in the aecidium. But this does not seem to me to be a satisfactory explanation of what takes place. The binucleate condition of the vegetative cells is a necessary preliminary to endokaryogamy in the teleutospore, but the result would be the same in whatever way the cells might become binucleate. We may regard the fusion of the cells in the aecidium as the result of a degraded or vegetative sexual differentiation, or simply as the fusion of somatic cells, taking the place of the original fusion of sexually differentiated gametes. It is not necessarily connected with the original sexual act, but may be a new type of cell fusion brought about in order to provide the binucleate condition of the vegetative cells necessary for endokaryogamy. The significant phenomena in this new type of fusion are the nuclear fusion and the subsequent reducing division in the teleutospore which provide just that new cytoplasmic and nuclear association upon which the stimulus necessary for the rejuvenescence and continued development of the organism depends.

In the Ascomycetes we have perhaps the clearest indication that a normal sexual fusion is being replaced by endokaryogamy. In some forms there are well-developed sexual organs, and, if Harper's observations are correct, a normal sexual fusion of nuclei, comparable in all respects with the sexual nuclear fusions in the lower Fungi. Others possess well-developed sexual

organs which are no longer functional, and in many forms the sexual organs show various stages of degeneration or have disappeared entirely. But whether sexual organs are formed or not there is always a nuclear fusion in the ascus.

Thus in the higher forms of the Ascomycetes there may be two distinct stages in the life cycle, the formation of well differentiated sexual organs, and, separated from these by a more or less numerous series of intermediate cell divisions, the formation of asci. On the evidence before us therefore the nuclear reorganisation which takes place in the ascus may have nothing whatever to do with fertilisation, but may be simply a means by which the vigour of the cell is restored just at the period when it is probably impaired and when renewed vitality is required for the formation of the reproductive elements.

The problem now arises: how is this phenomenon of endokaryogamy to be regarded in relation to a normal sexual act? Whatever may have been the original purpose or function of fertilisation it is clear that a normal fertilisation includes the blending of two lines of descent, and the restoration of vigour to cells which have become senescent. Hartog defines senescence as "the diminution of all vigour in life, nutrition, growth, and, above all, reproductive power" (Problems of Reproduction, p. 22), and he has given a most interesting explanation of the probable causes of senescence. The nucleus is the centre of the cell, governs its life and responds to the stimulus of the cytoplasm. We may well conceive, says he, that "the nucleus during the continuance of active cellular life gradually loses its readiness of response to the stimulation from the cytoplasm, and with its sensibility the power to guide and control aright the functions of the cytoplasm; so that the life of the cell is impaired." An internal reorganisation of the cell would restore the sensibility of the nucleus and the stimulatory activity of the cytoplasm, and this could be effected by fertilisation. But if the primary function of fertilisation or syngamy in its widest sense is merely rejuvenescence, and if, in any given form, this function is the only one effected by the sexual act, then it is clear that the complex sexual differentiation necessary for the blending of two lines of descent would no longer be required, since a complete cellular reorganisation can be effected in a much simpler way, by the fusion of cells and nuclei related by the closest bonds of cellular kinship.

It is therefore reasonable to conclude that if the blending of two lines of descent has become, for some reason or other, superfluous, the mere reinvigoration of the reproductive cell or cells may be effected by a much simpler type of nuclear reorganisa-

tion than that required for amphimixis. It is not improbable, therefore, that this affords a sufficient explanation, on the evidence available, of what is taking place in the higher Fungi where the endokaryogamy, a simple type of nuclear fusion which seems to be concerned solely with rejuvenescence, is apparently taking the place of a more complex process of binary sexual fusion.

RECORDS OF SURREY RESUPINATE HYMENOMYCETES.

By E. M. Wakefield, F.L.S. and A. A. Pearson, F.L.S.

The species in the third list we bring forward were for the most part collected within the same area as those recorded in the Transactions for 1917 and 1918. Our search, however, has been extended to include the woods in the Horsley district, which is the beginning of the chalk soil and is characterised by an abundance of beech. *Sistotrema variecolor* is included for its interest, though found in Hampshire. The list includes a number of species new to Britain, and we wish to express our gratitude to Monsieur l'Abbé Bourdot for valued help in determining many of these.

Tulasnella incarnata Juel.

This species is probably not uncommon in this country, but may be mistaken for a thin form of *Peniophora incarnata*, although there is a distinct difference in the colour when the two plants are compared.

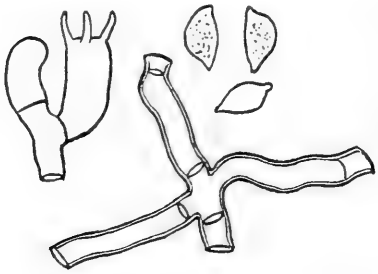
Hypochnella violacea (Awd.) Schroet.

The second record for Britain. It was found for the first time during the Doncaster Foray in 1914.

Corticium flavescens (Bon.) Mass. in Journ Linn. Soc. XXVII, 1890, p. 149. *Hypochnus flavescens* Bon., Handb. p. 160.

Irregularly effused, thin and pulverulent, whitish to dirty buff, with the habit of *C. botryosum*. Hymenium loose, as in

other allied species. Basidia oblong or clavate, 20–30 × 12–13 μ, with 2–4 curved sterigmata, 8 μ long. Spores somewhat lemon-shaped, apiculate at either end, and flattened on the inner side 15–17 × 7–9 μ (most 15 × 8 μ). Basal hyphae septate, hyaline or yellowish, without clamp-connections, branched at right-angles, loosely interwoven.



Corticium flavescens. × 550.

On rotten wood, St George's Hill, Weybridge, February 1920, A. A. P.

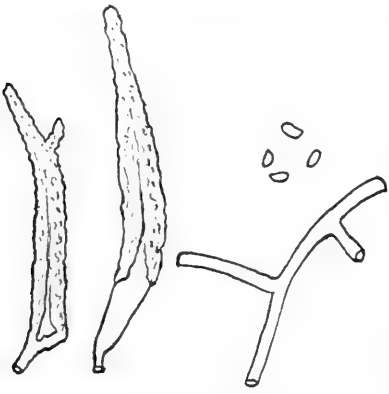
The species occurred abundantly, but most of the specimens were sterile. Fortunately some good fruiting specimens were obtained, and recognised at once by the characteristic spore.

Corticium praetermissum (Karst.) Bres.

The form which has been described as *Glococystidium tenue* (Pat.) von Hoehn. & Litsch. occurred amongst the typical form. *G. tenue* has cystidia which are very prominent, and are frequently swollen into a subglobose head at the apex and surmounted by a deposit of calcium oxalate. Intermediate forms occur so frequently that it is impossible to keep this form specifically distinct from *G. praetermissum.*

Peniophora leprosa Bourd. & Galz. in Bull. Soc. Myc. Fr. XXVIII, 1912, p. 394.

Irregularly effused, somewhat thick and crustaceous, margin white, indeterminate, occasionally prolonged into white rhizomorphic strands. Hymenium pinkish-ochraceous, somewhat cracked when dry, and rough with cystidia under the lens. Cystidia very rough, cylindrical to sub-fusiform, frequently occurring in clusters, so as to give an Odontia-like appearance, occasionally branched near the apex, 60–90 × 8–14 μ. Basidia inconspicuous, about 4 μ wide. Spores elliptical, 4–6 × 2·5–3 μ. Basal hyphae 3–4 (–7) μ, often strongly encrusted with crystals, clamp-connections rare.



Peniophora leprosa. × 550.

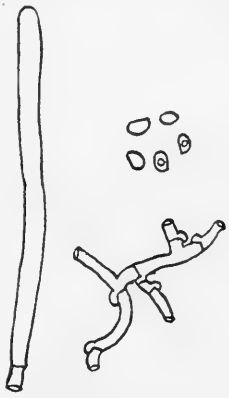
On dead bark, Horsley, April 1920, A. A. P.

This plant is very like *P. velutina* in appearance, and has similar spores, but it is distinguished by the much finer encrusted hyphae, and by the cystidia. Bourdot and Galzin give it as a subspecies of *P. radicata*, but it appears to us to be sufficiently distinct to rank as a species.

Peniophora detritica Bourd. in Rev. sc. du Bourb. 1910, p. 13, and Bull. Soc. Myc. Fr. XXVIII, 1912, p. 389.

Pure white, effused, very thin, with scattered granules suggesting a Grandinia. Hymenium not continuous, appearing farinaceous under the lens. Cystidia cylindrical or narrowly club-shaped, smooth, thin-walled, obtuse at the apex, 70–90 × 5–6μ. Spores broadly elliptical or obovate, one-guttulate, 5–6 × 4μ.

On rotten wood, St George's College, Weybridge, February 1920, A. A. P.



Peniophora detritica. × 550.

Peniophora laevigata (Fr.) Mass.

On yew logs, Horsley. The species is fairly common on yew in this district. The specimens gathered were of two kinds; some in thin small well-defined patches; other elongated and several mm. thick, representing apparently the successive growth of several years.

Jaapia Bres. in Ann. Myc. IX, 1911, p. 428.

Resupinate, effused, immarginate, flocculose-pulverulent, with the habit of some Corticia or of a pale Hypochnus; spores straw-coloured, sub-elliptical, hyaline-appendiculate.

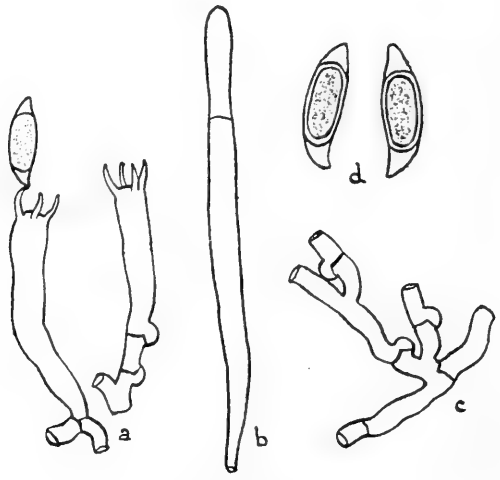
The genus is distinguished by the peculiar spores

J. argillacea Bres. loc. cit.

Irregularly effused, very thin, flocculose, sometimes with scattered granules, clay-coloured; hymenium at first loose, later more continuous. Cystidia present, cylindrical, obtuse, occasionally with a single septum, 100–160 × 7–8μ. Basidia clavate, up to 60μ long, 8–10μ wide, with 2–4 curved sterigmata, 8μ long. Spores fusiform, slightly curved, 22–25 × 7–8μ, consisting of a central oblong-elliptical portion, 14–18 × 7–8μ (most 15 × 7μ), containing faintly-coloured, granular protoplasm, divided off by a wall from a clear conical portion at either end. Basal hyphae flexuous, frequently septate, with clamp-connections, 4–6μ in diameter.

On a fallen stick, St George's Hill, Weybridge, October 1919, A. A. P.

In this material it was possible to see the peculiar spores attached to the basidia, as drawn, hence the suggestion which has



Jaapia argillacea.
a. Two basidia
b. Cystidium } × 550.
c. Hyphae
d. Spores × 850.

been made that the species represents a chlamydospore form of *Coniophora arida* is disproven. The mode of development of the spores could not be observed in the scanty material available.

Hymenochaete corrugata (Fr.) Lév.

The spore-measurements for this species are erroneously given in Massee's Fungus Flora as 7–8 × 4–5μ. In this specimen the spores were very slender and cylindrical, about 6–7 × 1·5μ. This agrees with the measurements given by Burt (4·5–7 × 1·5–2μ).

Grandinia granulosa Fr.

Odontia fimbriata (Pers.) Fr.

Hydnum udum Fr.

Sistotrema variecolor Bourd. & Galz. in Bull. Soc. Myc. Fr. xxx, 1914, p. 274.

Effused, soft and membranaceous; slightly separable, sulphur-yellow when fresh, becoming paler when dry. Hymenium with scattered subulate teeth and granules. Tissue of loosely interwoven hyphae, varying from 1·5–5μ in diameter, with occasional clamp-connections. Basidia about 30 × 8–9μ with 4

curved sterigmata, 6μ long. Spores yellow, obovate, one-guttulate, at first smooth then finely aculeate 6–8 (–10) × 4–5·5μ.

On a fallen twig, Farnborough, Hampshire, Rev. P. J. Alexander and A. A. P.

We are indebted to M. Bourdot for the identification of this plant. It is certainly not a Sistotrema in habit, but according to M. Bourdot it is very closely allied to *S. sulphureum*, a plant which is unknown to us. The habit of our plant is that of a Radulum, but it is distinguished from *R. mucidum*, the other yellow species of Radulum, by the large rough spores.

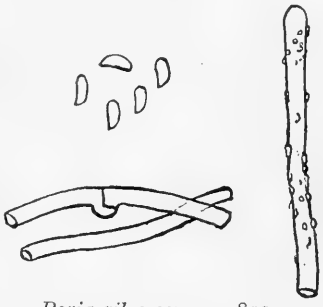
Poria farinella Fr.

This is distinguished among the white species of Poria by the shallow, angular pores, the very thin substance, and the curved cylindrical spores, 8–9 × 2–2·5μ. The hyphae are rather straight, 4–5μ in diameter, and without clamp-connections.

Poria farinella. ×550.

Poria gilvescens Bres. in Ann. Myc. VI, 1908, p. 40.

Effused, bleeding, at first white, then flesh-coloured, at length brownish, margin tomentose, persistently white, subiculum scarcely evident; tubes 1–4 mm. long, soft, sub-fleshy; hyphae about 3μ in diameter, yellowish. Pores sub-rotund, apex at length fimbriate, often oblique, medium-sized, variable. Spores hyaline cylindric-curved, 4·5–5 × 1·5–2μ. Basidia clavate, 12–16 × 4μ. Subhymenial hyphae hyaline, 2·5–3·5μ thick.



Poria gilvescens. ×850.

Grounds of St George's College, Weybridge, 1918–1920, A. A. P. and Rev. P. J. Alexander, C.J.

We are again indebted to M. Bourdot for the identification. The plant has appeared for some years on an old beech stump. It resembles *P. adiposus* in habit, but is at once distinguished by having allantoid instead of subglobose spores. The hyphae of the pore-walls are frequently encrusted with mineral matter, and encrusted hairs like that illustrated may project from the pore mouths. This is particularly noticeable under damp conditions, when the pore-mouths become whitish.

NEW OR RARE BRITISH FUNGI.

With Plate VII.

By Carleton Rea, B.C.L., M.A., etc.

Amanita aculeata Quél. Quél., Fl. Myc. 305; Quél., Champ. du Jura et des Vosges, I, 309, as *Amanita echinocephala* Vitt., t. I, fig. I, as *Amanita strobiliformis* Fr. Cke. Illus. no. 1102, t. 939, as *Agaricus* (*Amanita*) *solitarius* Bull.

Pileus 5–10 cm. wide, *white, becoming greyish,* fleshy, convex, then plane, *densely covered with erect, slender, pointed, angular, firm, adnate, whitish or greyish warts, that become tinged with bistre with age*; margin *white,* smooth. Stem 5–12 cm. long, 2–5 cm. thick, *whitish,* solid, equal, floccosely scaly; base bulbous, often attenuated downwards, *surrounded by several concentric, crenulate zones,* the remains of the volva. Ring *white,* superior, thin, torn, striate, often becoming fugacious. Gills *white,* becoming yellowish with age, 5–15 mm. wide, sinuate behind, crowded. Flesh *white,* then tinged with yellow, thick, soft. Smell and taste pleasant. Spores white, broadly elliptical, or subglobose, with a basal apiculus, 10–11 × 8–9μ, contents granular.

On the ground amongst beech leaves, Wood Norton, Worcestershire, 12th October, 1918.

Easily known by the firm, erect, pointed, angular warts on the pileus from the very first. In *Amanita strobiliformis* (Paul.) Quél. the warts are large, pyramidal, floccose and somewhat separable, and in *Amanita solitaria* (Bull.) Fr. the warts are plate-like, floccose at first, but becoming firmer with age. *Amanita Vittadinii* Moretti differs in the gills finally becoming greenish.

Lepiota scobinella (Fr.) Quél. & Bataille. Quél. & Bataille, Fl. Monogr. des Amanites et des Lépiotes, 69; Fr., Hym. Eur. 26, as *Agaricus* (*Amanita*) *scobinellus* Fr., see Pl. VII.

Pileus 3–6 cm. wide, *mouse grey, disc darker,* convex, then plane, umbonate, *pellicle breaking up into minute, separable, bistre scales*; margin *whitish,* smooth, silky. St. 4–6 cm. long, 4–7 mm. thick, *white,* stuffed, equal, slightly attenuated at the apex and base, *covered with white squamules, that become tinged*

with bistre, below the ring, striate above. Ring *whitish, becoming tinged with bistre at the edge,* membranaceous, superior, often fugacious. Gills *white, becoming yellowish,* 3–4 mm. wide, ventricose, free, crowded. Flesh white, often tinged with fulvous at the base of the stem, thick at the disc, very thin at the margin of the pileus, floccose. Smell and taste none. Spores white, elliptical, 6–7 × 3–4μ, contents granular. Cystidia hyaline, clavato-cylindrical, 28–30 × 6μ, sparse.

On the ground, Benthall, Shropshire, 29th September, 1918.

Easily distinguished from *Lepiota clypeolaria* (Bull.) Fr. by the minute, separable, bistre scales on the pileus, the white, squamulose stem, and the much smaller spores.

Tricholoma inodermeum Fr. Fr., Monogr. I, 66.

Specimens of this rare Agaric were collected by Mr W. B. Allen, at Wood Norton, Worcestershire, on the 12th October, 1918. The spores are hyaline, elliptical, obtuse at both ends, more rarely with a basal apiculus, 8–9 × 5μ, 3–4-guttulate. Cystidia none.

Pleurotus serotinus (Schrad.) Fr., var. *Alméni* (Fr.) Big. & Guill. Big. & Guill., Fl. des Champ. Supér. de France, II, 120; Fr., Hym. Eur. 176; Fr., Icon. t. 87, fig. 3, as *Agaricus* (*Pleurotus*) *Alméni* Fr.

Differs from the type in its larger size, the tawny fuscous pileus and paler stem and gills. Spores white, sausage-shaped, 5–6 × 1·5μ.

On a fallen log, West Kilbride, Ayrshire, 25th November, 1918, Mr R. B. Johnstone.

Mycena atrovirens Rea, v. Pl. VII.

Pileus 8 mm. latus, centro *atrovirens,* margine striato *albidus pallidusve,* circa marginem *laete viridis,* carnosulus, hemisphaericus, levis, centro primitus subviscidus. Stipes 3 cm. longus, 1 mm. crassus, *cinereus* vel *grisco-fuligineus,* aequalis, fistulosus, levis. Lamellae *albidae, acie minute denticulatae et virides praecipue versus marginem pilei,* adnatae, 2 mm. latae, subdistantes, antice attenuatae. Caro *fusca,* tenuis, inodora et insapora. Sporae hyalinae, ellipticae, utrinque vel oblique acutatae, 5–6 × 3–4μ, minute punctatae; basidia clavata, 23–25 × 6–7μ, 4-sterigmatibus. Cystidia acie lamellarum numerosa, saepe fasciculata, longe subclavata vel cylindracea, 35–40 × 3–4μ, flexuosa, *succo chlorino repleta,* tenuiter tunicata.

Ad truncos *Fagi sylvaticae,* Leeds, 26th October, 1919, Coll. F. A. Mason.

Easily known amongst the Calodontes by the green edge of the gill.

Mycena dilatata Fr. Fr., Hym. Eur. 151; Fr., Icon. t. 84, fig. 3. See Pl. VII.

Wholly white. Pileus 5–10 mm. wide, membranaceous, convexo-plane, obtuse, smooth; margin striate. Stem 10–15 mm. long, 1 mm. thick, filiform, straight, *arising from a convex, smooth, glabrous, orbicular disc.* Gills ·5–1 mm. wide, sublinear, *attached to a free collar behind.* Flesh white, thin. Spores white, oblong, obtuse at both ends, 7–8 × 3·5μ. Cystidia hyaline, clavate, obtuse, or produced into an acute point, 70–80 × 5–7μ.

On dead twigs, Highlow Wood, Derbyshire, 24th September, 1919.

Easily known amongst the Basipedes group by the gills being attached to a free collar.

Marasmius obtusifolius Rea, v. Pl. VII.

Pileus 1–2 cm. latus, *albidus, centro fulvus;* membranaceus, convexo-planus, papillatus, levis, *sulcatus;* margine primitus involuto. Stipes 2–4 cm. longus, 1 mm. crassus, *fulvus, apice albus,* aequalis, solidus, minute velutinus. Lamellae *pallidae,* adnatae, *postice annulato-conjunctae,* 2 mm. latae, valde distantes, aequales, *obtusissimae,* crassae, acie sub lente cystidiis prominentibus dense fimbriatae. Caro alba, lenta, tenuis, inodora et insapora. Sporae hyalinae, late ovatae, vel subglobosae, 14–15 × 10–12μ, intus guttula media, crassa repletae, crassiuscule tunicatae; basidia clavata, 2–4-sterigmatibus. Cystidia numerosa, fusideo-ventricosa, 95–140 × 17–25μ, apice capitata, 14–18μ in diam., tenuiter tunicata. Cuticula pilei cellulis subglobosis, vel subpyriformibus, 20–23μ in diam.

Ad radices *Carpini Betuli,* Epping Forest, Essex, 18th October, 1919, Coll. C. H. Grinling.

Easily known by the blunt, *Cantharellus*-like gills which are densely ciliate on the margin under a lens with the projecting cystidia, and the large, broadly ovate, or subglobose spores. It should be placed after *Marasmius torquescens* Quél.

Pluteus phlebophorus (Dittm.) Fr. var. albo-farinosus Rea.

A typo differt *apice stipitis albo-farinoso.* Cystidia hyaline, clavate, 25–35 × 10–12μ.

On rotten wood, Shrawley Wood, Worcestershire, 12th October, 1919, Miss Violet Rea.

Leptonia euchlora (Lasch.) Fr. Fr., Hym. Eur. 204; Boud., Icon. Myc. IV, 50, t. 99.

Pileus 1·5–3·5 cm. wide, *olivaceous, becoming paler,* submembranaceous, campanulato-convex, then plane, *fuscous fibrillose, subsquamulose,* especially at the darker, finally depressed disc.

Stem 3–6 cm. long, 3–5 mm. thick, *greenish, apex yellowish, becoming deep blue, or verdigris when bruised or handled*, equal, slightly thickened at the white, tomentose base, hollow, fragile, smooth. Gills *whitish, or very pale yellowish*, then *pink*, 5–6 mm. wide, broadly adnate, subdistant. Flesh *greenish, becoming deep blue, or verdigris when bruised or pressed*, thin. Taste and smell none. Spores pink, oblong, angular, 11–15 × 8–10μ, multi-guttulate.

Amongst short grass, Benthall Edge, Shropshire, 20th September, 1919.

Differs from *Leptonia incana* Fr. in the stem and flesh becoming deep blue or verdigris when bruised or handled, the non-umbilicate, subsquamulose pileus and the absence of a mouse-like smell.

Nolanea strigosissima Rea, v. Pl. VII.

Pileus 4–8 mm. latus, 3–5 mm. altus, *rufobrunneus*, vel *ferrugineus*, carnosulus, conico-campanulatus, *pilis erectis, strigosis, elongatis, obtusis, rufobrunneis et septatis dense obtectus*, 450–600 × 15–20μ; margine involuto. Stipes 1·5–2·5 cm. longus, 1 mm. crassus, *pilei concolor*, aequalis, basi leviter incrassatus, e farcto cavus, *pilis similibus dense obtectus*. Lamellae *e brunneo cinereae*, demum albo-pruinosae, adnatae, angustae, 1 mm. latae. Caro *concolor, cinerascens*, tenuis, firma, inodora et insapora. Sporae pallide roseae, oblongae, angulatae, saepe apiculatae, 15–17 × 7–8μ, 2-guttulatae; basidia pyriformia, vel clavato-capitata, 36–40 × 15–18μ, 4-sterigmatibus arcuatis, 3μ longis. Cystidia acie lamellarum parca, fusiformia, vel lanceolata, 60–70 × 10–12μ, apice acuta, tenuiter tunicata. Cuticula pilei cellulis pyriformibus, 25μ in diam.

Ad ligna mucida *Pini sylvestris*, St George's College, Weybridge, Surrey, 9th October, 1919. Coll. Rev. Philip J. Alexander, S.J.

Easily known amongst the Nolaneae by the densely strigose pileus and stem.

Pholiota subsquarrosa Fr.

Spores ochraceous, oblong-elliptical, 4·5–5 × 2–2·5μ. Cystidia ochraceous, fusiform, tapering into a long exserted point, 25–30 × 6–8μ, thick walled; contents yellowish, granular.

New Piece Wood, Chatsworth, Derbyshire, 26th September, 1919, Dr Harold Wager.

Inocybe conformata Karst. Karst., Krit. Öfvers. Finl. Basid. (1889), 465; Massee, Monog. of the genus Inocybe, 488.

Pileus 1–3 cm. wide, *pale fuscous, or tinged rusty*, convex, then

expanded, umbonate, fibrillosely rimose, sometimes minutely, appressedly, floccosely squamulose. Stem 3–5 cm.long, 3–6 mm. thick, *concolorous, apex at first tinged violet*, equal, often flexuose, solid, minutely fibrillose. Gills *pallid, then brownish*, 4–5 mm. wide, adnexed, ventricose, somewhat crowded; margin white, fimbriate. Flesh white, brownish under the cuticle of the pileus, bluish at first in the stem, thick at the disc, very thin at the margin of the pileus, firm. Smell and taste none. Spores brownish in the mass, oblong-elliptical, depressed on one side, 8–11 × 4–5μ. Cystidia hyaline, fusiform, ventricose, apex muriculate, 65–75 × 15–19μ.

On the ground under oaks, Bishop's Wood, Selby, Yorkshire, 9th September, 1918.

ASTROSPORINA *Schroet.*

This genus has the same characters as *Inocybe* but differs in having irregular, angular, echinulate, or verrucose, ochraceous or ferruginous spores and *Inocybe* becomes restricted to species having smooth, elliptical, ochraceous or ferruginous spores.

Astrosporina lanuginella Schroet. Schroet., Pilzfl. von Schlesien, 1, 577.

Pileus 1·5–3 cm. wide, *tawny, or greyish brown*, campanulato-convex, then plane, obtusely umbonate,. fibrillose, cracked ("fibrils septate, apical cell 35–40 × 8–11μ, with rounded ends," sec. Schroeter). St. 1·5–5 cm. long, 1·5–5 mm. thick, *pallid, apex at first delicately tinged with lilac, base brownish*, equal, fibrillose. Gills *pallid, then cinnamon*, 2–3 mm. wide, slightly adnexed, somewhat crowded, edge fimbriate. Flesh *white, tinged reddish under the cuticle of the pileus and stem*, thick at the disc, thin at the margin of the pileus, firm. Smell and taste none. Spores cinnamon in the mass, oblong, obtusely angular, 8–11 × 5–7μ. Cystidia hyaline, either fusiform, ventricose, obtuse at the apex, muriculate or not, 40–70 × 15–23μ, or acicular and acute.

On the ground in a cart track through oak woods, St George's Hill, Weybridge, Surrey, 4th August, 1919, Mr A. A. Pearson.

ASTROSPORINA FULVA Rea, v. Pl. VII.

Pileus 3–4 cm. latus, *fulvus, centro obscuriore*, carnosus, e convexo expansus, longitudinaliter adpresse fibrillosus, margine tenuis. Stipes 5–6 cm. longus, 5–6 mm. crassus, *pilei concolor, apice e lilacino expallens*, aequalis, basi leviter attenuatus, farctus, *fibrilloso-striatus*. Lamellae ex *albo ochraceae*, acie pallidiores, postice sinuato-adnatae, 6–7 mm. latae, subconfertae. Caro pilei alba, stipitis *leviter rubescens*, tenuis, inodora et insapora. Sporae ochraceo-flavae, oblongae, angulato-tubercu-

losae, 10 × 5–6·5μ. Cystidia hyalina, *vesciculosa*, obtusa, 42 × 20μ, tenuiter tunicata.

Ad terram nudam in sylvis frondosis, Bishop's Wood, Selby, Yorkshire, 9th September, 1918.

Known by the bluish apex of the stem, the flesh of the stem becoming reddish, and the obtuse, bladder-like cystidia.

Caldesiella italica Sacc. Sacc., Syll. VI, 477.

Receptacle 2–10 cm., *fuliginous*, widely effused, incrusting, resupinate. Spines *concolorous, becoming olivaceous with the snuff-coloured spores*, 1–1·5 mm. long, ·5–1 mm. thick, cylindrical, obtuse, often compressed, crowded, pruinose. Flesh *concolorous*, floccose, thick. Spores snuff coloured in the mass, olivaceous hyaline under the microscope, obtusely verrucose, angularly globose, 8–9 × 8μ; basidia clavate with 2–4-sterigmata. Basal hyphae concolorous, thick walled, 6–8μ in diam., septate, with clamp-connections.

On a dead birch stump, Trench Woods, Worcestershire, 20th October, 1917.

I am indebted to Miss E. M. Wakefield for kindly determining this species.

Puccinia Picridis Hazsl. Math. és Termés. Közlemények m. Tudományos Akad. XIV, 152 (1877).

Uredospores. Sori amphigenous, without spots, or on very indistinct spots, scattered, sometimes confluent, minute, punctiform, round, pulverulent, *cinnamon*; spores globose, subglobose, or broadly ovate, echinulate, pale brown, 21–27μ in diam., or 24–30 × 16–20μ, with two germ-pores.

Teleutospores. Sori similar, *dark brown*; spores elliptical, or ovate-elliptical, rounded at both ends, not thickened above, not or hardly constricted at the septum, delicately verruculose, brown, 27–35 × 18–24μ; epispore thin; pedicels hyaline, up to 16μ long.

On leaves of *Picris hieracioides*, Colesbourn, Gloucestershire, 6th September, 1919, Mr H. H. Knight.

In this gathering both spore forms were obtained. The uredospores were echinulate, globose, or subglobose, 28–30 × 25–28μ; and the teleutospores delicately verruculose, especially in the upper half, 35–40 × 23–25μ.

Acetabula calyx Sacc. Sacc., Myc. Ven., Patavia (1873), 168; Boud., Icon. IV, 133, t. 248.

Ascophores 2–6 cm. wide, *greyish bistre*, or *fuliginous*, externally *greyish*, pruinose, fleshy, cup-shaped, then expanded and finally *reflexed*, stipitate, hymenium smooth; margin often crenulate and becoming split. St. 1–6 cm. (generally 1–2 cm.) long,

1–2 cm. thick, *whitish*, at first short, cylindrical, longitudinally ribbed, the single ribs sometimes extending for a very short distance on the exterior of the ascophore, glabrous. Flesh *white*, solid or lacunose. Asci cylindrical, attenuated and somewhat flexuose at the base, 330–350 × 18–21μ, 8-spored, operculate, not turning blue with iodine. Spores hyaline, broadly elliptical, 20–23 × 11–13μ, with a large central gutta, accompanied by several smaller guttae at either end, 1-seriate. Paraphyses *fuliginous*, clavate or slightly thickened at the apex, 340–360 × 3μ, × 6–8μ at the apex, simple or branched, septate.

On garden soil, Woodcote, Weybridge, Surrey, 2nd May, 1920, Mr A. A. Pearson.

Easily distinguished from the other British species of Acetabula by the distinct stem and revolute receptacle.

Lachnea hemisphaerioides Mout. Mout., Compt. rend. Bull. Soc. Roy. Bot. Belg. XXXVI, 2nd fasc., 21 (1897).

Ascophores 5–15 mm. wide, gregarious or scattered, sessile, urceolate, then hemispherical, concave; hymenium *white, becoming greenish*; externally clothed, especially towards the margin, with simple, straight, *fuscous*, multi-septate, gradually tapering, acute hairs, 100–340 × 8–15μ, sometimes the hairs are hyaline or become so with age. Asci cylindrical, 200–260 × 8–12μ, 8-spored, operculate, not colouring blue with iodine. Spores white, elliptical, 12–16 × 7–8μ (average 14 × 7·5μ), with a moderate sized guttula at each end, 1-seriate. Paraphyses hyaline, linear, slightly thickened at the apex, 130–280 × 3–4μ, septate.

On an old cinder heap in a wood, West Porlock, Somersetshire, 9th April, 1920, Mr Norman G. Hadden.

I am much indebted to Mr J. Ramsbottom for kindly identifying and supplying me with the descriptions of this species and that of *Hyaloscypha radio-striata* (Feltg.) Boud.

Ombrophila verna Boud. Boud., Soc. Myc. Fr. IV, 77; Boud., Icon. Myc. IV, 250, t. 435.

Ascophores 4–8 mm. wide, *ochraceous, paler outside*, plane, lense-shaped, stipitate, very minutely fibrillose; margin entire, or slightly crenulate, not or scarcely prominent; hymenium *ochraceous*, or *ochraceous fuscous*, never rose-coloured, plane, or slightly convex. Stem 4–8 mm. long, 1–2 mm. thick, *blackish brown at the base*, pulverulent, or fibrillose. Flesh *ochraceous, blackish in the stem*. Asci cylindrico-clavate, slightly attenuated at the base, 90–100 × 9–10μ, 8-spored. Spores hyaline, smooth, oblong, hardly fusiform, often depressed on one side, 9–15 × 4–5μ, either with a small oil drop at each end, or with cloudy con-

tents. Paraphyses hyaline, simple, continuous, rarely septate, obtuse, slightly thickened at the apex, 85–98 × 3–3·5μ, contents granular.

On *Sphagnum* and dead grass haulms, Possil Marsh, near Glasgow, Lanarkshire, 27th May, 1919, Mr W. Rennie.

It differs from *Ombrophila clavus* (A. & S.) Fr. in colour, the receptacle is less convex, flatter and acuter at the margin, the paraphyses are more obtuse, the smaller asci less attenuated at the base and the spores are not fusiform.

Hyaloscypha radio-striata (Feltg.) Boud. Feltgen, Verstudien zu einen Pilz-Flora des Grossherzogthums Luxemburg; I Thiel, Nachtrage III (1903), 52–53.

Ascophores ·3–·5 mm. wide, *pallid*, or *ochraceous*, waxy, subpellucid, sessile, globose, punctiform, closed at first and when dry, then cup-shaped, and often finally becoming plane; externally *whitish or ochraceous* when moist, white floccose at base, *becoming deeper yellow, or brownish yellow when dry*; margin radiately striate or ribbed, *ciliato-dentate*, teeth triangular, marginal hairs hyaline, subclavate, connate, 40–60 × 4–5μ; hymenium *pallid* or *yellowish*. Asci clavate, 40–70 × 5–6μ, apex narrowed, obtuse, inoperculate, foramen slightly marginate, pore turning blue with iodine, 8- (rarely fewer) spored. Spores hyaline, oblong, more rarely clavate, 7–11 × 1·5–2μ, continuous, finally becoming sometimes 1-septate, obliquely 1–2-seriate. Paraphyses hyaline, filiform, 65–75 × 1–2·5μ, often slightly attenuated upwards. Hypothecium pale yellow, *pseudoparenchymatous*, cells 5–6μ in diam.

On dead stems of *Symphytum officinale*, Perth, 9th May, 1920, Mr James Menzies.

Von Höhnel in Annales Mycologici, XV, no. 5 (1917), 347–349, creates a new genus *Pezizellaster* for the reception of this and two other nearly related species and bases it on the distinctly toothed margin and large-celled pseudoparenchymatous hypothecium.

Urceolella leucostoma (Rehm) Boud. Rehm in Rabh. Krypt. Fl. 1, 3, 845, and figs. 1–4, 827, as *Dasyscypha leucostoma* Rehm. See Pl. VII.

Ascophores ·3–·5 mm. wide and high, gregarious, waxy, sessile on a broad base, globose and closed at first, then open and concave, becoming urceolate when dry, externally *reddish brown*, or *dark purple*, densely clothed with soft, slender, blunt, roughish septate, brown hairs, 100–170 × 3μ, hairs colourless at the margin; hymenium at *first tinged with pink, then becoming cinereous, margin white*. Asci cylindrical, 50–100 × 5–7μ, apex rounded,

thickened, pore turning blue with iodine, 8-spored. Spores hyaline, oblong, or oblong-fusiform, generally straight, continuous, 7–12 × 1·5–2μ, often with a small oil drop at each end, 2-seriate. Paraphyses hyaline, slender, 60–110 × 1–1·5μ.

On dead stems of *Oenanthe crocata*, Perth, 21st July, 1919, Mr James Menzies.

Easily known by the whitish edge of the receptacle when dry.

Urceolella Iridis Rea, v. Pl. VII.

Ascomata ·5–1 mm. lata, *flavo-virens, dein cinerea*, ceracea, gregaria, sessilia, urceolata, siccitate contracta, extus puberula, pilis albis, obtusis, basi incrassatis, 3–4-septatis, apice intus dense granulosis, 60–70μ longis, basi 8μ crassis. Asci cylindracei, basi parum constricti, apice acuti, 70–80 × 10-11μ, octospori, foramine immarginato, iodo haud tincti; sporae hyalinae, leves, oblongae, vel subfusiformes, 13–15 × 4–4·5μ, intus minute granulosae. Paraphyses hyalinae, filiformes, apice vix incrassatae, 55–70 × 2μ.

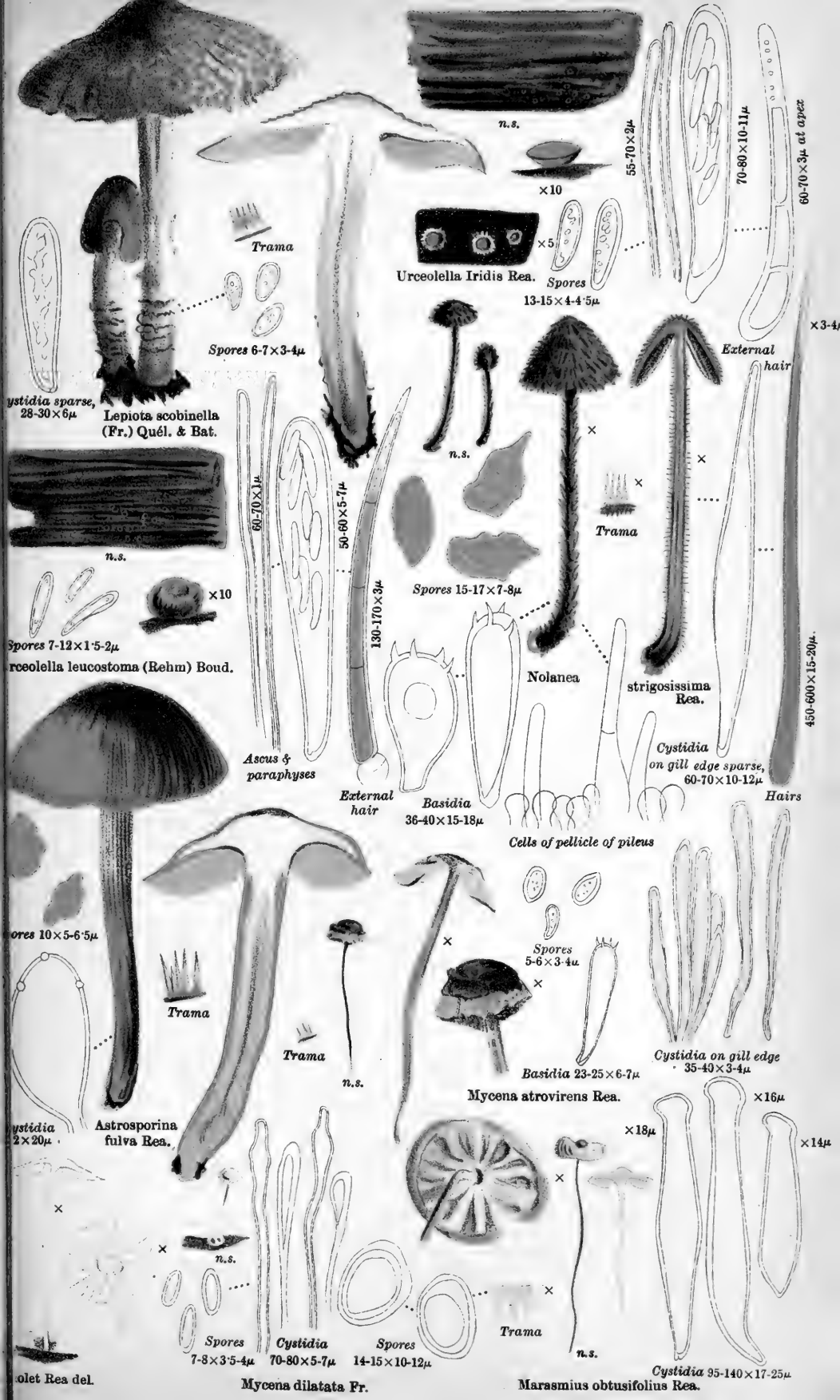
Ad folia putrida *Iridis pseudacori*, Methven Loch, Perthshire, 5th July, 1919. Coll. J. Menzies.

Urceolella pseudacori (Feltg.) Boud., which is also found growing on decaying leaves of *Iris pseudacorus*, differs in the hyaline, pale yellow, shortly stipitate receptacle and the smaller spores.

Pyrenopeziza millegrana Boud. Boud., Hist. et class. Disc. 133; Boud., Icon. Mycol. iv, 326, t. 552.

Ascophores ·30–·60 mm. wide, crowded, sessile, globose, urceolate, then cup-shaped; margin very prominent, entire, white; hymenium greyish; externally fuliginous, covered with short, brown, septate hairs, 5–7μ in diam., arranged in irregular, indistinct ribs below the glabrous margin. Asci oblong-fusiform, slightly attenuated at the base, 60–70 × 10–11μ, 8-spored, inoperculate, not colouring blue with iodine. Spores white, fusiform, 20–28 × 4–5μ, straight or somewhat curved, multi-guttulate, oil drops yellow. Paraphyses pallid, filiform, not thickened at the apex, 60–70 × 3μ, simple or branched, sparsely septate.

On dead stems of *Spiraea Ulmaria*, Perth, 20th April, 1920, Mr James Menzies.


n.s.
×10
55-70×3μ
70-80×10-11μ
60-70×3μ at apex
×3-4
Trama
Spores 6-7×3-4μ
ystidia sparse, 28-30×6μ
Lepiota scobinella (Fr.) Quél. & Bat.
Urceolella Iridis Rea.
×5
Spores 13-15×4-4·5μ
External hair
n.s.
Spores 15-17×7-8μ
Trama
Nolanea strigosissima Rea.
n.s.
60-70×1μ
50-60×5-7μ
130-170×3μ
Ascus & paraphyses
External hair
Basidia 36-40×15-18μ
Cystidia on gill edge sparse, 60-70×10-12μ
Hairs
450-600×15-20μ
Cells of pellicle of pileus
Spores 7-12×1·5-2μ
rceolella leucostoma (Rehm) Boud.
×10
ores 10×5-6·5μ
Trama
Trama
n.s.
Spores 5-6×3-4μ
Basidia 23-25×6-7μ
Cystidia on gill edge 35-40×3-4μ
Mycena atrovirens Rea.
ystidia 2×20μ
Astrosporina fulva Rea.
×16μ
×18μ
×14μ
n.s.
Spores 7-8×3·5-4μ
Cystidia 70-80×5-7μ
Spores 14-15×10-12μ
Trama
n.s.
Cystidia 95-140×17-25μ
olet Rea del.
Mycena dilatata Fr.
Marasmius obtusifolius Rea.

ON A NEW SPECIES OF MELANOTAENIUM WITH A GENERAL ACCOUNT OF THE GENUS.

With Plate VIII.

By Rudolph Beer, B.Sc., F.L.S.

During the early summer of 1918 specimens of White Dead-nettle (*Lamium album*) bearing curious tumour-like swellings caused by a fungus upon their underground organs were sent to the Pathological Laboratory at Kew. The diseased plants had been found by Mr W. F. Drew at Chalfont, Stroud, Gloucestershire, and upon request he kindly sent in 1919 a further sample of plants from the same locality in rather an advanced state of disease.

There appears to be no other record of the occurrence of such intumescences upon *Lamium album* and a careful search both at Kew and elsewhere failed to discover any further examples of these tumours. It would appear, therefore, that the disease is a rare one and in spite of the small amount of material available for study it seems advisable to place the fact of its occurrence upon record and to give a brief description of its general characters and of the fungus causing it.

Description of New Species and its Systematic position.

As already mentioned the tumour-like swellings occur upon the subterranean parts of the plant (Pl. VIII, fig. 1). In so far as the present material permits one to judge the intumescences are restricted to the underground stems and leaf-structures and are entirely absent from the roots and from the sub-aerial parts of the plant. In some cases they occur as dark blister-like swellings upon the side of the stem but when the entire circumference of the stem is affected they appear as distinct, spherical, tuberous bodies measuring as much as 8·5–9 mm. in diameter. When a bud is attacked it becomes much swollen and its leaf-organs greatly thickened and enlarged.

The presence of the disease does not cause the differentiation of any new structures in the organ but it stimulates the elements already present in the leaf or stem to division and growth. The swellings would, therefore, according to Küster's classification fall within the category of Kataplasmic galls*.

* Küster (1903) divides galls into two groups: (*a*) those which show little or no differentiation and are quite simple in their histological structure, and (*b*) those which exhibit specific differentiation and have quite a different histological structure from the normal organ. The former he names Kataplasmic galls, the latter Prosoplasmic galls.

A section through one of the galls shows that a fungus is present and the general characters of this, with its large brown spores, evanescent mycelium and intercellular development, indicate that it is a member of the Ustilagineae.

As is well known the most important feature distinguishing the two groups into which this family is divided consists in their mode of spore germination. In the Ustilaginaceae the promycelium is divided by septa and the conidia are borne laterally whilst in the Tilletiaceae the conidia arise in a terminal whorl from the apex of the promycelium.

Unfortunately all attempts to bring about the germination of the spores of the present fungus in hanging drops have been unsuccessful so that dependence must be placed on other characters to determine whether the organism falls within the Ustilaginaceae or the Tilletiaceae.

It has been pointed out by Lutman (1910) in his paper on the "Life History and Cytology of the Smuts" that the two groups contrast with one another in the development of their haustoria. "The Ustilagos apparently get sufficient nourishment from their host plants by occupying intercellular spaces and perhaps by occasionally passing through a host cell. The smuts of the Tilletia group on the other hand have well developed haustoria in three species at least."

This character is by no means of universal application as several species of Ustilago, such for instance as *U. Vaillantii* Tul. described by Miss Massee (1914), have very well developed haustoria but taken together with the general features in the appearance and life-history of the fungus it lends weight to the view that the present fungus falls within the group of the Tilletiaceae.

Of the twelve genera of this group it appears to agree most nearly with Melanotaenium. The fact that the spores are simple and not bound together in balls and that they never lie loose upon the exterior of the plant but only reach the surface by the decay of the tissues of the host plant limits the number of genera to which the fungus may be relegated to three, viz. Schinzia, Entyloma, and Melanotaenium.

In Schinzia (=Entorrhiza, Weber), which is a root parasite, the spores are pale to yellow-brown in colour with a membrane which is rough through the development of wart-like outgrowths. In the fungus at present under consideration the spores are dark brown and quite smooth. It is moreover not strictly a root parasite but appears (so far as the available material allows one to judge) to restrict its attacks to the subterranean stems and leaves.

In Entyloma and Melanotaenium spore development and germination are very similar, the principal difference consisting in

the distribution of the spores in the tissues of the host plant. In Entyloma the spore-masses are limited to small pustular swellings of the leaf or stem whilst in Melanotaenium the spores are spread over a wider area of the host tissues. In Entyloma, moreover, the spores germinate whilst they are still enclosed within the tissues of the host, whilst in Melanotaenium germination only takes place after the decay of these tissues.

In the case of the present fungus the spores are often spread over wide areas of the stem or leaf, whilst with regard to the question of their germination, although, as already mentioned, this has not been actually observed either in the tissues of the host plant or in artificial cultures, yet indirect evidence regarding the situation of their germination is obtained from the following experiments.

A series of inoculations were carried out on 15th May, 1919, in which ungerminated spores derived from completely decayed intumescences were transferred to small wounds made in healthy plants by means of a sterilised scalpel.

Most of these were unsuccessful but in the case of one plant examined on the following September it was found that the characteristic swellings had developed upon the subterranean shoot in close proximity to the point of inoculation. The plant inoculated had been obtained from a district in which the disease was unknown and it was in all respects perfectly healthy. Care had been taken to ensure that the soil in which the plant was grown was uncontaminated.

From these observations it may be concluded that the spores of the fungus do not germinate whilst still within the tissues of the host but only after these tissues have decayed and favourable conditions for germination have been established. It will be seen, therefore, that in both the features which were mentioned above as distinguishing Melanotaenium from Entyloma the present fungus is in agreement with the former genus. The fungus is named and described upon a later page of the present paper (see p. 337).

The Genus Melanotaenium.

The genus Melanotaenium was established by de Bary (1874) who sorted out and rearranged the heterogeneous series of forms which had hitherto been grouped together under the names of Protomyces and Physoderma. Some he retained in these genera and others he referred to Entyloma, whilst one form, discovered by Unger (1833) and named by him *Protomyces endogenus*, he placed in a new genus, Melanotaenium, which he believed, quite correctly, to have its closest affinities with the Ustilagineae. *M. endogenum* is parasitic upon the stems and leaves of various

species of Galium and causes the plants to become curiously dwarfed and blackened. It has a fairly wide distribution in this country having been found as far north as Aberdeenshire (Trail, 1884), whilst examples, preserved in the Kew Herbarium, have been collected at Swanage.

Protomyces Galii, Rabenhorst, described by Fuckel (1860) is apparently identical with *Melanotaenium endogenum*. Since this date the following species of Melanotaenium have been described: *M. caulium* Schroeter; *M. cingens* (Beck) Magnus; *M. hypogaeum* (Tul.) Schellenb.; *M. Ari* (Cooke) Lagerheim; *M. Selaginellae* Henn. et Nym.; *M. Jaapii* Magnus; and three doubtful species which have been named *M. Sparganii* Lagerh., *M. maculare* (Wallr.) Cornu, and *M. scirpicolum* Cornu.

With regard to the first of these (*M. caulium*) Schneider in 1871 discovered a fungus growing parasitically upon *Linaria vulgaris* which in an unpublished communication he termed *Ustilago caulium*. In 1881 Beck described a fungus upon the stems and leaves of *Linaria genistifolia* in the neighbourhood of Vienna. This he named *Ustilago cingens*.

De Toni in Saccardo's "Sylloge fungorum" (1888) included this fungus under the name *Cintractia cingens*. Schroeter (1889) in his "Kryptogamenflora von Schlesien" renamed Schneider's fungus *Melanotaenium caulium*. Three years later Magnus (1892) found a fungus growing upon the stems of *Linaria vulgaris* at Bozen which agreed in its characters with the parasite originally discovered by Schneider and also with the one found by Beck upon *L. genistifolia*. As the result of his observations Magnus drew the conclusion that *Ustilago caulium, U. cingens, Cintractia cingens* and *Melanotaenium caulium* were all one species and suggested that this should be named *Melanotaenium cingens* (Beck) Magnus.

There is only a single record of the discovery of this fungus in the British Isles. It was found in 1902 by Mr Theodore Green along the river Dee in the neighbourhood of Llangollen. Specimens of the British plant are preserved in the Kew Herbarium and at the British Museum.

Melanotaenium hypogaeum was first described by Tulasne (1851) as *Ustilago hypogaea*. It was found by him in tuberous swellings upon the hypocotyl and upper regions of the root of *Linaria spuria*. Since that time it has been found again by Dr John Lowe in 1869 on the same host in the Isle of Wight as recorded by Phillips and Plowright (1884). It may be mentioned, however, that the specimen is not to be found in Plowright's herbarium. In 1907, Cruchet again met with this fungus at Montagny. A brief account of the fungus was given by Fischer von Waldheim (1877) and again by Schellenberg (1911)

in the "Beiträge zur Kryptogamenflora der Schweiz," who transferred it to the genus Melanotaenium.

Melanotaenium Ari was first described by Cooke (1872) under the name of *Protomyces Ari*. It was found by Dr Paxton in May, 1872, upon the leaves and petioles of *Arum maculatum* growing at Chichester. The same fungus was found in Denmark in 1876 by Rostrup who named it *Ustilago plumbea*. Thirteen years later Pirotta (1889) rediscovered this fungus growing upon the leaves of *Biarum tenuifolium* and, believing its affinities to be nearest to de Bary's genus Melanotaenium, he named it *M. plumbeum* (Rostr.) Pirotta. Rostrup in "Ustilagineae Daniae" (1890) accepted this nomenclature. Lagerheim (1899) found the fungus growing upon the leaves of *Arum maculatum* at Pardailhan and he referred to it under the name of *Melanotaenium Ari* (Cooke) Lagerheim. In more recent writings, such, for example, as "Danish Fungi," revised by J. Lind (1913) and Schellenberg's (1911) "Beiträge zur Kryptogamenflora der Schweiz," and also in Jaap's "Fungi Selecti Exsiccata," issued by Magnus in 1903, the name *Melanotaenium Ari* (Cooke) Lagerheim is retained. Through the kindness of Miss Wakefield and Mr J. Ramsbottom I have been enabled to re-examine Cooke's original type-material of this fungus as well as other specimens collected elsewhere at various times. I find the spores to be quite different in character from those of either *Protomyces* or of any member of the Ustilaginaceae. Their membrane is comparatively pale in colour and is more complex in structure than is the case with that of either of these groups. It consists of an inner layer (endospore) and a comparatively thick outer coat (exospore) which swells up vigorously in strong sulphuric acid. Moreover, the outer coat is perforated by several narrow germpores. It was not found possible to determine more nearly the details of the structure of this fungus or its spores in herbarium specimens, and the true systematic position of the fungus must be left undecided until fresh material becomes available.

M. Selaginellae Henn. et Nym. (Hennings 1900) was found in Java growing upon the stem and bases of the leaves of Selaginella. Its spores are chestnut brown in colour and later black; their membrane is covered with wart-like outgrowths and they measure 17–19μ in diameter.

M. Jaapii Magn. was found by Jaap in 1911 near Vienna growing upon *Teucrium montanum*, and a short description of this fungus was given by Magnus (1911) in the same year. It forms swellings upon the base of the stem or the upper region of the root and in one case it was found to occur higher up the stem of the plant. In sections it could be seen that the hyphae of the fungus run in the intercellular spaces and send haustoria

into the surrounding cells. The spores, which are formed intercalarily upon the hyphae, are dark brown and possess a thick, firm, smooth membrane. The mature spores measure about 22–23·3μ across their longest diameter. Often they are completely spherical but at other times they may measure 23·3 × 20·6μ, 23·3 × 19·2μ, or even 22·3 × 17·8μ across their longest and shortest diameters respectively.

Besides the species mentioned above there are three others which have provisionally been placed under Melanotaenium but probably belong elsewhere. Of these, one is *M. Sparganii* which grows upon the leaves of Sparganium and possesses spores measuring 10–16 × 9–10μ in diameter and which are yellow-brown in colour. It was first described by Lagerheim (1899) and is probably more correctly to be referred to the Chytridiaceae.

Another doubtful form is *M. maculare* (Wallr.) Cornu. This occurs within the epidermal cells of the leaves of *Alisma ranunculoides* var. *repens*, and was first described by Wallroth as *Physoderma maculare* and provisionally referred to Melanotaenium by Cornu (1883). It forms small black spots upon the leaf but produces no swelling or hypertrophy of the tissues. This is almost certainly not a Melanotaenium and Wallroth's original name may be retained for it.

A third form which has been dubiously included under Melanotaenium by Cornu (1883) is *M. scirpicolum* Cornu. This occurs upon the rhizome of *Scirpus lacustris*. Its spores are ovoid, pale brown in colour and measure 28–32 × 18–20μ in diameter.

The foregoing appears to be a complete list of all the species of Melanotaenium which have hitherto been described and it remains to see what relationship the parasite upon *Lamium album* bears towards them.

Species	Host	Spore measurement
M. cingens (Beck) Magnus (Syn. *M. caulium* Schr.)	Stems and leaves of *Linaria vulgaris* and *L. genistifolia*	12–18μ
M. hypogaeum (Tul.) Schellenberg	Hypocotyl and root of *Linaria spuria*	14–22μ
M. endogenum (Unger) de Bary	Stems and leaves of *Galium* spp.	16–22μ
(*M. Ari* (Cooke) Lagerheim	Leaves and petioles of *Arum maculatum*	14–16μ)
M. Selaginellae Henn. et Nym.	Stem and leaf bases of *Selaginella*	17–19μ
M. Jaapii Magnus	Stem and root of *Teucrium montanum*	17·8–23μ
M. Lamii, sp. nov.	Subterranean stems and buds of *Lamium album*	17–20μ

The points in which the species are differentiated from one another are very slight and dependence has been chiefly placed

upon the size of the spores and upon the host plant which they attack. Omitting the doubtful forms the most important facts regarding the known species are briefly summarised in the above table.

From what has been said above, it will be recognised how slight are the morphological features which distinguish the species of Melanotaenium from one another. No doubt a more complete knowledge of the germination, development and cytology of the different forms would reveal other characters which would differentiate them morphologically rather more sharply from one another. In the meanwhile we must admit the total inadequacy of the existing morphological criteria for this purpose.

The slight differences observed in the dimensions of the spores of the various forms may quite possibly be due, partly to dissimilar conditions under which development has taken place, and partly to the personal equation which inevitably enters into the case when a number of different observers measure a comparatively small number of selected spores with different instruments.

The conclusion to which these remarks trend is that in the Melanotaeniums, as indeed in the Smuts in general, the "species conception" can only be used as a convenient means of separating the several forms which occur upon different host plants. It can have here even less significance, as a hard and fast morphological distinction between natural entities, than is the case with the more highly differentiated organisms in which several investigators, such as Klebs, Goebel and Brierley, have shown that the various morphological characters are merely the expression of the interaction between two factors: the internal, molecular constitution of the protoplasm upon the one hand and the external environment upon the other, and that if either of these factors vary the morphological characters may become changed. Based upon its occurrence upon a new host plant, I therefore consider it advisable, provisionally at any rate, to regard the Melanotaenium which has been found upon *Lamium album* as a new species (in the above sense) and would suggest for it the name *Melanotaenium Lamii* sp. nov.

Melanotaenium Lamii sp. nov.*

The fungus forms intumescences or tuber-like swellings upon the subterranean stems and buds of *Lamium album*. Spore mass

* *Melanotaenium Lamii* sp. nov.

Sori atri; sporae globosae vel ovatae, 17–20μ diam., episporio crasso, glabro, atro-brunneo tectae, per matricis putrefactionem liberatae. Sporarum germinatio non visa. Sporae hyphaeque totam matricem penetrantes intercellulares, mycelium haustoriis praeditum. In caulibus gemmisque subterraneis *Lamii albi*, tubercula forma variis ad 8–9 cm. diam. efficiens.

black, liberated by the decay of the host tissue. Spores spherical to oval, measuring 17–20μ in diameter. Spore-membrane thick, smooth, dark brown. Germination of spores not observed. The spores and hyphae occur in the cortex and pith of the host plant and are also frequently found in vascular tissue. Hyphae forming pseudo-parenchymatous masses in the intercellular spaces of host. Host plant *Lamium album*. Found at Chalfont, Stroud, Gloucestershire, by Mr W. F. Drew.

Morphology and Cytology of M. Lamii *and comparison with other Genera.*

Such features in the morphology and cytology of the fungus as the small amount of the material available permitted to be ascertained will now be described. The hyphae of the fungus run between the cells of the host plant and at the intercellular spaces they often become massed, closely interwoven, and frequently septate so that they form a pseudo-parenchymatous body at these spots (fig. 2).

Haustoria are developed at numerous points and these penetrate the cell wall and form much branched, coralloid structures within the host cell (figs. 5 and 10). They usually attain a considerable size and form a conspicuous feature in the morphology of the fungus. They resemble a bunch of grapes in form, and are seen to consist of a series of very short branchlets which arise from the apex of a common carrying thread and each of which is dichotomously forked at its end (fig. 6). The main thread of the haustorium arises as an ordinary lateral branch from one of the intercellular hyphae. No appressorium could be seen such as Lutman (1910) described in *Entyloma Nymphaeae* (Cunn.) Setch.

Lutman also found in his plant that the host cell nucleus frequently becomes enclosed in a tangled knot formed of the haustorial branches. In *Melanotaenium Lamii* the terminal branchlets of the haustorium have several times been observed to be closely applied to the nucleus of the host plant so that this body becomes partly enveloped by them (fig. 5) but this is not a constant feature, and just as many cases can be observed in which the haustorium and cell nucleus remain widely separated from one another (fig. 10) as those in which a closer relationship is established between them.

In spite of a number of works on the subject our knowledge of the cytology of the Ustilagineae is still very incomplete. Not only is the available information about any of the genera of this family contradictory but many genera have never been investigated at all. The genus Melanotaenium is among the latter and the few facts ascertained and described below may form the

starting-point for a more complete account when more abundant material becomes available.

With regard to the nucleus of Ustilagineae the following is a summary of work already carried out. The earliest paper of importance is that by Dangeard (1892). He examined *Ustilago Tragopogi, U. Carbo, U. violacea, Doassansia Alismatis, Entyloma Glaucii, Urocystis Violae,* and *Tilletia Caries,* and found that the spore-bearing hyphae and the young spores are always bi-nucleate.

In 1899 Harper (1899) confirmed Dangeard's results, working on *Ustilago Carbo, U. Maydis, U. antherarum,* and *U. Scabiosae.* Federley (1904) for the first time observed a passage of the nucleus from one conidium to the other during the conjugation of these bodies in *Ustilago Tragopogonis-pratensis* Pers. He believed that these nuclei fused at once and that a bi-nucleate stage of the hyphae and spores did not occur in this plant.

Six years later Lutman (1910) published the result of his investigations on *Ustilago laevis, U. Zeae, Urocystis Anemones, Doassansia Alismatis* and *Entyloma Nymphaeae.* He observed in *Ustilago laevis* that the conidia are uni-nucleate and that during conjugation the nucleus and most of the cytoplasm of one spore migrate into the other one. The mycelial cells in the host plant were found all to be bi- or multi-nucleate. During the development of the spores the two nuclei fuse so that the mature spore is uni-nucleate.

In 1912 and 1914 Rawitscher gave an account of the cytology of *Ustilago Tragopogonis, U. Maydis* and *U. Carbo.* In *U. Tragopogonis-pratensis* Pers. he found that the hyphae and young spores are bi-nucleate whilst the mature spore is uni-nucleate. The pro-mycelial cells and the conidia are uni-nucleate. In *U. Maydis* Corda the cells of the hyphae are uni-nucleate until just before spore-formation when the cell contents of two adjacent cells become fused with one another through the resorption of the membrane previously separating them from one another. Bi-nucleate spore rudiments are thus established. The two nuclei fuse and uni-nucleate spores result. The conidia are uni-nucleate.

In the case of *U. Carbo* it is either the cells of the uni-nucleate mycelium or the uni-nucleate sporidia themselves which may conjugate with one another and give rise to bi-nucleate cells. The young spores are bi-nucleate and the mature ones uni-nucleate.

In the case of *Tilletia Tritici* Rawitscher also found that the sporidia copulate in pairs and, upon their germination, give rise to bi-nucleate hyphae.

Werth and Ludwig (1912) came to very different conclusions

in their examination of *Ustilago antherarum* Fr. They found neither a fusion of two nuclei in the spores nor the migration of one cell nucleus into the other cell during the anastomotic union between the two sporidia.

In 1915 Wilson (1915) published a short account of his work upon the cytology of *Tubercinia primulicola*. He found the cells of the mycelium to be uni-nucleate, as are also the conidia which arise from it. The conidia conjugate in pairs and the nucleus of one passes through the connecting bridge into the other, giving rise to a bi-nucleate structure. The chlamydospores are formed in coils of hyphae which are bi-nucleate and which have most probably developed from the fusion-product of the two conjugating conidia. The spores are at first bi-nucleate but subsequently the two nuclei fuse and the mature spore is uni-nucleate.

Paravicini (1917) published an important contribution to the subject. He investigated the seven species into which the collective species *Ustilago Carbo* has now been divided as well as a number of other species including *Tilletia Tritici* (Bjerk.) Wint., *Entyloma Calendulae* (Oud.) de Bary, *Urocystis Anemones* (Pers.) Wint., and *Urocystis Violae* (Sow.) Fisch. v. Wald. In all cases he found the promycelial cells and the conidia to be uni-nucleate. Where the conidia conjugate with one another there is a passage of the nucleus from one spore to the other so that a bi-nucleate conidium results. In those cases, such as *U. Tritici* and *U. nuda*, in which no conidia are formed, the cells of the mycelium conjugate with one another and bi-nucleate cells are established by the migration of the nucleus from one cell to the other. The spores are bi-nucleate and the two nuclei fuse so that the mature spore is uni-nucleate.

No work has hitherto been done upon the cytology of the genus Melanotaenium. In the case of *M. Lamii* it was found to be a matter of considerable difficulty to ascertain the number of nuclei in the cells of the hyphae. These hyphae are usually exceedingly fine and their walls, especially the septa, stain very faintly with the dyes used. In the few favourable cases in which both the hyphal walls and the nuclei were satisfactorily stained two nuclei were present in each cell and it is most probable that this is the constant number in the cells of these hyphae (fig. 8).

The young haustoria are filled with dense cytoplasm and contain two nuclei in each of the terminal branchlets, one lying in each fork of the branchlet. It was not possible to determine whether the branchlet is cut off from the main branch by a septum, but if this should prove to be the case we have here the bi-nucleate condition of the cells maintained in the haustorial apparatus.

The spores are developed intercalarily upon the hyphae which form the pseudo-parenchymatous masses. The youngest spores observed measured 10 × 6μ in diameter (fig. 4). Spores at this stage were seen to be unmistakably bi-nucleate and it was found that the bi-nucleate condition was maintained in the spore until quite shortly before maturity (fig. 7). The mature spore is uni-nucleate (figs. 8 and 9), presumably through the fusion of the two nuclei which exist during the earlier stages, but the actual fusion was not observed. The single nucleus of the later stages is, however, much larger in size than either of the nuclei which occur in the bi-nucleate stage and this probably indicates that it has arisen through the union of the two smaller nuclei.

It may be mentioned here that spores in the most various stages of development may occur close together within one pseudo-parenchymatous mass of hyphae. Thus in fig. 3 a mature spore containing a single nucleus occurs side by side with a much younger one which is still bi-nucleate.

The spore-membrane itself is apparently single and no success was obtained in attempting to demonstrate any lamination in it or in revealing the presence of an endospore in any of the spores which were examined*.

It will be seen from this brief account that the mature spore of Melanotaenium is uni-nucleate whilst the hyphal cells and the young spores are bi-nucleate. As germination of the spores of *M. Lamii* was not obtained it is not possible to say definitely where the transition between the uni-nucleate and the bi-nucleate stages occurs, but it may be pointed out that Woronin (1881) in his study of *M. endogenum* observed numerous cases of the germination of the spores and found the conidia conjugating with one another. It is not improbable that this is the point in the life history of the fungus at which, by the passage of the nucleus from one conidium to the other, it attains the bi-nucleate condition.

I should like here to express my great indebtedness to Miss Wakefield for her kind assistance throughout in the preparation of this paper.

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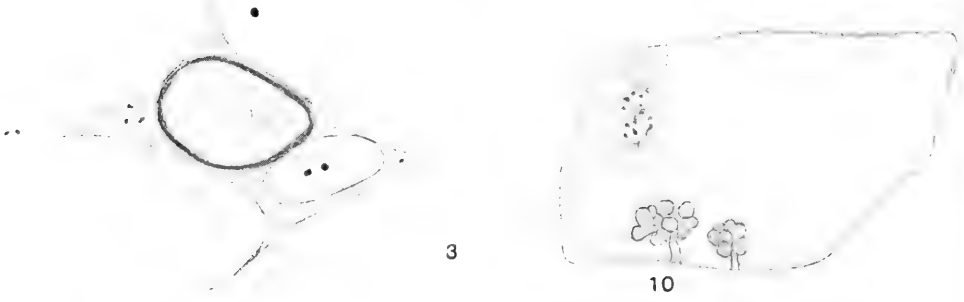

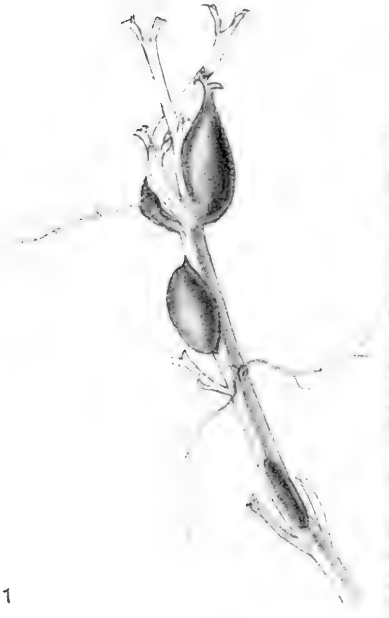

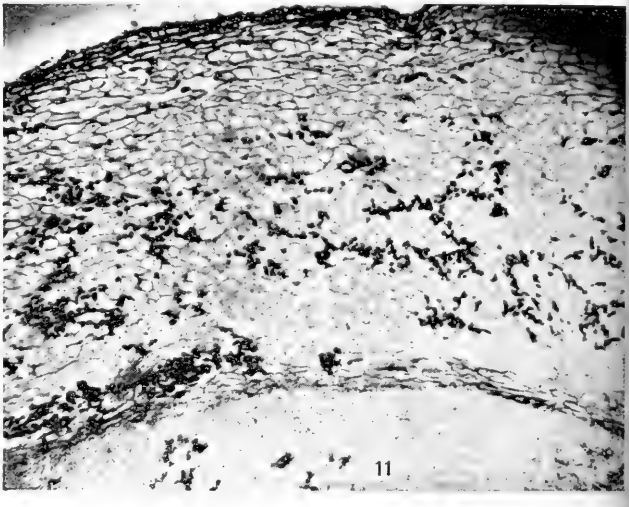

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EXPLANATION OF PLATE VIII

Fig.

1. Rhizome of *Lamium album* with swellings caused by *Melanotaenium Lamii*.
2. Mycelium forming pseudo-parenchymatous mass in an intercellular space of host plant. × 1000.
3. Spores of *M. Lamii*; one young, the other mature. × 1000.
4. Very young spores of *M. Lamii*. × 1000.
5. Haustorium of *M. Lamii*, partly enveloping host nucleus. × 1000.
6. Dichotomously branched terminal branchlets of haustorium. × 1000.
7. Young bi-nucleate spores of *M. Lamii*. × 1000.
8. Bi-nucleate hypha of *M. Lamii*. × 1000.
9. Mature uni-nucleate spore of *M. Lamii*. × 1000.
10. Two haustoria of *M. Lamii* within a bi-nucleate cell of host plant. × 1000.
11. Section of an intumescence upon a subterranean stem of *Lamium album* showing distribution of the spores of *M. Lamii* within its tissues. From a microphotograph.

NOTE ON MARASMIUS CAUTICINALIS (WITH.) FR.

By the Very Rev. David Paul, LL.D., D.D.

There would appear to be some question as to the orthography of the specific name of this Fungus. Fries quotes it as Withering's name, but apparently the plant was not known to Withering, and the name does not occur in his Arrangement of British Plants, 1796. Other authors—Quélet (Fl. Myc. p. 322) and Bigeard and Guillemin (Champ. supér. de France, II, 152)—follow Fries in this attribution of the name, seemingly without investigation. Fries also quotes Sowerby, and cites his Plate 163, but Sowerby spells the word *caulicinalis*, not *cauticinalis*. The same spelling is found in Swartz (Vet. Ak. Handl. 1808, p. 82) and in Secretan (Myc. Suisse, 1833, n. 838)—both quoted by Fries in connection with this Fungus. Fries himself (Syst. Myc. 1821, I, p. 167, under *Ag. campanella*) began by spelling the word *caulicinalis*. In his Mon. Hym. II, 227 (1863), however, he writes *Marasmius cauticinalis*, and says, "This seems to be the *cauticinalis* of Sow., and is certainly that of Swartz," making no reference to the fact that both these authors spelled the word differently. Finally, in his Hym. Eur. p. 476, he adheres to the new spelling of the Monographia which is followed by Quélet and the authors of the Flore des Champignons supérieurs de France.

So much for the history of the word as applied to this Fungus. How did the change in spelling come about? Some light may be thrown on the subject by tracing the history of another Fungus-name, that of *Ag. cauticinalis* Bull., given by Fries as a synonym of *Ag.* (*Coll.*) *stipitarius* in Hym. Eur. p. 117. Originally, as in the other case, he spelled the word *caulicinalis* (Syst. Myc. I, 138; Mon. Hym. I, 158). This is also Bulliard's own spelling (tab. 522, fig. 1), followed by Sowerby (fig. 163), and by Berkeley (Smith's Eng. Flora, V, 54). Quélet (Fl. Myc. p. 315) refuses to follow Fries' alteration, and describes the Fungus as *Marasmius caulicinalis* Bull., and Secretan (Myc. Suisse, n. 740, II, 176) adopts the same orthography. It is significant too that Dr Robert Fries, son of Elias Fries, in his Synopsis Hymenomycetum Regionis Gothoburgensis, 1888, instead of adopting his father's name of *Ag.* (*Coll.*) *stipitarius* for this

Fungus, calls it *Ag.* (*Coll.*) *caulicinalis* Bull., adding: "Denuo recepi nomen Bulliardi, cujus icon accurata." So Krok and Almquist in their Svensk Flora för Skolor, Stockholm, 1907, II, 248, call this Fungus *Mar. caulicinalis*, notwithstanding the fact that all Swedish botanists hold Fries and his nomenclature in supreme honour and reverence. Also, the Flore des Champignons supér. de France describes the Fungus under the name of *Mar. caulicinalis* Bull.

Originally, then, the specific name *cauticinalis* was not applied by any one, not even by Fries, to either of these Fungi. It cannot be said that he introduced the new spelling to avoid confusion, for from the outset he had named the one Fungus, *Ag.* (*Coll.*) *stipitarius*, and no confusion would have been caused by retaining the specific name *caulicinalis* for the other. It is possible that the change from *l* to *t* arose from inadvertence on Fries' part, or from an uncorrected printer's error. One can only conjecture. At any rate it would appear to the writer that, while the specific name *stipitaria* Fr. is retained for the *Collybia* of Bulliard*, the *Marasmius* of Sowerby and Swartz should have the name *caulicinalis* restored to it in accordance with the International Rules for naming Fungi.

It only remains to be said that *caulicinalis* is a well-chosen name to indicate the habitat of either Fungus, whereas in regard to neither of them has *cauticinalis* any point or significance. The former means "growing on stalks, stems, straws or suchlike," and the latter "growing on or among rocks." While almost any Fungus may be found growing near rocks it is hardly possible to think that Fries, so admirable in his selection of specific names, could have deliberately chosen *cauticinalis* for either Fungus.

* Dr Paul is in error in assuming that the *Agaricus caulicinalis* Bull. is now considered identical with the *Agaricus* (*Collybia*) *stipitarius* Fr. Quélet in Fl. Myc. de Fr. 315 distinguishes *Marasmius caulicinalis* (Bull.) Quél. from *Marasmius scabellus* (A. & S.) Quél. and makes the *Agaricus stipitarius* of Fries synonymous with the latter. I have also set out the distinctions between these two species in my definition of *Crinipellis caulicinalis* (Bull.) Rea in Trans. Brit. Myc. Soc. v, 436. C.R.

A NEW DISCINELLA.

By W. D. Buckley.

While searching for Discomycetes during the favourable conditions of the early Spring a gathering was made of some specimens among moss, under Ulex, suggesting at first sight a pale Humaria. Further gatherings produced apothecia in every stage of development and made it possible to identify a new species of Discinella, *D. margarita*. The genus Discinella was founded by Boudier in his Nouvelle Classification Naturelle des Discomycètes Charnus in Bull. Soc. Myc. Fr. 1885, I, p. 112, *Phialea Boudieri* Quél. being made the type of the genus. The generic characters were further amplified in his Histoire et Classification des Discomycètes d'Europe (1907) and as pointed out by Ramsbottom in Journ. Bot. (1914), p. 215, consist of the terrestrial habit and the size of the fungus which may reach 12 mm.; the apothecia being thick and more or less subtomentose; the inoperculate, exceptionally small asci, with marginate pore, and the slender paraphyses filled with oil globules. The spores are fusiform and guttulate with or without granulations. (Karsten's genus Discinella is not identical with Boudier's "est Discina Fr. cm apotheciis minoribus" (Hedwigia, 1891, 30, p. 301). *D. corticalis* the type is found on wood.) The number of species in the genus does not exceed seven (with possibly two synonyms) five of which have been recorded for Britain. The species of this genus are placed by Saccardo in Humaria. The present species approximates most closely in general characters to *D. Menziesi* Boud., described and figured in Brit. Mycol. Soc. Trans. 1913, IV, p. 62, as *Calycella Menziesi*. Boudier himself corrected this and assigned the fungus to its true position as a Discinella in Tom. cit. p. 323. (The specific name was misspelled as "Meuriesi" Boud. in Bull. Soc. Mycol. Fr. XXXIII, p. 17, 1917.)

Although *D. Menziesi* and the present species have points of resemblance they are very distinct plants: the latter is smaller and is marked by its pearl-grey colour especially when young, with a remote touch of pink, as contrasted with the pronounced rose colour of the former. In the many specimens of *D. margarita* examined none exceeded $1\frac{1}{2}$–2 mm. The stipe was never prominent as it often is in *D. Menziesi*, the specimens never being more than turbinate. It is slightly furfuraceous on the outside, the cells of the excipulum running out into patchy bundles of short irregular hyphae. The asci are intermediate in size between those of *D. Menziesi* and *D. minutissima*. The paraphyses are filiform about 1μ broad and frequently strongly

branched at varying distances from the base, sometimes subdichotomously and at others on one side only and often presenting a budding appearance; the apices are at times slightly thickened and shortly and acutely bent, but this is not the normal condition. They contain oil globules and granulations which give a pseudo-septate appearance. The excipulum shows signs of separate hyphae at the base, passing into a pseudo-parenchymatous condition of irregular cells of greatly varying size and form, becoming very small and compacted at the margin; the hypothecium is finely cellular. The three species, *Menziesi*, *minutissima* and *margarita* fall into a natural group, being characterised by a more or less intense shade of pink combined with white or grey, whereas the other species of the genus show some marked shade of purple or brown. The affinity indicated is natural and more easily recognised than expressed. The specimens were accompanied by *Helotium luteolum* Currey (*Dasyscypha luteola* (Curr.) Sacc.) which also occurred on Ulex stumps.

My thanks are due to Mr Ramsbottom of the British Museum for much help in the preparation of this note.

DISCINELLA MARGARITA.

Gregaria, minutissima ad 2 mm. lata, turbinata, crassa, margaritaceo-grisea roseolo-tincta; carnosa, margine integro; primo concava mox applanata. Paraphysibus tenuibus circa 1μ crassis, oleosis, filiformibus, simplicibus aut ramosis, ad apices non aut vix incrassatis, hyalinis, non-septatis. Ascis modicis 70–80μ longis × 9–10μ latis, inoperculatis, octosporis, foramine marginato, cylindrico-clavatis ad basim vix attenuatis, ad apicem iodo non caerulescentibus. Sporis fusiformibus, hyalinis, levibus, continuis, saepe leniter curvatis, 9–15μ longis × 3–4μ crassis, intus guttulosis, et granulosis; guttulis 2–5 plerumque, granulis minoribus.

Ad terram argillosam inter muscos, Slough, May 1920.

DISCINELLA MARGARITA.

Gregarious, up to 2 mm. broad, turbinate, thick, pearl grey with a tinge of flesh colour; fleshy, margin entire. At first concave then convex and spread out. Paraphyses filiform, simple or branched, apex slightly or not at all thickened, hyaline non-septate, containing oil drops. Asci medium size 70–80μ long by 9–10μ broad, inoperculate, 8-spored, opening marginate, cylindric-clavate, slightly attenuated at the base, not coloured blue with iodine. Spores fusiform smooth, continuous, sometimes curved on one side 9–15μ long by 3–4μ broad, 2–5-guttulate with granules.

On the ground among moss under *Ulex*, Slough, May 1920.

ON THE BIOLOGY OF PANUS STYPTICUS.

With Plate IX.

By Marie E. M. Johnson.

Panus stypticus Fr., so called because of its remarkable astringent taste, is found on old logs of fir, alder, beech, oak, hazel, birch, chestnut, etc. throughout the year. It grows best in damp situations, but too much moisture is injurious. When a log infected with this fungus was brought into a garden in the vicinity of some iron and chemical works, the sporophores became discoloured, lost their usual fresh appearance, and generally became unhealthy; the young sporophores almost ceased to grow, and no new ones appeared, although the log was continually moistened. The smoky atmosphere, sometimes charged with poisonous gases, was evidently quite unsuitable for its growth. It seemed at first as if the damage were due to frost, rather than to the unsuitable black-country atmosphere, but even when the log was kept in a more sheltered situation, and covered up during severe frosty nights, no new sporophores appeared, suggesting that frost could not have been the sole cause of their non-appearance, though it may have been the cause of a retardation of growth. Later, when the infected log was removed to a clearer atmosphere, young fresh-looking sporophores quickly appeared. Moreover, a large piece of wood, which had previously been broken off from this infected log and kept in a country district, produced sporophores which were unaffected by frost.

Panus stypticus is one of the many fungi eaten by slugs, which on discovering the whereabouts of an infected log, cause the rapid disappearance of young sporophores and bite large pieces out of mature ones, leaving only their slimy trail to account for the damage. It is possible that slugs may be active agents in the dispersal or even the germination of the spores.

Spores and their Germination in Hanging Drop Cultures. The spores are colourless, oval, and apiculate, having a size of $4\mu \times 3\mu$. They germinate readily in rain-water, 5 per cent. glucose, 10 per cent. gelatine, malt-wort extract, and various other media, and even spores which had been dried for five days in the atmosphere of the laboratory germinated after 20 hours.

Bacteria are said to assist germination but according to observations made on hanging drop cultures, their presence was not beneficial to the germination of these spores.

Wood Block Cultures. Small pieces of sterilised wood infected with basidiospores in an infection chamber, were placed in glass cylinders (7 inches long) and plugged with cotton wool which

was continually absorbing moisture. The cultures were placed in sets of three in large sterilised closed glass vessels. In about 12 days mycelium appeared which grew especially well on silver birch. After 5 weeks' growth, the cultures were removed to larger vessels and placed under similar conditions of light and moisture. Growth was then more rapid and within three weeks young sporophores appeared. Bayliss* also observed that an increased supply of air had a beneficial effect upon wood block cultures of *Polystictus versicolor* and this was followed by the production of small sporophores, but since then she obtained in less than eight months well developed sporophores of *Polystictus versicolor*† by using large instead of small sterile blocks of wood kept under good conditions of aeration and humidity.

Oidia were observed only in hanging drop cultures.

Destruction of Wood. The growth of the mycelial strands, which interlace in the vessels, wood fibres and medullary rays, causes the wood to become light, very soft and paler in colour.

Sections showed that the more highly lignified elements persisted the longer (fig. 1*b*) while the less lignified spring elements were the first to disappear (fig. 1*a*). In some cases the secondary thickening of the cells is first absorbed, the middle lamella persisting (fig. 1*a*) but finally this is removed also. In other cases the hyphae have penetrated straight through a cell wall, the middle lamella having been dissolved at the same time as the other part of the cell wall (fig. 1*a*). Sometimes the hyphae pass from tracheid to tracheid *via* the bordered pits. In the autumn wood and medullary ray cells, the pits become enlarged (fig. 1*b*).

The Sporophore. This first appears as a tiny white knob about $\frac{1}{8}$th of a cu. mm. in size (fig. 2). Within one or two days this tiny white knob grows into a horizontal pyramidal mass about $1\frac{3}{4}$ mm. in height (fig. 2*a*), increase in elevation being due to elongation of the contained hyphae. Soon a tiny pileus can be recognised (figs. 2*b'* and 2*b*), and the stipe lengthens; sometimes the latter is only about 1 mm. in length when the pileus first appears. The hyphae of the stipe gradually cease to grow terminally and then commence to branch, many of the branches following a horizontal direction, giving rise to the pileus. This is indicated by the flattening and broadening out of the apex of the stipe (fig. 4*b*). These horizontal hyphae give off vertical branches which remain more or less parallel, and finally cease to grow, and so give rise to the dorsal tissue of the pileus. Other similar branches are given off which turn downwards and form the hymenium, which can be seen when the pileus is about $2\frac{1}{2}$ mm. across (figs. 4*c*, 2*c'*, 2*c*). The young pileus is globose and

* Jessie S. Bayliss, The Biology of Polystictus versicolor, Journal of Economic Biology, III, 1908. † An unpublished statement.

its growth is at first epinastic, its margin being incurved and pressed against the stipe (fig. 4*b*). Thus the hymenium begins to be formed within a special chamber. As the hymenial surface increases and keeps pace with the growth of the dorsal tissue of the pileus, the latter expands and exposes the gills (figs. 4*c*, 2*d'*, and 2*d*). The gills are formed by the continual downward growth of some of the hyphae; these bend outwards and bear the elements of the hymenium. The gills are thus exposed before the pileus is completely developed and before the spores are mature. Spores can be obtained from sporophores, which are about half an inch across, and liberation of the spores continues until the sporophore is fully grown—a period of a month or two. The mature spores are disseminated by the wind. When the sporophore is nearing maturity, some of the terminal portions of the hyphae of the dorsal surface separate, and thus the upper surface of the sporophore becomes granular in appearance.

The free margin of each gill is fringed by a number of cystidia, some being club-shaped, while others are pointed and some bear tiny branches (fig. 3). Among the basidia are occasionally seen cystidia (figs. 7*a* and 7*b*), which resemble some of those fringing the free margin of the gills; they are colourless and project out beyond the basidia.

With variations of temperature and moisture there is a variation in the amount of growth of the pileus, but under moderately favourable conditions a sporophore takes about three months to develop. An insufficient supply of air delays growth.

The sporophore projects out horizontally from the substratum (fig. 4*d*). If the position of a log is altered after young sporophores with the beginnings of gills have appeared, the stipes of these attempt to readjust themselves in order to place the pileus in a horizontal position.

The pilei are sometimes zoned and this depends on changes in the humidity of the atmosphere, variations in the amount of moisture causing alternate acceleration or retardation of growth.

The yellowish-brown pigment is diffused through the cell sap of the hyphae and is much deeper in colour just below the cuticle of the pileus. In very young sporophores stipes and pilei are very pale buff, but soon the colour of the pilei deepens and subsequently becomes cinnamon. Intensity of colouring appears dependent on light, for when sporophores are grown in diffuse light (temperature and humidity being constant) they are a uniform pale buff colour but in bright light cinnamon or tan.

According to Atkinson*, the young sporophores of *Panus stypticus* are phosphorescent, but no fruit bodies which were examined exhibited this phenomenon.

* G. F. Atkinson, Mushrooms, p. 136.

Reactions of Sporophores to (*a*) *Light.* Logs bearing young sporophores having an average height of about 2 mm. were kept in darkness for four months under suitable conditions of humidity. At the end of this period examination showed no increase in the size of the fruit bodies, in fact some had become smaller and looked very withered. The majority of the fruit bodies were about one and a half mm. in height and had developed no pilei; others had a stipe of about 2 mm. in length and a pileus about half a mm. across. Even in partial darkness the sporophores which appeared had abnormal stipes and small or no pilei. Yet darkness appeared to favour the growth of mycelium.

(*b*) *Gravity.* A branch bearing a few small fruit bodies was attached to a clock clinostat and rotated on a horizontal axis, a continuous and constant supply of moisture for the fruit bodies being arranged: a control experiment was kept. The branch on the clinostat was rotated once every 20 minutes. For four months the experiment was continued but normal sporophores were never formed. New tiny pyramidal masses appeared which quite quickly developed pilei: the stipes of these fruit bodies were shorter in comparison with the breadth of the pilei than on normally grown fruit bodies; gills soon appeared and the sporophores matured quickly. Some of the stipes became curiously swollen and without exception the fruit bodies expanded their pilei at right angles to the axis of revolution so that the gills developed horizontally instead of assuming the normal vertical position (fig. 5).

Thus it appears that both light and gravity influence the development of the sporophores.

Panus stypticus is a xerophytic fungus, for sporophores after being dried for six months or longer will revive when moistened and shoot off spores capable of germination.

The mycelium also of this fungus retains its vitality after receiving little or no moisture for many months.

In conclusion I wish to express my thanks to Dr Jessie S. Bayliss Elliott for the valuable assistance she has given me in many ways during the course of this study.

SUMMARY.

1. The sporophores of *Panus stypticus* can withstand frost and so can be cultivated out of doors in winter months. A sporophore takes about three months in developing.

2. The spores germinate readily in suitable media, and wood block cultures when given a favourable supply of light and moisture produce sporophores in the course of six or seven weeks.

3. Wood when attacked by this fungus becomes light, very soft and paler in colour. The less lignified spring elements are the first to disappear.

4. Sporophores of this fungus which have been dried for a considerable time when moistened shed spores which will germinate, moreover the mycelium can be dried for many months and still retains its vitality.

EXPLANATION OF PLATE IX.

Fig.

1. Transverse section to show the effect of the mycelium of *Panus stypticus* upon the wood of alder. "*a*" shows the more rapid destruction of the spring wood, while "*b*" shows the destruction of the more persistent autumn wood, both drawings being taken from the same section. × 534.

a. The destruction of the less lignified fibres is shown in the regions "*c*," "*d*," and "*e*," while the medullary rays and more highly lignified elements near "*f*" are seen to be more persistent. "*g*" are walls which have been practically consumed except for the middle lamella. Removal of secondary thickening and later of the middle lamella is represented at "*h*," "*i*" shows a hypha penetrating through a cell wall, the middle lamella having been dissolved at the same time as the other part of the cell wall. At "*n*" secondary thickening and middle lamella have been removed. × 534.

b. Near "*j*" can be seen the enlargement of the pits, which takes place in the autumn wood cells. At "*k*" are elements which have lost some of their secondary thickening. × 534.

2. "*a*," "*b*," "*c*," "*d*," and "*e*" are successive stages in the development of the sporophore—ventral views. "*a'*," "*c'*," "*d'*" and "*e'*" are lateral views natural size.

3. Cystidia found at the free margin of the gills. × 534.

4. *a*, *b*, *c*, longitudinal sections through young fruit bodies.

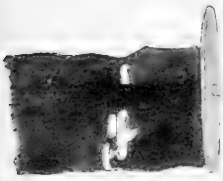
5. This figure shows sporophores which have developed upon wood fixed horizontally to a clinostat; the pilei of the fruit bodies have expanded vertically. Sporophores are about natural size.

6. Abnormal sporophores which have developed in a dark position in the laboratory. Natural size.

7. Section through hymenium. × 534.

a. Basidia and attachment of basidio-spores. Figure also shows cystidia. × 534.

b. Shows a cystidium with a pointed end. × 534.



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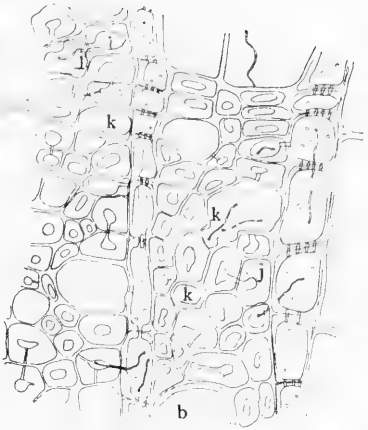

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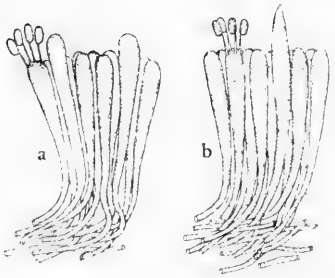

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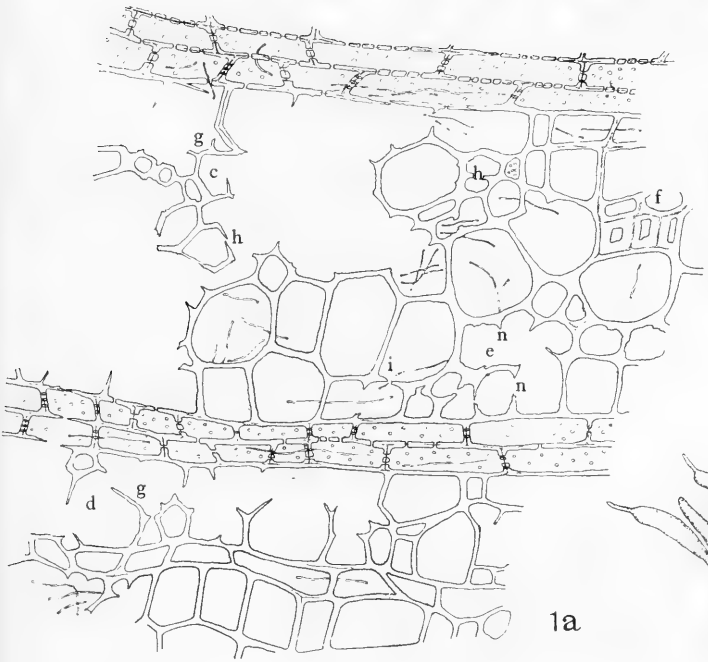

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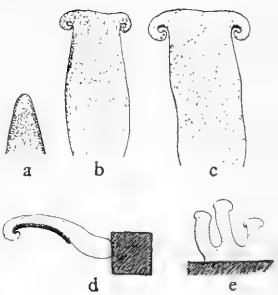

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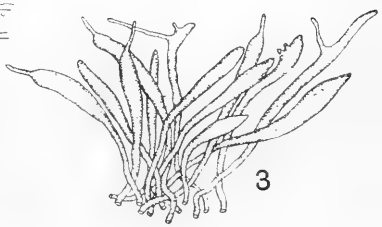

3

M. E. M. Johnson del.

The ascospores are very large and do not seem to be readily discharged from the ascus, although they have been under similar cultural conditions to *Peziza aurantia*, *Cudoniella acicularis* and *Dasyscypha virginea*, all of which we have frequently seen "puff" off their ascospores, yet we have never observed "puffing" in *Pezicula eucrita*.

We have also tried the effect of various chemical substances, solutions of silver nitrate, acetic acid, sulphuric acid, copper sulphate, alcohol, iodine, mercuric chloride, potassium nitrate, and sodium chloride (such as were used by Buller (4) in his experiments on *Peziza repanda*) on ripe asci lying in water, and found that none of them had the slightest effect in bringing about the discharge of ascospores, whereas ripe asci of *Dasyscypha Soppittii*, similarly treated, burst at once, discharging their ascospores. No doubt the profuse formation of conidia from ascospores which have germinated in the ascus, or from those lying on the surface of the apothecium may be correlated with the ineffective explosive mechanism of the asci.

When the ascospores of *Pezicula eucrita* were germinated in water in hanging-drop culture-chambers, the growth and profuse formation of conidia were similar to that seen under natural conditions; conidia treated similarly germinated and produced a small germ-tube, or they budded off conidia again.

Conidia were present in every apothecium examined, even in quite young specimens, but were more numerous in the more mature stages of growth.

In both young and old apothecia paraphyses were found. Some were long, slender and unbranched, whilst others were dichotomously branched and clavate, and similar to those figured by Boudier (3). Although the paraphyses are dichotomously branched they never presented the rigid dichotomy seen in those figured by Rehm (2), neither is there the abrupt transition from slender filament to clavate head.

The excipulum is parenchymatous and covered with short hairs. In all descriptions of this fungus no mention is made of the excipulum which is usually an important feature to note when identifying a discomycetous fungus.

REFERENCES.

(1) Trans. Brit. Myc. Soc. 1912, Vol. IV, p. 198.
(2) Rehm in Rabenhorst's Kryptogamen Fl. 1, 3, p. 255.
(3) E. Boudier.—Icones Mycologicae, Pl. 559, p. 330.
(4) A. H. R. Buller.—Researches on Fungi, p. 238.

THE RED SQUIRREL OF NORTH AMERICA AS A MYCOPHAGIST.

By Professor A. H. R. Buller, D.Sc., Ph.D., F.R.S.C.

In the Transactions of the British Mycological Society for 1916, an interesting paper was published by Hastings and Mottram upon the edibility of fungi for rodents. It was shown by citations from other authors, by field observations, and by a series of experiments that both squirrels and rabbits attack the fruit-bodies of many of the higher fungi and devour them as food*. The investigations of Hastings and Mottram were made in England but their conclusion that squirrels and rabbits are mycophagists doubtless applies not merely to British species but very generally to non-British species the world over. As a contribution to our knowledge of the relations of rodent and fungi I shall here record a series of observations upon the Red Squirrel and its fungus food, made by myself and by several other naturalists in Canada and the United States.

The Red Squirrel or Chickaree has an extensive geographical range in North America, for it is found in the woods of Canada and the United States from the east coast to the Rocky Mountains. It does not hibernate profoundly during the winter for, on any sunny winter's day, it may be seen about the trees in woods. I myself have seen it in mid-winter at Winnipeg in a park and about houses. The Red Squirrel feeds on the seeds of fir-cones, nuts, etc., but it is also an habitual mycophagist. In the autumn, it often collects fleshy fungi in large numbers for its winter supply of food and it stores the fungi sometimes in holes and sometimes on the branches of trees. This latter mode of storage, although of peculiar interest, does not seem to be generally known to mycologists even in North America.

Whilst studying fungi in the woods at Gimli on the western shore of Lake Winnipeg, at Minaki on the Winnipeg River, and at Kenora on the Lake of the Woods, I have many times observed fruit-bodies of Hymenomycetes which had been partly devoured or otherwise injured by rodents. From the appearance of the damaged fungi which was similar to that described by Hastings and Mottram, I came to the conclusion that the destructive agent was sometimes a squirrel and sometimes a rabbit.

* S. Hastings and J. C. Mottram, The Edibility of Fungi for Rodents, Trans. Brit. Mycolog. Soc., Vol. v, 1916, pp. 364–378.

In the autumn of 1919, I spent many days studying the fungi in the woods about Kenora. There, in the first week of October, *Armillaria mellea*—the Honey Fungus—was exceedingly common, and I noticed that, here and there, clumps of it had been damaged by a rodent. I also found a few isolated, half-eaten fruit-bodies hanging in the forks of branches of trees at a height of from six to about twelve feet above the ground. Two of these fruit-bodies I identified as *Armillaria mellea* and one as *Hygrophorus chrysodon*. I suspected that the destructive agent had been a Red Squirrel, for Red Squirrels were not uncommon in the woods. On October 6, my suspicions were confirmed. On that day I was approaching the Lake of the Woods and, just as I came to its margin, I saw a Red Squirrel on the top of a wood-pile close by the water's edge not twenty feet away. I stood still and observed that the squirrel was sitting on its hind legs with its tail curled over its back and was engaged in eating an agaric held in its fore-paws. I watched this little scene for some moments and then drew nearer, whereupon the squirrel suddenly dropped the fungus and darted away. I then went up to the wood-pile and recovered the fungus which proved to be a fruit-body of *Armillaria mellea*. The pileus had been eaten all around the periphery; but the disc showed the characteristic honey colour and scales, and the stipe still retained its annulus and its peculiar dingy yellow base. On the ground at the foot of the wood-pile I found a clump of *Armillaria mellea* fruit-bodies, some of which had been broken off by a rodent. Doubtless, this clump had been the source of the fruit-body which the squirrel had been eating.

Dr W. P. Fraser, Plant Pathologist of the Dominion Division of Botany, made the following statements to me: "In some of the woods in Pictou County, Nova Scotia, Red Squirrels are very numerous. Many scores of times I have seen these animals carrying or eating the sporophores of Hymenomycetes. A squirrel, after seizing a sporophore upon the ground and before eating it, usually carried it to the top of a stump or log or up to one of the branches of a tree. Partially devoured sporophores were often left lying about on stumps, logs, etc. Most of the fungi were Russulae."

Dr E. M. Gilbert of the Botanical Department of the University of Wisconsin told me that in the woods of Wisconsin he had often watched squirrels picking fungi, running with them along the ground, carrying them up trees, and eating them on the branches. When making these observations, he usually lay on the ground with his head resting on a cushion. Among the fungi carried up into the trees were various species of Russula and also *Lactarius piperatus* parasitised by *Hypomyces lactifluorum*.

It thus appears that the Red Squirrel is just as keen a mycophagist in the State of Wisconsin as in Nova Scotia more than a thousand miles distant.

Professor J. E. Howitt of the Ontario Agricultural College told me that at Muskoka, Ontario, in the month of September, he had often seen squirrels carrying fungi about trees, and that once he had seen an Amanita so carried. Sometimes the squirrels fetched and carried fungi with great persistency for several days in succession. Doubtless they were laying up provender for the winter.

The Red Squirrel stores up fruit-bodies of fungi for the winter often in large quantities. Sometimes the fruit-bodies are: (1) stored in bulk in a hole in a tree, in an old crow's nest or in some disused building, etc., but sometimes they are (2) hung up separately in the horizontal forks of trees. When thus hung up in the autumn, they soon dry and thus become preserved until the snow is on the ground and they are required for food.

(1) *Storage in bulk.* Mr Stuart Criddle of Treesbank, Manitoba, in a letter to the author, says: "I have often found fungi stored by squirrels above ground but never under ground. The chief places where I have found fungus stores have been woodpeckers' holes, hollow trees, and birds' nests—especially crows' nests." Soon after writing thus, Mr Criddle very kindly sent me a collection of dried fungi which had been stored by a squirrel in an old box in the loft of a disused house. In the collection there were 116 fruit-bodies altogether, many still quite intact, but some partially devoured and some represented only by large fragments. Of these 116 fruit-bodies, 22 were Boleti and 94 Agaricaceae. The former weighed $6\frac{1}{4}$ oz. and the latter 14 oz., so that the total weight was 1 lb. $4\frac{1}{4}$ oz. The fruit-bodies were sent to me in February and, owing to this being a very dry time of the year, they were exceedingly dry and very tough or brittle. When being gathered by the squirrel, they must have weighed many pounds. Some of the pilei bore the characteristic marks of a squirrel's incisor teeth. Many of the Boleti, and perhaps all, belonged to *Boletus scaber* and, among the Agaricaceae, there were at least two species of Russula, at least one species of Cortinarius, a Hypholoma—possibly *H. fasciculare*, and *Lactarius piperatus*. Some of the fruit-bodies of the last-named species had been parasitised by *Hypomyces lactifluorum* and therefore showed only slight ridges beneath their pilei in place of gills. A second collection of fungi sent me by Mr Stuart Criddle from another squirrel's home at Treesbank was even larger than the first for it contained between two and three hundred fruit-bodies. These, except in their

larger number, resembled the fruit-bodies of the first collection, so that a further description of them is unnecessary.

Mr Norman Criddle of the Dominion Department of Agriculture, has informed me by letter that he has never yet found fungi mixed with the usual winter stores of squirrels but that, nevertheless, he has found "old holes in trees literally crowded with semi-dry fungi which had apparently been stored as they were gathered and not previously dried." He further states that the fungus stores were invariably abandoned so that he could never trace the owner. These stores resembled those already described and may well have been collected by the Red Squirrel.

Dr C. N. Bell of Winnipeg has a summer-house at Minaki, a village situated where the Canadian National Railway crosses the Winnipeg River, 114 miles east of Winnipeg. This house, after having been closed for the winter in the autumn of 1916, was invaded by squirrels. The squirrels stored cones and fungi in the attic and made two nests in the mattresses on the beds. The number of stored-up fungi was large. Dr Bell wrote to me concerning the invasion of his house as follows:

"On opening my summer-house on the shore of Sandy Lake in the village of Minaki in the spring of 1917, I found unmistakable evidence that one or more of the Common Red Squirrels which play about the rocks and trees of the locality, had obtained access to the house, for there were two squirrels' nests in the mattresses on the beds and, in the attic, many gnawed pine-cones and a large quantity, say two or three quarts, of dried fungi. Also, many dried stalks of fungi were scattered about the other parts of the house accessible from the attic. Some individual squirrels have become so tame that they run up the steps to the veranda floor and, holding on to the wire screening, peer in on us while we sit at meals; and, occasionally, they have eaten crumbs out of my little daughter's hand. At times they are rather a nuisance as they frequently jump from the trees to the roof of the house and scamper about in the very early morning, at the same time making their chattering noise. Closing up every crevice in the roof and attic has effectually prevented them from entering the house since 1917."

The above observations made by Messrs Stuart Criddle and C. N. Bell prove conclusively that the Red Squirrel does store fleshy fungi in bulk in the autumn for winter use. The air in Manitoba during the autumn and winter is very much dryer than in England, so that the collected agarics dry without rotting or becoming unduly mouldy.

(2) *Storage in the forked branches of trees.* When I first heard of squirrels storing fungi in the branches of trees, the story

sounded in my ears like a romance and I was somewhat sceptical. However, as a result of a series of enquiries, although I myself have not as yet seen a tree with more than two fungi hanging in it, I cannot now doubt that trees laden with fungi by squirrels have been observed by others. Thompson Seton writes of them quite familiarly and his observations are supported by others made by M. W. Gorman in Alaska and by my personal friends and acquaintances at Winnipeg.

Thompson Seton in his well-known book on the mammals of North America writes of the Red Squirrel as follows:

"The second food supply in winter is mushrooms, chiefly of the genus Russula. If these were to be stored in the same way as the other provisions they would doubtless rot before they could be of service. The Squirrel stores them in the only available way, that is, in the forked branches of the trees. Here they are safe from the snow that would bury them, from the Deer and Field-mouse that would steal them, and instead of rotting, they dry up and remain in good order until needed.

"I have seen Red Squirrels storing up these mushrooms in the Sandhills south of Chaska Lake, Manitoba, in the Selkirk Mountains, on the Ottawa, and on the upper Yellowstone River. The Squirrel's sense of private ownership in a mushroom-stored tree is not so clear as its feeling regarding a hoard of nuts it has gathered.

"During early winter in Manitoba I have once or twice seen a Red-squirrel dig down through the snow to some mushroom still standing where it grew, and there make a meal of it.

"While camped at Caughnawanna, on September 14th, 1905, I was witness of a comic display of frugality and temper on the part of a Red-squirrel. A heavy footfall on the leaves had held me still to listen. Then appeared a Chickaree labouring hard to drag an enormous mushroom. Presently it caught in a branch, and the savage jerk he gave to free it resulted in the 'handle' coming off. The Squirrel chattered and scolded, then seized the disc, but again had the misfortune to break it, and now exploded in wrathful sputterings. Eventually, however, he went off with the largest piece and came back for the fragments one by one.

"The scene was an exact reproduction of one described by Dr Merriam in 1884."

Thompson Seton evidently thinks that the tree-fork mode of storage is the only kind of storage for fungi resorted to by the Red Squirrel, but in this he is in error for, as I have shown by citing the observations of Stuart Criddle and C. N. Bell, the Red Squirrel often stores up fungi in bulk in various holes and cavities. I suspect, but am not sure, that bulk-storage in holes

and cavities is more common than storage in the branches of trees.

M. W. Gorman who has botanised in Alaska, is reported by W. A. Murrill as having made the following statement*:

"In the region west of the Yukon River the small red or 'pine' squirrel lives during the winter upon the seeds of *Picea alba* and mushrooms. The latter are collected in large quantities during the summer and placed in the forks of branches and other secure spots above the ground to dry." Three different kinds of brownish-coloured agarics were noticed by Gorman who says that the squirrels visit their collections every day, even in the coldest weather.

The two following statements sent to me in writing by Mr Ernest Hiebert and Mrs Doern, both of whom are known to me as careful observers, supplement one another and prove in the clearest manner that, in Manitoba, the Red Squirrel not only stores fungi in particular trees in the autumn but also feeds upon the fungi so stored during the winter.

Mr Ernest Hiebert thus recounts his observations:

"In the middle of August, 1917, at Sandy Hook, near Gimli, Manitoba, I noticed what appeared to be a mushroom stuck between the lower branches of a spruce tree. Upon closer examination I discovered several more fungi in the same tree to the number of twelve in all. Most of them were in the lower branches about fifteen feet from the ground and a few as high as forty feet from the ground. They had all been placed between the horizontal forks of the twigs in the upright position in which they grow. I removed several of these fungi and found them quite dry and all apparently belonging to the genus Russula except one, which I took to be *Lactarius piperatus*.

"Several days later in the same grove of spruce trees, I came across a Common Red Squirrel carrying a fungus along the ground. Upon being pursued, it dropped the fungus which proved to be a perfectly fresh Russula."

Mrs A. H. Doern's observations were made in a suburb of Winnipeg and are still more interesting. She says:

"In October, 1918, I noticed a common red squirrel carrying a mushroom up one of the trees which grew in my yard at Norwood. The fungus was then placed between the twigs so that the gills looked downwards. Several more mushrooms were placed in a similar position in the same tree; and, during the winter that followed, I repeatedly watched the squirrel eat of these dried mushrooms. The squirrel would remove a mushroom from the twigs on which it had rested, nibble at it, and then replace it as before but in some other part of the tree.

* W. A. Murrill, Animal Mycophagists, Torreya, Vol. II, 1902, pp. 25–26.

Finally, during a cold spell in mid-winter, the mushrooms which still remained all disappeared from the tree and, after this, the squirrel failed to return."

Another observer who has watched squirrels taking fungi up into trees and storing them there is my friend and colleague, Dr Gordon Bell, who writes as follows:

"I have often seen squirrels carrying pieces of fungi up into trees. At Fox Lake in Ontario there was a large pinkish fungus which was very common in the woods and which interested me because I wished to find out whether or not it was edible. One day in the latter part of August, for fully fifteen minutes, I watched a red squirrel carry pieces of the fungus up into a pitch-pine tree and deposit them in the forks made by the branches. I have also seen squirrels in Fort Rouge, Winnipeg, carrying pieces of a Peziza-like fungus up into trees. I think it highly probable that the squirrels eat these fungi after they have dried, but I cannot assert this from actual observation."

From the foregoing evidence, it appears that the storing of fungi in the branches of trees in the autumn by the Red Squirrel is a well developed instinct. It is remarkable with what care the fungi are deposited. The fork of a branch is first selected and then the stipe is pushed downwards through it so that the pileus rests on the twigs, the result being that the fruit-body as a whole cannot fall to the ground by its own weight or be easily dislodged by the wind or by the swaying of the branches. The trees chosen by the squirrels for their open larders are usually Spruce-trees.

In England, during the late autumn and winter, as is well known, the climate is mild, the rainfall heavy, and the periods of frost not very intense or long continued. The English squirrel lays up for the winter a store of nuts and seeds but, so far as is known, never any fungi. Fleshy fungi, if stored by this animal either in holes or on the branches of trees would, owing to the dampness and mildness of the English climate, surely be apt to go rotten rather rapidly. On the other hand, in the inland parts of Canada and of the northern United States, the climate, during the late autumn and winter, is relatively very cold, the precipitation relatively slight and in the form of snow, and the frost very severe and prolonged. In central and western Canada and in North Dakota, snow lies upon the ground and the earth is frost-bound for at least four months each year. In the northern part of North America, therefore, the storage of winter food-supplies by squirrels is even more important than in England. The Red Squirrel lays up for the winter not merely cones and nuts but, in addition, a store of fungi. Owing to the dryness and coldness of the climate, the fungi hung in the branches of

trees by squirrels in late autumn, dry without rotting and remain good to eat until the spring comes, while those deposited in bulk in holes, although moist when collected, become partially dried and, in this condition, preserved by the action of the frost. The fungi heaped together in holes, etc., are put by the weather into a state of cold storage resembling that in which mankind now preserves many of his food-stuffs, such as beef and mutton. The storage of fungi for the winter, by increasing and varying the supply of food, is undoubtedly beneficial to the Red Squirrel and is due to an instinct which appears to have been developed in response to severe winter conditions.

Mr J. B. Wallis, Principal of the Machray School, Winnipeg, once observed a squirrel which, instead of storing fungi in the branches of a tree, hung up there two chickens. As is well known, the Red Squirrel robs birds' nests and kills birds freely. The killing of the two chickens, therefore, was not very extraordinary; but the hanging of the chickens in the forked branches of a tree was a very curious and unusual proceeding and suggests that for once the fungus-storing instinct had become perverted. Mr Wallis has written to me concerning the incident as follows:

"A red squirrel had taken up its abode just behind a farmhouse near Thornhill, a village some eighty miles W.S.W. of Winnipeg. This squirrel had become quite friendly and showed no fear of its human neighbours. One day, whilst visiting the house, I was called outside and here was the squirrel laboriously dragging by the neck, up a small oak-tree, a chicken nearly as big as itself. On looking more closely, two other chickens were discovered, hung by their heads in forked branches. The three chickens had all been killed by bites at the back of the head. The squirrel, on perceiving my friend and myself, immediately seemed to sense disapproval of his thrifty habits and retired rapidly to a high bough from whence he was dislodged with a charge of number six shot. As a really advanced squirrel, he thus fell a victim to his very advancement."

Summary. The Red Squirrel of North America not only feeds on the seeds of fir-cones, hazel-nuts, etc., but is also an habitual mycophagist. In the late autumn, it often collects fleshy fungi in large numbers for its winter supply of food, and it stores these fungi sometimes *en masse* in holes in tree trunks, old birds' nests, etc., and sometimes separately on the branches of certain trees.

THREE NEW BRITISH COPRINI.

By Professor A. H. R. Buller, D.Sc., Ph.D., F.R.S.C.

1. *Coprinus echinosporus* Buller, sp. n.

Pileus 15–18 mm. high before expansion, white, then grey, and finally dirty yellowish-brown, oval, then conico-campanulate, becoming flattened, about 3 cm. broad, and finally revolute and radially splitting along the lines of the longest gills, at first clothed with short dense down which then breaks up into small, delicate, thin, fugacious tufts or scales consisting of slender branched cells, 80–150 × 5–10μ. Stipe 9 cm. × 3 mm. at base, white, slightly attenuated upwards, straight or flexuose, firm, adpressedly hairy. Gills blackish at maturity, adnexed, very thin, very slightly wedge-shaped, autodigesting on the edges. Flesh brownish-yellow, brownish at the apex of the pileus, becoming finally dirty ochraceous. Spores black in the mass, very dark and opaque under the microscope, finely warted or echinulate, oval, more or less pip-shaped, truncate at the apex, 9–11 × 5–7μ, with an apical germ-pore through which a transparent membrane often protrudes; basidia of three lengths, surrounded by 3–4 paraphyses. Cystidia abundant, rounded at both ends, generally parallel-sided, rarely globose, 70–95 × 23–30μ, varying up to 105μ in length and 45–57μ in diameter. Habitat, on sticks dredged from a pool at Kew, October, 1911.

The most striking character of this species lies in the coarsely verrucose spores which are truncate at the apex; but, in general aspect, it resembles *Coprinus lagopus* Fr. (= *C. fimetarius* and *C. cinereus* of authors).

Pileo 15–18 mm. alto, ovali, albo-cinerascente, dein 3 cm. lato, conico-campanulato, sordide fusco-lutescente, postea revoluto radiatimque fisso, farina tenui cônsperso. Stipite albo, sursum attenuato, firmo, adpresse pubescente. Lamellis adnexis, atris; sporis amygdaliformibus, verruculosis vel echinulatis, apice truncatis, 9–11 × 5–7μ; cystidiis copiosis, ellipticis.

2. *Coprinus bisporus* Lange.

Lange, Studies in the Agarics of Denmark, pt. II, Coprinus, Dansk Bot. Ark., bind 2, no. 3, p. 50. Synonym: *Coprinus bisporiger* Buller in Trans. Brit. Myc. Soc., 1911, p. 350.

Pileus 5–12 mm. high and broad, pallid or ochraceous, then greyish-hyaline, ovate-conical, then revolute and radially sulcate up to the disc which remains prominent, covered with erect, minute hairs, 45–120 × 12–24μ. Stipe 3–8 cm. × 1–3 mm., white, equal, strigose at the base. Gills white, then blackish, adnexed, narrow, 2 mm. wide. Flesh white, ochraceous under the pellicle of the pileus, thin except at the disc. Spores purplish-brown in the mass, dark brown under the microscope, oval or oblong elliptical, 12–14 × 6–7μ; basidia broadly ovate, 8–10 μ in diameter, with 2 sterigmata and 2 spores. Cystidia inflated, ovate, 80–90 × 45–55μ. Habitat, wood and dung, at Kew, Aug.–Oct., 1911 and 1916.

The British specimens found at Kew, on which this description is based, had invariably two spores only on each basidium and never three or four. By this character, combined with the deeply sulcate pileus with its prominent disc, the strigose base of the stem, and the ovate cystidia, this species can be readily distinguished.

3. *Coprinus curtus* Kalchbr.

Lange, Studies in the Agarics of Denmark, pt. II, Coprinus, Dansk Bot. Ark., bind 2, no. 3, p. 45, t. 1, fig. h. Synonym: *Coprinus plicatiloides* Buller, in Researches on Fungi, Vol. 1, 1909, p. 69.

Pileus 3–8 mm. high when young, 0·5–1·5 cm. broad when expanded and flattened, foxy-red or rufescent to tan colour at first, becoming grey to dark grey, at first oval to cylindrical or elliptical, then expanded and flattened with a strongly depressed disc, splitting along the lines of the gills and becoming plicate, bearing a certain number of minute, scattered, flaky, separable, rufescent or whitish scales composed of globose, angular, or elliptical cells, often in chains, 12–30μ in diameter, some brown and some colourless, not ornamented with crystals of calcium oxalate, the pileus also villose or downy with many colourless hairs, 70–100 × 5μ, enlarged at the apex where minute drops of a clear fluid are exuded under moist conditions. Stipe 2–8 cm. × 1–2 mm., white, becoming stained with dull yellow, equal, smooth, hollow. Gills grey, then black, at first attached to the stem by the margin for its entire length, then adnexed and finally free, linear, narrow; margin before autodigestion begins slightly divided and fimbriate. Flesh white, thin. Spores black in the mass, dark brownish to black under the microscope, elliptical, 9–15 × 6–9μ. Cystidia on the sides of the gills none. Habitat, on horse dung at Kew and Taunton, August and September, 1911, commonly coming up on horse dung in cultures in glass dishes.

The distinguishing characters of this species lie in the foxy-red colour of the very young pileus, the minute reddish or whitish scales which remain on the expanded pileus interspersed with clavate hairs, the finally depressed disc, the deep black spores and the absence of cystidia on the sides of the gills. The pileus, when expanded, reminds one of that of *Coprinus plicatilis*. Sometimes very minute or dwarf fruit-bodies are to be found along with similar dwarfs of *C. lagopus* in crevices in old horse dung masses. The fungus is common on horse dung cultures at Winnipeg.

NEW OR RARE MICROFUNGI.

By A. Lorrain Smith, F.L.S., and J. Ramsbottom, M.A., F.L.S.

PHYCOMYCETES.

Phytophthora cryptogea Pethybr. & Laff. in Sci. Proc. R. Dublin Soc. XV, p. 498, 3 pls. 1918.

On roots and stems of *Lycopersicum esculentum* and Petunia sp. Ireland.

PYRENOMYCETES.

Nectria fusco-purpurea Wakef. in Kew Bull. 1918, p. 232.

On dead branches of plum (Pond's Seedling). Wisbech (J. C. F. Fryer, 1917; A. D. Cotton, 1917).

Melanospora Zobelii Fuck.

On the hymenium of *Sepultaria arenicola* Mass. Coll. W. G. Travis. Sand-hills, S. Lancs. Recorded in Trans. Brit. Mycol. Soc. IV, p. 314, 1914.

Sphaerulina intermixta f. *valde-evoluta* Grove in Journ. Bot. LVII, p. 210 (1 fig.), 1919.

Differing from the species in the somewhat scattered perithecia, slightly larger spores and in the presence of an occasional thin longitudinal septum.

On dead branches of *Rosa damascena*, associated with *Hendersonia Rosae* in the Botanic Garden, Edgbaston, Birmingham, May, 1919.

HYSTERIACEAE.

LOPHODERMIUM LINEATUM n. sp.

Perithecis nigris, nitidis, in series lineares dispositis, arcte ellipsoideis utrinque subacutis, circa ·25–1 mm. long., ·1–·15 mm. lat.; paraphysibus filiformibus; ascis crasse cylindraceis breve stipitatis, 75–105μ long., 18–20μ lat.; sporis cylindraceis, ob-

tusulis, hyalinis 28–35μ × 2½–3μ, strato mucoso usque ad 3μ lat. obvolutis.

In foliis dejectis *Pini excelsae.*

Collected by Dr G. Pethybridge at Wexford, Ireland, Oct. 1919. The specimen agrees in several respects with *L. brachysporum* Rostr. but the spores of the latter are of different dimensions, being shorter and wider.

DISCOMYCETES.

Sepultaria sepulta (Fr.) Mass.

Collected by W. G. Travis on sand-hills S. Lancashire in June, 1920. In this specimen both the exterior and the disc of the ascocarp are a dull black. In section the paraphyses are a light shade of dull brown towards the clavate tips, but collectively they form a thick brown epithecium, much darker than might be inferred from the usual descriptions. Paraphyses in *Sepultaria* are generally described as "hyaline."

Keithia thujina Durand. Mycologia, v, 1913, p. 9, pl. 81, figs. 1–5, 1913; Pethybridge in Quart. Journ. Forestry, April, 1919.

Ascomata epiphyllous, erumpent, orbicular or ellipsoid, pulvinate, olivaceous or brown-olivaceous, 1–1·28 mm. long, ·5 mm. wide, the epidermis not laciniate; asci clavate 80–100μ × 18–20μ; spores 2 in the ascus, brown-olivaceous, unequally septate at the anterior end, punctate 22–25μ × 15–16μ; paraphyses furcate, septate, clavate at the tips, olivaceous.

On *Thuja.* Found by Dr Pethybridge on young trees of *Thuja* at the Forestry Station, Baunreagh, Queen's County, and at Lough Esk, Donegal.

SPHAEROPSIDEAE.

Phyllosticta Bolleana Sacc. Syll. Fung. III, p. 15 (1884), *P. Euonymi* Thüm. non Sacc.

Spots irregular, whitish grey with dark margin; pycnidia scattered, globose, up to about 230μ in diam.; epiphyllous, semi-immersed, black; spores small, ellipsoid, rounded at the ends, 4–5μ × 2–2·5μ, greyish-white, brownish in mass.

On living leaves of *Euonymus japonicus.* Richmond, Surrey, June, 1916.

The same fungus was found at Wisley, Surrey, June, 1916, on dead leaves of *E. japonicus* the stem of which was attacked by *Cytospora Euonymi,* Cooke.

Sphaeronema piliferum (Fr.) Sacc. in Mich. II, p. 342, 1881, *Sphaeria pilifera* Fr.

Pycnidia superficial, crowded, black, spherical, c. 250μ in diameter, prolonged into a long, black, hair-like, smooth, often

flexuose beak 1050–1200 × 25–30μ; spores ovoid, cylindrical or allantoid, continuous, 3·5–5 × 2·5μ; long, dark brown, septate hairs, 2–3μ in diameter, are given off from the base of the pycnidia.

On pine wood, Camberley, Surrey, Aug. 1916.

The fungus appeared in great quantity on sawn tree stumps, on pine wood and on boxes made from it and not properly dried. The hyphae did not penetrate the wood but the discoloured appearance of the boxes made them unsaleable.

The description of the fungus given above agrees closely with that by A. Jaczewski in his Monograph of the genus *Sphaeronema* (Nov. Mém. Soc. Imp. Nat. Moscow, XV, p. 330, 1898). Saccardo, Allescher and Diedicke give the spore measurements as included within the limits 3–4 × 1–1·5μ, and the two latter record a smaller size for the pycnidium. In the Camberley specimens spores of this smaller size were obtained several times when the pycnidia were crushed. They always emerged with a mass of food reserve material: the mature spores escaped through the ostiole.

Ceuthospora Mahoniae Grove in Journ. Bot. LVI, p. 314, 1918.

On dead leaves of *Mahonia japonica*, Studley, June.

C. latitans (Fr.) Grove, loc. cit.

On dry, dead, blackening leaves and twigs of *Vaccinium Vitis-idaea*. Cheviots, Shropshire, Ayrshire, etc.

Diplodia Opuli Pass. in Atti. R. Accad. Lincei Rom. ser. 4, VI, p. 465, 1889–90; Grove, tom. cit. p. 317.

On dead twigs of *Viburnum*. Hunts Cross, Cheshire (Ellis), April.

Ascochyta Boydii Grove, tom. cit. p. 315.

On living leaves of *Alisma Plantago*. Stevenston, Ayrshire (D. A. Boyd); Cheshire (Ellis), July–Sept.

A. Equiseti Grove, loc. cit.

On dry dead stems of *Equisetum limosum*. Ardrossan (Boyd); Harborne and King's Norton.

A. Mercurialis (Desm.) Grove, tom. cit. p. 316.

On living leaves of *Mercurialis perennis*. Arran and Ayrshire (Boyd), July–Aug.

A. Tiliae Kab. & Bub. in Hedwigia, XLVI, p. 293, 1907; Grove, loc. cit.

On living and fading leaves of *Tilia grandifolia*. West Kilbride, Ayrshire (Boyd), July.

A. Viburni Sacc. Syl. III, p. 387, 1884; Grove, loc. cit.

On living leaves of *Viburnum Opulus*. Beitte, Ayrshire (Boyd), August.

A. Phaseolorum Sacc. in Mich. I, p. 164, 1878.

Spots indefinite, ochre-brown on drying; pycnidia epiphyllous, orbicular-lenticular, 100μ in diam., with an apical pore; spores oblong, uniseptate, constricted, 10 × 3μ, biguttulate, hyaline.

On leaves of *Phaseolus vulgaris*.

On pods of Phaseolus. Richmond, August, 1916.

Actinonema Aquilegiae (Roum. & Pat.) Grove, tom. cit. p. 343.

On living or fading leaves of *Aquilegia vulgaris*. Saltcoats, Ayrshire (Boyd), Kew Gardens, Hereford, July–Aug.

Diplodina Cirsii Grove, tom. cit. p. 317.

On white spots on the stalk of *Cirsium arvense*. King's Norton, June.

Hendersonia Typhae Oud. in Arch. Néerl. Sci. exact. et nat. II, p. 19, 1867.

Var. *major* Grove, loc. cit.

On dead leaves of *Typha latifolia*. Killermount, Dumbartonshire (Boyd), Oct.

H. vagans Fuck. Symb. Myc. p. 392, 1869.

Form *cuspidati* Grove, tom. cit. p. 318.

On dead stems of *Polygonum cuspidatum*. Edgbaston, Birmingham, May.

Stagonospora Tussilaginis (Fuck.) Died. in Ann. Mycol. X, p. 482, 1912. *Septoria Tussilaginis* Fuck., *Septoria Fuckelii* Sacc.

Spots on the upper surface of the leaf, rusty brown, round, indefinite, with a blood-red border; pycnidia about 500μ in diam., with thin, rusty brown, parenchymatous wall thickened and almost black round the pore (25μ wide), finally emergent with prominent ostiole; spores elongate clavate, somewhat bent, with blunt ends, 4–5-septate, green, coherring for some time in a mucilaginous ball.

On leaves of *Tussilago Farfara*. Mortlake, Surrey, Oct. 1916.

S. Hygrophila Sacc. in Malpigh. XIII, p. 22, fig. iii 2, 1899. Var. *vermiformis* Grove in Journ. Bot. LVI, p. 318, 1918.

On living leaves of *Oxalis Acetosella*. Dalry, Ayrshire (Boyd), Aug.

LEPTOSTROMATACEAE.

Leptothyrium Hederae Starb. in Bih. K. Sw. Vet. Akad. Handl. Stockholm, XIX, Afd. iii. n. 2, p. 96, 1894; Grove in Journ. Bot. LVI, p. 319, 1918.

On dead leaves and petioles of *Hedera Helix*. West Kilbride, Ayrshire (Boyd), Dec.

Melasmia Urticae Grove, loc. cit.

On dead stems of *Urtica dioica*. Stevenston, Ayrshire (Boyd), Feb., March, associated with *Rhytisma Urticae*.

EXCIPULACEAE.

Heteropatella umbilicata Grove, tom. cit. p. 319, 1918.

On dead stems of herbaceous plants. Not common.

Sporonema strobilinum Desm. var. *accedens*, Sacc. Syll. III, p. 679, 1884; Grove, tom. cit. p. 320, 1918.

On the apophysis of the cone scales of *Pinus sylvestris*. Tanworth-in-Arden (Dr Bayliss Elliott), June.

MELANCONIEAE.

Gloeosporium Robergei Desm. in Ann. Sci. Nat. XX, p. 214, 1853; Grove in Journ. Bot. LVI, p. 320, 1918.

On fading leaves of *Carpinus Betulus*, Stewarton, Ayrshire (Boyd), July.

G. salsum Grove, loc. cit.

On living leaves of *Cochlearia officinalis*, West Kilbride, Ayrshire (Boyd), Oct.

Myxosporium carneum (Lib. Exs. n. 882) Thum. in Hedwigia XIX, p. 181, 1880; var. *Carpini* Grove in Journ. Bot. LVI, p. 321, 1918.

On still living branches of *Carpinus Betulus* near Tanworth in Arden (Dr Bayliss Elliott), Feb.

Colletotrichum Holci (Syd.) Grove, tom. cit. p. 341.

On fading leaves of *Holcus mollis*. West Kilbride, Ayrshire (Boyd), Aug.

C. petiolicola (Brun.) Grove, loc. cit.

On fallen petioles of *Acer pseudoplatanus*. Eastham (Ellis), Nov.

C. linicolum Pethybr. and Laff. in Sci. Proc. R. Dublin Soc. XV, p. 368, 2 pls. 1918.

On stem leaves and seeds of *Linum usitatissimum*. Ireland.

Cylindrosporium microspermum Sacc. in Mich. II, p. 169, 1880–82; Grove, loc. cit.

On living leaves of *Saxifraga oppositifolia* which it kills. Crianlarich, Perthshire (J. R. Lee) July. Ben Lawers (Boyd).

Cryptosporium Vincae Otth. Bern. Mitth. p. 61, 1868. Var. *ramulorum* Grove in Journ. Bot. LVI, p. 342, 1918.

On dead stems of *Vinca major*. Seamill, Ayrshire (Boyd), 1918.

Libertella Opuli Oud. Contr. Fl. Myc. Pays Bas, XVII, p. 295, 1901; Grove, loc. cit.

On thin twigs of *Viburnum Opulus*. Storeton, Cheshire (Ellis), Feb.

HYPHOMYCETES.

Sporotrichum chrysospermum Harz. Hyphom. p. 19, pl. v. fig. 3, 1872.

Already recorded by Grove (Trans. Brit. Mycol. Soc. III, p. 368, 1911) on a stick. It covered a fairly large patch of decaying damp wood in the timber-yard, Chatsworth. Originally it was recorded as *Fomes* sp.

Trichoderma Koningii Oudem. in Arch. Néerl. Sci. exactes et nat. 1902, p. 291, pl. 31, figs. 1–7.

Tufts orbicular, woolly at first, white then vaguely green-punctate and spotted, at length aeruginous-green or brightly olivaceous; hyphae colourless, septate, branched, the branches alternate or opposite, the ultimate ramuli bearing conidia at the tips; conidia almost hyaline, ellipsoid 3–4μ × 2·5–3μ, in green glomeruli 8–10μ diam., not mucilaginous.

Found by Oudeman in a gelatine culture of soil at Bussner, Holland, and stated by him to be very common.

On a rotten branch on the soil. Sherrett's Wood, Abbey Wood (St John Marriott), Dec. 1919.

Botrytis truncata Sacc. Syll. IV, p. 138, 1886. *Polyactis truncata* Cooke in the Journ. Quek. Microsc. Club. ser. 2, II, p. 142, pl. 10, fig. 5, 1885.

Tufts small, white. Conidiophores slender, flexuose, septate, with numerous short branchlets at the tip, the ultimate ramuli fastigiate or digitate, bearing at the tips an elongated oblong-ellipsoid colourless conidium abruptly truncate and often concave at the tips, the outer cell wall projecting like points, about 15–20μ × 7μ.

First collected by Madame Bommer on the fronds of ferns in Belgium. Found by Mr St John Marriott on decaying wood, Co-operative Woods, Abbey Wood, Woolwich, Dec. 1919.

The conidia of Mr Marriott's specimen are generally shorter than 20μ, but though the habitat is different there is no doubt that it is the same as the Belgian plant.

B. Paeoniae Oud. in Med. Konink. Ak. Wet. Amsterdam, p. 464, fig., 1897.

Mycelium within the leaf. Conidiophores long, numerous, emerging by the stomata, congregate in tufts, branched, the branches, three to five, produced spirally, once or more divided at the tips, the end cell developing to a globose or flattened swelling covered with fine spines; conidia (in heads 20–40μ across) ovate-elongate 16–18μ × 7–7·5μ, hyaline or faintly coloured.

Causing disease of Paeonies. Spalding, Lincs. (J. K. Ramsbottom), April.

See Massee (Dis. Cult. Plants, etc. p. 267, 1910) on *Sclerotinia Paeoniae*.

MARTENSELLA Coemans in Bull. R. Ac. Belg. sér. 2, XV, p. 536, 1863.

Sterile hyphae creeping, branched; fertile erect, simple or dichotomous, septate; conidiophores lateral, short, curving at the apex. Conidia subfusiform biseriate along the upper surface of the conidiophore.

M. pectinata Coemans, loc. cit. t. 2, fig. 10.

Scattered or in tufts. Fertile hyphae greyish-yellow or greenish; conidiophores scattered, 7–9-septate; conidia biseriate-pectinate 18μ × 3μ on the curving boat-shaped branchlet.

Parasitic on hyphae of *Mucor* or *Saprolegnia*.

Found in a soil-culture by Miss Jewson at Rothamsted. Comm. W. B. Brierley.

Ramularia Hypochaeridis Magnus, in Verh. Bot. Ver. Prov. Brand. XXXVII, p. 83, 1895.

Leaf spots roundish, scattered, 2–5 mm. in diameter, brownish, almost constantly epiphyllous, with a violet coloured margin, sometimes concentrically zoned; tufts amphigenous; conidiophores emerging in tufts from the stomata, unbranched, rarely septate, somewhat bent, 27–38 × 2·5–3μ; conidia cylindrical, blunt at the ends, often somewhat tapering, simple or uniseptate, 19–27 × 3–3·5μ.

On living leaves of *Hypochaeris radicata*. Wisley, Surrey, June 1916.

The fungus was abundant at Wisley on the host plant on which were large decaying violet patches. The spores in our specimens measure up to 36μ long.

R. acris Lindr. in Acta Soc. Faun. Flor. Fenn. XXIII, no. 3, p. 14, 1902.

Leaf spots large, irregular, limited by the veins, yellowish or greyish-brown; tufts hypophyllous, whitish to reddish; conidiophores emerging from the stomata, straight, simple, mostly septate, blunt, 1–3-dentate at the tips, hyaline, 30–60 × 3μ; conidia elongate-cylindrical, rounded at the ends, mostly 1-rarely 3-septate, straight, slightly constricted, hyaline, 22–34 × 3–8μ.

On living leaves of *Ranunculus acer*. Oxshott and Sheen Common, Surrey, Oct. 1916; Addington, Oct. 1919.

R. Tanaceti Lind in Ann. Mycol. III, p. 431, 1905; Lindau in Rabenb. Krypt. Fl. I. viii. p. 514, 1906.

Spots covering entire pinnae or portions of the leaf, starting generally at the tips and spreading downwards, brown or dark brown, with a somewhat lighter margin; tufts scattered on the under surface; conidiophores emerging through the stomata, crowded; up to 38 × 4–4·5μ; conidia cylindrical, blunt at the ends, occasionally in a chain of two, septate (1–3), 23–40 × 5μ.

On living leaves of *Tanacetum vulgare*. Wisley, Surrey, June 1916.

The conidiophores in the Wisley specimens measure up to 60μ in length. The measurements in the description are those of Lind.

R. brunnea Peck, in 30th Ann. Report, New York State Museum, p. 55, 1878.

Spots brown, unequal, suborbicular, sometimes confluent; flocci occupying the larger spots and giving them an ashy tint, epiphyllous, fasciculate, short, delicate, spores cylindrical, colourless, very unequal in length, 12–40 × 3·5μ.

On leaves of *Tussilago Farfara*. Headley, Surrey, Aug. 1916.

R. Cirsii Allesch. in Ber. d. Bayr. Bot. Ges. II, p. 18, 1892.

Spots on both sides of the leaf, circular, white with black border; tufts small, white; conidiophores 30–40 × 3μ; conidia in chains, ovate-cylindrical, blunt at the ends, finally 1–3-septate, hyaline, guttulate 30–35 × 2·5–3·5μ.

On living or decaying leaves of *Cirsium lanceolatum*.

Not uncommon on leaves of *C. arvense*. Oxshott, Surrey, Oct. 1916.

R. Scrophulariae Fautr. & Roum. in Rév. Mycol. XLIX, p. 81, 1891; Grove in Journ. Bot. LVI, p. 344, 1918.

On living leaves of *Scrophularia nodosa*. Ayrshire (Boyd), Trench Woods, Droitwich, July–Aug.

Verticillium globuliforme Bon. Abh. Geb. Mykol. p. 94, 1864; Grove in Journ. Bot. LVI, p. 345, 1918. Var. *ellipsoideum* Grove, loc. cit.

On culms of *Juncus*. Sutton Park, Warwickshire, May.

Cercosporella Antirrhini Wakef. in Kew Bull. 1918, p. 233.

On living leaves and stems of garden *Antirrhinums*. Worcester, Sept. 1917; also Birmingham, June 1918 (W. B. Grove).

Mastigosporium album, var. *muticum* Sacc. in Ann. Mycol. IX, p. 254, 1911; Kew Bull. 1918, p. 233.

On leaves of *Dactylis glomerata*. Kew, 1918, and Oxshott, Oct. 1917 (E. M. Wakefield).

Torula fusca (Bon.) Sacc. Syll. IV, p. 260, 1886.

Tufts spreading, pulverulent, brown. Conidia in chains, fusiform, brown, decumbent.

Growing on decaying *Bulgaria inquinans* and on rotten wood (*Corylus Avellana*).

A specimen, collected in Abbey Wood, has been referred to this somewhat imperfectly described species. It was growing over the disc of a *Peziza* (possibly *Ombrophila clavus*) as well as on the damp rotten wood. Superficially it is yellowish-brown, in mass under the microscope it is chestnut-brown. The sporophores are branched, the conidia from ovoid to fusiform in rather long chains, measure 7–14μ × 5μ C. H. Grinling and St John Marriott, Dec. 1919.

Hadrotrichum anceps Sacc. in Ann. Mycol. IX, p. 255, 1911.

Tufts usually hypophyllous, in lines, gregarious or somewhat scattered, shortly linear, minute, ·5 mm. long, brownish-black, prominent, firm; conidiophores densely packed, cylindrical, straight, rarely wider upwards, 35–40 × 5·5–6μ, smoky brown, generally with one septum near the base; conidia globose, rarely ellipsoid-globose, 8–9μ diam., fuliginous, epispore thin, slightly punctate.

On fading leaves of *Brachypodium*.

Collected on fading leaves of *Arrhenatherum elatius* at Wisley, Surrey, June 1916.

The conidiophores of the British specimen reach a length of 65μ and the conidia are more persistently ellipsoid and measure up to 10–12μ × 8μ; otherwise it corresponds exactly with Saccardo's species.

The *Arrhenatherum* was attacked by *Ustilago perennans*.

BOTRYOTRICHUM Sacc. et March. in Bull. Soc. Roy. Bot. Belg. XXIV, 1, p. 66, 1885.

Sterile hyphae growing in fascicles, simple, septate, grey.

Conidiophores short, developing at the base of the sterile hyphae, colourless, irregularly branched; conidia acrogenous, globose, simple, colourless.

B. piluliferum Sacc. et March. loc. cit. pl. 2, figs. 5–8.

Sterile hyphae crowded, slightly bent, smooth or slightly rough, 200–250μ × 3·5–5μ. Conidia globose 11–14μ diam.

On rabbit dung.

On sacking, Baslow.

The specimen from Baslow grew as a grey felt on old and very dirty sacking. The fungus closely resembles the figures of the original specimens but the spores are larger, up to 20μ in diam., with a slightly roughened thick epispore.

Cladosporium Typharum Desm. Exs. N. 304.

Tufts in scattered lines, dark coloured or greyish spots. Conidiophores in groups upright or bent, sparingly septate, more closely septate towards the tips 75–175μ × 5–6μ. Conidia elongate or ovoid, punctate, blackish-green, 2–4-celled, 16–22μ × 5–8μ.

Found by C. Rea on *Typha latifolia*, New Pool, Malvern, Worcestershire, Aug. 1919.

This species somewhat resembles *Heterosporium Typharum* Cooke, but the spores are smaller than in that species.

Helminthosporium Warpuriae Wakef. in Kew Bull. 1918, p. 233.

On an injured stem of *Warpuria clandestina*. Tropical Pits, Kew, July, 1917. (Stapf.)

Cercospora dubia Wint. in Hedwigia, XXII, p. 10, 1883; Grove in Journ. Bot. LVI, p. 345, 1918.

On leaves of *Atriplex patula*. Near the Severn, Worcester, Sept.

Microcera coccophila Desm. in Ann. Sci. Nat. 3 ser. X, 359 (1848).

A specimen of this fungus was collected by Mr Grinling at Woolwich. The habit is that of *Microcera* but the spores are blunt at the ends, and some of them are larger than the sizes published, being about 120–145μ × 7–9μ. It is probably a form of the above.

Communicated by Miss E. M. Wakefield.

USTILAGINEAE.

Ustilago perennans Rostr., Overs. K. Dansk. Vid Selsk. Forh. 1890, p. 15.

Spore masses in the ears of the grass dark-brown. Spores globose (rarely ovoid), 5–9μ diam., the surface clear brown and finely punctate. Mycelium perennial in the root-stock.

In flowers of *Arrhenatherum elatius*. Symonds Yat, May, 1914. Leg. H. H. Whetzel. Herts, June, 1919. Leg. C. H. Grinling.

GALACTINIA AMETHYSTINA (PHILL.) WAKEF.

By E. M. Wakefield, F.L.S.

Under the name *Humaria Phillipsii* Cooke described a fungus which he said he found mixed with the type specimens of *Ascobolus amethystinus*, Phill. It is characterised by its deep purple colour, and large, fusiform, coarsely warted spores, and has been found on several occasions since Cooke's time. In a note in the *Naturalist*, 1906, pp. 9–10, Massee and Crossland state that they observed spores which were shot off naturally to be hyaline, and conclude therefore that the purple-coloured spores seen in microscopic preparations are merely stained from the tearing of the surrounding tissues. It is known, however, that under suitable conditions spores which are not fully mature may be set free naturally. In the specimens gathered at Baslow young hyaline spores and fully mature purple spores were seen together in the same preparation, and there seems little doubt that the spores do at length become coloured.

On looking up the original specimens and descriptions, it is obvious that Phillips' description of *Ascobolus amethystinus* was drawn up from this plant, called *Humaria Phillipsii* by Cooke, and later transferred to *Galactinia* by Boudier. On the other hand, as Cooke noticed, the type material contained also a true Ascobolus. This is a small species, with cups 2–3 mm. across in the dried state. The asci are clavate, about 15 μ long, and the spores sub-distichous, occupying only the upper, broader part of the ascus. The spores are smooth, elliptical, deep-clear brown, 20–24 × 12–14 μ, rather thick-walled. Filiform paraphyses are present.

For this Ascobolus another name will have to be found. It will probably prove to be an already described species. "*Ascobolus amethystinus*" of Phillips' description is absolutely synonymous with *Galactinia Phillipsii* (Cke.) Boud. The specific name will therefore have to be changed, and this plant with purple warted spores must be called *Galactinia amethystina* (Phill.) Wakef.

LIST OF MEMBERS.

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Rea, Mr Carleton, B.C.L., M.A., 6, Barbourne Terrace, Worcester (1918).

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1. Aberdeen, The University Library (1916).
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3. Alcock, Mrs N. L., Ministry of Agriculture, Pathological Laboratory, Kew (1919).
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5. Arnold, Mr F., M.A., Holmdene, 56, Cathedral Road, Cardiff (1917).
6. Barr, Rev. Robert, The Manse, Nielsden, Renfrewshire (1918).
7. Barrington, Dr F. J. F., University College Hospital, Medical School, University Street, London, W.C. 1 (1901).
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9. Baxter, Mr W. R., 19, Ashton Terrace, Hillhead, Glasgow, W. (1919).
10. Bayliss, Miss Jessie Sproat, D.Sc. (B'ham), B.Sc. (Lond.). (See Mrs J. S. Bayliss Elliott.)
11. Beer, Mr Rudolph, B.Sc., Ministry of Agriculture, Pathological Laboratory, Kew (1919).
12. Bellerby, Mr William, 8, Burton-stone Lane, York (1917).
13. Biffen, Professor R. H., M.A., F.R.S., 136, Huntingdon Road, Cambridge (1899).
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15. Blackman, Professor V. H., M.A., F.R.S., Imperial College of Science, South Kensington, London, S.W. 7 (1900).
16. Blackwell, Miss Elsie M., M.Sc., Botanical Laboratories, The University, Liverpool (1917).
17. Blagden, Mr Charles Otto, 57, Earl's Court Square, London, S.W. 5 (1910).
18. Bloom, Rev. James Harvey, 601, Bank Chambers, 329, High Holborn, London, W.C. (1915).
19. Borthwick, Mr A. W., D.Sc., O.B.E., Royal Botanic Garden, Edinburgh, and 46, George Street, Edinburgh (1911).

20. Boston, The Mycological Club, c/o Miss Jennie F. Conant, 26, Prospect Street, Melrose, Mass., U.S.A. (1906).
21. Boyd, Mr D. A., St Clair, Caledonia Road, Saltcoats, N.B. (1906).
22. Brand, Mr Frederick J., High Beech Road, Loughton, Essex (1918).
23. Brierley, Mr William B., Institute of Plant Pathology, Rothamsted Experimental Station, Harpenden (1919).
24. British Museum, The Trustees of, Cromwell Road, South Kensington, London, S.W. 7 (1914).
25. Brooks, Mr F. T., M.A., The Botany School, Cambridge (1907).
26. Bruxelles, Jardin Botanique de l'Etat, c/o M. P. van Aerdschot (1911).
27. Bryce, Mr G., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon (1915).
28. Buckley, Mr W. D., 27, Bengal Road, Ilford, Essex (1916).
29. Buller, Professor A. H. R., D.Sc., Ph.D., F.R.S.C., University of Manitoba, Winnipeg, Canada (1911).
30. Calder, Mr Ronald B., B.A. (Cantab.), B.Sc., Lecturer in Botany, East London College, Mile End Road, London, E. 1 (1920).
31. Carr, Professor J. W., M.A., University College, Nottingham (1896).
32. Cartwright, Mr K. St S., Rothbury, Hay, Hereford (1913).
33. Cayley, Miss Dorothy M., John Innes Horticultural Institute, Mostyn Road, Merton, Surrey (1913).
34. Cheesman, Mr W. Norwood, J.P., F.L.S., The Crescent, Selby (1896).
35. Chicago, The Library, University of, Ill., U.S.A. (1914).
36. Chipp, Mr T. F., B.Sc., F.L.S., Assistant Director, Botanic Gardens, Singapore (1919).
37. Clarke, Miss H., M.Sc., 45, Beaconsfield Road, Seaforth, Liverpool (1917).
38. Clarke, Dr Henry, Cournswood, North Dean, High Wycombe (1919).
39. Clarke, Mr James Jackson, 25, Norfolk Road, London, N.W. 8 (1920).
40. Cleland, Mr J. Burton, M.D., Professor of Pathology, University of Adelaide, South Australia (1918).
41. Coimbatore, The Librarian, Agricultural College, South India (1918).
42. Collins, Miss Florence, The School of Gardening, Clapham, nr Worthing, Sussex (1920).
43. Cooper, Miss Charlotte A., Hillside Cottage, California Road, Bushey Heath, Herts (1911).

44. Cornell University Library, Ithaca, New York (1920).
45. Cotton, Mr Arthur D., F.L.S., Ministry of Agriculture, Pathological Laboratory, Kew, Surrey (1902).
46. Curtis, Miss Kathleen M., M.A., c/o Bank of New Zealand, 1, Queen Victoria Street, London, E.C. 4 (1917).
47. Darbishire, Professor O. V., B.A., Ph.D., University College, Bristol (1913).
48. Dastur, Mr J. F., M.Sc., Imperial Agricultural Research Institute, Pusa, Bengal, India (1920).
49. Drinkwater, Mr Harry, M.D., C.M.Edin., M.R.C.S.Eng., F.R.S.E., F.L.S., J.P., Lister Lodge, Wrexham (1910).
50. Edwards, Mr W. H., Curator, The Museum, Birmingham (1896).
51. Elliott, Dr W. T., L.D.S., R.C.S., F.Z.S., Arden Grange, Tanworth-in-Arden, Warwickshire (1913).
51.* Elliott, Mrs J. S. Bayliss, D.Sc., Arden Grange, Tanworth-in-Arden, Warwickshire (1911).
52. Ellis, Mrs Annis, 13, Stoney Hey Road, New Brighton, Cheshire (1917).
53. Essex Field Club, c/o Mr Percy Thompson, F.L.S., Essex Museum of Natural History, Romford Road, Stratford, Essex, E. 15 (1919).
54. Evans, Mr William, F.R.S.E., 38, Morningside Park, Edinburgh (1911).
55. Eyre, Miss J. C., Ippelpen, Newton Abbot, Devon (1915).
56. Fenton, Mr E. W., Botanical Department, Seale-Hayne Agricultural College, Newton Abbot (1920).
57. Finlayson, Mr Raymond A., F.L.S., The Parsonage Farm, Downton, Wilts (1910).
58. Fitzgerald, Rev. H. P., F.L.S., Lidwells, Goudhurst S.O., Kent (1896).
59. Franklin, Hon. Mrs, Glenalla, Ray, Letterkenny, co. Donegal (1919).
60. Fraser, Miss H. C. I., D.Sc. (See Dame Helen Gwynne-Vaughan.)
61. Fynes-Clinton, Rev. C. E., M.A., St James' Vicarage, Leyland, Preston (1917).
62. Gardner, Captain Frederic, c/o Lloyd's Bank, Jersey, Channel Islands (1898).
63. Goodwin, Mr D. P., Oakden, Kidderminster (1902).
64. Gould, Mr F. G., Elmhurst, Church Hill, Loughton, Essex (1918).
65. Green, Col. C. Theodore, A.M.S., M.R.C.S.Eng., L.R.C.P. Lond., F.L.S., 31, Shrewsbury Road, Birkenhead (1901)
66. Green, Mr E. Ernest, F.Z.S., F.E.S., Way's End, Camberley, Surrey (1917).

67. Grinling, Mr C. H., B.A., 26, Bedford Grove, Woolwich, S.E. 18 (1913).
67.* Gwynne-Vaughan, Dame Helen, D.B.E., D.Sc., F.L.S., LL.D., 93, Bedford Court Mansions, London, W.C. 1, and Birkbeck College, Chancery Lane, London, W.C. 2 (1906).
68. Hadden, Mr Norman G., Breezy Bank, West Porlock, Somerset (1911).
69. Harrison, Mr H. W., c/o 2, Elson Road, Formby, Lancs. (1913).
70. Harrison, Mrs E., c/o 2, Elson Road, Formby, Lancs. (1913).
71. Harvey, Mrs Cecily D., Barwick-in-Elmet Rectory, near Leeds (1910).
72. Hastings, Mr Somerville, M.S., F.R.C.S., 43, Devonshire Street, Portland Place, London, W. 1 (1913).
73. Hawley, Sir H. C., Bart., Holly Mount, Hurst Wood, Buxted, Surrey (1907).
74. Hibbert-Ware, Miss Alice, 3, Chaucer Road, Wanstead, E. 11 (1911).
75. Hildyard, Mr F. W., 14, Lambridge, Bath (1913).
76. Hiley, Mr Wilfred E., M.A., Research Institute, School of Forestry, Oxford (1913).
77. Holmes, Mr E. Morell, F.L.S., F.R.H.S., Ruthven, Sevenoaks, Kent (1906).
78. Holt, Mr W. H., 17, Ashville Road, Birkenhead (1914).
79. Howard, Mr H. J., F.R.M.S., 94, Rosary Road, Norwich (1918).
80. Hughes, Mr G. C., Chesterton, Bicester, Oxon (1898).
81. Huish, Mr Charles Henry, F.R.M.S., The Limes, London Road, Redhill, Surrey (1913).
82. Illinois, The Library, University of, Urbana, Ill., U.S.A. (1920).
83. Jack, Mr H. W., B.Sc., B.A., Agricultural Instructor, Department of Agriculture, Kuala Lumpur, Federated Malay States, and Waterloo Place, Cork (1913).
84. Jewson, Miss S. T., B.Sc., Institute of Plant Pathology, Rothamsted Experimental Station, Harpenden (1919).
85. Johnson, Mr J. W. Haigh, M.Sc., F.L.S., 71, Northgate, Wakefield (1919).
86. Johnstone, Mr R. B., 134, Cambridge Drive, Glasgow (1908).
87. Jones, Mr Robert Fowler, 8, Lendal, York (1918).
87.* Kidd, Mrs Franklin, The Botany School, Cambridge (1919).
88. Knight, Mr H. H., M.A., The Lodge, All Saints Villas, Cheltenham (1914).

89. Linnean Society of London, Burlington House, Piccadilly, London, W. 1 (1919).
90. Lister, Miss Gulielma, F.L.S., Leytonstone, Essex, and Highcliff, Lyme Regis (1903).
91. Lister, Mr A. B., D.I.C., B.Sc. (Lond.), Experimental and Research Station, Turner's Hill, Cheshunt, Waltham Cross, Herts (1916).
92. Lloyd, Mr C. G., The Lloyd Library and Museum, 224, West Court Street, Cincinnati, Ohio, U.S.A. (1907).
93. Macfie, Dr John William Scott, M.A., D.Sc., 21a, Alfred Street, Liverpool (1900).
94. Mackenzie, Mr D., Afton, Busby, N.B. (1900).
95. Main, Mr Robert, 1, Roslyn Avenue, Low Fell, Gateshead (1918).
96. Maire, Dr René, D.Sc., Professeur à la Faculté des Sciences de l'Université, Algers (1907).
97. Maitland, Mr T. D., Chief of Economic Plant Division, Agricultural Department, Nairobi, British East Africa (1916).
98. Marmont, Mr Basil P., Windsoredge House, Inchbrook, near Woodchester, Glos. (1908).
99. Marriott, Mr St John, 37, Owenite Street, Abbey Wood, S.E. (1920).
100. Mason, Mr F. A., F.R.M.S., The Laboratory, 3, Queen's Square, Leeds, and 29, Frankland Terrace, Leopold St, Leeds (1912).
101. McCutcheon, Mr William, B.A., B.Sc., Goulburn, 89, Argyle Road, Saltcoats, N.B. (1920).
102. Menzies, Mr James, 117, Scott Street, Perth (1917).
103. Minnesota, The Library, University of, Minneapolis, U.S.A. (1915).
104. Missouri, The Botanical Garden, St Louis, Mo., U.S.A. (1902).
105. Miyabe, Dr Kingo, Professor of Botany, Hokkaido Imperial University, Sapporo, Japan (1919).
106. Montague, Mrs A., Penton, Crediton, N. Devon (1898).
107. Morris, Mr T. N., B.A., Dip. Agr. (Cantab.), St John's College, Cambridge (1919).
108. Mysore, The Library, University of (1919).
109. Nederlandsche Mycologische Vereeniging, c/o M. H. A. A. van der Lek, Bennekom, Holland (1920).
110. Newcastle-upon-Tyne Literary and Philosophical Society (1902).
111. Newman, Mr Leslie F., M.A., F.L.S., Dip. Agr. (Cantab.), St Catharine's College, Cambridge (1906).
112. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904).

113. Nicholson, Mr Charles, F.E.S., 35, The Avenue, Hale End, Chingford, N.E. (1916).
114. Nicholson, Mr W. E., Lewes (1913).
115. Noel, Miss E. F., F.L.S., 37, Moscow Court, London, W. (1913).
116. Ogle, Mr B. S., Hill House, Steeple Aston, Oxon. (1904).
117. Oke, Mr Alfred William, B.A., L.L.M., F.G.S., F.L.S., 32, Denmark Road, Hove (1908).
118. O'Loughlin, Miss Bessie, Rocklands, Wallasey, Cheshire (1913).
119. Osborn, Professor T. G. B., M.Sc., Adelaide University, South Australia (1910).
120. Overeem, Mr C. Van, Mycological Museum, Weesp, Holland (1920).
121. Overton, Mr H., Newlands, Boswell Road, Sutton Coldfield, Birmingham (1920).
122. Owen, Miss M. N. (See Mrs Franklin Kidd.)
123. Paul, The Very Rev. David, LL.D., D.D., 53, Fountainhall Road, Edinburgh (1899).
124. Paulson, Mr Robert, F.L.S., F.R.M.S., Glenroy, Cecil Park, Pinner, Middlesex (1918).
125. Peacock, Dr H. G., Hareston Lodge, Torquay (1896).
126. Pearson, Mr Arthur A., F.L.S., 59, Southwark Street, London, S.E. 1 (1911).
127. Peck, Mr A. E., Tosti, 20, Avenue Road, Scarborough (1918).
128. Peltereau, Monsieur E., Vendôme, Loir-et-Cher, France (1909).
129. Perceval, Mr Cecil H. Spencer, Longwitton Hall, Morpeth (1901).
130. Perthshire Society of Natural Science, c/o James Winter (Hon. Treas.), 35, George Street, Perth (1919).
131. Petch, Mr T., B.A., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon (1911).
132. Pethybridge, Dr G. H., B.Sc., Department of Agriculture and Technical Instruction for Ireland, Royal College of Science, Upper Merrion Street, Dublin (1919).
133. Phillips, Professor Reginald W., M.A., D.Sc., F.L.S., University College, Bangor (1911).
134. Plowright, Mr Charles Tertius Maclean, B.A., M.B., King Street, King's Lynn (1901).
135. Potter, Professor M. C., Sc.D., M.A., F.L.S., Armstrong College, Newcastle-upon-Tyne (1896).
136. Potts, Mr George, Benthall House, Broseley, Salop (1910).
137. Price, Mr S. Reginald, B.A., Fernleigh, Wellington, Somerset (1911).

138. Priestley, Professor J. H., B.Sc., F.L.S., Botanical Department, University of Leeds (1912).
139. Priestley, Mrs Marion E., 10, Monk Bridge Road, Headingley, Leeds (1919).
140. Ramsbottom, Mr J., M.A., F.L.S., O.B.E., British Museum, Cromwell Road, South Kensington, London, S.W. 7 (1910).
141. Ramsbottom, Mr J. K., c/o Geo. Munro, Ltd., 4, Tavistock Street, Covent Garden, W.C. 2 (1914).
142. Rayner, Mr J. F., Swaythling, Southampton (1902).
143. Rea, Mrs E. A., 6, Barbourne Terrace, Worcester (1896).
144. Richards, Mr R. M., A.R.C.S., The Laboratory, Caledonia Estate, Province Wellesley, Straits Settlements (1915).
145. Roberts, Mrs A. W. Rymer, The Common, Windermere (1920).
146. Robson, Mr R., M.Sc., F.Z.S., Writtle, Chelmsford, Essex (1914).
147. Rushton, Mr W., A.R.C.S., D.I.C., St Mary's Hospital Medical School, Paddington, and 90, Sugden Road, Clapham Common, London, S.W. 11 (1914).
148. Sampson, Miss K., B.Sc., Economic Botanist, Plant Breeding Station for Wales, University College, Aberystwyth (1920).
149. Saunders, Miss E. R., F.L.S., Newnham College, Cambridge (1913).
150. Searle, Mr G. O., B.Sc. Agric. (Lond.), Research Botanist, Linen Industry Research Association, Glenmore House, Lambeg, Lisburn, Ireland (1920).
151. Selborne Society, 42, Bloomsbury Square, London, W.C. 1 (1913).
152. Sharpe, Mr C. J., Brambleside, Manor Road, Sidcup (1905).
153. Simon, Monsieur Eugène, 16, Villa Saïd, Paris (1906).
154. Small, Mr W., M.A., Government Botanist, Department of Agriculture, Kampala, Uganda (1915).
155. Smith, Miss Annie Lorrain, F.L.S., 20, Talgarth Road, West Kensington, London, W. 14 (1899).
156. Smith, Miss K. E., 64, Coton Road, Nuneaton (1913).
157. Smith, Mr Thomas, 25, Lyme Street, Stockport (1918).
158. Stoward, Dr F., 69, Tate Street, Leederville, Western Australia (1914).
159. St Paul, Minn., U.S.A., The Library, Department of Agriculture University Farm (1920).
160. Sutherland, Mr G. K., M.A., D.Sc., 10, Bank Parade, Preston (1914).

161. Swanton, Mr E. W., A.L.S., Brockton, Haslemere (1899).
162. Swedish Academy of Sciences, Royal.
163. Tabor, Mr Richard John, B.Sc., F.L.S., Imperial College of Science and Technology, South Kensington, London, S.W. 7 (1914).
164. Tatum, Mr E. J., Salisbury (1896).
165. Taylor, Miss Beatrice Katharine, 98, Cheyne Walk, Chelsea, London, S.W. 3 (1910).
166. Temperley, Mr Nicholas, 4, Carlton Terrace, Low Fell, Gateshead-on-Tyne (1918).
167. Thomas, Mr H. Hamshaw, M.B.E., M.A., The Botany School, Cambridge (1910).
168. Thomson, Miss Mary R. H., c/o The Chief, Division of Botany, Box 994, Pretoria (1917).
169. Toronto, The Library, University of (1910).
170. Tothill, Lieut. Vincent, R.A.M.C., Ilketshall, St Andrew, Bungay, Suffolk (1912).
171. United States, Department of Agriculture (1907).
172. Vines, Professor S. H., M.A., D.Sc., F.R.S., Headington Hill, Oxford (1915).
173. Wager, Dr H., F.R.S., F.L.S., Hendre, Horsforth Lane, Far Headingley, Leeds (1896).
174. Wakefield, Miss E. M., F.L.S., Herbarium, Royal Botanic Gardens, Kew (1911).
175. Watkin, Mr J., 38, Park Avenue, Oswestry (1909).
176. Wheldon, Mr H. J., Cubbington, Leamington Spa (1918).
177. Whetzel, Professor H. H., Cornell University, Ithaca, New York (1914).
178. Wilson, Mr A. E., Southey House, College Green, Bristol (1920).
179. Wilson, Mr Malcolm, D.Sc., A.R.C.S., F.L.S., Royal Botanic Garden, Edinburgh (1912).
180. Wiltshire, Mr S. P., Research Station, Long Ashton, Bristol (1920).
181. Woolhope, The, Naturalists' Field Club, Hereford, c/o Mr C. S. Scobie, 2, Offa Street, Hereford (1896).

Elected since the above went to Press.

182. Birmingham Natural History and Philosophical Society (1920).
183. Cutting, Mr E. M., M.A., F.L.S., The Botanical Department, University College, Gower Street, London, W.C. 1 (1920).
184. Dowson, Mr W. J., F.L.S., Nairobi, East Africa Protectorate, and Crosslee, Heathside Crescent, Woking (1920).
185. Rea, Miss M. W., Salem House, Sydenham, Belfast, Ireland (1920).

RULES.

Society's name and objects.

1. The Society shall be called "The British Mycological Society," and its object shall be the study of Mycology in all its branches.

Members of Society.

2. The Society shall consist of Honorary Members, Foundation Members and Ordinary Members; the number of Honorary Members shall be limited to 20, and that of Foundation Members to 100*, but the number of Ordinary Members shall be unlimited.

Honorary Members.

3. Honorary Members shall be persons of pre-eminence in Mycology, or who have rendered special service to the Society.

Foundation Members.

4. Foundation Members shall be those Members or Societies who joined the Society previous to the limit of 100 Members having been attained*.

Officers.

5. The Officers of the Society shall consist of a President, one or more Vice-Presidents, Treasurer, Secretaries, and Editor or Editors. They shall be elected annually at the Annual General Meeting of the Society.

Government of Society.

6. The government of the Society shall be vested in a Council, which shall consist of the President and other Officers for the time being, together with two or more other Members who shall be elected annually at the General Meeting, and one-half of whom shall retire each year and not be eligible for immediate re-election. The Members to retire shall be those who have been longest in office or, in case of equality, shall be determined by ballot. Ex-Presidents are *ex officio* Members of the Council.

Every Meeting of the Council shall be duly summoned by the Hon. Secretary by at least seven days' notice in writing to each Member of the Council.

* The limit of 100 Foundation Members was reached 22nd Oct., 1903.

Period of Office.

7. The Officers and Council shall hold office as from the 1st of January following their election.

Election of Members.

8. Honorary Members shall only be elected at a Meeting of the Society by a majority of the Members then present.

All Ordinary Members shall be proposed and seconded respectively by existing Members, who shall sign a certificate (see appendix) of recommendation, one at least of the proposers so certifying from personal knowledge. Every candidate for election shall sign an undertaking to abide by the Rules if elected (see appendix). They shall be elected by a majority of the Members present at any meeting of the Society or by the President and Officers of the Society.

Subscription.

9. All Ordinary Members and Societies shall pay an annual subscription of ten shillings, and Foundation Members five shillings, due on the 1st of January in each year. Honorary Members shall be exempt from any annual subscription.

Any Member wishing to retire from the Society shall give notice to the Hon. Secretary or Treasurer in writing before the 1st of December of the previous year.

Meetings.

10. The Society shall hold one or more Meetings annually, at a place and time determined by the Members at the preceding Annual General Meeting, or by the Council. The Annual General Meeting for the election of Officers and the transaction of other business shall coincide with the Autumn Foray.

Accounts.

11. At the Annual General Meeting of the Society in each year the Hon. Treasurer shall present duly audited accounts.

Alteration of Rules.

12. The Rules shall not be altered except by a two-thirds majority of the Members present at an Annual General Meeting. A printed copy shall be sent to every Member of the Society on election, and in the event of alteration to all Members.

APPENDIX.

Form of proposal for Ordinary Membership of the British Mycological Society.

.....

of .....

.....

being desirous of becoming an Ordinary Member of the British Mycological Society, we, the undersigned Members of the Society, certify that we consider h to be a desirable Member of the Society, and beg to recommend h for election.

Dated this day of 19

.....(From personal knowledge).

Certificate to be signed by the Candidate.

I hereby certify that I desire to become an Ordinary Member of the British Mycological Society and that I will abide by the Rules if elected.

.....

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Published the 22nd September, 1920

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