Considering, first, the northern hemisphere alone, the constants are introduced into such a formula by a comparison of the observed temperatures of latitudes 0° , 30° , 50° , and 70° , with the following result :—

$$T_\lambda = 12^\circ.5 + 59^\circ.2 \cos. \frac{5}{4} \lambda + 38^\circ.1 L' \cos. \sqrt{2} \lambda$$

where T_λ is the temperature of latitude λ on Fahrenheit's scale, and L' the effective proportion of land in the circumference of that parallel.

The extension of the formula to the southern hemisphere is shown to give satisfactory results, although all merely *empirical* formulæ for the northern hemisphere altogether fail in this case.

Some other and independent confirmations of the formula are then adduced.

Supposing the globe to be entirely composed of land, or entirely of water, the temperature of any parallel may be deduced from the formula. In the case of a globe all land, the Equatorial temperature would be about 110° , and the Polar temperature about -26° ; whereas, on an aqueous sphere, the former would be about 72° , and the latter $+12^\circ$.

2. On the Spermogones and Pycnides of Lichens. By W. Lauder Lindsay, M.D., F.L.S. Communicated by Prof. J. H. Balfour.

The researches contained in the author's memoir, of which the following is a brief abstract, extended over a period of several years, and are based on careful microscopic examination of several thousand specimens of lichens from every part of the known world. The author examined the lichens of the Hookerian Herbarium at Kew, which contains an unrivalled series of specimens collected by the various surveying and exploring expeditions of the British Government, as well as by all the more distinguished modern British travellers. This collection is further valuable, from containing authentic specimens collected and named by Borrer, Turner, Hooker, Brodie, Carmichael, Babington, and other distinguished British lichenologists, as well as by Acharius, Schærer, Swartz, and other continental authors. Access was also had to the Menziesian Herbarium in the University of Edinburgh, the Herbaria of the said University, of the Botanical Society of Edinburgh, of the Museum of Irish

Industry, Dublin, and of Dr Mackay of Dublin, which last contains authentic specimens of the lichens described by Dr Taylor in the "Flora Hibernica." The fasciculi of dried specimens published by Schærer, Hepp, Leighton, and others, as well as large numbers of specimens gathered in, and sent from, various parts of England, Wales, Scotland, and Ireland, were also examined. Besides the examination of dried specimens in herbaria, the author studied lichens extensively in their native habitats on the mountains of Scotland and Norway, and elsewhere.

With the exception of two short memoirs,* already published by the author, the researches in question are the first that have been made on the subject under review in this country. The memoir is essentially organographic, and gives full details of the characters of the spermogones and pycnides of the higher lichens,—that section, namely, which comprises fruticulose, filamentous, and foliaceous species. The genera, whose spermogones and pycnides are described, are :—

1. <i>Usnea</i> , Hoffm.	21. <i>Solorina</i> , Ach.
2. <i>Neuropogon</i> , Nees and Flot.	22. <i>Sticta</i> , Ach.
3. <i>Chlorea</i> , Nyl.	23. <i>Ricasolia</i> , DN.
4. <i>Alectoria</i> , Ach.	24. <i>Parmelia</i> , Ach.
5. <i>Evernia</i> , Ach.	25. <i>Physcia</i> , Fr.
6. <i>Dufourea</i> , Ach.	26. <i>Pyxine</i> , Fr.
7. <i>Dactylina</i> , Ach.	27. <i>Psoroma</i> , Fr.
8. <i>Ramalina</i> , Ach.	28. <i>Pannaria</i> , Del.
9. <i>Roccella</i> , Bauh.	29. <i>Coccocarpia</i> , Pers.
10. <i>Thamnomia</i> , Ach.	30. <i>Amphiloma</i> , Fr.
11. <i>Sphærophoron</i> , Pers.	31. <i>Squamaria</i> , DC.
12. <i>Acroscyphus</i> , Lév.	32. <i>Placodium</i> , DC.
13. <i>Stereocaulon</i> , Schreb.	33. <i>Ephebe</i> , Fr.
14. <i>Bæomyces</i> , Pers.	34. <i>Lichina</i> , Ag.
15. <i>Cladonia</i> , Hoffm.	35. <i>Synalissa</i> , DR.
16. <i>Umbilicaria</i> , Hoffm.	36. <i>Omphalaria</i> , DR. and Mont.
17. <i>Cetraria</i> , Ach.	37. <i>Collema</i> , Ach.
18. <i>Platysma</i> , Hoffm.	38. <i>Leptogium</i> , Fr.
19. <i>Nephromium</i> , Nyl.	39. <i>Obryzum</i> , Wallr.†
20. <i>Peltigera</i> , Hoffm.	

* 1. "Monograph of the Genus *Abrothallus*." Quarterly Journal of Microscopical Science, Jan. 1857. Transactions of British Association for 1856. Botanische Zeitung, Dec. 25, 1857.

2. "On the Structure of *Lecidea lugubris*." Quart. Journ. of Microsc. Science, July 1857.

† The nomenclature and arrangement followed here and in the Memoir is that of Dr Nylander of Paris, as given in his "Synopsis methodica Lichenum omnium hucusque cognitorum." Paris, 1858. Pp. 65.

The crustaceous section of the lichen family has been examined by the author in a similar manner; but the description of the pycnides and spermogones of the lower lichens is reserved for a separate memoir. Neither does he profess to enter upon the *questio vexata* of the physiology of reproduction in lichens generally. To this subject also he proposes devoting a special memoir. The memoir contains, *inter alia*, descriptions of the spermogones, or pycnides, of many species, in which they either have not hitherto been found, or in which they are very rare and difficult of discovery. Such are the spermogones of *Usnea barbata*, *Thamnolia vermicularis*, *Neuropogon melaxanthus*, *Alectoria jubata* and *A. Taylori*, *Evernia furfuracea*, *Lecanora tartarea*, &c. The letter-press of the memoir is accompanied by 16 quarto plates of coloured drawings—amounting to several hundreds—and by specimens of lichens, bearing spermogones or pycnides, amounting to about 140.

Among the more interesting or important general facts brought out by the memoir, may be enumerated the following :—

1. In addition to the sporiferous organs,—so long familiar to botanists,—called *Apothecia*, lichens possess more or less microscopically minute organs, called *Spermogones*. The *latter* organs the author has found alike in species from arctic and antarctic, temperate and equatorial, regions.

2. The spermogones of lichens may concisely be described as follows :—In *form* they are usually more or less spherical or oval, appearing on the surface of the thallus as punctiform or papillæ-form, wart-like or barrel-shaped, bodies. In *colour* they are usually blackish, brownish, or of divers colours. In *site* they are usually scattered over particular portions of the thallus—seldom generally over its whole surface; they are usually more or less immersed in the tissues of the thallus, sometimes they are sessile on its surface, or on the apices of its ramifications, when it is erect and fruticulose. In *size* they are seldom sufficiently large to be visible to the naked eye, and are frequently so minute that they can, with difficulty, be recognised even with the aid of a good lens. In the latter case, especially, it is advisable or necessary to moisten the thallus in order to render them prominent from the contrast of colour or surface. They consist of a capsule, enclosing a cavity, that opens to the surface by a minute pore or ostiole, which is generally of a darker colour than the said capsule. From the inner wall or surface of the

capsule project, convergently into the cavity, a series of filaments, closely aggregated, called *Sterigmata*. These are either simple, formed of a single elongated cell,—or compound, made up of a series of cells, varying in size and form, superimposed the one upon the other. They produce from their apices, when simple,—from apices and sides, when compound or articulated,—a succession of very minute, solid, homogeneous corpuscles, called *Spermatia*. Just as the importance of the apothecia resides in the spores, so the importance of the spermogones resides in the spermatia. These corpuscles are destitute of any essentially vital motions, though they frequently, from their great tenuity, exhibit Brownian or molecular movements. Nor are they provided with any such appendages as cilia.

3. Spermogones usually occur on the same plant or specimen which bears apothecia: sometimes, however, only on barren plants or specimens. Hence, in regard to apothecia and spermogones, lichens have been described by continental authors as monœcious and diœcious. Again, spermogones occur in some species which never bear apothecia, as in *Thamnolia vermicularis*.

4. Spermogoniferous states of many species are what were regarded by the older lichenologists as separate varieties, species, or even genera, *e. g.*, vars. *encausta* and *vittata* of *Parmelia physodes*, and var. *denticulata* of *Platysma nivalis*. The discovery, therefore, of spermogones and pycnides simplifies lichenology by abolishing certain genera, species, and varieties, and materially reducing the number of names, *e. g.* the old genera *Cliostomum*, *Thrombium*, and *Pyrenotheca*, being found to consist wholly of spermogoniferous states of more familiar lichens, have been abolished.

5. To a certain extent, or with trifling exceptions, just as certain families or genera of lichens are characterised by apothecia and spores of a particular kind, so they are also characterised frequently by spermogones, sterigmata, and spermatia of a particular kind. Thus *Usnea* and *Ramalina* have wart-like spermogones of the same colour with the thallus, and inconspicuous in consequence thereof. The spermogones of *Cladonia* are barrel-shaped, deep brown, and easily visible. Those of *Parmelia* are mostly punctiform, immersed, black or brown, very minute and crowded; those of *Physcia* are mostly papillæform; and those of *Collema* and *Leptogium* discoid, and of a pale brown or yellow colour. In *Sticta*, *Ricasolia*,

Umbilicaria, *Collema*, *Leptogium*, *Thamnomia*, *Coccocarpia*, and *Placodium*, the sterigmata are articulated, consisting of numerous, short, broadish, frequently thick-walled, cells. They are also articulated or compound,—but the component cellules are few, longish, and delicate,—in *Usnea*, *Neuropogon*, *Parmelia*, *Evernia*, and *Platysma*. They are simple and filiform in *Ramalina*, *Cladonia*, *Ephebe*, and *Lichina*. The spermatia of *Cladonia* and *Rocella* are curved or sickle-shaped. Those of *Squamaria* are very long, slender, and twisted or curved. Those of *Collema*, *Leptogium*, and *Umbilicaria* are short, straight rods; while those of *Ramalina*, *Ephebe*, and *Lichina*, are oblong or oval-oblong.

6. The spermogones sometimes of themselves yield important characters for classification. For instance, the spermogones, sterigmata, and spermatia of *Thamnomia vermicularis* are sufficient of themselves to separate this puzzling lichen from the genus *Cladonia*, in which it has hitherto been almost uniformly placed.

7. Spermogones frequently outwardly resemble, and are therefore apt to be confounded with—

- a. Nascent apothecia, as in some *Ricasolias*;
- b. Pycnides, described below;
- c. Minute *Verrucarias*; or
- d. Minute parasitic fungi, chiefly of the genus *Sphæria*.

For instance, the author frequently receives from correspondents as new *Verrucarias* what prove to be merely spermogoniferous states of other lichens. From all the bodies above named, spermogones may at once be distinguished by microscopic examination, and by this alone.

8. The spermogones of lichens are now generally regarded as male organs of reproduction—the spermatia being supposed to be analogous in function to the antherozoids or spermatozoids of other cryptogams, and to be endowed with a fecundating or fertilizing influence on the spores. But it is necessary to state distinctly that this is a mere hypothesis, for direct or distinct proof is still wanting. The following circumstances, however, give great support to this hypothesis, and ought, at all events, to be borne constantly in mind in all speculations on the functions of the spermogones and spermatia:—

- a. Intimate relation between the spermogones and apothecia in regard to *site*—the former being generally seated in close proximity to the latter. As illustrations of this intimate

relationship, it may be stated that spermogones sometimes occur—

1. In the hypothecial tissue of the apothecium itself, as in *Celidium fusco-purpureum*, Tul. [Mém., Pl. 14., f. 12.]
 2. On the apothecium itself, as in *Lichina pygmæa* and *confinis*, and sometimes in *Cladonia rangiferina*.
 3. On the exciple of the apothecium, as in *Urceolaria scruposa* and *Parmelia conspersa*.
 - b. Relative period of development,—the spermogones normally preceding the apothecia. Spermogones should therefore be looked for in specimens bearing no apothecia or young apothecia; when the apothecia are mature, we should expect to find the spermogones old, and perhaps degenerate.
 - c. Relative abundance of spermatia and spores,—the former being infinitely more numerous than the latter.
 - d. Relative size of spermatia and spores,—the former being infinitely the smaller.
 - e. Essential difference in structure between spermatia and spores, the former being solid, simple, or homogeneous, without septa; the latter vesicular, frequently compound or septate, with heterogeneous contents.
 - f. Essential difference in form, the spermatia being usually elongated and of extreme tenuity, the spores being generally oval or spherical.
 - g. Greater constancy of size in spermatia than in spores, which are frequently very variable in this respect. Some spermatia are much larger when attached to their sterigmata than when free—as in some *Parmelias*; but this is only an apparent anomaly, for it would appear that they normally split into two on being shed from their sterigmata.
 - h. Absence of all germinative faculty,—so far as yet known.
 - i. Similarity in structure between the capsule or envelope of the spermogone and the exciple of the apothecium,—the cellular tissue of which they are composed being generally the same.
 - k. Constancy of occurrence of spermogones in all lichens, and from every part of the world yet visited by man.
9. Many lichens possess, in addition to apothecia and spermogones, minute organs, outwardly resembling spermogones, called

Pycnides. They may be described in general terms as papillæform or wart-like bodies, generally black,—sometimes brown,—usually very minute,—generally partially immersed in the thallus, on the surface of which they are scattered,—occupying a site similar to that of the spermogones. Indeed they differ essentially from spermogones only in containing corpuscles, called *Stylospores*, which are spore-like bodies,—sometimes septate,—usually oval or pyriform in shape,—but varying greatly both in form and size, with oily, distinct contents, always borne on the apices only of simple or unicellular, strongish sterigmata.

10. As the essential difference between spermogones and pycnides lies in the characters of the contained corpuscles, and as their characters are of great importance, as bearing on the physiological functions of the said corpuscles, the comparison or contrast undernoted is made:—

<i>Spermatia.</i> [representing Spermogones.]	<i>Stylospores.</i> [representing Pycnides.]
1. Structure solid, homogeneous.	1. Hollow: contents heterogeneous—in part, at least, oily.
2. Always colourless.	2. Sometimes pale yellow.
3. Of extreme tenuity: generally linear—of equal thickness throughout—straight or curved—never spherical.	3. Vesicular: usually oval or pyriform.
4. Of uniform size and shape.	4. Varying more or less in size and shape.
5. Exist in myriads.	5. Greatly less abundant.
6. Absence of germinative power.	6. Presence of germinative power.
7. No oil globules intermixed: embedded in a mucilage.	7. Oil globules generally intermixed.
8. Borne on the apices and sides of the sterigmata—on the apices when they are simple, on the apices and sides when articulated.	8. Borne on the apices only of sterigmata, which are always simple and stoutish.

11. There is much more dubiety and difficulty regarding the nature of the pycnides and the functions of the stylospores than regarding the nature and functions of the spermogones and spermatia. Two hypotheses have been advanced regarding the pycnides and stylospores, viz.—

- a. That they are substitutes for the spermogones and spermatia,—or in other words, a different form or type thereof. What lends probability to this view, is the perfect resemblance to spermogones in outward appearance, site, &c. of

such pycnides as those of *Peltigera*, in which the contained corpuscles are the only reason for regarding the conceptacles as pycnides rather than spermogones. But in certain lichens pycnides co-exist with spermogones of the ordinary character.

- b. That they are sporoid in function as well as form and general aspect. The strong argument in favour of this view is their germinative faculty. According to this view, pycnides may be regarded as secondary apothecia, or female organs, —and stylospores as secondary or supplementary spores. It has been noticed that, in certain cases, there is a general resemblance in form between the stylospores and the spores of the same species ; but this, if not exceptional, is still far from being the general rule.

12. Pycnides are much more common among the lower, or crustaceous, lichens, than among the higher or fruticulose, filamentous, and foliaceous ones ; while, on the other hand, the spermogones are most abundant and distinct in the latter. Pycnides would appear to be a connecting link between the lichens and the fungi, and we find them most frequent, perhaps, in species most nearly allied to the fungi.

13. Pycnides may occur in plants or specimens bearing apothecia, but not spermogones ; or they may occur alone, both apothecia and spermogones being absent ; or pycnides and spermogones, one or both, may occur in species seldom or never bearing apothecia, as in some species of *Strigula*.

14. Pycnides, from their outward resemblances, are apt to be confounded with, or mistaken for,—

- a. Spermogones.
- b. Minute *Verrucarias*.
- c. Minute parasitic fungi, for which, indeed, they have hitherto been almost universally mistaken. Pycnides resemble the fructifications of fungi, called by the older mycologists, *Diplodia*, *Phoma*, *Septoria*, *Cytispora*, *Sclerotium*, *Mesal-mia*, *Phyllosticta*, and *Polystigma*.

15. A few lichens,—especially crustaceous ones,—possess several forms of spermogones, or of pycnides, or of both,—though such a phenomenon is comparatively rare. This is just what occurs in such fungi as *Erysiphe*, which has *five* several forms of reproductive

organs. The simultaneous occurrence of spermogones and pycnides also characterises certain fungi, *e.g.*, *Sphæria epicymatia*, Wallr. Indeed, the presence of multiform reproductive organs in lichens, renders more indefinite and unsatisfactory the line of definition between them and the fungi; or in other words, renders more clear and intimate the alliance between these two great cryptogamic families.

16. By the discovery in Germany in 1850, and the subsequent description by various French and German authors, of the spermogones and pycnides of lichens, this family of plants has been placed on, at least, as good a footing, in respect of their anatomy and physiology, as other cryptogamic families, which have hitherto been more carefully and successfully studied.

The following Donations to the Library were announced:—

- Anniversary Address to the Geological Society of London. By Major-General Portlock, R.E. 8vo.—*From the Author.*
- The Quarterly Journal of the Geological Society. February 1859. 8vo.—*From the Society.*
- The American Journal of Science and Arts. January 1859. 8vo. *From the Editors.*
- Proceedings of the Royal Geographical Society of London. Vol. III. No. I. 8vo.—*From the Society.*
- Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. No. 64 (March 1859). 8vo. —*From the Society.*
- Quarterly Journal of the Chemical Society. January 1859. 8vo. —*From the Society.*
- Journal of the Statistical Society of London. Vol. XXII. Part. 1. 8vo.—*From the Society.*
- A Catalogue of the Graduates in the Faculties of Arts, Divinity, and Law, of the University of Edinburgh since its Foundation. 8vo.—*From the University.*
- Comets: their Constitution and Phases. By Christopher Kemplay. 8vo.—*From the Leeds Philosophical and Literary Society.*
- Report on the Teneriffe Astronomical Experiment of 1856. Addressed to the Lords Commissioners of the Admiralty. By Professor C. P. Smyth. 4to. *From the Author.*
- Report of the Proceedings of the Geological and Polytechnic Society

- of the West Riding of Yorkshire. 1857-8. 8vo.—*From the Society.*
- China and its Trade. By John Crawford, F.R.S. 8vo.—*From the Philosophical and Literary Society of Leeds.*
- Sensorial Vision. By Sir J. F. W. Herschel, Bart. 8vo.—*From the same.*
- Annual Report of the Leeds Philosophical and Literary Society for 1857-8. 8vo.—*From the Society.*
- On the Structure of Lecidia lugubris. By W. Lauder Lindsay, M.D. 8vo.—*From the Author.*
- Atti dell' imp. Reg. Istituto Veneto de Scienze, Lettere ed Arti. Dal Novembre 1858 all' Ottobre 1859. Tomo IV. Dispensa Terza. 8vo.—*From the Institute.*
- Transactions of the Botanical Society of Edinburgh. Vol. I. Part 3. Vols. II., III., IV., and V. Proceedings for 1856. Sixth, Seventh, and Eighth Annual Reports and Proceedings for 1841-44. 8vo.—*From the Society.*

Donation to the Museum—

Geological Specimens from the Peak of Teneriffe.—*By Professor C. Piazzi Smyth.*

Monday, 21st March 1859.

PROFESSOR KELLAND, Vice-President, in the Chair.

The following Communications were read:—

1. On some First Principles of a Mental Science, deduced from Correlations of the Primary Laws of Matter and Mind. By Dr Laycock.

The author commences his communication by showing the need that has arisen for a scientific exposition of the laws of thought in relation to the laws of life and organization. In all the practical business of society, as well as of the physician, the phenomena of life and mind are inseparably associated; and consequently without such scientific exposition anything like a scientific application of mental philosophy to medicine and the sciences of human nature,