that another experiment should be tried in winter time, with clear and cold weather. He has also promised to direct to these experiments the attention of the Parisian Committee for Scientific Aeronautical Ascents. But it is likely that funds will be supplied by Lyonnese scientific men and capitalists. The expense of this ascent was borne by M. Jacquemet, a country gentleman, whose estate is in the vicinity of the Lyons Observatory. It is but fair to add that these all-important investigations should not be conducted with electrical kites, as used so cleverly in America for obtaining the temperature of the air. W. DE FONVIELLE.

BOTANY AT THE BRITISH ASSOCIATION.

THE business of the Section was opened by the presentation of reports (1) on the preservation of plants for exhibition, and (2) the fertilisation of the Phæophyceæ. Since the interim report on the preservation of plants (B.A. Report, 1896), the Committee have continued their inquiries and investigations, and the result of their work has been largely to confirm the statements contained in their previous report. They express the opinion that alcohol on the whole yields the best results as a liquid medium for the preservation of specimens. Drying in sand, in cases where the specimens are not intended to be handled, is recommended as a method by which admirable results may be obtained.

The Committee appointed to conduct experiments on the fertilisation of the Phæophyceæ presented an interim report on the favourable progress of the work. In the course of the meeting a cablegram was received by Prof. Farmer, the Chairman of the Committee, from Mr. J. L. Williams, of Bangor, announcing the discovery of motile antherozoids in the genera *Dictyota* and *Taonia*.

PHYSIOLOGY.

A preliminary account of a new method of investigating the behaviour of stomata, by Francis Darwin, F.R.S. The instrument used by the author in the present researches is a hygroscope depending for its action on the extreme sensitiveness to watery vapour of certain substances. The best material consists of thin sheets of horn treated in a special manner, and known as "Chinese sensitive leaf." The other is what is used for the toys described as "fortune-telling ladies," "magical fish," &c. When either of these membranes is placed on a damp surface it instantly curves with the concavity away from the source of moisture. If one end of a strip of the material is fixed to the lower surface of a block of cork, and is placed on the stomatal face of a leaf, it is clear that only the free end can rise. It is on this principle that the hygroscope is constructed, the angle to which the hygroscope tongue rises being a rough indication of the degree of transpiration. Thus on a leaf having stomata only below, the index of the hygroscope remains at zero on the upper surface of the leaf, while on the lower side it instantly rises to an angle varying with the condition of the stomata. If they are widely open the angle will be 30° or 40° to a horizontal line; if the stomata are closed the reading will be zero on both surfaces of the leaf. The author is engaged in a general investigation of the behaviour of the stomata under varying conditions.

Some considerations upon the functions of stomata, by Prof. C. E. Bessey. Prof. Bessey summarily reviewed the structure of stomata, and discussed the needs of aquatic, terrestrial, and aerial plants as to their getting of food, and the means by which they resist the drying of their tissues. The author concludes (1) that one of the functions of stomata is the admission of carbon dioxide to the chlorophyll-bearing tissues of the plant, for use in the formation of the carbohydrates. (2) That the loss of water by terrestrial plants was originally hurtful, and is so now in many cases. (3) That if plants have utilised this constant phenomenon, it is for the supply of food matters of secondary importance, as the salts in solution in the water of the soil.

Report upon some preliminary experiments with the Röntgen rays on plants, by Prof. G. F. Atkinson. The experiments were conducted for the purpose of testing the effect of the Röntgen rays on plants exposed during a considerable period of time. After a few preliminary experiments with leaves of *Caladium*, flowers of *Begonia*, and various seedlings exposed for one to ten hours, in which no perceptible injury resulted, a run was made in which several seedlings were exposed for a total of forty-five hours in a dark room. The plants behaved exactly as plants grown in a dark room. On removing the seedlings from the dark room they all became slowly green, but those which were under the influence of the Röntgen rays recovered the green colour more slowly; this suggests that the rays may have a slightly injurious effect on the chloroplastids. No other influence could be detected. Experiments were made on the absorption of the Röntgen rays by plants. Species of *Mucor*, Bacteria, and *Oscillatoria* were exposed to the action of the rays, but no influence was exerted on their growth or movement.

One morning session was devoted to a joint discussion with Section I, on the chemistry and structure of the cell. Prof. Meldola contributed an important paper on the rationale of chemical synthesis, and Prof. J. R. Green gave an account of his investigations on the existence of an alcohol-producing enzyme in yeast.

Dr. Armstrong exhibited a series of diagrams, which showed in a comparative manner the principal results of fifty years experimenting on the growth of wheat at Rothamsted.

Dr. Saunders, the Director of the Dominion Experimental Farms, contributed a paper on the results of some experiments in cross-fertilisation. He dealt chiefly with the efforts that had been made to introduce fruits suitable for the climate of the North-west Territories of Canada. Experiments were described on hardy apples from Northern Russia, and other regions; and Dr. Saunders referred to two forms of Siberian crab-apples from which promising crosses have been obtained. The author expressed the opinion that it will be possible in a few years to supply the North-west Territories with apples capable of withstanding the severe climate.

On the structure of a hybrid fern and its bearings on hybridity in general, by Prof. J. B. Farmer. This paper dealt with the characters, both macro- and micro-scopic, of *Polypodium Schneideri*, a hybrid between *P. aureum* and *P. vulgare*, var. *elegantissimum*. The facts elicited from a study of this plant were compared with those of analogous cases, and served as the basis for a discussion as to the nature of hybrids and of hybridisation.

THALLOPHYTA.

Prof. Marshall Ward (President) contributed a paper on *Stereum hirsutum*, a wood-destroying fungus.

The author cultivated this fungus from the spores, on sterilised wood blocks, and traced the action of the mycelium week by week on the elements of the wood. He obtained spore-bearing hymenia, and worked out the life-history very completely. Hartig, in his "Zersetzungserscheinungen des Holzes," examined the wood-destroying action of this fungus, but used material growing in the open, and therefore not pure. Brefeld attempted its culture, but failed to make it develop any fructification or spores.

The fertile hymenium arises in about three to four months. The author examined the development very thoroughly, and referred to discrepancies in the existing descriptions. The details of its destruction of the wood were fully described; the fungus delignifies the inner layers of the walls of the wood-elements, and in three months' cultures and upwards these turn blue in chlor-zinc-iodine, and are shown by other reagents to undergo alteration to cellulose-like bodies before their final consumption by the fungus.

On the mycelium of the witches' broom of Barberry caused by *Æcidium graveolens*, by Prof. P. Magnus. The author of the paper criticised the work of Dr. Eriksson on this parasitic fungus. The intracellular mycelium, described by Eriksson in the cambium cells of the host-plant, is regarded by Magnus as the plasmolysed cell contents. The latter author finds that the mycelium is always intercellular, and that it puts out branches into the cells of the pith, medullary rays, and cortical parenchyma of the host.

The nucleus of the yeast plant, by Harold Wager. In *Saccharomyces cerevisiæ* the nucleus can be easily demonstrated by careful staining in hæmatoxylin, Hartog's double stain of nigrosin and carmine, or by staining in aniline-water solution of gentian violet. It appears to consist, in the majority of cases, of a homogeneous substance, spherical in shape, placed between the cell-wall and the vacuole. On the whole, it resembles more than anything else the fragmenting nuclei in the older leaf-cells of *Chara*; that is, it consists of deeply-stained granules embedded in a slightly less stainable matrix.

The process of budding in a yeast cell is accompanied by the division of this nucleus into two. The division is a direct one,

and does not take place in the mother-cell, but in the neck joining it to the daughter-cell. When about to divide, the nucleus places itself just at the opening of this neck, and proceeds to make its way through it into the daughter-cell, until about half of it has passed through, when it divides completely, and the two nuclei thus formed separate from each other towards the opposite sides of their respective cells.

The nuclei of *Saccharomyces Ludwigii* and *S. Pastorianus* were also described.

The process of spore-formation was observed in *S. cerevisiæ*. In a cell about to sporulate the nucleus is found in the centre of the cell, and appears to be homogeneous in structure. When the nucleus divides its outline becomes irregular, and the granules arrange themselves in the form of a short rod surrounded by the other portion of the nucleus, which stains differently and appears to form a structure of the nature of a spindle. The granules separate into two groups, and each group becomes a nucleus. The two nuclei thus formed again divide, and four nuclei are produced, each of which becomes the nucleus of a spore. A small quantity of protoplasm accumulates round each nucleus, spore membranes appear, and four spores are thus formed, standing in the remainder of the protoplasm, from which ultimately the thick spore membranes are produced.

The author referred to the process of nuclear division in spore-formation as probably a simple form of karyokinesis.

A disease of tomatoes, by W. G. P. Ellis. From diseased tomatoes received in August 1896 from Jersey, the associated fungi and bacteria were isolated and cultivated on nutrient gelatine, and the mycelium was traced in sections of the fruits. On removing the fruit skin with carefully sterilised instruments the mycelium within the fruit formed in a short time the well-known sporangiophores of *Mucor stolonifer*. Though late in the season, infection of sound plants at the University Botanic Gardens, Cambridge, from pure cultures caused a disease resembling that of the fruits received in August and September from the grower. Experiments are in progress to determine (1) whether the fungi obtained, other than *Mucor stolonifer*, cause disease, and (2) the site of infection.

Note on *Pleurococcus*, by Dorothea F. M. Pertz. Cultures of *Pleurococcus* in nutritive solutions were made during the winter months, from November to April. They did well in Knop's solution, ·2 per cent., in sterilised glass dishes and flasks, which were placed in different situations: in the laboratory, in a greenhouse, and out of doors.

Separate clusters of *Pleurococcus* in hanging drops of the same solution were also observed as continuously as possible. These drops were suspended in carefully sterilised moist chambers, which were kept for several weeks, in one case for two months.

The chief difficulties met with were, first, to obtain the *Pleurococcus* in absolutely pure condition, and then to keep it sufficiently aërated without running any risk of making the culture impure. Both the "globular sporangia" and those of "elongated or quadrangular form," observed by Chodat, occurred frequently, and they seem undoubtedly to be produced by the transformation of normal *Pleurococcus* cells. Individual sporangia were repeatedly selected for special observation, and the process by which they break up into separate spores was noted at all its stages.

The filamentous form described by Chodat never occurred.

Prof. Farmer, in referring to Miss Pertz' experiments, announced that he had succeeded in obtaining the filamentous form of Chodat from *Pleurococcus* cells.

Prof. Crookshank read a paper on *Streptothrix actinomycotica* and allied species of *Streptothrix*, and Prof. Macallum, of Toronto, contributed a paper on the origin of intracellular organs.

Vascular Cryptogams and Phanerogams.

The gametophyte of *Botrychium virginianum*, by E. C. Jeffrey. The author's researches were conducted on prothallia of *Botrychium* obtained from several localities in the province of Quebec and other parts of Canada.

The gametophyte of *B. virginianum* is of flattened oval shape, 2–18 mm. in length and 1·5–8 mm. in breadth. The middle of the upper surface is occupied by a well-defined ridge which bears the antheridia. The archegonia are found on the declivities which slope away from the antheridial ridge. The lower part of the prothallium is composed of yellow tissue rich in oil, the upper portion, on which the sexual organs are situated, is white in colour and free from oil. An endophytic fungus, probably a *Pythium*, occurs in the oily tissue. The antheridia originate behind the growing-point from a single superficial cell. The spermatozoids are large in size, but otherwise resemble the ordinary fern type. This development appears to agree closely with that described in the Marattiaceæ and Equisetaceæ. A young archegonium consists of three cells: the most external gives rise to the neck, the middle cell to the neck-canal-cell and the ventral cell, and the internal cell constitutes the basal cell. The first division of the oospore is across the long axis of the archegonium, the next division is parallel to the long axis of the prothallium, and the third cross-wall is in the transverse direction of the prothallium and at right angles to the other two. The organs appear very late, and only after the embryo has attained a large size.

Remarks on changes in number of sporangia in vascular plants, by Prof. F. O. Bower, F.R.S. Comparison shows that in certain cases a progressive increase in number of sporangia has taken place, in others a decrease. The changes may be classified as follows:—

Increase in Number of Sporangia.

Directly
- (*a*) by septation of sporangia.
- (*b*) by interpolation of sporangia.

Indirectly
- (*c*) by continued apical or intercalary growth of the part bearing the sporangia, with or without branching.
- (*d*) by branchings in the non-sporangial region

Decrease in Number of Sporangia.

Directly
- (*a*) by fusion of sporangia.
- (*b*) by abortion of sporangia.

Indirectly
- (*c*) by reduction or arrest of growth or branching of part bearing the sporangia.
- (*d*) by suppression of branchings in the vegetative region, resulting in fewer sporangial shoots.

The author pointed out that the physiological condition of the plant during development may largely determine the greater or less prominence of any one factor; he maintained that an analytical study, such as the above, may afford assistance in solving the problem of the origin of homosporous Pteridophyta

On spermatozoids in *Zamia integrifolia*, by H. J. Webber. Mr. Webber gave a short account of his recent discovery of the existence of large multiciliate spermatozoids in the pollen-tube of *Zamia integrifolia*, a cycad which he investigated in Florida. The facts brought forward by the author of the paper were of exceptional interest; he described the development of an unusually large antherozoid from each of the daughter-cells formed by the division of the generative cell in the pollen-tube, each antherozoid being encircled by a spirally disposed ciliate band which the author believes to be developed from the fragments of a centrosome-like body. Mr. Webber observed the discharge of the antherozoids from the pollen-tube, and followed the passage of the motile male-gamete into the archegonium. "The entire antherozoid swims into the archegonium, passing between the ruptured neck-cells." Several antherozoids commonly enter each archegonium, but only one of them takes part in fecundation. The method of antherozoid formation in *Zamia* is regarded as similar to that in *Cycas* and *Ginkgo*.

Prof. Campbell gave an account of some recent work on the genus *Lilæa*, a member of the Juncaginaceæ, and Prof. Coulter read a paper on the life-history of *Ranunculus*. The formation of endosperm prior to fertilisation, and other points of interest in connection with reproduction and embryogeny, were dealt with by these authors.

Natural History, &c.

On the chimney-shaped stomata of *Holacantha Emoryi*, by Prof. Bessey. This prickly leafless shrub, known as the "Sacred Thorn," "Crucifixion Thorn," &c., is a native of the arid regions of Southern Arizona. It possesses remarkable breathing pores, which are evidently designed to enable the plant to obtain carbon dioxide, while at the same time preventing the loss of water from its interior tissues. The epidermis is extremely thick, and the stomata have long chimney-shaped openings above them, terminating in hollow papillæ, which project some distance above the surface.

Prof. Bessey also contributed a paper on the distribution of the native trees of Nebraska.

Messrs. Pound and Clements presented a communication on the vegetation-regions of the Prairie Province. A portion of the paper was devoted to a critique of the treatment accorded by various authors to the floral covering of the North American continent. The authors endeavoured to demonstrate the integrity of the Great Plains as a single vegetation province, and summarised the most salient floral features.

Mr. F. E. Clements also contributed a paper on the zonal constitution and disposition of plant formations.

On the species of *Picea* occurring in the North-Eastern United States and Canada, by Prof. D. P. Penhallow. Since the time of Pursh, the validity of the red spruce as a distinct species has been generally denied by systematic botanists. In 1887 Dr. George Lawson maintained that the red and black spruces are distinct species. This view has been sustained during the last year by Britton in his illustrated "Flora of North America." Prof. Penhallow's studies have led him to the conclusion that there are abundant reasons for the separation of *Picea rubra* as a distinct species. Incidentally, attention was directed to a form of the white spruce characterised by its fœtid odour, and its strongly glaucous, rigid and often cuspidate leaves, which are commonly broadened at the base. The name of *fœtida* is suggested for this form.

PALÆOBOTANY.

Notes on fossil Equisetaceæ, by A. C. Seward. The author of these notes gave examples of the difficulty of distinguishing between certain Palæozoic fossils referred to *Equisetites* and the genus *Calamites*. He expressed the opinion that the fused leaf-segments usually regarded as characteristic of *Equisetites* may not afford a trustworthy distinguishing feature. Reference was made to *Equisetites Hemingwayi*, Kidst, from the English coal-measures as a species of which the precise affinity remains doubtful. Evidence was brought forward that the Jurassic species originally described by Bunbury as *Calamites Beanii*, and referred by some authors to the Monocotyledons, should be referred to *Equisetites*. Another Jurassic species, *Equisetites lateralis*, was also described, and reasons were given for regarding this species as a true *Equisetites* rather than a form of *Phyllotheca* or *Schizoneura*.

On Monday afternoon, August 23, a lecture was delivered by Mr. A. C. Seward, on fossil plants. The lecturer gave illustrations of the bearing of Palæobotany on the problems of plant evolution, and special reference was made to the genera *Ginkgo*, *Bennettites*, *Lyginodendron*, and others.

ON OBTAINING METEOROLOGICAL RECORDS IN THE UPPER AIR BY MEANS OF KITES AND BALLOONS.[1]

A KNOWLEDGE of the physical conditions which prevail up to the highest cloud levels, five to nine miles above the earth, is of great importance to meteorologists, who until recently have been studying principally the conditions existing near the floor of the aerial ocean, and from that standpoint have endeavoured to formulate the laws which control the pressure, temperature, humidity, and currents in the great volume of air above them. Continued and systematic observations on mountains in different parts of the world latterly have contributed much to our knowledge of the approximate conditions of the atmosphere, under various circumstances, up to a height of more than three miles above sea-level; but the mass and surface of the mountain, even when this is an isolated peak, influence very considerably the surrounding air. Recognising, then, the value of the determination of the true conditions of the free air, let us consider what methods are available for this investigation, which must necessarily be sporadic and of shorter duration than if conducted on mountains. In the writer's opinion, free balloons with aeronauts cannot be recommended on account of the large cost in money, and sometimes the loss of life, which attend their frequent use, while without artificial aids to respiration the aeronaut cannot rise much above five miles. Captive balloons, with observers, have been used in England, and more recently, with self-recording instruments, in Germany; but their height is limited to about two thousand feet by the weight of the lifted cable, and a wind which is sufficient to overcome their buoyancy drives them down and occasions violent shocks to the suspended instruments. A kite-balloon on trial in the German army is intended to combine the advantages of a kite and a balloon; but the cost and the moderate height attainable render it inferior to the simple kite for meteorological researches, except during calms which sometimes occur at the earth's surface, but rarely extend aloft.

There remain kites and unmanned balloons, both recording graphically and continuously the chief meteorological conditions, and these it is my intention to describe in this paper. The recent development of the kite for meteorological purposes has taken place in the United States, while the use of the automatic balloon for obtaining data at very great altitudes has hitherto been confined to Europe.

Kites appear to have been first applied in meteorology by Alexander Wilson, of Glasgow, who in 1749 raised thermometers attached to the kites into the clouds (*Trans. Roy. Soc. of Edinburgh*, vol. x. part ii. pp. 284–286). Three years later, Franklin performed in Philadelphia his celebrated experiment of collecting the electricity of the thunder-cloud by means of a kite (Sparks's "Works of Benjamin Franklin," vol. v. p. 295). Although kites have served a variety of purposes, their first systematic use in meteorology was probably in England between 1883 and 1885, when E. D. Archibald made differential measurements of wind velocity by anemometers raised by kites fifteen hundred feet (NATURE, vol. xxxi.). In 1885, A. McAdie repeated Franklin's kite experiment on Blue Hill, using an electrometer (*Proceedings* of the American Academy, vol. xxi. pp. 129–134), and in 1891 and 1892 made simultaneous measurements of electrical potential at the base of Blue Hill, on the hill, and several hundred feet above it with kites as collectors (*Annals. Astr. Obs. Harv. Coll.*, vol. xl. parts i. and ii., Appendices A and C). The invention of light-weight self-recording instruments made it possible to obtain graphic records in the air by means of kites, and after W. A. Eddy had introduced tailless kites into America, and had attached a minimum thermometer in 1891 (*Am. Met. Journal*, vol. viii. pp. 122–125), a thermograph reconstructed of lighter materials by S. P. Fergusson, of the Blue Hill Observatory, was raised on August 4, 1894, 1430 feet above the hill (*ibid.* vol. xi. pp. 297–303). It was no doubt the first instrument, recording continuously and graphically, to be lifted by kites, and it permitted simultaneous observations to be obtained in the free air and near the ground. This method of studying the meteorological conditions of the free air has ever since been in regular use at the Blue Hill Observatory; but notwithstanding the general interest which has recently been aroused in kites, it is not known by the writer that meteorographs have elsewhere been raised by them.

The details of the work, as now carried on at Blue Hill, are as follows. The kites, which have no tails, are of Eddy's Malay, or of Hargrave's cellular types, the former presenting a convex surface to the wind, and the latter two pairs of superposed planes, each pair being connected by side planes. In addition to the two leading kites, others are attached by independent cords to various points of the line, which is a steel music wire, 0·033 inch in diameter, having a tensile strength of three hundred pounds, and weighing fifteen pounds per mile. The meteorographs are composed mostly of aluminium and weigh less than three pounds each, the one constructed by J. Richard, of Paris, recording on a single clock cylinder atmospheric pressure, air temperature, and relative humidity (*La Nature*, 8 Février, 1896), while that made by Mr. Fergusson similarly records wind velocity and air temperature. One of these instruments is hung to the wire between two kites, in order to ensure its safety in case of breakage of the wire or of one kite, or the failure of the wind to support the latter. The wire is coiled upon the drum of a windlass, which may be turned by two men, and a measuring device registers the amount of wire uncoiled, while the angular elevation of the meteorograph, when not hidden by clouds, is observed from time to time with a surveyor's transit at the windlass or at the ends of a base line. From these data, or from the barometric record, the altitude of the meteorograph is calculated. Kites may be flown in all kinds of weather, whenever the wind's velocity is between fourteen and thirty-five miles an hour: and since on Blue Hill the average velocity is more than eighteen miles an hour, days are frequent when flights are possible.

Probably the greatest elevation yet attained by kites, and certainly the highest level to which kites have lifted a meteorograph, is 8740 feet above Blue Hill. This was accomplished, October 8, 1896, by the aid of nine kites, having a total area of 170 square feet, which gave a maximum pull at the ground of

[1] By A. Lawrence Rotch. (Reprinted from the *Proceedings* of the American Academy of Arts and Sciences, vol. xxxii. No. 13, May 1897.)