uniform; and its basal position is also uniform, though some difference of detail does appear in the relation of this absorbing body to the first segmentation of the embryo.

In the Pteridophyta it is exceedingly difficult to be sure of the correspondence by descent of the foot in distinct types, and indeed it should not be assumed that a specialised absorbent organ was always present, though general surface-absorption will naturally have taken place in all archegoniate embryos; indeed the condition of some upright embryos is such that a foot would never have been described, were it not for comparison with other types. In *Equisetum*, *Isoëtes*, *Botrychium*—all forms without a suspensor, and with an upright growing embryo—the hypobasal half of the embryo, with or without a root, is absorbent as in the Bryophyta, and is described as a foot; it is quite possible to see in them the continuation of a primitive absorbent organ. This may also be the case in the Marattiaceae, and it is specially noted by Campbell that "in *Marattia* all the superficial cells of the central region become enlarged and act as absorbent cells for the nourishment of the embryo." From such types we may imagine the more specialised foot of the Leptosporangiate Ferns to have been derived by a localisation of the absorbent function on one side only, which would be a natural consequence of the embryo taking the prone, in place of the vertical position.

A different course of events probably occurred in the Lycopodineæ. I am disposed to think that here the suspensor represents nothing more than a specialised part of the primitive absorbent organ; this seems to be indicated by the details as shown in Treub's figures of *L. cernuum* and *L. Phlegmaria*, in which the suspensor is continuous with the foot. But what is then the "foot" of *Selaginella*, which is quite apart from the suspensor, the root intervening? On this point I think we obtain light from *Welwitschia* and *Gnetum*, for in these we see an absorptive organ formed at a comparatively late period; and it corresponds in position and function, though not in time of origin or details of structure, with that of *Selaginella*. I conclude that the "foot" of *Selaginella* is probably a later formation, not comparable as regards descent either with the foot of *Lycopodium*, or with the "feeder" of *Welwitschia* or *Gnetum*. The latter are plainly of recent independent origin, as comparison shows, and their actual position is defined according to the position of the seed in germination. Probably, then, there is homoplasy in such cases, not true homogeny.

Similarly with such structures as the pinnae, stipules, indusium, corona, and still more so with such inconstant bodies as emergences and hairs; when we speak of the "homologies" of these parts it is rarely the *homogeny*, or identity by descent, which we mean to express; usually it is only *homoplasy*, a comparison of parts similar, it may be, in form and position, or even in development and function, though not shown to be comparable by descent.

ALTERNATION.

But the questions above discussed are mere matters of detail, compared with that great enigma of the alternation of generations in green plants, or of alternation at large. This is, after all, a question of degree of homology, not now of the parts only, but of the whole plant or "generation." How this greatest of all adaptations was really initiated, we cannot expect to bring to the point of demonstration; at best we can only venture opinions of probability. Still this discussion commands at present more widespread interest among botanists than any other in the sphere of plant morphology.

There was a time when the attempt was made to reduce all plants to one scheme as regards their life-cycle, a method which not only prevented elasticity of theory, but was responsible for some unfortunate comparisons. It was characteristic of the period when the text-book of Sachs reigned supreme; we find it there definitely laid down that "the doctrine of alternation has the object of reducing to one scheme the main phases of the life of all plants which bear sexual organs." But the controversy between Pringsheim and Celakovsky had, as one of its results, the recognition of various types of life-history, not of one scheme only. The tendency at present is towards the opposite extreme; the frequency of the parallel developments now recognised has led some to accept a comprehensive polyphyletic view as regards alternation, and wherever difficulties of comparison arise, to take refuge in the plausible suggestion that the organisms compared represent altogether distinct lines of descent. But the view which should be confidently upheld, is that even where this may actually be the case useful comparisons may yet be made; and that the method of progress within one phylum may illustrate the probable mode of progress in another. The green Algæ may thus throw light upon the probable origin of the sporogonium in the Bryophytes, though they may in no sense be in the line of their descent; the Bryophytes may suggest valuable ideas for the comparative study of the Pteridophytes, though they may not represent their actual ancestry.

It is the alternation as seen in these green plants that I propose to discuss. Writers have distinguished various types of alternation, including under the term divers modes of "alternation of shoots"; and it should be remembered that this was the original sense of the word alternation as applied by Steenstrup. But gradually the issue in the case of green plants has been simplified, and the question now centres round that alternation of phases which some of us describe as "antithetic," while others believe the phases to be really "homologous" as regards their origin.

Briefly put, the question is, How was the first start made? Has the neutral generation or sporophyte been the result of change of any other part of the sexual generation than the zygote itself? If so, the alternation is of *homologous* generations; if not, then the alternation is what is styled *antithetic*. The whole discussion is like a purely historical inquiry, but with the minimum of documentary evidence; for on this point the fossils give scanty help. In the absence of more direct evidence we are thrown back on other aguments, such as those based on comparison of normal specimens, and secondly upon the study of abnormalities. I shall not attempt to treat the matter exhaustively; it will, however, be necessary for me to deal with certain points in the discussion which were raised in the able address of Prof. Scott at Liverpool. He there restated Pringsheim's view of homologous alternation as against the antithetic. I propose now to consider three matters which I think are most material to the discussion, viz. (1) the bearing of the Algae and certain Fungi on the question; (2) the comparison from the Bryophyta; and (3) the argument from abnormalities.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At the conjoint examination for entrance scholarships, just completed, the following awards have been made in Natural Science. At Pembroke College: Scholarship, G. H. Delf, Camberwell Grammar School, 40*l.* At Gonville and Caius College: Exhibition, M. M. L. Rittenberg, Tonbridge School, 30*l.* At Jesus College: Scholarship, J. Hewitt, Derby School, 40*l.* At Christ's College: Scholarship, C. H. B. Epps, City of London School, 40*l.*; exhibition, R. B. S. Sewell, Weymouth College, 30*l.* At St. John's College: Scholarship, G. C. E. Simpson, Mill Hill School, 60*l.*; Lupton and Hebblethwaite Exhibition (open *pro hac vice*), J. F. Hough, Mason University College, Birmingham; Johnson Exhibition (open *pro hac vice*), B. E. Mitchell, Brighton Grammar School. At Emmanuel College: Scholarship, H. U. B. Banham, Ipswich Grammar School, 40*l.*; exhibition, A. C. H. Rothera, Market Bosworth School, 30*l.* Clare College: Scholarships of 60*l.* to E. B. Bailey, Kendal Grammar School, and W. Cartwright, Middlesburgh Grammar School. Trinity College: Minor Scholarship of 75*l.* to C. S. Coles, University College, London; Exhibitions of 40*l.* to J. Frame, Mason College, Birmingham; C. W. Hutt, St. Paul's School, London; T. C. James, Aberystwyth University College; H. Lambert, Perse School, Cambridge.

Mr. F. G. Hopkins has been appointed University Lecturer in Chemical Physiology.

The degree of LL.D. will be conferred on Lord Kitchener of Khartoum on November 24.

The Clerk Maxwell Studentship in Experimental Physics will be vacant at the end of this term. Candidates, who must have worked in the Cavendish Laboratory, are to send their names to Prof. Thomson by December 9.

It is proposed that Advanced Students shall be admitted to Part II. of the Mechanical Sciences Tripos, and that for the B.A. degree they shall be required to attain the standard of the Second Class at least.

The General Board of Studies have proposed a scheme for the establishment of an Allen Research Studentship under the bequest of the late A. W. G. Allen. The studentship is of the value of 250*l.*, is tenable for one year, and is open in alternate years to students proposing approved courses of research in (1) literary subjects, or (2) scientific subjects.

Seventy-five candidates have presented themselves during the past year for the Sanitary Science Examination. Of these thirty-nine were successful in obtaining the University diploma in Public Health.

The Engineering Laboratory Syndicate have lost no time in proposing a plan for the Hopkinson Memorial Building. The new wing will adjoin the present laboratory, and provide a lecture-room, three laboratory-rooms, and small rooms for students engaged in research. For the completion of the plan some 500*l.* will be required, in addition to the 5000*l.* generously given by Mrs. Hopkinson and her children. It is expected that the building will be ready for occupation in October 1899.

Mr. W. N. Shaw, F.R.S., was on November 10 appointed Assistant-Director of the Cavendish Laboratory for one year.

IN Berlin the flowers gathered in the town gardens are placed in the municipal schools for the purpose of furthering the study of botany. Arrangements have now been made by the London School Board, and will come into operation in April next, whereby a gardener will collect, pack, and forward to the schools of the Board botanical specimens and flowers, budding plants, leaves, &c., required for teaching botany or for object-lessons, or for the combination of drawing and object-lessons.

IT is expected (states the *Athenaeum*) that the London University Commission will commence its sittings this month. Mr. Bailey Saunders, the secretary, has been collecting information in Germany, especially concerning the organisation of higher commercial education, which will be made an important element in the newly constituted university, with the co-operation, it is hoped, of the London County Council. It is probable that the headquarters will be removed from Burlington Gardens. Christ's Hospital is talked of as the new site.

THE Calendar of the Imperial Tientsin University for the year 1897 has been received. The University was established towards the end of 1895, and its faculty includes several graduates of colleges in the United States. Mr. C. D. Tenney is the president, Prof. Oliver C. Clifford occupies the chair of chemistry and physics, Prof. E. G. Adams the chair of civil engineering, and Prof. N. F. Drake the chair of mining. Most of the tutors and teachers are natives of China. It is announced that last year his Excellency Li Chung-ta'ng showed his good will towards the University by a present of a 4-inch telescope, a phonograph, and several things for the physical laboratory.

ALDERMAN JOHN HOPKINSON, the members of his family, and near relatives, have offered to the Owens College, Manchester, in memory of the late Dr. John Hopkinson, a gift of 1600*l.*, to cover the expense of building the dynamo house connected with the new physical laboratory. It is hoped that by additional contributions from friends who desire to see a suitable memorial of Dr. Hopkinson in Owens College, where he was a student for three years, it may be possible to complete and equip the annexe containing in addition to the dynamo house a number of other rooms devoted to electrotechnics, and that the whole may be known as the "Dr. John Hopkinson Electrotechnical Laboratory."

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 11.—Mr. Shelford Bidwell, F.R.S., President, in the chair.—The discussion on Mr. Albert Campbell's paper on the magnetic fluxes in meters and other electrical instruments was resumed. Prof. Ayrton said he wished to offer some remarks on behalf of Mr. Mather and himself. The paper would, perhaps, have received more adequate discussion at the Institution of Electrical Engineers, for it was chiefly of a technical character. The importance of neutralising the effect of leads when using instruments with very weak fields, such as a Siemens' electro-dynamometer, should be emphasised. In instruments of the Kelvin-balance type where two opposed coils carry two opposed currents, the field spreads at the edges; the true "working" flux is not that directly between the coils. Mr. Campbell would have done better if he had used a long search coil wound round one of the swinging coils, forming part of a vertical cylinder. It would have been well also to have supplied some experimental proof that the astatic arrangement of the swinging coils of the Kelvin balance makes the instrument independent of the earth's field. The effect of the earth's field is of the order 0·2, so that with instruments of the Weston type, with a field of the order 1000, it was sometimes assumed, erroneously, that the readings were practically independent of the earth's H. Prof. Ayrton's own tests showed that by turning a Weston voltmeter towards different points of the compass, the errors in a particular case were far greater than might be predicted from the above ratio; the induction in the voltmeter pole-space, due to the earth's field, was much higher than 0·2; the earth's field was exaggerated by the iron pole-pieces; it was not necessary to suppose that the magnetism of the permanent magnet caused the variation. The error observed was about 0·2 per cent. in a horizontal field, and 0·8 per cent. when the field of the voltmeter was parallel to the earth's induction. Here the induction in the gap was 1200, and $H = 0 \cdot 2$. In tests relating to the Ayrton and Perry magnifying-spring voltmeter, it was more important to know the B in the air-space *near* the iron than the B *within* the iron. Eddy currents might account for the extraordinary results obtained with the Shallenberger meter. Mr. J. H. Reeves described a method he had adopted for measuring the effect of stray fields upon ammeters and voltmeters. The instrument to be tested is first mounted on a stand and is brought under the influence of a large coil carrying a current. In this way, fields of known magnitude can be superimposed on the working field, throughout the range of the instrument, and the change of deflection due to them can be observed. From these known values, the working field can be deduced. For let the current in the solenoid of the instrument at any moment be A amperes, producing a corresponding unknown working field of magnetic force X. Then X is proportional to the solenoid current, as measured by the indications of the instrument. If a magnetic force x is superimposed on X, then x is measured by x/X of A. If x is known, the working field X can be calculated from the change of deflection produced by the superposition. With Evershed ammeters, the field measured in this way was in one instrument 200, and in another 226; or about one-third of Mr. Campbell's figure (700) for the Evershed ammeter. Mr. Campbell's value of B did not represent the working field, but the field at the end of one of the fixed pieces of iron. Mr. Campbell, in reply, said he thought the theory of electrical instruments to be well within the limits of physics, and he had for that reason presented the paper to the Physical Society. The position chosen for the search coil in the Kelvin-balance tests may not have corresponded to the working flux, but it was near to the right position, and he had carefully specified the position chosen. His results as regards the Weston instrument differed from those of Prof. Ayrton, the errors he had observed for the particular ammeter used were under 0·1 per cent. The earth's field probably produced an effect different for different Weston instruments, according to the degree of saturation of the permanent magnet. In Mr. Campbell's tests, the Weston instrument did not have an iron case.—A paper by Prof. W. B. Morton, on the propagation of damped electrical oscillations along parallel wires, was then read by Prof. J. D. Everett. In a paper published in the *Phil. Mag.* for September 1898, Dr. E. H. Barton compared the attenuation of electrical waves in their passage along parallel wires, as experimentally determined by him, with the formula given by Mr. Heaviside in his theory of long waves. He finds close agreement as regards the effect of a terminal resistance, but large discrepancy in the case of the attenuation constant. Prof. Morton now investigates how far the results should be modified when it is supposed, as under actual conditions, that the oscillations propagated from the origin are damped, and that the circuit is not balanced, as in the ideal case of distortionless transmission. He finds (1) that the velocity of propagation is increased, while (2) the attenuation is increased, and (3) with infinite resistance between the ends of the wires, the waves are, as before, reflected completely with phase unchanged. As the resistance is diminished the amplitude of the reflected waves is decreased, and a phase-difference is introduced. For a certain value of the resistance the reflected amplitude is a minimum, and the phase-difference is $\pi/2$. When the resistance is zero there is again complete reflection, with the phase-difference π; *i.e.* the waves are reversed. The