to plants; the function of statoliths is believed to be performed (in Phanerogams, at least) by starch grains which are free and movable, and thus fall to the lower end of the cell. So long as the plant is vertical, the starch grains rest in a layer on the basal walls of the cells. If the plant is placed obliquely or horizontally, the falling starch grains rapidly take up a different position, and, by pressing on a new region of the cell walls, can be conceived to originate a stimulus.

The fact that the power of being gravitationally stimulated occurs in certain definite regions (*e.g.* the root-tip) suggests the existence of that type of physiological machine which we call a sense-organ. Now falling starch grains supply the physical conditions which are known, in the case of animals, to supply a sense-organ for orientation. Therefore, when we find in the root-tip groups of specialised cells provided with falling starch grains, such grains being absent in the parts of the root which have no power of geotropic perception, we have strong *a priori* evidence for the statolith theory.

This general line of argument has been fully and convincingly developed by Haberlandt and Němec, who have also supplied direct experimental evidence. Some of the latter is not quite so satisfactory. Thus Němec succeeded in destroying the starch in bean roots by embedding seedlings in gypsum, when such roots were found incapable of geotropic curvature. Němec not unnaturally put down his results to the loss of an integral part of the sense-organs. But I have shown that grass seedlings, the starch of which has been largely removed by exposure to high temperatures, not only fail to respond normally to gravitational stimulus, but also to the stimulus of light. The loss of starch must be looked at as a symptom of general inability to respond to stimulation rather than as a loss of special sense-organs.

In the autumn of 1901, feeling the unsatisfactoriness of the available methods of attacking the problem, I devised what was then a new method.[1] My point of view was that if gravitational sensitiveness is a form of contact-irritability (which must be the case if the pressure of the statoliths on the plasmic membrane is the critical event), then it might be possible to intensify the stimulus by vibration. I hoped, by applying vibration in a vertical plane to a horizontal seedling, to make the starch grains dance on the lateral walls, and by such repeated blows on the protoplasm to produce a more active geotropic response.

The result was as I expected, the seedlings which had been kept horizontal for from eight to ten minutes,[2] on a tuning-fork vibrating in a vertical plane, showed about 44 per cent. more curvature than the control specimens.

In order to make sure that the tuning-fork did not act by merely increasing the *general* irritability of the seedlings, the experiment was repeated with vertical specimens exposed to lateral illumination. In this case it was found that the curvature of the vibrated plants was only 5 per cent. more than that of the control specimens. We may therefore conclude that vibration increases the geotropic reaction, but does not materially affect heliotropism. This is precisely what might be expected on the hypothesis that geotropism is the result of tactile stimulation of the plasmic membranes lining the lateral cell walls by means of starch grains. So far as it goes, the method is therefore clearly confirmatory of the statolith theory. FRANCIS DARWIN.

ENTOMOLOGY AT OXFORD.[3]

THE second volume of the "Hope Reports" contains the papers published by the workers in the entomological department of the University of Oxford during the years 1897–1900, and it is a cause for much congratulation to see this evidence of the very interesting and important work that is being done under the direction of Prof. Poulton with the valuable collections of tracheate arthropods possessed by the University.

In the first paper, on mimetic attraction, by Dr. Dixey, there is an important contribution to the subject which seems to be a favourite one with the Oxford entomologists, namely, the evolution of the patterns of the wings of those butterflies that form Müllerian associations. The whole theory underlying the work of Dr. Dixey and his colleagues has, it is well known, met with considerable opposition from several well-known entomologists who have studied Lepidoptera in tropical countries, and it is therefore a very satisfactory feature of this volume to find included in it a good report of the discussion that took place at the Entomological Society in 1897 at the conclusion of Dr. Dixey's papers.

The two papers on mimicry, by Prof. Poulton, which follow contain many additional facts of importance, but as they are not illustrated, they are rather difficult to follow for those who have not a special acquaintance with the butterflies; but Prof. Poulton's interesting communication to the Linnean Society entitled "Natural Selection, the Cause of Mimetic Resemblance," illustrated by five plates and several figures in the text, is an important contribution to knowledge which any zoologist may read with advantage. The volume also contains some reports on the experimental inquiry into the struggle for existence in certain common insects, and the colour-relation between pupæ of several species of butterflies and the surroundings of their larvæ.

The third volume is mainly devoted to the investigations of Mr. Guy Marshall and Prof. Poulton on the bionomics of South African insects. In South Africa entomologists have found several excellent examples of those forms of mimicry which are known as "Batesian" and "Müllerian" mimicry respectively. It was clearly important to test experimentally the value of the colours of these insects as a protection from their enemies. This Mr. Marshall has done with results which are as interesting as they are remarkable. The fact that Mantidæ and spiders exhibit unmistakable signs that certain species of Lepidoptera are distasteful to them, but are unaffected by colours whether warning or cryptic in character, suggests that birds and other vertebrates are the principal enemies which have caused the evolution of the colour patterns of these insects. The experiments with living kestrels and the results of an examination of the contents of the crops of a large number of wild birds go a long way towards a proof of the importance of the colours of both Lepidoptera and Coleoptera as a protection from their avian enemies. These and other investigations of a similar character, excellently illustrated by several plates, make up a paper of singular interest. The opponents of the evolution theory as applied to the colours of insects have a difficult task before them when they attempt to explain away the results of the experiments that are here recorded.

Space does not permit us to refer more fully to the other papers which appear in these volumes, but enough has been said to show that a very important work is being carried on in Oxford. The rows and rows of insects that the labours of entomologists in many countries have brought together in the Hope Museum are not only ticketed and arranged in systematic order, but they are made to yield up facts which, when intelligently studied, have an important bearing upon the current theories of evolution. But this is not all. Work that is done in a museum only, valuable as it may be, is of little account unless it stimulates to, and is supplemented by, experimental work in the field. That this is what museum work does lead to in Oxford is one of the most pleasing features of these volumes. S. J. H.

MAGNETIC WORK IN MARYLAND, U.S.A.

IN a second report on magnetic work in Maryland (Maryland Geological Survey, special publication, vol. v. part i. pp. 23–98, the Johns Hopkins Press, Baltimore, 1902), Dr. Bauer gives the results of the survey which he commenced in 1896. In the earlier years the work was done mainly under the direct auspices of the Maryland Geological Survey, but subsequent to May, 1899, when Dr. Bauer took charge of the magnetic department of the U.S. Coast and Geodetic Survey, the Geodetic Survey contributed materially to it. The result, in Dr. Bauer's words, is that "Maryland now possesses the most detailed magnetic survey of any country, with the exception of Holland," there having been on the average one station to each 100 square miles.

1 Practically the same method has meanwhile been made use of by Haberlandt, who has published the results in *Pringsheim's Jahrb.*, 1903.

2 After being subjected to vibration, the plants were placed on a klinostat to prevent further gravitational stimulation. The curvature was measured after several hours slow rotation.

3 "Hope Reports," vols. ii., iii., 1900, 1902. Edited by Edward B. Poulton. Oxford: Printed for private circulation by Horace Hart, 1901, 1903.)

The present report enumerates the position of all these stations, and tabulates the values of the declination, inclination and horizontal force as observed, and as reduced to the common epoch January 1, 1900. The data are also embodied in a series of charts. In the reduction to a common epoch the secular change was derived from numerous absolute observations made at Linden, Montgomery County; whilst diurnal variations were deduced from the records of the Naval Observatory, Washington. Unfortunately, owing to the disturbing action of electric trams at Washington, no satisfactory data were obtainable for the actual years occupied by the survey, and recourse was necessary to earlier records, mainly of the three years 1889 to 1891, particulars of which appear in the report. This, of course, is open to objection, on the ground that the amplitudes of the diurnal inequalities of the several elements vary from year to year. However, as both the magnetograph records and the field observations relate to years of relatively small sun-spot frequency, the objection is less serious than might appear at first sight.

Calculations are given of the probable errors in single observations with the instruments employed. The results appear fairly satisfactory in the case of the declination and inclination, but less so in the case of the horizontal force (*cf.* Table 18, p. 84). Dr. Bauer considers the weak point in the magnetometer—of the Geodetic Survey's old pattern—to have been the employment of wood in the deflection bar, and he states that the U.S. Survey is now procuring a superior type of instrument. One point that may be also worth reconsidering in this connection is the employment of 35 and 49 cms. as the two distances for deflections in horizontal force observations. Large distances have the advantage of reducing the uncertainties connected with the law of force between two magnets of finite size; but except in regions where the horizontal force is very low, distances such as 35 and 49 cms., with magnets of ordinary strength, imply small deflection angles, and the writer is inclined to think this may more than compensate for any theoretical advantage, especially in field work.

One of the interesting points discussed, and illustrated in the charts, is the existence of a considerably disturbed region near Gaithersburg, some twenty or thirty miles north-west of Washington. The abnormalities here were apparently first disclosed by special observations made with a view to the selection of a site for a magnetic observatory near Washington. The fact emphasises the dangers to which random choice of such a site may be exposed. At the end of the report there is an outline of a scheme for the complete mathematical investigation of the magnetic distribution in Maryland, but the working out of this and various other details is postponed, pending, apparently, the elaborate survey of the entire United States which the U.S. Coast and Geodetic Survey has now in contemplation. C. C.

SCIENTIFIC SERIAL.

American Journal of Science, March.—Studies of Eocene Mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman. Part ii. Primates.—On ceric chromate, by P. E. Browning and C. P. Flora. An excess of chromic acid precipitates a ceric chromate of the composition $Ce(CrO_4)_2,2H_2O$ from solutions of cerium salts. Although the sulphates of lanthanum, didymium and yttrium were present, these metals were not present in the precipitate.—The effects of changes of temperature on permanent magnets, by H. B. Loomis. After giving a historical *résumé* of previous work on this subject, experiments are described showing the changes in the magnetic moment of magnets of different lengths, but of the same cross section, and on the change in distribution due to change of temperature.—On the chemical composition of axinite, by W. E. Ford. Expressed as an orthosilicate, the formula is found to be $Ca_7Al_4(SiO_4)_8$, in which the calcium may be in part replaced by varying amounts of Mn, Fe, Mg, and hydrogen, while a little Fe is isomorphous with the Al.—The electrical conductivity and absorption of energy in the electrodeless discharge, by Bergen Davis.—The geological structure of New Mexican Bolson Plains, by C. R. Keyes.—Note on the marine turtle Archelon. (1) On the structure of the carapace; (2) associated fossils, by G. R. Wieland.—The ionisation of water and of phosphorus nuclei, by C. Barus.—On a method of demonstrating Newton's rings by transmitted light, by H. N. Davis. If a number of wire rings of the same size be mounted in parallel planes, and dipped together in a soap solution, their planes being kept perpendicular to its surface, a series of films results through which light can be passed and caught on a sheet of paper, showing very beautiful colour phenomena.—Note on the amphibole Hudsonite previously called a pyroxene, by S. Weidman.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 26.—"An Attempt to Estimate the Relative Amounts of Krypton and of Xenon in Atmospheric Air." By Sir William **Ramsay**, K.C.B., F.R.S.

In these experiments 191·1 kilograms of gaseous air were passed into a Hampson's liquefier, and 11·3 kilograms of air were liquefied. This liquid air was evaporated in a partial vacuum, until only about 200 cubic centimetres remained. The residue, consisting largely of oxygen and also containing argon, krypton and xenon, was deprived of oxygen and nitrogen by means of red-hot copper and magnesium lime, and the resulting mixture was fractionated, so as to separate the argon, krypton, and xenon. Complete separation was not achieved, but knowing the densities and volumes of the fractions of gas obtained, their relative amounts could be calculated. This method does not preclude loss of the rarer gases, but that loss, especially in the case of xenon, must have been small; the vapour-pressure of krypton at the temperature of fractionation, $-195°$, being only 2·8 mm., and that of xenon, 0·02 mm.

The results are reproduced in the following tabular statement:—

Percentage krypton in gaseous air, 0·000014 by weight.

Percentage xenon in gaseous air, 0·0000026 by weight.

Krypton equal to 1 part by weight in about 7 millions of air; by volume, 1 part in 20 millions.

Xenon equal to 1 part by weight in about 40 millions of air; by volume, 1 part in 170 millions.

As before remarked, it is not maintained that all the krypton and all the xenon have been separated; it is likely, however, that the separation of the xenon was more perfect than that of the krypton. The results are merely brought forward as the result of a careful experiment to quantitatively isolate these gases.

As a quantity of pure krypton, sufficient for determination of density, had been collected, occasion was taken to redetermine the density of that gas, with the following result, that the value, compared with $O=16$, was found to be 40·81.

The atomic weight of krypton would accordingly be 81·62; the mean of former determinations is 81·28. This is in accordance with its position in the periodic table, which lies between bromine, 80, and rubidium, 85.

"An Inquiry into the Variation of Angles observed in Crystals, especially of Potassium-Alum and Ammonium-Alum." By Prof. H. A. **Miers**, F.R.S.

The author has endeavoured to trace the changes of angle upon one and the same crystal during its growth by measuring it at intervals without moving it from the solution in which it is growing. This is accomplished by means of a telescope-goniometer in which the crystal is observed through one side of a rectangular glass trough, and the changes in the inclination of each face are followed by watching the displacements of the image of a collimator slit viewed by reflection in it.

Examined in this way an octahedron of alum (ammonium or potassium) is found to yield not one but three images from each face; and closer inspection shows that the crystal is not really an octahedron, but has the form of a very flat triakis octahedron.

When a growing crystal of alum is watched for several hours or days, it is found that the three images yielded by an apparent octahedron face continually change their position; one set fades away and is replaced by another set.

The images do not move continuously, but *per saltum*, indicating that the reflecting planes are vicinal faces which