especially in males, as very well exemplified in some of the commoner gnats (see Fig. 5, *d*, *e*), without feeling that they have been developed in obedience to, and as a result of, some such subtle and intuitive power as this of telepathy. Every minute ramification of the wonderfully delicate feelers of the male mosquito, in all probability, pulsates in response to the piping sounds which the female is known to produce, and doubtless through considerable distance.

There is every justification for believing that all the subtle cosmic forces involved in the generation and development of the

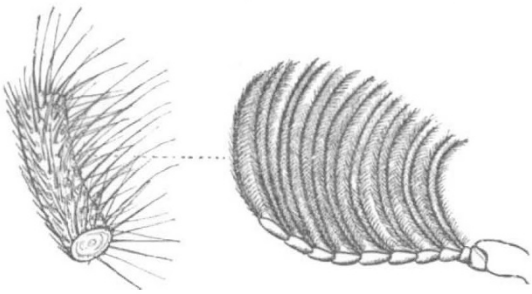

FIG. 4.—Antenna of male Phengodes with portion of ray.—Greatly enlarged (original).

highest are equally involved in the production and building up of the lowest of organisms, and that the complexing and compounding and specialisation of parts have gone on in every possible and conceivable direction, according to the species. The highly developed and delicate antennæ in the male Chironomus, for instance, may be likened to an external brain, its ramifying fibres corresponding to the highly complicated pro-

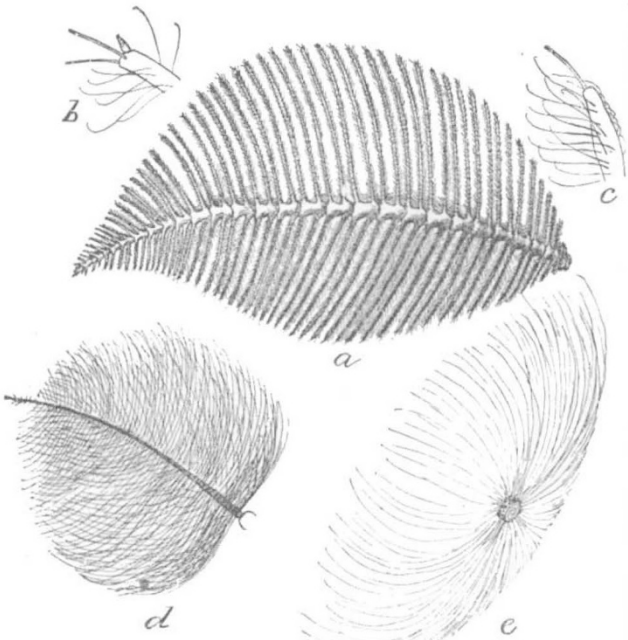

FIG. 5.—Some Antennæ of Insects: *a*, Telea polyphemus, male, × 3; *b* and *c*, tip of the rays of same—still more enlarged; *d*, Chironomus × 6; *e*, section of same—still more enlarged (original).

cesses that ramify from the nerve cells in the internal brains of higher animals, and responding in a somewhat similar way to external impressions. While having no sort of sympathy with the foolish notions that the spiritualists proclaim, to edify or terrify the gullible and unscientific, I am just as much out of sympathy with that class of materialists who refuse to recognise that there may be and are subtle psychical phenomena beyond the reach of present experimental methods. The one class too readily assumes supernatural power to explain abnormal phenomena; the other denies the abnormal, because it, likewise, is past our limited understanding.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Harkness Scholarship in Geology has been awarded to Arthur William Rogers, of Christ's College.

Mr. J. S. Gardiner, of Caius College, has been chosen to occupy the University's table at the Naples Zoological Station for six months from October 1.

The Newall Observer reports that the fine spectroscope designed for use with the Newall Telescope is now ready, and that the preliminary trials of it have been satisfactory. The mounting has been made by the Cambridge Scientific Instrument Company, and the optical parts by Mr. Brashear, of Alleghany.

Mr. F. Darwin, Mr. W. G. P. Ellis, Prof. Liveing, Mr. T. B. Wood, Prof. M. Foster, Mr. A. Eichholz, Mr. A. E. Shipley, Mr. C. Warburton, Prof. Hughes, Mr. P. Lake, Mr. O. P. Fisher, Mr. J. Owen, Mr. R. Menzies, and Mr. C. B. Fisher, have been appointed Examiners in the Science and Art of Agriculture for the University Diploma. The examination will be held in July.

Sir David L. Salomons, Bart., has founded, in connection with Caius College, a Scholarship in Engineering. The first award will be made in October. The value of the Scholarship is £40 a year for three years. The Salomons Scholar must become a candidate for the Mechanical Sciences Tripos. Applications for further information should be made to the Tutors of Caius College.

THE Conference on Technical Education held at the Society of Arts last Thursday, resulted in the adoption of the following resolution:—"That in the opinion of this meeting it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by technical instruction committees but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts, and that with the object of giving effect to the same this conference recommends that a representative committee be appointed to draw up a report and prepare recommendations on the whole subject."

SCIENTIFIC SERIALS.

American Journal of Science, June.—The preparation of perchloric acid and its application to the determination of potassium, by D. Albert Kreider. The difficulty attending the removal of the potassium in the ordinary preparation of this acid from potassium chlorate may be overcome by using the sodium salt instead. The insolubility of chloride of sodium in strong hydrochloric acid, with the aid of the acid-proof Gooch crucible, affords a means for the liberation of the perchloric acid and the removal of the greater part of the sodium in one operation. Sodium chlorate is heated until it gives off oxygen. When all the possible oxygen has been given off, and only the chloride and the perchlorate remain, the residue is treated with strong hydrochloric acid and filtered. The perchloric acid is thus liberated, and the sodium precipitated as chloride. The liquid is decanted, and undergoes the same operation again. The solution, containing hydrochloric and perchloric acids and a small amount of sodium chloride, is evaporated till the former acid is driven off and the heavy white fumes of the perchloric acid appear. It is then ready for potassium determinations, with which the small residue of sodium does not interfere. The filtering is done by means of a Gooch crucible, and the operation requires less time and attention than the old process, and is much less dangerous.—Mode of growth and development of the grapholitic genus *Diplograptus*, by R. Ruedemann. By the possession of a pneumatocyst and the arrangement of the reproductive organs at the bases of the stipes, the colonial stocks of *Diplograptus* have a general similarity to those of certain *Sephonophoræ*, while the chitinous structure of the hydrothecæ and gonangia can only be referred to the Sertularians. It thus becomes evident that the genus *Diplograptus*, like so many palæozoic fossils, has the combined properties of different groups, thus giving valuable hints in regard to the common ancestors of those groups.—On the elevation along the Rocky Mountain range in British America since the close of the Cretaceous period, by Dr. G. M. Dawson. In the mountains, the cretaceous rocks have been involved in all the flexure, faulting, and overthrust suffered by the Palæozoic; and both in the mountains and foothills these rocks are found at all angles up to vertical, and even overturned.

It is thus difficult to know the amount of elevation of these rocks, but about latitude 50° the base of the cretaceous must in several places have considerably exceeded 10,000 feet in altitude.

Symons's Monthly Meteorological Magazine, June.—The principal article deals with rainfall in China, with remarks by the editor, based on observations made from 1886-92, and published in various places by Dr. Doberck, of Hong Kong. The mean annual rainfall is small in the north, and increases greatly towards the south. In the Gulf of Pe-chi-li the fall is 20 inches, but reaches double that amount in the Delta of the Yang-Tse-Kiang, 58 inches at Hankow, and 68 inches at Ningpo. In Formosa it ranges from 60 to 90 inches, but at Keelung, in the north-east, it reaches 148 inches. The seasonal rainfall is shown in tables divided into six districts. Notwithstanding the proximity of most of the stations to the sea, the distribution is, generally speaking, of that type which prevails over the greater part of Asia.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 24.—"Micro-Metallography of Iron." Part I. By Thomas Andrews, F.R.S.

In the course of a research with high microscopical powers (including 300, 500, 800, 1200, and upwards to 2000 diameters) on the micro-crystalline structure of large masses of wrought iron, the author observed the following novel metallurgical facts:—

When large masses, several tons in weight, of practically pure wrought iron were allowed to slowly cool from a white heat, a secondary or subcrystallisation of the metallic iron occurred. The normal primary crystals of the iron, or those which have hitherto been regarded as constituting the ultimate structure of the metal, were found to enclose a subcrystalline formation consisting of very minute, and much smaller, crystals of pure iron also belonging to the regular order of crystallisation. These crystals sometimes manifested the hexagonal form, the predominant angle being about 120°, and often they assumed the form of simple cubes. The secondary crystals were contained within the area of the larger primary crystals.

Typical illustrations of this duplex crystallisation found in two large iron forgings are given in Figs. 1 and 2, and the relative dimensions of a number of individual crystals are given in the paper.

The results of twenty measurements of the primary crystals and twenty measurements of the secondary crystals taken on each forging are given on these tables.

The markings of the intercrystalline spaces or junctions of the secondary crystals were very clearly defined, but they were exceedingly minute. The general form, contour, and relative size of the primary and secondary crystals, as seen in section, will be noticed on reference to the accurate tracings, Figs. 1 and 2. The linear dimensions of the primary crystals would average about 0·01 inch, the linear dimensions of the secondary crystals averaging about 0·001 inch.

Judging roughly from the indications of the average micro-measurements, there would appear to be approximately 1,000,000,000 of the secondary crystals in a cubic inch of the metallic iron.

In the case of both the primary and secondary crystals the predominant well-defined angles of the facets of the crystals hovered more or less about the angle of 120°. The majority of the angle readings, made with the goniometer attached to the microscope, indicating generally a hexagonal structure on form of crystallisation. There were, however, also perfect cubical crystals observed.

The observations were made with a Ross first-class microscope. The micro-measurements afford an indication of the comparative size of the primary and secondary crystals. These measurements were carefully taken by a Jackson micrometer, and in some cases by a Ramsden screw micrometer, both accurately calibrated with a standard stage micrometer. The wrought iron forgings on which the observations were made were constituted of practically pure hammered wrought iron, the dimensions of the mass being about 10 feet long and about 12 inches square. The great length of time required for such large masses of iron to cool from a white heat appeared to facilitate the production of the crystals of the secondary formation.

The *rationale* of this duplex crystallisation has apparently been as follows:—The mass of metallic iron on cooling having reached the crystallising point at about 740° C., the periphery or skeletons of the larger or primary crystals were then formed. As the period of cooling was, however, very slow, the semi-fluid or viscous metal in the interior of these primary crystals was, on finally consolidating, apparently further broken up or subdivided

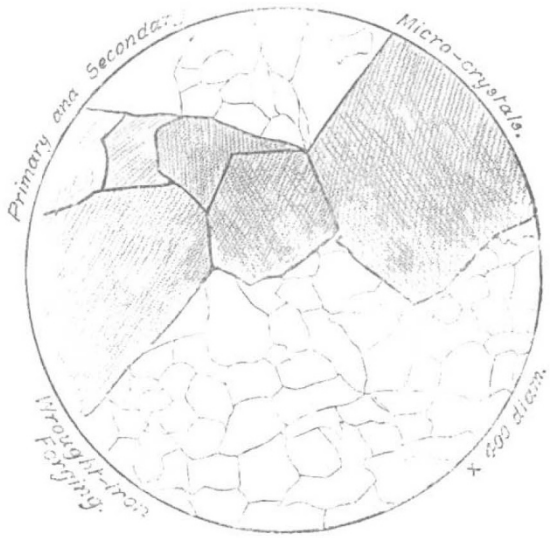

FIG. 1.

into a considerable number of smaller crystals, enclosed within the boundary or periphery of the primary crystals.

In the course of further experiments on the cooling of large masses of wrought iron, the author has also found, by the use of high power objectives, that the secondary crystals sometimes enclosed a still more minute form of crystals of pure iron, of the cubical form, which may hence be regarded as constituting a tertiary system of crystallisation in pure metallic iron. These

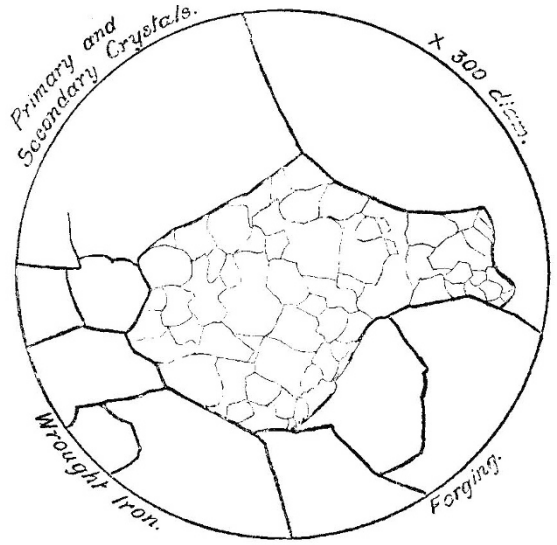

FIG. 2.

experiments therefore indicate that large masses of heated wrought iron, on cooling from above the temperature of the crystallisation of metallic iron, viz. 740° C., are capable of crystallising in three distinct modifications which may tentatively be called the primary, secondary, and tertiary system of crystallisation in iron, these various crystalline modifications being all, however, connected with the regular system of crystallisation.