the features of Alaska, the Alps, Norway or New Zealand. In face of the fact that such peculiar, strongly marked and abnormal features always occur concordantly in regions known to have been extensively glaciated, any other hypothesis than that they are due directly or immediately to ice action of some kind seems gratuitous and impertinent. To set up such trifles as a patch of residual soil, an island in the lake, a shore cliff, etc., as competent to negative the evidences of glacial erosion is to swallow gnats and strain out a camel. A gnat may be as difficult to explain as a camel, but it is of relatively little consequence whether he is explained or not. As a means of progress across the desert of hypothesis to the oasis of conclusion, the camel may be relied on and the gnats that annoy him disregarded. The various sessions and excursions of the section were attended by thirty different members of the association.

The section finally adjourned at about 4 P.M., Tuesday, July 3.

EDMUND OTIS HOVEY,
Secretary.

SCIENTIFIC BOOKS.

Zur Erkenntnis der Kolloide. By RICHARD ZSIGMONDY. Jena, Gustav Fischer. 1905. Pp. vi + 185. 4 Marks.

The names of Siedentopf and Zsigmondy have become familiar to the whole scientific world through the brilliant researches which resulted in the development of the 'ultra apparatus'; their device for observing particles so small as almost to reach the hypothetical molecular dimensions.[1]

In this monograph, 'Zur Erkenntnis der Kolloide,' Zsigmondy has given a careful account of his own and Siedentopf's methods and results, a brief historical review of many other noteworthy researches and a short discussion of the bearing of the 'ultra' methods upon certain theoretical issues.

He states that the main purpose of his researches on colloids has been to determine whether or not the polarization and dispersion of light in Tyndall's experiment is an essential characteristic of all hydrosols or colloidal solutions. He has answered this question in the affirmative in numerous cases, having demonstrated that the dispersion of light is due to the presence of the same particles to which are to be ascribed the other remarkable properties of the liquids containing them.

It may not be amiss to state briefly the principle of Tyndall's experiment and of the 'ultra apparatus,' and to recount some of the interesting facts described in the book. A beam of light is sent through the space under observation, and the observer looks at the space in a direction perpendicular to the course of the beam. If dust, or other fine particles, are present in that space, they polarize, disperse and reflect the light, and the beam is seen. If no such particles are present, the beam is not seen, and the space is said to be optically empty.

With all the resources of the famous firm of Carl Zeiss at Jena at their command, Siedentopf and Zsigmondy constructed their apparatus to send a beam of great intensity, a minute image of the sun, into the medium under investigation, and observed through the best of microscopes. Under these conditions, the particles of metallic gold in a colloidal gold solution appear as brilliant sources of light, but their shape can not be determined.

Siedentopf and Zsigmondy counted the number of these bright spots in a space of known dimensions, they knew the concentration of the gold solution (the weight of gold per unit volume); they assumed that all the gold present was visible, that it had the same specific gravity in this finely divided state as when massive, and that the particles were cubes. From these values they easily calculated the linear dimensions of the individual particles. It will be seen at once that these dimensions can not be regarded as ascertained, because of the assumptions, but

[1] The original articles appeared in the *Zeitschrift für Elektrochemie,* Vol. VIII., pp. 684–687 (1902) and in Drude's Annalen, Vol. X., pp. 1–39 (1903).

they possess a high degree of probability. The smallest particles which they were able to count appeared to have a linear dimension of $6 \mu\mu$ (millimicrons, or thousandths of a micron).

The extraordinary character of this achievement, actually counting such small particles, is best realized through comparisons. The smallest object visible with the best microscope has a linear dimension of about $\frac{1}{4} \mu$ or $250 \mu\mu$. The hypothetical diameter of a molecule of soluble starch has been estimated by Lobry de Bruyn at about $5 \mu\mu$ and of a hydrogen molecule by O. E. Meyer at about $0.1 \mu\mu$. On the other hand a human blood corpuscle has a diameter of about 7.5μ or $7{,}500 \mu\mu$. The diagrams in the book make these comparisons yet more striking.

Some solutions contain smaller particles, as is evident from the fact that the course of the light can be traced, although the individual particles can not be counted. Many solutions appear optically empty even under this searching test. We may wish to define true solutions as those which are optically empty under the 'ultra apparatus,' and colloidal solutions as those which are not optically empty under the same conditions. But there are countless intermediate steps, and these observations raise the natural question whether, after all, there is any difference between true and colloidal solutions, except in degree. That we fail to find lack of homogeneity in what we call true solutions may be due merely to the limitations of our apparatus. One naturally wonders if we may not some day, by these methods, be able to answer, in terms of fact instead of theory, those puzzling questions; in what form is a substance when in solution, and why are some things soluble and other things practically insoluble in given solvents?

Siedentopf and Zsigmondy consider it desirable to coin some new words to cover the new region which they have brought within the range of direct observation. They suggest that all particles smaller than $\frac{1}{4} \mu$ shall be called ultra-microscopic particles or, for the sake of brevity, ultra-microns. These are to be subdivided into two groups, (1) those which may be counted in the 'ultra apparatus,' to be called sub-microscopic particles, submicrons, or hypo-microns, (2) those which may not be so counted, to be called amicroscopic particles or amicrons.

The sub-microns, in water solutions, possess lasting and extremely rapid oscillatory and translatory motions which differ from the typical Brownian motion in several particulars. The description of this motion, illustrated with figures, is interesting.

As is well known, we have blue solutions of colloidal gold as well as red. Zsigmondy concludes, in harmony with the majority of other authorities, that there is no observable connection between the color and the size of the particles.

Ruby glass is unquestionably to be considered as a supercooled colloidal solution. It is possible to obtain colorless 'ruby glass' by cooling, with sufficient rapidity, the solution of metallic gold in molten glass. This colorless glass, upon being heated to a temperature at which it softens, turns red. Zsigmondy devotes a good deal of space to a theoretical discussion of how the amicrons accumulate at centers to form submicrons and small crystals.

A clue is obtained to the size of the pores of filters by determining the size of gold particles which have passed through them. For instance, sub-microns of gold with linear dimensions of $30 \mu\mu$ passed through Maasen, Pukal and Chamberland filters, which must then have some pores of that size.

The book closes with the well-justified statement that the 'ultra' methods form an important addition to, and extension of, other physical and chemical methods for the study of conditions which have hitherto escaped direct observation. It can not be considered an exhaustive review of the whole subject of colloids. Lottermoser's 'Ueber anorganische Colloïde' in the sixth volume of Ahren's Sammlung chemischer und chemisch-technischer Vorträge is a more complete summary of the literature. But Zsigmondy has given us an eminently satisfactory, and most welcome treatise on the 'ultra' methods, and the deeply interesting results obtained by them. Moreover, it is suggestive of many possibilities of future discovery.

S. Lawrence Bigelow.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Experimental Zoology, Vol. III., No. 2 (July, 1906), contains the following articles: 'Observations and Experiments Concerning the Elementary Phenomena of Embryonic Development in *Chætopterus*,' by Frank R. Lillie. This is a study of the origin and behavior of formative stuffs in the early development of an annelid by direct observation, and by various experiments, *e. g.*, analysis by centrifugal force, by staining intra vitam, and by suppressing the process of cleavage without prejudice to other embryonic processes. The standpoint is that a complete account of embryonic development would trace everything back to the chromosome complex of the species. 'Regeneration of Grafted Pieces of Planarians,' by Lilian V. Morgan. A complete head may regenerate from a posterior cut surface of planarians if a very short piece is grafted in a reverse direction on a larger piece. 'Experiments on the Behavior of Tubicolous Annelids,' by Charles W. Hargitt. 'Inheritance of Dichromatism in *Lina* and *Gastroidea*,' by Isabel McCracken, Stanford University. In this paper the author records the results of an attempt to determine the behavior in heredity of the alternate characters in dichromatic species. Two dichromatic beetles, *Lina lapponica* and *Gastroidea dissimilis*, were bred under controlled conditions through a series of generations, four in the former, seven in the latter. The investigator finds an accumulative dominance of one color over the other from generation to generation, or a prepotency of the dominating color that apparently eventually eliminates the recessive color from the dominant line. The recessive color behaves like a typical Mendelian recessive.

DISCUSSION AND CORRESPONDENCE.

WHEN DID FRANKLIN INVENT THE LIGHTNING-ROD?

The bi-centenary of Benjamin Franklin's birth has served to recall attention to the varied achievements of this remarkable man, but it would hardly be expected that new facts could be learned regarding the invention of the lightning-rod, upon which his popular fame as a natural philosopher chiefly rests.

Franklin's classic experiment with the electrical kite, by which he demonstrated the identity of lightning and artificial electricity, was performed at Philadelphia during the summer of 1752. The date June, which is frequently quoted, seems to have been authorized by Priestley in his *History of Electricity*. On the contrary, his French contemporary, De Romas, who claimed the idea of the electrical kite, maintained that Franklin did not fly his kite in June, nor until after he had heard of the success of the French experimenters, Dalibard and Delor, who, in May, 1752, collected the electricity during a thunderstorm by metal rods, according to a method which he himself had suggested. Authorities differ as to whether Franklin knew of this when he obtained the same results with his kite, Park Benjamin, on page 589 of his 'Intellectual Rise in Electricity,' asserting that Franklin desired to confirm the French experiments. If this be true the kite experiment could hardly have been executed at Philadelphia so soon as the following month, that is in June, but, at all events, no mention of it occurs anywhere until a letter describing it, written there in October to Peter Collinson at London, was read before the Royal Society on December 21, 1752. This communication, which appeared in the *Gentleman's Magazine* for December, 1752, and in the *Philosophical Transactions* for the same year, was reprinted with Franklin's 'Experiments and Observations in Electricity,' of which the second part of the first edition was published at London in 1753. While it seems to have passed unnoticed that the letter describing the electrical kite in the *Philosophical Transactions* is dated October 1 and the same letter in the collected papers bears the date October 19, a date subsequently adopted by his biographers, it was reserved for a German bibliographer, Professor Hellmann, to point out, in publishing a facsimile of this