

in the large laboratory on the first floor, the tables have their ends against the windows and the hoods extend along the interior walls. On this floor there are also four smaller rooms for research work, a room for photometric and spectroscopic work, a balance room, a room for organic combustions and store rooms for apparatus and chemicals. These last are immediately over the store rooms on the first floor, and communicate with them and with the unpacking room in the basement by means of an elevator.

In the basement, besides the unpacking room, there are two large well lighted rooms fitted up with furnaces for work in assaying. There is also a room for the apparatus used in preparing distilled water.

In the rooms on the north side of the basement are located the ventilating fans. These are driven by electric motors. In the system of heating and ventilating adopted cold air from the outside is drawn in by the fans and is forced over steam radiators and into the rooms. The warm air enters the rooms near the ceiling and the outlet flues have their openings near the floor. A separate system of fans, also driven by electricity, is placed immediately under the roof. These are connected with the hoods and with the hydrogen sulphide room, and they have been so arranged that they can be made to draw air from all the hoods or they can be made to draw simultaneously from the hoods of any one laboratory.

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SCIENTIFIC BOOKS.

Ueber die Natur der Centrosomen. By THEODOR BOVERI. Zellenstudien, Heft 4. Fischer, Jena. 1901. Pp. 220, 8 plates, 3 text-figures.

Probably the most remarkable series of cytological papers yet published by a single author are the 'Cell-Studies' of Theodor Boveri,

which have placed before students of cellular biology not only a wealth of original discoveries, but also a model of critical analysis and lucid exposition that has hardly been surpassed. They form to-day a fine example of the value of intensive work in this field, for although they have extended over a period of nearly fifteen years they have been mainly devoted to the examination of but two objects, namely, the eggs of *Ascaris* and of the sea urchin; yet few works have accomplished more for the advancement of the general subject.

The first three parts, which appeared successively in 1887, 1888 and 1890, were inspired by the epoch-making researches of Van Beneden on the eggs of *Ascaris*, and the first two were entirely devoted to the same object. The first cleared away the confusion of the earlier work regarding the formation of the polar bodies and laid the basis for most of the subsequent work on the reduction of the chromosomes, a subject which was thrown into especial prominence through the theoretical essays of Weismann. The second was a masterly study of the phenomena of fertilization and cleavage, with a full development of the hypotheses of the individuality of the chromosomes and of fibrillar contractility in mitosis, which exerted a far-reaching influence on all subsequent work in this field. The third placed upon a broad comparative basis the epoch-making discoveries of himself and Van Beneden on the equivalence of the paternal and maternal chromosomes in fertilization ('Van Beneden's Law'). The fourth, which appears eleven years after the third, deals with the nature and function of the centrosome, which has become one of the most difficult and perplexing problems of cytology. Students of cellular biology have eagerly awaited a critical discussion by Boveri of the later and in many respects conflicting aspects of this subject, in which he was one of the ablest pioneers. The present work contains a detailed study of the centrosomes in the segmenting eggs of *Echinus* and *Ascaris*, a valuable critique of technical methods, and a critical examination of the literature, with chapters on the structure and division of the centrosome in general, its relation to cell-division, its origin and physiological activity, and related questions.

All these matters are treated in the lucid and attractive style characteristic of the author, and the work easily takes its place as a worthy companion to its predecessors.

The portion of the work that will be read with greatest interest is that which deals with the vexed question as to whether the centrosome is a permanent cell-organ, comparable with the nucleus in point of morphological persistence. The independent discovery by Van Beneden and Boveri in 1887, that the centrosome in the *Ascaris* egg is such an organ, since extended to many other cases, was at first hailed as the most important step taken since the establishment of genetic continuity in the case of the nucleus. That a like principle applies to the centrosome, as was first stated by Van Beneden and Boveri, has been widely accepted by cytologists, but of late years a marked reaction against this view has taken place, a considerable number of competent observers having been led to conclude that centrosomes may form *de novo*, as well as by the division of pre-existing centrosomes. While recognizing that the centrosome theory has been in some directions pushed too far, Boveri regards the present reaction as a backward step. Nevertheless, in the course of a highly interesting discussion, he makes a large concession to the advocates of formation *de novo*, though his general theory is developed with the utmost ingenuity so as to save the principle of genetic continuity for which he has always contended. He sharply distinguishes between a protoplasmic (cytoplasmic) and a nuclear origin of centrosomes. While formation of centrosomes *de novo* in the protoplasm is denied, such an origin is admitted in case of the nucleus, though with qualifications that involve only a modification and not the abandonment of his original theory.

The strongest evidence in favor of the cytoplasmic formation of centrosomes *de novo* is afforded by the observation of the American observers, Lillie, Mead and Morgan; but all arguments based on this evidence are regarded as 'in high degree vulnerable.' The multiple asters observed in the eggs of *Chætopterus*, *Arbacia* and other animals are believed by Boveri to be 'almost certainly' of two kinds, the one (polar asters, cleavage-asters) being true asters

arising through the activity of the egg centrosome or its derivatives, the other being 'pseudospheres' of different nature from the former and containing no true centrosomes. All arguments based on the apparent disappearance and reappearance of the centrosomes in the cytoplasm during fertilization (as described for instance, by Lillie and MacFarland) are regarded as having little weight, in view of the impossibility of distinguishing the centrosome amid other granules when not surrounded by astral rays. On the positive side the persistence of the centrosome in *Ascaris* is once more demonstrated, step by step, throughout the first cleavage, and the same phenomenon is for the first time fully demonstrated in the egg of the sea urchin (*Echinus*) which, as Boveri emphasizes, is one of the most difficult of objects. These cases are illustrated by a large number of new and very convincing figures.

When Boveri turns to the nuclear origin of centrosomes he takes a different ground, basing his conclusions on the absence of centrosomes in the higher plants, on the phenomena of division in the Protozoa and on the experimental evidence brought forward especially by Hertwig and Ziegler. This interesting discussion is based primarily on the fact that in Infusoria and some other Protozoa a spindle is formed from the achromatic substance of the elongated nucleus, the bipolarity of the division figure being determined by the nucleus without the appearance of individualized centrosomes; and with this is compared the formation of the polar spindle in the eggs of *Ascaris*. To such a spindle the new term 'netrum' is applied (*νήτρον*, spindle), and its mode of origin is assumed to be a primitive mode of spindle-formation to which all other types may be referred. The accumulation of substance at the poles of such a spindle to form 'pole-plates,' as occurs in some Protozoa, represents an incipient centrosome-formation, with which is compared the peculiar mode of division of the centrosome in *Diaulula* as described by MacFarland. In the latter case the centrosome is extra-nuclear, but its mode of division closely resembles the phenomena observed in Infusoria, the mother-centrosome elongating to form bodily the spindle from the ends of which are differentiated the daughter-

centrosomes. This case gives the transition to the usual types (*Ascaris*, cleavage, etc.) where the extra-nuclear centrosome divides bodily.

Boveri is thus led to regard the centrosome of the higher types as equivalent to the intra-nuclear material from which the 'netrum' of the lower types (Infusoria) arises, and he characterizes the nucleus of the latter as a 'centronucleus'—a view which is nearly identical with that of Richard Hertwig. In the higher types in general, individualized and permanent centrosomes have been differentiated, and as it were emancipated, from the primitive 'centronucleus,' and as a rule lie outside the nucleus in the cytoplasm; but the nucleus has in some cases retained the power to give rise, upon occasion, to a karyokinetic spindle (as occurs in the polar spindles of *Ascaris*), or even to produce new centrosomes. This, Boveri believes, is the case with the egg-nucleus in echinoderms, and he would thus explain the division figures formed as a result of chemical stimulus. In normal fertilization, on the other hand, the centrosome-producing power of the egg-nucleus remains latent, since the spermatozoon imports an active individualized centrosome. How far the nuclei of higher forms in general have remained 'centronuclei' and still possess the power of forming centrosomes, how far they have lost this power, remains to be determined; but Boveri does not consider it probable that such a mode of centrosome-formation is wide spread. It is worth pointing out that Boveri regards as not improbable the view of Calkins that phylogenetically the primitive form of nucleus (centronucleus) may have arisen through the union in one body of a cytocentrum and other elements (chromatin) originally scattered through the general cell substance.

It is evident from the foregoing that the original centrosome theory of Van Beneden and Boveri, as commonly understood, has thus undergone a considerable modification, which will very likely be regarded by some readers as a virtual abandonment of that theory. Such is not, however, Boveri's own view. "Strictly speaking the cases in question do not involve a new formation. For even though the centrosome may not preexist as an individualized structure, it does not arise as something really

new * * * but only by the final transformation of a preexisting cytocentrum" (p. 193).^{*} If, however, we accept the widely held view that the achromatic nuclear substance is closely related to the cytoplasm, the step does not seem very great from the formation of 'individualized' centrosomes *de novo* out of the achromatic nuclear material to such a formation in the cytoplasm. Boveri's denial of such cytoplasmic centrosome-formation rests upon a series of assumptions, some of which are opposed by the recent discovery that Morgan's 'artificial astrospheres' may multiply by division, even in enucleated egg-fragments. He has nevertheless entrenched the centrosome theory in a strong position, from which it can only be dislodged by a stronger attack than has yet been made upon it.

Other valuable discussions deal with the relation of centriole and centrosome, and of centrosome and sphere, and with the physiological activities and cyclical changes of the centrosome. Without attempting to review these *in extenso* it may be pointed out that Boveri holds fast to the view that the centrosome passes through a regular cycle of changes, during one part of which it is a body of considerable size within which lies a smaller 'centriole.' He repudiates some of the interpretations that have been placed by other writers upon his own earlier observations, and identifies his 'centrosome' with Van Beneden's 'corpuscule central,' and not with the latter author's 'medullary zone' of the sphere. He overturns Kostanecki's and Siedlecki's contention that the size of the centrosome depends merely on the degree of extraction of the hæmatoxylin or other dye, by the highly important observation that when at its greatest size the centrosome in *Ascaris* is clearly visible not only in unstained material but also *in the living object*. He believes that the so-called pluricorpuscular centrosome, such as he himself and others earlier described in echinoderms, is an artifact; but his observations justify some severe strictures that are passed on the scepticism of such writers as Fischer, who have more than hinted that the centrosome itself is an artifact. Fischer's valu-

^{*} For a related though not identical interpretation see Wilson, 'The Cell,' pp. 111, 215.

able experiments, with those of Bütschli, Hardy and others, have shown how much caution is necessary in the interpretation of the coagulated material observed in sections; but they have produced in some minds a pessimism regarding the morphological investigation of the cell that is without justification. The cyclical changes observed in sections of fixed material are not a matter of chance, but form a highly significant connected series, and many of them have been fully confined by comparison with the living material. The experiments in question have provided us with a valuable critique of our methods, but have not destroyed their value. Even though we may not agree with all the conclusions set forth in the present paper, we must regard it as weighing heavily on the side of the view that the cell possesses a definite and complex morphological organization that passes through perfectly ordered cyclical changes, and of which our cytological methods give us not indeed a photographic image, but still a definite record.

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Elements of Mineralogy, Crystallography and Blowpipe Analysis. By ALFRED J. MOSES and CHARLES L. PARSONS. New York, D. Van Nostrand Co. 1900.

The edition of the book before us is in plan essentially like the former edition of 1895. Many parts have, however, been re-written and considerable additions are to be noticed in text and illustration.

The part devoted to crystallography has undergone complete revision, and in its treatment of the subject conforms to the prevailing classification. Over one hundred figures, for the most part excellent, have been added and we are pleased to note a new chapter treating entirely of twin crystals. The chapters on blowpipe analyses treat of the apparatus used in, and the operations of, blowpipe analyses. A summary of blowpipe tests is also given with a short scheme for qualitative blowpipe analysis.

The descriptive mineralogy opens with chapters treating of the various characters of minerals, that on optical characters being intended as introductory to a subsequent study of minerals in thin sections under the microscope. In the part describing the individual minerals we

find them grouped according to the economic classification, viz., iron minerals together, copper minerals together, etc. Before each group a brief discussion is made of the uses of the particular metal in hand, the minerals from which it is obtained and the metallurgical processes involved in its production. We think this an excellent feature of the book. The silicates do not yield to such a classification and are grouped according to the usual chemical classification. While the descriptive part as a whole and in many of its details seems to us excellent and worthy of commendation, we can not but express our regret that it should be marred by so many poor illustrations. The crystal drawings are excellent, but with few exceptions the other illustrations are not what they should be. It is doubtless difficult to represent the characteristic appearance of a mineral on paper and unless great pains is taken in this regard it were better for both books and mineralogy not to attempt such illustration.

In describing the crystallization of the minerals we notice that the real angle between the crystal faces are given instead of the supplementary angle as is customary. As the latter angles are the ones most convenient for use in calculation it would seem desirable to have had them given.

The book is concluded by a series of tables designed for the rapid determination of the common minerals.

C. H. W.

A Text-Book of Important Minerals and Rocks.

By S. E. TILLMAN. New York, John Wiley and Sons; London, Chapman & Hall. 1900.

Professor Tillman has prepared this book with the idea of furnishing the general student of mineralogy with a convenient and serviceable book, condensed in form, yet sufficiently complete in descriptive matter to equip the student with a good general knowledge of the subject.

The opening chapter consists of a very brief outline of the crystallographic character of minerals. The second treats of other physical characters and of the chemical properties of minerals. With the latter is included a brief description of blowpipe and chemical tests. That four pages should be deemed sufficient for