to 65½ inches; the middle-sized group individuals measuring 65 and 66 inches, the tall group individuals of from 67 to 69.5 inches. In arranging such a table either the total material must be utilized or a certain portion selected at random, and the limits which are originally selected must be adhered to most rigidly. Therefore it is not admissible to include in these tables individuals whose measurements at 16 years are not given but whose later development is similar to that of other boys of the class. The deviations of these three tables which are given at the foot of the columns have been miscalculated.

It is very curious that although the paragraphs discussed here show that the theory of percentile grades as applied to the study of growth cannot be held any longer, nevertheless the whole valuable material is presented in this form so that it is all but useless for the purpose of further investigations. The very conclusions which the author draws from his study of individual records prove that all the tables (XXIX. to XLVIII.) which contain the annual increases for the different percentile grades have no biological significance whatever and ought to have been omitted.

Dr. Beyer's investigations show that it is quite indispensable to publish the original records of each individual as the only means of really furthering our knowledge of the laws of growth. Only on such tables can future study be founded, and if there is to be a wholesome advance in the science of anthropometry such tables must be accessible to all. We hope that the author may find an opportunity of extending the brief abstracts of such individual records which are printed in tables XIV. to XVI. and give us the whole valuable material which would represent the most important contribution to the study of growth made for a long time.

FRANZ BOAS.

Untersuchungen über die Stärkekörner; Wesen und Lebensgeschichte der Stärkekörner der höheren Pflanzen. Von ARTHUR MEYER, Professor der Botanik an der Universität Marburg. Mit neun Tafeln und 99 in den Text gedrückten Abbildungen.

As the title suggests, this work contains an exhaustive treatment of the subject. Its principal interest lies in the fact that the manner of origin and growth of the starch grain has been for many years a subject of patient investigation, and different theories respecting the unit of organized structures have been based on the facts thus obtained.

The work is divided into five parts. The first treats of the chemical nature of the starch grain, its relation to the action of the ferment diastase; the second, of the physical character of the grain; the third, of its biology; the fourth consists of biological monographs of the starch grains of various plants; the fifth is a short discussion of the relation of the starch grain to the living protoplast.

In order to make clear the conclusions reached by the author in the first part, it will be necessary to explain that Naegeli was the first to construct a theory concerning the chemical nature of the starch grain, its manner of origin and subsequent growth. Since his book was written many facts have come to light, which have invalidated some of his conclusions. His work, however, forms the basis of all subsequent investigations. He considered the grain made up of two substances which he named starch cellulose and granulose. The latter he thought contained the essential principles of starch, and is that part which is dissolved by the action of saliva on certain acids; the former he supposed differed but little from the substance composing the principal part of the vegetable cell wall, or cellulose; this starch cellulose forms the skeleton or framework left after the grain has been treated with saliva or acids as before described. Later investigators, among whom is Walter Naegeli, claim that the intact grain consists of one substance only, and that the skeleton is the product of the chemical action of the acids on this substance, and they name this product amylodextrine.

According to the results obtained by the author in a long series of experiments, he concludes that the grain consists of one substance, amylose, which exists in two forms or modifications, and a slight amount of another substance, amylodextrine, which is a dissociation product of amylose. The two forms of this latter substance he names for convenience β- and a-

amylose, and says it is quite possible that future investigations will show that β- and α- amylose are crystals of one and the same substance, the former containing water, the latter without. Of the difference between them, he says β-amylose is soluble in water at 100°, while α-amylose requires a greater degree of heat to render it soluble, and that if the starch grain be treated with water at 138° a single substance may be obtained in the form of β- amylose as the α- amylose is changed to this form.

Amylodextrine is said to be of interest for three reasons. First, it exists in those starch grains which turn red with the application of iodine; second, the ordinary starch grain can be easily changed into it; third, because the sphærocrystal of the pure amylodextrine is very important in explaining the real nature of the starch grain. The first discoverer of amylodextrine was Musculus (Comptes rendus 1870, page 857), who named it insoluble dextrine. Its present name was given it by Walter Naegeli, who, with many other scientists, afterwards obtained this substance by treating starch with various acids. The author conducted a series of similar experiments for the purpose of obtaining amylodextrine in a pure form and then to determine its molecular weight. He succeeded in the former, but in the latter attempt only learned with certainty that its molecular weight was very high. He then gives in detail the exact methods and results of a long series of experiments with various substances more or less clearly related to amylodextrine. Among other conclusions concerning it he states that the skeleton of the starch grain, obtained by treating it with saliva or acids, does not consist entirely of amylodextrine as was formerly supposed, but of a mixture of crystals of this substance with crystals of α— amylose. Part first closes with the macro- and micro-chemistry of the starch grain.

In the second chapter he gives a statement of his conclusions concerning the physical constitution of the starch grain, with an explanation of his reasons, then a full account of all the theories preceding his own. It is impossible to give more than a brief summary of the contents of this chapter in the space allotted to a review.

Naegeli's theory, as the author states, was the first which was founded on an extended series of observations, and from the year it was published, 1858, till now, it has been the prevailing theory with most scientists and text-book writers. According to our author, however, it has wrought much harm by introducing the use of the terms, intussusception and apposition as applied to methods of growth, also by the application of the supposed manner and growth of the starch grain to that of cell wall and protoplasts. Schimper, in his work published in 1880 and 1881, was the first to destroy the deep-seated faith in Naegeli's theory. This he did first, by proving that most starch grains are formed in the chromatophores, while the foundation of Naegeli's theory rests on the assumption that the starch grain grows free in the cell sap. Second, Schimper claimed that the inner part of the grain is the older, the outer the younger. His conclusion is that the starch grain is a sphærocrystal composed of fibrous crystalloids, therefore the whole is a crystalloid. The author contrasts the opinions of Naegeli and Schimper as follows: Naegeli supposed the grain to be made up of long crystals lying perpendicular to the layers of stratification, but free in the cell sap. Schimper supposed the crystalloid threads composing the grain to be united at their bases. Naegeli made the spherical bodies or balls, forming the transition between fluid and solid bodies, grow by means of the intercalation of new substances between the old particles; Schimper, by the superposition of new masses of substance. Naegeli explained the layers as resulting from a difference in tension caused by the new particles of substance intercalated between the old, Schimper, by a difference in tension caused by the influx of water between the particles of substance. It is in this particular, and in other characters of the grain which Schimper claimed as a cause for its striations, that his theory differs from that of the author.

According to the latter, the starch grain is a sphærocrystal (not a sphærocrystalloid) composed of crystals of β— and α— amylose and amylodextrine. He defines the word sphærocrystal in the sense in which it was used by Naegeli and Rosenbusch, that is, a microscopically small spherical body with a more or less plainly radial structure, and more or less clearly marked striations, and which shows a cross when viewed with a polarizer. These bodies exist in the mineral, animal and plant kingdoms, and may be artificially produced from organic or inorganic material. The author claims that the starch grains are sphærocrystals which are exactly similar in structure and action to those of other carbohydrates, with the single exception of their manner of swelling in the formation of paste. This difference he attributes to the peculiarity of the β— amylose crystals, and says it is too unimportant to make a distinction between the starch grain and the sphærocrystal. The typical sphærocrystal consists of very fine, long, needle or thread-like crystals which may be called trichiten. These trichiten are united in clusters and the clusters branch in such a manner as to form pores or channels for the entrance of water. The manner of branching depends upon certain conditions in the way the material by which the crystal grows is furnished. The appearance of stratification is caused by the difference in the size of the pores, and consequently the amount of water in the different layers. In all this the starch grain corresponds to the sphærocrystal of the pure amylodextrine, both bodies enlarging to a certain extent on taking in water. It is otherwise when heat or chemical reagents are used, by which the starch grain is partially dissolved. This he terms 'Lösungsquellung,' a process peculiar to starch and due to the nature of β— amylose. In conclusion he adds, as the structure of the starch grain corresponds to that of the sphærocrystals of other carbohydrates it is highly probable that it grows in the same manner.

The result of the author's investigations concerning the biology of the starch grains must also be condensed into a few sentences. He describes the chromatophore as a drop of a complex viscous fluid solution. In the viscous fluid of this drop the carbohydrates are formed and eventually condensed to amylose, etc. The form of the starch grain depends upon the form of this drop. It is also influenced largely by the diastase which is in the chromatophore itself and works principally from the outside inward so that the grain grows smaller by its action. He claims that starch grains may be formed in the three different kinds of chromatophores, and that in the angiosperms, at least, they never originate free in the cell sap or cytoplasm. He describes the chloroplast as consisting of a colorless or yellowish substance, stroma, in which lay drops of a chlorophyll-colored substance, grana. He suggests that the latter form the apparatus of assimilation, while the stroma produces the starch and is also the organ by which diastase is formed. The growth of the starch grain is said to be influenced considerably by the formation of crystalloids of proteid substances which the chromatophores are known to form. He suggests that the names of the various kinds of grains, given to them by Naegeli, be changed to others more in harmony with their manner of growth. Numerous examples are given from various plants, and the experiments of a large number of scientists are quoted in addition to his own, to explain the cause of rifts and clefts in certain grains, the origin of the layers and many other points.

Finally, he treats of the starch grain as a part of the living protoplast. After contrasting the views of Naegeli and Wiesner by which they formulated hypotheses concerning the organization of the cell, he says both these scientists hold that there is no important difference between the structure of the starch grain and that of protoplasm. An entirely different relation, however, between starch grain and protoplast must be assumed by all who consider the protoplast a fluid. He then quotes from a large number of scientists who agree with him in this opinion of protoplasm.

If this view of the nature of the starch grain be correct, the commonly accepted theory concerning the unit of structure of cell wall and of protoplasm loses its foundation. It is true that the greater part of Naegeli's studies was confined to the starch grain, while other botanists applied these conclusions to the structure and manner of growth of cell wall and even to the unit of structure of the living protoplasm. It is highly probable that, as a German botanist said to the writer of this review, referring to another contested physiological problem, "The last word concerning this subject has not been spoken."

EMILY L. GREGORY.