the Berlin Convention, which imposes an obligation on all commercial stations to intercommunicate without regard to the make or system of transmitting apparatus employed. I am of the opinion that there will be no difficulty in carrying this into effect provided that the stations using the spark method send out long trains of waves, as they should do to obtain syntonic working, which is also called for by the Berlin Convention.

An extremely interesting development which is now progressing rapidly owing to the possibility of producing continuous oscillations by the arc method is wireless telephony. Suppose that we can vary the intensity of the oscillations in a manner corresponding with the vibrations of the air which constitutes sound and speech, then we should obtain at the receiving stations a train of Hertzian waves whose amplitude varies in a corresponding way; by allowing these waves to act on a telephonic receiver which is sensitive to the intensity of the waves we shall obtain in the telephone a reproduction of the sounds. This has actually been carried into effect by employing an ordinary microphone to modify the current through the transmitting arc so as to vary the intensity of the oscillation current produced, and by employing what is known as a point-detector and a telephone at the receiving station.

Another method which may be used consists in causing the microphone to vary the frequency of the oscillations of the generator, and by arranging the receiver so that it is more or less strongly affected according to the frequency of the received waves.

I am informed that such good results have already been obtained on the experimental stations for wireless telephony that it is proposed to equip stations at Oxford and Cambridge for the further perfecting of this application.

It is greatly to be desired that wireless telephony may develop rapidly, as it seems to me that for the purpose of communicating with ships wireless telephony will have great advantages over wireless telegraphy.

I am deeply indebted to Mr. Colson for all the facilities that he has placed at my disposal, and to his engineers for their assistance, which has enabled me to carry out the experiments in the lecture; and I have also to thank the tramway department for the special supply of current.

W. Duddell

SCIENTIFIC BOOKS

Experimental Zoology. By Thomas Hunt Morgan. New York, The Macmillan Co. 1907. Pp. xii + 454.

The field of experimental zoology has of late years been greatly extended and includes problems of widely different nature. The title of this book justifies the expectation of finding between the covers an attempt to bring together the results of experiment in the various fields and at the same time raises in the mind of the reader the question as to how the author has found it possible to treat adequately in some four hundred and fifty pages the data and problems involved. This question is answered in part, however, by the preface and table of contents, from which it appears that experimental embryology, regulation and animal behavior are not included within the scope of the book because, as the author states, they have recently received full consideration and, furthermore, would require too much space to be included in a single volume.

In short, the book treats primarily of those subjects and problems of experimental zoology which have not been considered in other books. This limitation necessarily defines its scope in a somewhat arbitrary manner and without relation to the problems involved. It is a fair question, therefore, whether the subject-matter of the book justifies its title: it would seem that some less inclusive title would have been more fitting.

In the preface the author states that

The central problem of morphology—the causes of changes in form or at least the determination of the conditions under which changes of form occur—will furnish the main theme of this treatise.

On reading this, one is forced to ask how any adequate consideration of this problem is possible without reference to experimental embryology and form-regulation. As a matter of fact the book treats almost solely of those fields in which the results of experimentation can not as yet be analyzed nor definite conclusions reached concerning the relation between conditions and the complex effect. Consequently the consideration of the morphological problem is of necessity very general and in certain respects rather barren of results.

The subject-matter of the book is treated under six heads or sections, viz.: Experimental Study of Evolution, Experimental Study of Growth, Experimental Studies in Grafting, Experimental Studies of the Influence of the Environment on the Life Cycle, Experimental Study of the Determination of Sex, Experimental Study of Secondary Sexual Characters.

The first of these sections, "Experimental Study of Evolution," comprises about half the book and includes chapters I.–XIV. Briefly stated the principal subjects considered are: the influence of external conditions on animal structure and the inheritance of changes thus produced, the inheritance of acquired characters, hybridization and the behavior of the germ-cells in hybridization, inbreeding and selection.

Only a few points can be taken up here. As regards the inheritance of acquired or somatic characters Professor Morgan points out that experimental data have not, up to the present, supported the hypothesis and maintains that until some positive evidence is presented we can not accept it as a well-established theory.

In the chapters on hybridization special stress is laid on the importance of Mendel's law and much space is devoted to an account of the experiments which bear upon it. In conclusion the author holds:

That Mendel's law accounts in many cases for the results and is therefore an invaluable acquisition to our method of interpretation; yet in some other cases it is evident that the inheritance is not strictly Mendelian. Used with discretion the law may still unlock many problems (p. 166).

At various points, however, notably on pp. 77 et seq. and again on p. 169, Morgan questions the so-called purity of the germ cells and points out that in various cases it is possible to bring out certain characters which should not be present if the germ cells are pure in the Mendelian sense. He suggests the hypothesis of an alternating dominance and recessiveness in the germ cells instead of purity as a means of accounting for the results.

As a matter of fact neither this suggestion nor Mendel's law contains any solution of the problems involved. Both are merely attempts to state in general terms what takes place in certain cases of hybridization and as such constitute only a formulation of the problems. Moreover, the chapters on hybridization show very clearly that work along this line has not yet attained the point where the problems involved can be clearly and consistently stated. Even Mendel's law, which is commonly regarded as the most important generalization attained thus far in this field, applies at best only to certain cases and Morgan disputes the correctness of one of its fundamental assumptions, viz., purity of the germ cells.

In a discussion of the phenomena of maturation of the germ cells in relation to Mendel's law attention is called to the arbitrary character of the assumptions required as regards the distribution of characters, and the fact that the chromosomes have not been demonstrated to be the sole bearers of hereditary qualities is emphasized. Incidentally it may be noted that maturation is considered as involving in all cases a transverse and a longitudinal division of the chromosomes, no mention being made of those cases in which two longitudinal divisions are believed to occur, although they constitute an argument in support of the author's position.

While the Mendelian terminology is freely used, we find no attempt to discuss or analyze the terms employed. Much has been written

of late regarding dominance, recessiveness, latency, etc., and it is highly desirable to keep in mind the fact that all these abstractions are really expressions of our ignorance.

Although the terms "character" and "unit-character" are frequently employed no definitions are given nor do we find any discussion of the possible nature of characters except in the section on sex determination, where morphological and physiological conceptions are briefly contrasted (pp. 420–422), the author favoring the physiological.

As in earlier writings, Morgan follows de Vries in drawing a sharp distinction between mutations and fluctuating variations and inclines toward the view that species arise by mutation and that selection does not originate but merely eliminates.

The second section, "Experimental Study of Growth," is rather brief, comprising an introductory chapter, in which normal growth, senescence, length of life, and absorption of parts are briefly discussed; a second chapter, on "External Factors that Influence Growth," and a third, on "Growth and Regeneration." Any treatment of the subject of growth on an experimental basis from which the data of experimental embryology and form-regulation are excluded must of necessity be incomplete and in certain respects unsatisfactory, and this section does not escape these disadvantages of limitation.

In the introductory chapter growth is defined as "an increase in the volume of the living material" (p. 240). According to this definition the increase in volume of bone, shell and other skeletal structures is not growth. Morgan himself is not consistent in his use of the term; within half a page of the definition he speaks of "steady and rapid growth due to imbibition of water" (p. 241) and on page 258, in discussing the effects of salts on growth, the experiments of Herbst and Maas on the relation between certain salts and the development of the skeleton in sea-urchin larvæ and sponges are cited.

Moreover, since it is expressly stated in connection with the definition that change of form is not necessarily associated with growth, this section, according to the author's position, has no connection with the main theme of the book, "the determination of the conditions under which changes of form occur" (p. v, preface).

The chapter on "Growth and Regeneration" is not, as its title might lead one to expect, a consideration of the relation between normal and regulatory growth, but a discussion of certain experiments on the rate of regeneration at different levels and the author's pressure-tension hypothesis. Since this is the fullest statement of this hypothesis that Morgan has presented, portions of it are given here in his own words:

> What factor determines that the *terminal* organs are those that are first laid down in the new part? . . . A number of considerations, that I can not enter into more fully here, have led me to suspect that this relation of the parts can be accounted for as due to a condition of stratification or polarity, due to the mutual pressure of the parts on each other, which acts as the stimulus for the differentiation of the cells. By these same assumptions we can, I think, also give a fairly consistent explanation of the difference in the rule of growth at different levels (p. 280).

And again in discussing the formation of head and posterior end from anterior and posterior cut surfaces in Lumbriculus he says:

> Since the development of these new parts seems to be largely a centripetal phenomenon, we can not assume that the influence of the old part on the new, a centrifugal influence, determines the result; but since the order or sequence of the differentiation in the new part is the same as that in the old part this may determine whether a head or a tail develops. . . . The centripetal influence acting on the new material at the anterior end determines therefore that this is a head, and acting on the new material at the posterior end determines that this is a tail. The centripetal influence is, according to my interpretation, nothing more than the tension of the outer layer of cells and the pressure relations in general, in the rounded dome-shaped mass of new materials. In this way we can give a formal solution of the development of a head in one case and of a tail in the other.

> Let us see whether the same hypothesis will explain the different rates of growth of the posterior end according to the level of the cut, as seen in the earthworm, salamander and fish. A growing region is present near, but not quite at,

the tip of the tail. From this region new material is continually being produced, out of which the new part is differentiated. The way in which the new part differentiates is determined by the pressure relation of the neighboring parts. This pressure relation is the result of the differentiation with its concomitant pressure relations, that has already taken place in the old part on the one side and of the tension of the new material at the tip on the other side. The new part differentiates therefore into something that is less than the former and more than the latter. In consequence there will be an ever-decreasing stimulus and differentiation as the new parts are formed, until finally no further stimulus for growth and differentiation is present or is strong enough to act and the growth comes to an end (pp. 280, 281).

To sum up: I have attempted to account for certain phenomena of regeneration by a process of growth in which the following factors appear to enter: (1) the differentiated material as a factor in limiting the character of new parts; (2) the relation of the cells to each other as a factor in their differentiation, and assume that this relation is due to the mutual pressures or tensions of the cells on each other; (3) the differentiated cells also determine the existing tension in that part, and this may in turn react on the new cells with which they are in contact. Remove a part and the pressure relations are upset, but this leads ultimately to the reestablishment again of the same relations of pressure (p. 282).

While space does not permit a critical discussion of this hypothesis, one must admire the author's audacity in putting forward so remarkable a hypothesis without a vestige of evidence to support it. At present his own criticism of Geddes and Thomson's theory of sex seems to apply most aptly:

> So vague and general are most of the statements . . . that their interpretation belongs to that class of hypothesis, so common in much of our biological speculation, in which the issue is obscured by the appeal to phenomena as uncertain and little understood as the problems that they pretend to explain (pp. 387, 388).

In the following section, "Experimental Studies in Grafting," the attempt is made to apply this pressure-tension hypothesis to certain phenomena observed in grafts of lower animals. The data presented in this section comprise only a small part of those existing. Only the briefest mention is made of the experiments on the higher vertebrates.

"Experimental Studies of the Influence of the Environment on the Life Cycle" form the subject of the fourth section. Here the influence of food on the life cycle in Lepidoptera, the effect of environment on ripening of the sexual organs, alternation of sexual and parthenogenetic forms in aphids and phylloxerans, the influence of environment on the life cycle in the lower Crustacea, in Hydatina and in the Hymenoptera are considered. The section is merely a résumé of facts and includes much that is descriptive rather than experimental.

The facts and theories bearing on the problem of sex determination are presented in the fifth section. Here, too, there is much that is, properly speaking, not experimental, though of value in consideration of the subject in hand. The factors in sex determination are treated under two heads, the external and internal, food being the only external factor discussed. None of the factors discussed prove certainly upon examination to be real factors in sex determination, for the evidence in all cases is either negative, conflicting or of uncertain value.

In discussion of the relation between the accessory chromosome and sex two possibilities are suggested: the one that the accessory chromosome contains the elementary characters, pangenes, determinants, or whatever we may prefer to call them, of the female sex, the other that it produces its results quantitatively. Morgan points out the difficulties involved in the first alternative and maintains that the second affords a much simpler and more plausible basis for interpretation. He suggests that sex may be determined not in the egg or sperm, but "later by the quantitative relation resulting from the activity of the chromatin in the cells of the embryo." This hypothesis meets difficulties in those cases where the accessory chromosome has a mate of equal size, for here, as Morgan points out, the quantitative difference does not exist.

As a matter of fact, there is a third possi-

bility which Morgan does not mention, viz., that the visible nuclear phenomena, *e. g.*, size and behavior of chromosomes, etc., are results or incidents of processes which are themselves the real determinative factors. If we adopt and consistently maintain a physiological as opposed to a morphological point of view, we are, it would seem, forced to this position.

In conclusion, morphological and physiological conceptions of sex are contrasted, the author favoring the latter:

> The average equality of males and females indicates, I think, that external conditions do not regulate the result, but that some internal physiological mechanism exists that determines the sex. This physiological mechanism does not involve the separation of male and female elements or units in the egg and sperm, but only involves the production of those conditions that determine whether one or the other sex will develop. In some cases the initiatory process may exist in the egg, in others in the sperm, and in still others after the union of egg and sperm (pp. 422, 423).

The final section of the book, on secondary sexual characters, comprises a brief account of the data on the correlation between these characters and the ovary and testis, and a discussion of the theories of the origin of secondary sexual characters.

The book as a whole is largely, as any such book must be, a compilation of facts. The author deserves the commendation of all biologists for his attempt to bring together the scattered data in so many different fields of experimental zoology. But the concentration of material within the limits of a single volume has necessarily resulted in a rather summary treatment of various subjects and entire omission of others. Moreover, since the author has felt himself obliged to omit all consideration of experimental embryology, form-regulation and animal behavior, his consideration of certain subjects is somewhat one-sided. Many of the facts in all these fields have a most important bearing on the problems of heredity and evolution and one which still awaits consideration.

The material which is presented is not always fully digested. Many of the chapters read like a part of some "Jahresbericht" and in many cases the reader is left to go over the data of the experiment and work out the results for himself instead of finding them presented clearly and briefly.

Bibliographies are appended to the various chapters, but no direct references to these bibliographies are made in the text. The disadvantages of this omission are obvious. In many cases also the bibliographies are far from being complete.

As regards the numbering of the figures confusion exists in several cases. Many of the figures are groups of separate figures: the groups are designated "Fig. 1," "Fig. 2," etc., and the single figures are also numbered, beginning with "1" in all cases except in Figs. 3 and 5, where the numbers continue from the preceding figures. In referring to the figures no distinction is made in most cases between the group and the single figure, so that a reference to Fig. 4, for example, may mean either the group Fig. 4 or the single figure 4 in any of the groups. The explanations of the figures make this confusion less serious than it would be otherwise, but some other system is certainly preferable.

Style and method of presentation present certain features which can be due only to haste or lack of care. Repetition is not infrequent; for example, the two following sentences appear within two pages of each other and in reference to the same experiments of Weismann:

> He believed that his observations and experiments show that external factors do not determine the appearance of the sexual generation (p. 337).
>
> Weismann carried out some experiments which show, he thinks, that external conditions do not regulate the alternation of generations (p. 339).

And again in the account of the work of Kellogg and Bell on sex determination in silk-worms these two sentences are half a page apart:

> The chief interest of their work is their examination of the possible effects of nourishment on the second generation (p. 377).
>
> The possible influence of food in determining the sex of the egg (or sperm) was also examined (p. 378).

Various errors in construction seem also to have escaped the author's notice and deserve mention for correction in a second edition:

The order is so different from that given by Yung that, although done on different animals, the interpretation of the real influence of light is probably open to question (p. 264).

He found that when the tadpoles of *Rana temporaria* . . . were fed on a mixed vegetable and meat diet that 95 per cent. of them were females and 5 per cent. were males (p. 381).

The potentialities of producing both sexes is present in all eggs and in all sperm (p. 422).

The development of Cowper's gland seems to be correlated with the development of the prostate and after castration remains undeveloped (p. 436).

With pimprennelle, which also gives an abundant nourishment, but not so well as the preceding, the caterpillars that showed the female type of marking were in excess (p. 437).

Typographical errors are most frequent in scientific names. We find, for example, the following: "pollychloros" for polychloros (p. 16), "fasceata" for fasciata (p. 24), "macchaon" for machaon (p. 29), "ingra" for nigra (p. 34), "rectvoctris" for rectirostris (p. 40), "hortenses" for hortensis (in the explanation of Fig. 15), "*Lymnœa*" for *Limnœa* (p. 263), "nemorales" for nemoralis (p. 273), "*Hormaphs hamamelistes*" for *Hormaphis hamamelidis* (p. 328), "*Hydratina*" for *Hydatina* (p. 348), "*Rhoditis*" for *Rhabditis*, throughout the table on p. 371, and *Rosii* for *Rossi* (p. 374).

Some other typographical errors are: "subjects of 'Formative Reiz'" (p. vi, preface), "25,000 grams" for 2,500 grams as the weight of the adult rabbit, "birth-rate" for birth-weight (pp. 255, 256), "extensive" for extensively (p. 317), "temperate" for temperature (p. 338), "dandylion" for dandelion (p. 380), "capulatory" for copulatory (p. 408), "primoidia" for primordia (p. 421). On p. 374 the specific name "*Rossi*" (spelled *Rosii*) is capitalized, while on p. 438 we find "*fraissei*."

The book will undoubtedly prove of value especially to the younger students of experimental zoology and to the more general reader who desires to know something of the work that has been done along these lines.

C. M. CHILD

Chemical Pathology. By H. GIDEON WELLS. Philadelphia, W. B. Saunders Co.

While only a comparatively short time has elapsed since the appearance of Virchow's "Cellular Pathology," yet it is significant of the steady progress of pathology that meanwhile new and infinitely finer means for its advancement have been developed and many new fields within its territory have been opened to investigation.

The cell is essentially chemical in its functions. Normal and pathological processes as well as bacterial influences in their relation to higher forms present so many problems that can be solved only by chemical agencies and explained only in chemical terms, that any book dealing adequately with chemical phases of pathology offers an important addition to the means at hand for acquiring a mastery of the subject.

In his "Chemical Pathology," Professor Wells addresses himself to three classes of readers: the student of medicine, the physician and the investigator, but it seems evident, as one reads his book, that it is the medical student whose interest he has sought chiefly to attract. For reference reading on the chemical side of pathology in the same way that the student would use his Orth for morphology, the book is well designed. The exposition of fundamental chemico-pathological changes, such as inflammation, cell necrosis, etc., is clear and concise, and is well designed to enable the student to grasp a larger concept of pathology than he could well obtain without such an aid. Of the chapters dealing with the problem of immunity one may not speak so unreservedly. The elucidation of the theories and the experimental evidences pertaining to that extensive subject are not so well put as in some other works of this kind. It is also to be regretted that in dealing with the problems of bacteriology the author did not go into the physical chemistry of the subject in more detail—a field that has become particularly fruitful, in recent years, in its yield