

The Determination of Sex.

Mechanismus und Physiologie der Geschlechtsbestimmung. By Prof. Richard Goldschmidt. Pp. viii + 251. (Berlin: Gebrüder Borntraeger, 1920.) Price 32 marks.

THOUGH Prof. Goldschmidt's treatise on sex-determination is in scope similar to the textbooks published by Doncaster and by Morgan in 1912, knowledge has increased so rapidly since then that there is plenty of room for a new statement. Moreover, as the author has himself devoted several years to the study of a special case which departs from the ordinary rules, his views will be of interest to geneticists. Up to a point, the mechanism of sex-determination is clear. On the one hand, we know that in several birds and some Lepidoptera the female is heterozygous in sex, but we have equally sound proof that in man and in several insects other than Lepidoptera the condition is reversed, the female being homozygous and the male heterozygous in respect of the sex-factor. The evidence for these conclusions is mainly either genetical or cytological. With the exception of *Drosophila*, which, after some doubt, observers have agreed to regard as having the male XY and the female XX, there is no specific form in which positive evidence of both kinds, genetical as well as cytological, can yet be produced. The absence, however, of such convergent testimony need not trouble us at this stage, for each class of proof is by itself adequate so far as it goes. On the whole, also, though difficulties are met with in special examples, the evidence from operative and other collateral observations agrees well with the conclusions deduced from genetical and cytological sources.

Sex being, then, decided by the contribution which one or other of the gametes makes to the offspring, how shall we account for cases in which these seemingly predetermined consequences can by interferences of various kinds be disturbed? Evidence of this description falls into several classes, and its consideration forms a chief purpose of the present book. Hitherto the most famous is that provided by R. Hertwig's experiments on frogs. By delaying fertilisation, he found that the proportion of males could be greatly increased. The suggestion that the females had died off was shown to be inapplicable, and there seemed to be no escape from the conclusion that eggs which in the ordinary course would have become females did after, and presumably because of the delay in fertilisation, become males. The fact, however, that the maturation-divisions in the case of the frog occur after

the eggs are laid offered, as Hertwig pointed out, a possible, if rather unlikely, solution; for the artificial delay might have some influence in deciding which elements should be extruded in the polar bodies, and thus the sex-ratio might be disturbed. Quite recently Seiler, a colleague of Prof. Goldschmidt's, claims to have actually witnessed consequences of this kind following upon the introduction of special conditions in the case of the Psychid moth *Talæporia*, and to have obtained cytological evidence that a rise of temperature during the reduction-division caused the X-chromosome to stay more often inside the egg, and so increased the proportion of males, whereas a lowering of the temperature had the contrary effect. In the case of the frog, even if the delay does act in the way surmised, various difficulties remain to be elucidated, and before definite conclusions can be reached as to sex-determination in Amphibia, and fishes also, we require strict genetical proof as to which sex in those animals is heterozygous in the sex-factor.

Much more serious difficulty arises from a class of fact to which Standfuss was, I believe, the first to introduce us. He found that in Lepidoptera hybridisation might affect the sexes differentially, producing in certain crosses males only, in others predominantly males (the few females being sterile), and similar phenomena proving that the influence of the cross was not alike for the two sexes. A result obtained by an amateur named Brake led Prof. Goldschmidt to investigate a most remarkable case of such differential influence. *Lymantria dispar*, the gipsy moth, is represented by various races all over the northern temperate regions. The sexes are very different, the male being small and dark, the female large and pale in colour. The original observation was that, whereas crosses in the form Japanese ♀ × European ♂ gave in F_1 the two sexes distributed as usual, the reciprocal cross, European ♀ × Japanese ♂, produced normal males, but *females more or less modified in the male direction*. Eggs, therefore, which, if fertilised by the sperm of European males, would have produced females gave rise to "intersexual females," as Prof. Goldschmidt calls them, when the sperm came from these Japanese males. To investigate this curious problem, he proceeded to Japan before the outbreak of the war, and when Japan became involved he went to the United States, where he was interned and encountered other serious difficulties when that nation also joined the Allies. But in the course of his travels he was able to collect and experiment with a long series of species or local races inhabiting various parts of Europe, Japan, and North America, raising some-

thing like 50,000 specimens. Obscure as the meaning of the phenomena still is, there can be no question that when the full interpretation is unravelled the work will be admitted to have an importance at least proportionate to the astonishing labour which has gone to its production.

In outline the main result claimed is that the various races can be arranged in a scale ranging from the "strongest" to the "weakest," and, this series once established, the consequences of matings made between races occupying different positions on the scale can be predicted with considerable accuracy. Intersexual females appeared whenever the male of a "stronger" race was mated with the female of a "weaker." The intersexuality in its several degrees might affect all the sexual characters, primary or secondary, and in its higher manifestations the instincts also. Where such a diversity of features is concerned, a quantitative scale must obviously be largely a matter of individual judgment, but it is claimed that the amount to which these females were modified in the male direction was roughly proportional to the interval between the parent races on the scale of strength; and in the extreme case, when the strongest male was mated with the weakest female, the brood generally consisted of males only, which are interpreted as being in part aboriginal, genetically determined males, and in part individuals which would have been females but for the disturbing influence which has transformed them into males.

Other matings led to the production of intersexual *males*. The discrimination between the two kinds of intersexes was not, to judge from the illustrations, so difficult as one would have expected. The intersexual males appeared with some regularity in F_2 from the cross mentioned above (Japanese ♀ × European ♂) as giving all normals in F_1 and in certain other families besides. There were also some considerable families all-female. Throughout the complicated series of matings glimpses of order appear which suggest that a comprehensive solution is not very far off. It has, nevertheless, not yet been attained. One of the most curious features, as yet inexplicable, is the fact that in the matings giving all-male families females occasionally appear which are perfectly normal, though their sisters are supposed to have been wholly transformed into males.

The interpretation which Prof. Goldschmidt proposes cannot be adequately expressed in a brief statement. He is under the influence of the theory that each sex contains the potentialities of the other, a conception to which it is now not easy

to attach a precise, still less a factorial, meaning. He is disposed to regard the sex ultimately assumed by a given zygote as decided by a struggle or reaction taking place between two components: (1) the sex-factors brought in by X-chromosomes, and (2) a substratum conceived of as inherent probably in the cytoplasm, and capable by its own development of conferring potentialities opposite to those borne by the factors proper. To these opposing elements numerical values are assigned, arbitrarily as it appears to me, and I have been unable to discover in what way the analysis thus offered differs from a restatement of the empirically observed facts, nor is the representation of the all-male and all-female families as alternative end-products of a balanced reaction at all satisfactory. During the period covered by Prof. Goldschmidt's experiments, phenomena closely analogous have been discovered by J. W. H. Harrison in the *Bistoninae*. Evidently we are thus brought into touch with a set of facts, probably abundant in nature, which must be accounted for before the problem of sex-determination is disposed of; but, paradoxical as these occurrences are, they do not justify a return to earlier stages of confusion. The problem created by the existence of intersexes, gynandromorphs, and other sex-monstrosities has always been realised. The case of the free-martin, though its true nature is now settled by the brilliant work of Lillie (well summarised in Prof. Goldschmidt's book), proves that influences as yet little understood may be taking part in these determinations.

An interesting attempt was lately made by Morgan and Bridges to apply the chromosome theory rigorously to a number of mosaic gynandromorphs which have appeared from time to time in the pedigreed work on *Drosophila*. The parental composition being known, it could be shown from the distribution of the sex-linked factors that in nearly every case these curious patchworks might be represented as resulting from a presumably accidental elimination of a sex-chromosome from the affected parts of the body. The result was certainly a striking one; but this interpretation is not readily applicable to intersexual forms which are not mosaics. Admitting, however, that in mosaics *something* may have been eliminated from the affected patches, the suggestion that this something is the sex-chromosome raises the questions: Why do not the miscellaneous variations, to which the chromosomes of somatic tissues are conspicuously liable, more frequently show their consequences as somatic patchworks? and, conversely, Why are

the chromosomes of normally dissimilar tissues not themselves dissimilar? But, apart from difficulties to which that line of argument must immediately lead, the occurrence of the intersexes among Prof. Goldschmidt's moths can scarcely be a consequence of accidental elimination, inasmuch as they came with extraordinary regularity. Appeals to the action of "hormones," from which he hopes a good deal, are a mere veiling of the difficulty. No one will dispute that these products are part of the proximate mechanism by which the effects of sexual differentiation are produced; but the problem of sex-determination is to discover the influence which primarily causes that differentiation to proceed in one direction rather than in the other; and herein, where the evidence of gametic differentiation is insufficient, we are left without any plausible conjecture. In considering the characteristics of partly or wholly sterile forms, it may be worth remembering that in proportion as a zygote is sterile, it *may* be retaining elements which, if it were fertile, would be extruded in its gametes. May not this retention influence the characters of the zygote?

Like its predecessors, this book expressly abstains from the attempt to deal with the problem of sex-determination in plants. We cannot quarrel with the wisdom of that decision, for the truth is that we are very far from any workable scheme which can be applied to them; but it is unfortunate that the diagram put forward by Correns as a representation of his views on sex in Bryonia should be chosen as the model of a "digametic" system of sex-determination. The author does imply that he has misgivings about that illustration, which, as I have elsewhere shown, is quite inconclusive. The incautious reader could scarcely avoid the inference that the scheme of sex-determination applied to animals is one which had been proved to hold in the case of a flowering plant—a very misleading conclusion.

Another region of the subject still altogether obscure is the genetical relation of the unisexual to the functionally hermaphrodite forms in animals. Prof. Goldschmidt's book contains all that can yet be said on that difficult question. There are, of course, various sorts of monœcism, and for scarcely any of them have we yet even an acceptable cytological scheme, still less any genetical evidence.

The book, as a whole, is very well done, and may be recommended to all students who wish to have the latest presentation of the facts in a clear and readable form. As I have implied, there is a want of lucidity in the discussion of the problem of the intersexes, and trouble would be saved to

the reader if he were at once told that he will not be presented with a real solution. If he reads the book carefully he will discover that for himself; but the series of facts is exceptionally interesting and, at the present stage of genetical theory, of such vital importance that the effort will not be wasted.

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Anæsthetics.

Anæsthetics: Their Uses and Administration. By Dr. Dudley Wilmot Buxton. Sixth edition. (Lewis's Practical Series.) Pp. xiv + 548 + viii plates. (London: H. K. Lewis and Co., Ltd., 1920.) Price 21s. net.

THE appearance of this new edition is to be welcomed because great advances have been made during the past few years, and also several other text-books on this subject have been for some time out of date and even out of print.

Although the size of the new volume is not much increased, Dr. Buxton has found means to add much fresh material and to re-write a great deal of the old. The chapter on the history of anæsthetics remains one of the most readable in the book, and will repay perusal by anyone not otherwise interested in the subject.

Within the past few years, and especially during the war, many new methods of anæsthesia have been devised or perfected, and many new problems attacked with more or less success. It is naturally to the chapters dealing with these methods and difficulties that one turns with the greatest curiosity. Nothing appears to have been forgotten, and each subject is discussed clearly and as fully as the space of one volume allows. The advantages of the administration of warm anæsthetic vapours are dealt with and the apparatus is described. Perhaps the section devoted to the use in major surgery of nitrous oxide with oxygen is one of the most important to the student of to-day. The advantages of this method of anæsthesia are shown to be real, although it has no doubt suffered from the too hearty advocacy of enthusiasts. In cases of severe shock, in both military and civil practice, its merits are so great as to make its use almost obligatory. On the other hand, many anæsthetists, and certainly most surgeons, will agree that as a routine method for abdominal sections it is not suitable. Dr. Buxton wisely points out that on the count of safety alone its advantages have so far been assumed rather than proved, and he agrees with Page that in cases of marked arterial degeneration, emphysema, or obstructed air passages its use is contra-indicated.