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## FLORAL BIOLOGY.

*Handbook of Flower Pollination based upon Hermann Müller's work "The Fertilisation of Flowers by Insects."* By Dr. Paul Knuth. Translated by J. R. Ainsworth Davis, M.A. Vol. i. Introduction and Literature. Pp. xix+382; illustrated. (Oxford: At the Clarendon Press, 1906.) Price 18s. net.

THE Clarendon Press is to be congratulated on the appearance of the first volume of what is a serious undertaking—the translation of a German book in five volumes and nearly 3000 pages.

Hermann Müller's book "*Die Befruchtung der Blumen*" appeared thirty-three years ago, and D'Arcy Thompson's translation, published in 1883, has long been out of print. English readers will therefore welcome the present work, incorporating as it does the great mass of research on floral biology which has been carried out in recent years.

The book appears under favourable conditions, since the author—a recognised authority on the subject—has been able to come to an arrangement with H. Müller's representatives by which he is allowed to make use of all that naturalist's writings and admirable illustrations.

The chief feature in which it differs from Müller's books is the prominence given to the statistical method of studying the visits of insects. This subject has received especial attention of late from MacLeod, Verhoeff, Loew, Willis, Burkill, and others. It was a department of study to which the author devoted much time, and in consequence his book contains perhaps more on this subject than most readers require.

It is, as Prof. Balfour says in his preface, an encyclopædic work, and it has some of the defects of its qualities. It is admirable as a book of reference, and will be of great value to anyone desirous of extending his knowledge of the subject; but we confess to missing what we expect in the introductory volume of a handbook, namely, a broad treatment of the subject such as is needed to introduce a student to a detailed account of flower-pollination. There is no effective discussion of what lies at the root of the whole science of floral biology, namely, that fertilisation at any price is the primary necessity, while cross-fertilisation is a secondary need. From this standpoint the arrangements of the sexes in plants become comprehensible as compromises between the extreme cases of cleistogamy and dioeciousness. In one case fertilisation is assured, while cross-fertilisation is impossible; in the other fertilisation is not a certainty, but if it occurs it implies of necessity a cross between two individuals. Nor, again, is the point of geitonogamy made clear, namely, that if pollen is brought from a separate flower there is at least a chance that it may come from another plant.

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In referring to Darwin's "Cross- and Self-Fertilisation," Knuth speaks of the paucity of the experiments on crosses between flowers on the same plant, but he neglects to mention what Darwin thought the chief outcome of his work—the fact that crosses between individuals grown under identical conditions fail to give vigour to the offspring; and this is a result that includes the effect of crosses between flowers on the same plant.

The need of a more generalised introduction to floral biology was not so obvious to us in reading Knuth's book in German, but those who read it as an English text-book, presumably intended for university students, and who know the standard of knowledge which such readers bring to the study, will probably form a similar opinion.

In the pages devoted to the history of the subject a full account is given of the various ways of classifying flowers from a biological point of view. Here we find Hildebrand's and Axell's systems, of which the second is not generally accessible to English readers, being written in Swedish. Here, too, is Delpino's interesting arrangement of typical floral mechanisms into classes. Thus class iii., made up of flowers which are visited by insects crawling into the tubular corolla, contains the types named after the genera *Datura*, *Digitalis*, *Campanula*, &c. In class vii. we find one of the instances of the awkward translations which occur here and there in the English edition. The mechanism of *Genista*, *Ulex*, &c., is named by Delpino "*Forma a scatto*," and this is rendered by "tension form," which has none of the appropriateness of the original and does not direct attention to the explosion which is so characteristic of the type. In other cases the translator is a little too literal. What service is it to an English reader to find Hymenoptera described as membrane-winged insects, or Diptera as two-winged?

Under the heading "Autogamy" a list is given of all known instances of self-sterility; this, together with the corresponding lists of heterostyled and cleistogamic plants, forms a useful feature in the book. Again, in relation to cleistogamy, we are glad to see a refutation of some of the supposed instances of perpetual and unavoidable self-fertilisation, such as the case of *Juncus bufonius* and of *Salvia cleistogama*.

A good deal of space is given to the various classifications of flowers according to their mode of fertilisation and the type of insect visitors. The best-known system is that of H. Müller, who divided them into flowers visited for pollen only, flowers with exposed nectar, with concealed nectar, those adapted to the visits of bees, Lepidoptera, &c. These classes are known by the symbols Po, A, B, H, F, &c. Knuth propounded a more elaborate classification for which he had good reasons; but why the translator has altered the symbols so as to suggest the English equivalents of the class-names we cannot understand. Thus, instead of keeping K1 for "small-insect flowers," he gives Sm as the symbol. This, except on general principles, is no great matter; but when

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we find the familiar F which stood for lepidopterid flowers applied to those fitted to the visits of Diptera we have ground for complaint. The same is true of the introduction of new symbols for the well-known A, AB, and B. Surely English standards are sufficiently different from those in use on the Continent without our needlessly multiplying instances.

The discussion which follows on the different classes of flowers forms one of the most interesting parts of the volume. Thus we get Knuth's curious observations on the proportion of anemophilous plants on the wind-beaten Halligen Islands in the North Sea, where they form 47 per cent. of the flora, whereas on the mainland the percentage is 21.5—a case which may remind us of the wingless insects of Madeira. Then, again, we have details of flowers fertilised by bats, birds, slugs, and snails which we think are here put together for the first time in English. There is also a discussion of some interest on flowers which to our eyes are inconspicuous, but which nevertheless attract many visitors. Further on is a good account of the well-known methods of fertilisation in the yucca and the fig.

Under pollen flowers, *i.e.* those visited for the sake of their pollen, the author makes what seems to us an unnecessary blot in his system of classification. Thus *Sarothamnus scoparius*, *Genista tinctoria*, &c., though devoid of nectar and visited solely for pollen, "are not regarded as pollen-flowers but as well marked bee-flowers." Even here he is not consistent, since *Cassia chamaecrista* and *Solanum rostratum* are described as pollen flowers, though they too are adapted for bees.

H. Müller's important work on the specialisation of insects in relation to flowers is fully given, and this is a subject often neglected for the converse instances of floral adaptations. Here too is an interesting account of differences in habits according as the visitors are of the social or solitary bees. The social class, having to work hard for a living, is forced to visit flowers which the luxurious solitary bee neglects. Near the end of the book is a good account of the statistical method of treating the visits of insects, as illustrated chiefly from MacLeod's researches. The volume concludes with a valuable bibliography comprising 3748 entries, and occupying 160 pages.

The translator has done his work well on the whole. We must, however, direct attention to a few instances of faulty rendering. Thus "Blumenblätter" is translated by "floral leaves," "Saft" (nectar) by "sap." But the few slips in translation that occur are not serious; we have no objection to H. Müller being described as a "genial" author (p. 25), or to the incorrect statement that Darwin inherited his house at Down (p. 8n), except that they are due to the translator, not to the author.

But these are trifles in comparison to the fact that his English is thoroughly readable, and this is a standard by no means easy of attainment in translating from German.

F. D.

#### SINGLE-PHASE COMMUTATOR MOTORS.

*Single-phase Commutator Motors.* By F. Punga. Translated from the German by R. F. Looser. Pp. xvi+187. (London: Whittaker and Co., 1906.) Price 4s. 6d. net.

RECENT advances in the application of single-phase alternating currents to electric traction have given rise to a large volume of literature dealing chiefly with the motors employed. The possibility of working direct-current motors with alternating currents is by no means new, but it is only within the last few years that the principles of good design have become sufficiently well known to enable such working to be made a commercial success.

It was perhaps inevitable that a large part of the literature devoted to this subject should be somewhat academic; in any new departure of this kind the experimental work which forms the basis of progress is in the hands of manufacturers, to whose interest it is that the information so obtained should not be made public. It is, therefore, all the more interesting to examine a book which is evidently written for the practical man. In such a book circle diagrams should occupy a subordinate position, and attention should be directed to the question of proportions that may be assumed in practice.

The course adopted in this book is to set out as clearly as possible what may be called the practical theory of the motors, and to follow this up by applications of the theory to the design of actual examples. This is no doubt the right course, for however valuable a knowledge of the fundamental theory may be, there are many points of equal importance which can only be brought out in the calculation of an actual motor.

The setting out of the theory of single-phase commutator motors has been made very clear, and although circle diagrams are referred to, the author states very truly that they are of little practical value, and that it is better to calculate the current for a few points from first principles. Particular attention has been paid to the question of sparking, and its dependence on the "transformer voltage," the "reactance voltage," and the "rotation voltage" in the coils short-circuited by the brushes. The effect the transformer voltage has on the general design is also clearly explained, but hardly sufficient reference is made to the magnetising action of the circulating current produced.

Turning now to the calculation of typical motors, a series motor of 60 h.p. is worked out, and also a repulsion motor of 48 h.p. It is unfortunate that practically no indication is given as to how these motors are rated. At present, single-phase commutator motors are inevitably associated with traction work, in which it is customary to speak of the one-hour rating. Supposing this to be the intention of the author, it must be confessed that the size of the motors is rather large for their output, chiefly on account of the low speed chosen. Another objection, which is perhaps more serious, is that the windings have been made