made by laboratories least concerned with it—by men who have dabbled in the Einstein theory and the mysteries of the Bohr atom and stumbled on principles applicable to industry. If purely commercial standards are to guide the research director he finds it difficult to attract men of the finest scientific type. His net result is merely a heightening of technical efficiency, an improvement in finished products. Grant a laboratory the right to work untrammeled and both science and industry gain. It was the adoption of this large-visioned policy that made the discovery of ductile tungsten possible—a discovery that unexpectedly gave us electric lamps of an economy and brilliancy undreamed of twenty years ago, radio tubes that have made broadcasting and television twentieth century triumphs, and deeply penetrating X-ray tubes that have been a boon to the sick.

The richest assets of some of our largest corporations are not their physical properties but the discoveries made in laboratories where research has been conducted for its own sake. Perhaps because these assets can not be even approximately appraised, at least one corporation carries its priceless patents on its books at the valuation of one dollar.—*The New York Times.*

SCIENTIFIC BOOKS

The Ferns (Filicales). Vol. II. *The Eusporangiatae and other relatively Primitive Ferns.* F. O. BOWER, Sc.D., LL.D., F.R.S., pp. 344, many figures. Cambridge, the University Press. 1926.

FOR more than forty years Professor Bower has been recognized as a leader in the study of the Pteridophytes; and this work, the second volume of a comprehensive treatise on the ferns, of which the first appeared in 1923, is especially welcome to those, who in these days when morphology is rather discredited still feel that the subject not only is far from exhausted, but will again be revived when some of the current botanical fashions are out-moded.

The present volume treats in detail the Eusporangiatae and the more primitive families of the Leptosporangiates, and is a contribution of the first importance. It records the latest conclusions of the author as to the structure and classification of the ferns.

Not the least valuable feature of the present volume is the attention paid to the fossil ferns, as well as to the living ones; and the comparison of the latter with their ancient relations is constantly borne in mind in an endeavor to construct a system of classification which, approximately at least, will represent the true genetic relationships, and throw light upon the origin of the existing ferns.

Professor Bower recognizes three types of sporangium-development, and on this basis he arranges the families in three categories, *viz.:* Simplices, in which all the sporangia of a sorus are formed simultaneously; Gradatae, in which they are of different ages, formed in basipetal succession; and Mixtae, in which sporangia of different ages are mingled in the same sorus. The Simplices are the most primitive, the Mixtae the most specialized.

There are two types of sorus, marginal and superficial, *i.e.,* borne on the lower surface of the leaf. The marginal sporangia are believed to be the older type, although the superficial sori are characteristic of the Marattiacae as well as of some other paleozoic ferns. The present volume deals with the Simplices and Gradatae, of which fourteen families are recognized.

Before considering the living ferns, a chapter is devoted to a group of fossils, Coenopteridaceae, which have no existing representatives. There are three families of these: Botryopterideae, Zygopterideae, and Anachoropterideae. They are all confined to the Palaeozoic, occurring from the Upper Devonian to the Permian.

The author concludes that the Coenopteridaceae include an assemblage of more or less synthetic types which may probably be assigned to the Filicales, but which do not show any close relationships with existing ferns.

Of the living Filicales, it is pretty generally admitted that the two Eusporangiate families, Ophioglossaceae and Marattiaceae, are the most primitive.

In his earlier writings Professor Bower separated the Ophioglossaceae from the Filicales, but in the present work he has restored them to a place among the ferns, where there is no doubt they belong. It is true that their exact relationship with the other ferns is not easy to determine.

While almost nothing is known of the geological history of the Ophioglossaceae, there is very strong evidence that they are the most primitive, and presumably the oldest, of the living ferns. There seem to be sufficient resemblances to the fossil Coenopterideae to warrant the assumption of a remote relationship with that order.

Although a very full description of the external morphology is given by the author, there are certain points that might be criticized. In the discussion of the venation in Botrychium, for instance (p. 43), Professor Bower emphasizes the difference between the open venation in Botrychium and the reticulate venation of Ophioglossum; but he fails to note the two types of venation found in Botrychium, although he figures these. The simpler, and probably more primitive species, *e.g., B. Lunaria, B. simplex,* have "Cyclopteroid" venation, while the larger species show a

midrib and lateral veins like those of the typical ferns. Now the transition from the cyclopteroid venation of Eu-botrychium to the simple reticulate venation of the cotyledon of *Ophioglossum Moluccanum,* for example, is not a very great one. A similar transition from the open venation to the reticulate is shown by Professor Bower in Marsilea (p. 179, Fig. 461). In short, the contrast between the venation in Ophioglossum and Botrychium is not so marked as Professor Bower believes.

The statement (p. 57), "In the ontogeny of the Pteridophytes a coherent body of tissue called the stele, partly made up of elements having a truly cauline origin, exists from the first, and it serves to connect up adjacent leaf-traces," is certainly open to question. A most careful study of the ontogeny of Ophioglossum, especially *O. Moluccanum,* has shown as conclusively as possible that the whole of the vascular skeleton of the axis is of foliar origin and that there is no truly cauline stelar tissue. This is true also for Botrychium and probably for Helminthostachys, as well as for the early stages, at least, of the Marattiaceae.

It may be said that Professor Bower seems to be aware of the difficulty in harmonizing the stelar theory with the conditions that exist in Ophioglossum.

Professor Bower's studies on the development of the sporangium in the Ophioglossaceae are quite the most complete that have been made, and are amply treated in the present volume. One may venture to differ from his conclusions in one particular, *viz.,* the nature of the sporangial spike. There is good evidence that this is not an appendage of the leaf, but a structure coordinate with the whole sterile segment. Both in *Ophioglossum Moluccanum* and *Botrychium Lunaria* there is a dichotomy of the very young leaf primordium, the branches forming respectively the fertile and sterile segments.

A sufficiently complete account of the gametophyte is given, but the embryo and young sporophyte, especially in Ophioglossum, are not treated as fully as might have been wished. Why the young sporophyte in *O. Moluccanum,* with its functional cotyledon, should be considered less primitive than that of the other species in which the early leaves are rudimentary, is hard to understand; nor will the conclusion that Ophioglossum is less primitive in structure than the other genera be accepted without question. Space will not permit a fuller discussion of these points.

The very distinct order Marattiaceae is of particular importance in the phylogeny of the ferns, since unlike the Ophioglossaceae, to which they are undoubtedly related, there are abundant fossils obviously allied to living forms.

In the later Palaeozoic, fern-like fronds with sori similar to those of existing Marattiaceae are found, and in the older Mesozoic rocks occur fossils much like the living genera.

The statement (p. 102) that the very young sporophyte of Danaea is "protostelic," is incorrect, as there are several distinct xylems belonging, respectively, to the leaf traces which have united to form the solid stele.

The relationships of the Marattiaceae to the other ferns are difficult to determine. They seem to be relics of a Palaeozoic and Mesozoic stock which have come down to the present with little change and have not given rise, directly at least, to any of the existing Leptosporangiates.

In the enumeration of the number of living Marattiaceae (pp. 124–125), there is an obvious typographical error. Christensenia (Kaulfussia) has only two species, not 26, as indicated in the table.

To some extent intermediate between the true Eusporangiatae and the Leptosporangiatae is the small family Osmundaceae with two genera, Osmunda and Todea, and 17 species. Like the Marattiaceae, the living species are but remnants of a once much more extensive order. The earliest fossils of Osmundaceae are in the Permian, where perfectly preserved stems closely resembling the structure of living species are found.

The intermediate character of the Osmundaceae is shown in the gametophyte, embryo and sporangia, as well as in the anatomy of the adult sporophyte. This is excellently summarized on page 148.

The three remaining families of Simplices, Schizaeaceae, Gleicheniaceae and Matoniaceae, like the Osmundaceae, are undoubtedly relics of once much more predominant types. Of these the Schizaeaceae lead up to the series of Leptosporangiates with marginal sori, while the Gleicheniaceae are the most primitive of the series with superficial sporangia.

The Gleicheniaceae, and the related Matoniaceae, are very uniform in their structure; but the Schizaeaceae differ greatly among themselves, and their relations to the other ferns, both living and fossil, are by no means clear. Possibly going back to the Carboniferous, and certainly to the Jurassic, they show great variety both as to external form and anatomy. Their sporangia, however, are quite uniform in type.

Probably an offshoot of the Schizaeaceae are the heterosporous Marsileaceae, which agree closely with the Schizaeaceae in their anatomy and in the development of the sporangia.

During the Mesozoic, especially the Cretaceous, species of Gleichenia were abundant in the northern regions, extending even to West Greenland. Fossils resembling Gleicheniaceae occur in the coal measures, but there is some doubt as to their real nature.

The first family of the Gradatae, the Hymenophyllaceae, is a very natural one, all of the nearly 500

species being referable to the two closely related genera, Hymenophyllum and Trichomanes. Their geological history is obscure, but the latest conclusion is that the family is not an extremely old one. Their nearest relationship is probably with the Schizaeceae.

Formerly included in the Hymenophyllaceae is the monotypic genus Loxsoma from New Zealand; but it has now been separated as the type of a separate family, Loxsomaceae, which also includes three species of a recently described second genus, Loxsomopsis. Professor Bower believes that the Loxsomaceae are related to the Dicksoniaceae.

The most radical change in classification is the separation of the Cyatheaceae, to which most of the tree-ferns belong, into three families, *viz.*, Dicksoniaceae, Protocyatheaceae and Cyatheaceae, the latter including only the three genera, Cyathea, Hemitelia and Alsophila. The Dicksoniaceae have marginal sori, and are believed to have no relation to the Cyatheaceae, in which the sori are superficial The family Protocyatheaceae is proposed to include two genera, Lophoria and Metaxya.

Professor Bower notes a remarkable peculiarity of the young sporangia in Metaxya and the Cyatheaceae in which they differ from all other ferns that have been investigated, *viz.*, the apical cell of the young sporangium is two-sided, instead of three-sided. Figure 55 suggests the segmentation in the antheridium of a moss.

The family Plagiogyriaceae is proposed to include the single small genus Plagiogyria. It is to some extent a synthetic type, intermediate between the Gradatae and Mixtae. "It is a relatively primitive type, but not very closely allied downwards to any one of the known primitive Ferns."

The last family discussed in the present volume is the Dipteridaceae, with the single genus Dipteris, as to whose relationship there has been some controversy.

The final chapter is an excellent summary of the conclusions reached from the detailed study of the different families. This chapter includes maps showing the present distribution of several of the most important families, as well as their occurrence in a fossil condition. There is also a diagram showing the relationships of the families discussed in the text.

Professor Bower's long continued and exhaustive investigations in the development of the sporangium have made him the leader in this important subject, and he has treated it admirably in the present volume. It is this perfect mastery of the subject which makes his classification, based mainly upon sporangial characters, so satisfactory. There will probably be little dissent from his conclusions.

One could wish that less space had been devoted to the elaborate details of stem-anatomy, and somewhat more to the gametophyte and embryo-sporophyte, especially to the question of the origin of the vascular system.

The conclusions reached by recent studies on the origin of the vascular tissues of the Eusporangiatae point to a foliar origin for the bundles of the axis, and these results are hardly given adequate attention by Professor Bower. It is by no means unlikely that further investigations on the vascular bundles of the Leptosporangiates will show that in them also, there is no "stele" in the sense used by the author.

Professor Bower is to be congratulated on the completion of the second volume of this very important undertaking, and the final one will be looked forward to with the keenest interest. To all students of the Pteridophytes these volumes will be indispensable.

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SPECIAL ARTICLES

THE INFLUENCE OF X-RAYS ON THE DEVELOPMENT OF DROSOPHILA LARVAE

DURING the past two years we have been engaged in carrying out experiments the results of which we have hoped would give some definite data concerning certain fundamental aspects of radiation effects on biological processes. As a preliminary report we wish to present some of the observations made on the influence of X-rays on a given biological process, namely, the development of Drosophila larvae into pupae. The larvae employed in our experiments have been raised from an original culture of Drosophilae obtained from Dr. J. H. Northrop who had grown these flies under aseptic conditions for many generations; and we have maintained the same conditions.

Our procedure, briefly stated, has been to wash larvae (mean age, 2.5 days) out of a seeding flask on to a piece of aseptic voile, then to transfer them by a method of random sampling to wells in paraffin blocks, or to paraffin permeated pill boxes (in which case the boxes were then set in wells in paraffin blocks). A Kelly-Koett X-ray machine, supplied with 12.5 cm. spheres for spark gap, has been used throughout.

We observed that the larval stage was significantly prolonged, and that the fraction of the total number of irradiated larvae reaching the pupal stage was sensibly the same as for controls, when the conditions of irradiation were as follows: Spark gap 2 cms., distance between spheres; M. A., 8; target distance, 30.5 cms. Three experiments were then performed in each of which three lots of larvae were irradiated