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.

DOUGLAS HOUGHTON CAMPBELL
STANFORD UNIVERSITY, CALIFORNIA

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

for the same period (one hour) to test the reproducibility of this effect.

The values obtained for the mean duration of the prepupal period, expressed in days, were as follows:

Experiment	*Irradiated*	*Controls*	*Difference*
1	8.35	5.18	3.17
2	8.37	5.04	3.33
3	8.04	4.83	3.21

In another group of experiments larvae were irradiated with radiations, a larger proportion of the energy of which was due to radiations of short wavelength. The conditions of irradiation were as follows: Spark gap 8 cms. between spheres; M. A., 5; target distance 54 cms.; filter 1.0 mm. aluminum and 0.5 mm. copper. The X-ray bulb was contained in a lead drum with a circular aperture of 13.5 cms. diameter. The periods of irradiation were varied, being 50, 100, 150, 200, 250 and 350 minutes, respectively, the corresponding mean duration of the prepupal period, *expressed in days,* being 5.76 ± 0.08; 6.02 ± 0.04; 6.39 ± 0.11; 6.77 ± 0.05; 7.02 ± 0.10; 7.46 ± 0.08; 7.87 ± 0.12, while the value for the controls was 5.63 ± 0.05 (where the precision measure is the a. d. and the number of independent observations for each irradiation interval was four). *These data indicate that the mean duration of the prepupal period is an increasing function of the period of irradiation, under otherwise fixed conditions of irradiation, at least within the interval studied.*

These results suggested the possibility of observing an effect of the radiations just described when employed in a manner similar to that utilized in determining "depth dosage" in radiation therapy, where either water or paraffin phantoms are used in conjunction with the ionization chambers placed at various depths. To this end paraffin blocks were prepared, 25 by 25 by 2.5 cms. with cylindrical wells at the center of one of the large faces of each. These wells were 2.5 cms. in diameter and 0.5 cm. deep. The larvae to be irradiated were selected from a batch of prepared larvae by a method of random sampling and distributed in the wells mentioned above and in a similar well utilized for the controls, aseptic technique being employed throughout. The wells were then covered with a piece of paraffin-permeated paper and sealed, following which perforations were made in the paper lid. The blocks were now stacked so that the edges of the square faces coincided and the wells were accordingly co-axial. Previously air vents had been arranged in the paraffin for ventilation which was facilitated by the use of an electric fan. The stacked blocks were so placed under the X-ray bulb that the centroid of the target lay on the common axis of the cylindrical wells.

Experiments were performed in accordance with the procedure just outlined, in which the period of irradiation was six hours and the distance from the target to the upper face of the top paraffin block was 54 cms. The resulting mean duration of the prepupal periods, *expressed in days,* for the larvae in the various blocks was as follows: 8.37; 7.90; 7.16; 6.47; 6.17; while the mean value for the controls was 5.57 days.

Obviously, it would be desirable to have a measure of the time of irradiation required to produce the same extension of the mean prepupal period in the different layers rather than or in supplement to the data given above. We have been unsuccessful with experiments of this kind, because the facilities for producing a sufficient radiation intensity available at present in our laboratory are such that the period of time required to effect significant changes in the larvae irradiated at the lower levels is so great that it is disadvantageous to maintain the larvae in the unnatural environment. In the experiments performed so far we have not obtained reproducible results.

We hope that in the near future we shall have the necessary facilities for completing these experiments and extending our work to include observations of other biological processes in the same as well as in other systems. Such experiments will undoubtedly lead to a better understanding of how radiations affect biological processes and it is possible that methods may be made available which will permit the measures of biological effects and those of ionization effects to be contrasted.

R. G. HUSSEY
W. R. THOMPSON
E. T. CALHOUN

DEPARTMENT OF PATHOLOGY,
YALE UNIVERSITY

THE ANTI-STERILITY VITAMIN E AND POULTRY[1]

HERBERT M. EVANS and George O. Burr,[2] of the University of California, stated in a paper presented at the Washington meeting of the National Academy of Sciences, and reported in Volume LXI, No. 1585, SCIENCE, that "sterility is a dietary deficiency disease for it can be cured or prevented by a change in dietary régime, a change involving the addition of certain single natural foods high in a food factor or the addition of very much smaller amounts of extracts of those foods." The work reported was with rats.

In this report they state that Vitamin E is present

[1] Published by approval of the Director of Agricultural Experiment Station as Technical Paper No. 47.

[2] "Anti-Sterility Vit. E.," Evans and Burr, SCIENCE, 61, 519–520, May 15, 1925.