a matrix of haploid cells interspersed throughout with cells containing 2 or more nuclei. The aecium becomes differentiated into a lower half of large vacuolated cells, which later die, and an upper half of smaller denser cells. In this upper area multinucleate cells are abundant. The number of nuclei varies, ranging in extreme cases to 15 or 20 per cell. With further growth and cell division the number of nuclei per cell decreases. From this mass cells grow down to form the sporogenous layer of "basal" cells. Young basal cells contain from 2 to 8 nuclei. The extra nuclei are used in forming the first spores and by the time the spore chains are well started the basal cells are regularly binucleate.

The question of the effectiveness of the receptive hyphae that grow to the upper surface of the leaf is still an open one. Aecia occur that open on the upper surface, but they are uncommon. Either fertilization of the upper receptive hyphae is rare, or those that are fertilized grow to the lower surface before developing further. So far this has not been observed.

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THE REDIA OF THE GASTEROSTOMES[1]

An intermediate generation has been found in the life history cycle of the trematode order *Gasterostomata*, thereby bringing this form into line with normal life histories of other digenetic trematodes. The adult of this generation, the redia, is found in abundance in the lumen of the young mother-sporocysts. Young redia dissected from the mother-sporocysts are very active swimmers due to the covering of long cilia over the entire surface of the body. Older specimens indicate a loss of cilia followed by a coating of spines which are similar in character to the final adult. Two eyes are present. The redia is hermaphroditic. The testis is large, median in position with an extensible penis. In a live redia, mature active spermatozoa have been observed. The ovary is small, below the testis on the left side. Laurer's canal is long and apparently functions in cross-fertilization as a sperm-duct leading to the ovary. The vitelline complex in two lateral rows is very well developed. Eggs are shed through a short oviduct into the cavity of the mother-sporocyst and give rise to cercariae.

The origin of the redia was found to be in the gonads of the mother-sporocyst, and localized in the distal ends of the branches. The testis is large and situated below the tip of the branch previous to the expanded portion of the lumen. The ovary in the mother-sporocyst of *Bucephalus pusillum* appears in the form of "stroma." In *B. elegans* the ovary is located in a "plug" extending downwards into the lumen. This "plug" is composed of the ovary and nutritive glands, both in the form of "stroma" which, as development proceeds, extend for a considerable distance through the lumen even in older branches heavily packed with cercariae.

Spermatogenesis has been worked out in detail for all three generations; in the mother-sporocyst, redia and final adult.

It is therefore concluded that each of the three generations starts with a fertilized egg and gives rise to hermaphroditic "adults." Maturation with polar bodies and reduction is evident. There is no parthenogenesis or metagenesis. The life history of the trematodes as witnessed in this order is simple, with comparable embryological and larval stages in each of the three generations. The differences in the adults undoubtedly has evolutionary significance and is probably due to parasitism: first, within a mollusk; second, within the mother-sporocyst, and third, within the vertebrate.

Other species, not related to the gasterostomes are being studied by the author to find out how universal this method of reproduction is, among the class *Trematoda*. Material to be examined must be young before the reproductive stage is over and before the nutritive phase increases to confuse observation. Completely known life cycle material is preferable. Differential staining is advisable.

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[1] Contribution from the Zoölogical Laboratory of the University of Michigan.

VARIATIONS IN THE EVENING PRIMROSE INDUCED BY RADIUM

Geneticists are now aware that x-rays and radium are agents by which genetic changes, both genic and chromosomal, may be produced. However, in the several years since 1927, in which many investigators have published on the genetic effects of irradiation on both plants and animals, nothing, in so far as I am aware, has appeared dealing with the irradiation of the evening primrose. For the past three years the writer has been making such an investigation, using radon (radium emanation) in the treatment of *Oenothera Lamarckiana* and *Oe. franciscana*, a preliminary account of which appears here.

The method of treatment was to insert an unfiltered tube of radon parallel with the buds in a flowering cluster, thus treating buds in all stages of development at distances varying from direct contact to 4 cm. As the flowers opened after treatment they were self-pollinated. Eight irradiations of *Lamarckiana* and four of *franciscana* were made, the tubes of radon used varying from 7 millicuries to 17 mc, and the times of application from four to twenty hours. At the same time, flowers on another shoot of the same plant were selfed (being adequately protected by lead) to provide control material. In all cases, control families have shown only the usual species characteristics.

The immediate effects of the radium treatment were a development after two days or less of a necrotic area in the cluster where the radon tube had rested, an abscission of buds thus affected regardless of size or age unless the injury was very slight, and a necrosis of all buds in the stages of meiosis or younger. The rate of flowering, the size of the flowers, and the fertility, chiefly of the pollen, were affected to a greater or less degree depending on the dosage.

Single capsule sowings were made in 1930 of the seed from treated buds, making 95 families of *Lamarckiana* origin and 29 families of *franciscana* origin. The percentage germination was lowered in those cultures which had the heavier dosages. As the seedlings developed their rosette characters it was found that many unclassifiable leaf shapes, sizes and peculiarities existed in both *Lamarckiana* and *franciscana*. In the majority of cases, the leaves were very much distorted and retarded in growth. In some cases, however, quite new and distinct leaf features were present. In *Lamarckiana* material small, weak plants were rather common in irradiated cultures, some with very unusual leaf characters; mottled, pale green, reduced size, wiry, irregular, no crinkling, excessive crinkling and the like. No two were identical. In the *franciscana* cultures the same general conditions were present, although the percentage of abnormal forms was lower. However, the most striking of the radium variants have been in *franciscana* material.

It is unfortunate that the vast majority of the atypical forms mentioned above were too weak to survive field conditions, either dying or not coming into bloom. A few of the stronger ones did bloom, however, and have proved very interesting plants. The abnormal characteristics manifest in the rosette condition continued and new ones peculiar to the mature condition appeared. As a rule, the flowering tip was smaller, bore fewer flowers, and had quite a high percentage of buds drop before blooming. The flowers were generally smaller, distorted in most features, and pollen sterility was much in evidence. Some few plants were wholly sterile.

Breeding work, in so far as was possible, was done with the above forms. The progenies are now being grown. It is known definitely that one of the abnormal types found in *Lamarckiana* when selfed throws a progeny in which the parent type composes approximately one-fourth (7 in 27) of the population. This type is a little more viable than the majority. It is a form with dull coarse leaves, free from crinkling with very irregular margins, sometimes toothed. The behavior at present suggests some unbalanced chromosome condition.

One of the more viable of the atypical *franciscana* forms was selfed and its progeny grown this summer. An entirely new form has appeared, extremely weak with very linear mottled leaves. Twenty-three of these plants have appeared in a population of 64, the frequency suggesting a 1:2 ratio. It is disappointing that this new form is not viable under field conditions. Selfings are being made among the 41 other plants in the hope of discovering a few heterozygotes which will give the same form next year.

Many of the normal plants in irradiated cultures were selfed in the summer of 1930, so that any recessive condition induced by radium treatment might appear in their progeny this summer. In one case, that of a *franciscana* plant, an abnormal type has appeared. In a population of 25 plants, four are of this new type, characterized chiefly by the tiny, much distorted crinkled condition of the leaves on the flowering tip.

It is intended to continue the genetical investigation on these new forms occurring in the progenies from radium-treated buds, in so far as the conditions of reduced fertility will permit. It is also planned to investigate the chromosomal conditions in the radium variants.

I wish to acknowledge the invaluable aid of those who are making this work possible: Dr. Halsey J. Bagg, of Memorial Hospital, New York City, who has kindly supplied me with the radon, and Dr. George H. Shull, of Princeton University, who has been very helpful in his guidance and criticism.

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BOOKS RECEIVED

BINET-SANGLE, DOCTEUR. *Les Ancêtres de l'Homme.* Pp. xx + 290. 16 photographs. Michel. Paris. 25 francs.

CAMPBELL, GEORGE A. and RONALD M. FOSTER. *Fourier Integrals for Practical Applications.* Pp. 177. 7 figures. Bell Telephone Laboratories.

DITMARS, RAYMOND L. *Snakes of the World.* Pp. xi + 207. 84 plates. Macmillan. $6.00.

HALE, GEORGE E. *Signals from the Stars.* Pp. xx + 138. Illustrated. Scribner's Sons. $2.00.

MAXWELL, JAMES CLERK. *A Commemoration Volume. 1831–1931.* Pp. viii + 146. 2 portraits. Macmillan. $2.50.

NEW YORK COMMISSION ON VENTILATION. *School Ventilation: Principles and Practices.* Pp. ix + 73. Teachers College, Columbia University. $1.00.

ROBINSON, HOWARD. *Bayle the Sceptic.* Pp. x + 334. Illustrated. Columbia University Press. $4.25.