λ	Int.	Term combination
1576.5	6	$^2P_2 - {}^4P_3$
1540.8	6	$^2P_2 - {}^4P_2$
1488.6	8	$^2P_2 - {}^4P_1$
1633.6	10	$^2P_1 - {}^4P_2$
1575.0	9	$^2P_1 - {}^4P_1$
1449.9	3	$^2P_2 - {}^2P_1$
1582.4	8	$^2P_1 - {}^2P_2$
1531.9	7	$^2P_1 - {}^2P_1$

the ionization potential of approximately 12.2 volts for the neutral atom. This value is checked by interpolation from the known ionization potentials of Ga, Ge and Kr.

Both Kimura[3] and Hori[4] have published observations of the complex structure of Br lines. We have used the Fabry-Perot interferometer in observing the Br spectrum and we confirm their findings as to the fine structure of numerous lines.

The details of this investigation will appear in an early number of the Bureau of Standards *Journal of Research.*

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[3] Memoirs, College of Science, Kyoto, 4: 139. 1920.

[4] Memoirs, College of Science, Kyoto, 9: 307. 1926.

ON THE BIOLOGICAL EFFECTS OF X-RAYS

THE object of this note is to record briefly the results of experiments upon *Saprolegnia ferax* carried out during the summers of 1925 and 1926 at Woods Hole. It was to be expected that with modern radiation apparatus and a knowledge of the technique as applied to *Drosophila, Saprolegnia* with its extremely sensitive behavior toward chemical changes and its various modes of reproduction would provide changes under the action of X-rays which could be treated statistically. Except for a possible stimulus to nuclear division in the mycelium under the influence of X-rays, extensive experimentation on the rate of growth in culture media, on the formation and liberation of zoospores, the formation of oogonia and oospores, and the movement of protoplasm, failed to produce any results which could be attributed to the action of X-rays. The amount of radiation was enormously greater than had been employed with *Drosophila.* A dosage of 50,000 volts at 2.5 m.a. for twenty minutes with a standard Coolidge tube, and the material at 12 cm from the tungsten target (in our method of recording represented by 32D),[1] had been sufficient to cause complete sterility in *Drosophila* for two days and partial sterility for ten days. Applications as high as 75,000 volts at 10 m.a. for forty-five minutes at a similar distance from the tube failed to produce any results in *Saprolegnia.* The material radiated was exposed in water in small petrie dishes, duplicate material being kept as a control. The entire life cycle of *Saprolegnia* may be carried out in from two to three days. These experiments were so conducted that samples of the radiated material could be removed for study or staining without disturbing the remaining material. It was desirable to keep a large amount of material permanently, and after experimentation with many stains it was found that gentian violet for eighteen to twenty-four hours, destained by xylol, would show chromosomes in the mycelium and the oogonia without recourse to sectioning. The chromosomes, however, are minute.

As regards *Drosophila,* the writer does not presume to say that mutations can not possibly be induced by X-rays, but a series of carefully planned and extensive experiments carried out in 1922–1924 by the writer with the cooperation of Dr. Mavor, having as one of the primary ideas the possible production of mutations by X-rays, failed entirely to produce any physical mutations which could be detected. In these experiments, with special reference to three characters of the second chromosome, black, purple and curved, under various dosages of X-rays, some 120,000 individuals were individually examined in four repeated experiments, one half the number being controls. In no case could mutations be detected in greater numbers than appeared normally in the stock. Crossovers from the "recovery period," *i.e.,* the period of greatest percentage of crossover after X-ray treatment, were bred in numerous auxiliary experiments; in one of these the increased crossover percentage was clearly demonstrated as not inherited,[2] and there was no sign of mutations.

From these experiments the writer believes that X-rays tend to show the extraordinary resistance of the germ-plasm to change by experimental means. Either the organism is killed, *i.e.,* by lethal rays during maturation divisions in the egg, resulting in complete or partial sterility; or the changes in percentage of crossing-over which accompany the recovery period disappear in the succeeding generation.

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[1] J. W. Mavor and H. K. Svenson, *Genetics,* 9: 588–608 (1924), and previous papers.

[2] *Am. Nat.,* 58: 311–315. 1924.

CONTROL OF THE COTTON BOLL WEEVIL BY INSECT ENEMIES

PRIOR to the use of poisons for the control of the cotton boll weevil (*Anthonomus grandis* Boh.), the attention of many entomologists interested in the control of this insect pest became directed towards an intensive study of the weevil's insect enemies.[1] During the past fifteen years, however, but little recognition has been given this phase of natural control of the weevil. On the other hand, distinct advancement in the cultural methods of boll weevil control is generally recognized, and consequently a larger quantity of more suitable fertilizer is annually used for growing better and earlier varieties of cotton.

Since the heavy weevil damage in 1923, there appears to be a lessening of the general damage to cotton which is attributed directly to the boll weevil. Severe local infestations, however, have occurred throughout the cotton belt. Such occurrences are similar to the experiences of entomologists working with other insect pests controlled wholly or in part by their insect enemies. Furthermore, it must be remembered that the boll weevil has been in the United States for at least thirty-four years, becoming established in the entire cotton belt by 1922. Consequently it seems probable that the importance of insect enemy control might be greatly increasing.

It is a significant fact that the boll weevil has some fifty-five insect enemies, including parasites and predators; but of still greater significance is the fact that these enemies are all native insects which were present in the cotton belt before the weevil arrived. Stated more in detail, the boll weevil is attacked by twenty-nine native species of parasites, twenty native species of predators which attack the immature stages and six native species of predators which attack the adults. These particular insects have a large number of native hosts (fifty-two other weevils which in turn attack ninety-one other species of plants), and are to be found in great abundance in the neighborhood of cotton fields.

A number of entomologists have determined that the life-cycle development of the boll weevil parasites is as rapid as that of the boll weevil. This fact, in addition to the early occurrence of other hosts of the parasites, tends to insure a timely presence of numerous parasites to combat the boll weevil. It is not astonishing, therefore, that there should be many areas in the cotton belt where boll weevil damage appears to be growing less severe.

During the past six years the writer has repeatedly observed natural control of rather severe initial boll weevil infestations. Out of these six years only three were climatically unfavorable for the weevil, hence the writer's attention became directed to the insect enemies of the weevil. The accompanying table was compiled from a series of collections of weevil-punctured cotton squares which were forwarded to the insectary at Gainesville, Florida, where the weevils and parasites were hatched.

Locality	Date collected 1926	Punctured squares examined	Boll weevils hatched	Parasites hatched	Per cent. hatched boll weevils	Per cent. hatched parasites
Campbellton, Fla.	July 30	190	119	1	62.63	0.53
Americus, Ga.	July 7	765	381	7	49.80	0.92
Greenville, Fla.	August 1	405	190	37	46.91	9.14
La Crosse, Fla.	July 18	540	207	35	38.33	6.48
Thomasville, Ga.	July 5	450	170	0	37.78	0
Bonifay, Fla.	August 1	390	135	5	34.62	1.28
12 Mi. S. of Dothan, Ala.	July 30	413	137	80	33.17	19.37
Alachua, Fla.	July 18	900	282	58	31.33	6.44
6 Mi. S. of Greenville, Fla.	August 1	402	102	3	25.37	0.75
4 Mi. W. of Campbellton, Fla.	July 30	348	87	16	25.00	4.60
Hurtsboro, Ala.	July 9	1100	266	18	24.18	1.64
4 Mi. N. of Madison, Fla.	July 29	376	75	18	19.95	4.79
Dothan, Ala.	July 30	316	56	9	17.72	2.85
Columbus, Ga.	July 8	900	150	8	16.67	0.89
5 Mi. N. of Madison, Fla.	July 29	574	83	24	14.46	4.18
6 Mi. S.E. of Madison, Fla.	July 29	382	13	68	3.40	17.80

Sixteen localities were examined and in but three of these, Campbellton, Florida, and Americus and Thomasville, Georgia, was weevil poisoning carried on. A fair yield of cotton was obtained in all sixteen localities.

It is the opinion of the writer that a more extensive study of the natural enemies of the boll weevil will indicate that they are generally becoming more important as a limiting factor in boll weevil damage.

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1 W. Dwight Pierce, "The Insect Enemies of the Cotton Boll Weevil," Bul. 100. Bureau of Entomology, U. S. D. A. 1912.