STUDIES ON THE EFFECT OF BETA RADIATIONS ON INSECTS

I. The Effect of Beta Radiations (Irradiation of Eggs and 1st Instar Larvæ) on the Life-history of *Corcyra cephalonica* Stainton

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Received April 6, 1959

INTRODUCTION

VERY little published information is available on the effects of beta radiations on insects. Butler (1936) has reviewed the major effects of nuclear radiations on developing animal structures, like inhibition or retardation of growth and differentiation as well as the production of atypical organs. Similar effects of beta radiations from radioactive phosphorus have been reported by Martin, Dent and Joseph (1948) in a parasitic wasp, *Habrobracon juglandis* Ashmead and by Blumel (1950) in two species of *Drosophila.* It is evident that the nuclear radiations cause considerable damage to the biological tissues, as these highly energetic radiations penetrate the body tissues and dissipate energy to the latter. But the probability of tissue being damaged may be little with low levels of radiation exposures since the size of the nucleus is smaller as compared to that of a tissue cell and consequently the probability of nuclear radiations striking the nucleus will be low with low levels of radiation intensities (Bleuler and Goldsmith, 1952). If the nuclear radiations do not hit the nucleus of a tissue cell, there will not be any destruction of the latter. Keeping this in view the present work was undertaken to study the effects of different intensities of beta radiations on the development of *Corcyra cephalonica* Stainton which is a useful laboratory host for several beneficial hymenopterous parasites like *Bracon gelechiæ* Ashmead, *B. hebetor* Say, *B. brevicornis* Wesmael and *Apanteles angaleti* Muesebeck, etc.

MATERIAL AND METHODS

The eggs and larvæ of *C. cephalonica* were taken from the mass culture maintained in the Parasitology Laboratory of the Division of Entomology. The beta radiations from phosphorus (P^{32}) source were used in this investigation. Radioactive phosphorus (P^{32}) decays into a stable isotope of sulphur (S^{32}) with the emission of beta particles having the maximum energy of

1·71 Mev. and an average energy of 0·695 Mev. The physical half life of P^{32} is 14·3 days. The radioactive isotope of phosphorus was supplied by the Radiochemical Centre, Amersham, England, in the form of phosphoric acid ($H_3P^{32}O_4$).

Requisite volumes of radioactive phosphoric acid containing 0·5, 1, 2 and 3 millicuries of P^{32} were pipetted on to one inch diameter aluminium planchets and were then dried under an infra-red lamp. The planchets were then covered with a cellophane paper to avoid accidental radioactive contamination. The absorption of the radiations by the cellophane covering (1·14 mg./cm.^{2}) was negligible. The cellophane covered side of the planchets was kept parallel and facing the bottom of the glass jars (4 inches in diameter and 6 inches in height) where the freshly laid eggs and freshly hatched larvæ were kept in petri dishes for irradiation. A distance of 12 cm. was maintained between the test material and the P^{32} source on the planchet in all the experiments. The radiation exposure dosages were calculated after Bleuler and Goldsmith (1952), who have shown that one millicurie source of P^{32} gives at a distance of one metre a radiation dose of 16 mrep per hour. On the basis of this, P^{32} sources of 0·5, 1, 2 and 3 millicuries activities at a distance of 12 cm. thus give dosages of 555, 1111, 2222 and 3333 mrep/hr. respectively.

Batches of 250 eggs laid by the females within four hours were spread uniformly on the bottom of petri dishes (3 inches diameter), the latter being placed in the irradiation jars kept at 29 ± 4° C. and 70 ± 4% R.H. They were exposed for 24 hours to beta radiations from sources of radioactive phosphorus giving dosages of 555, 1111, 2222 and 3333 mrep/hr. Then the eggs were placed singly for hatching in specimen tubes (3 inches × 1 inch) closed with perforated corks. The freshly hatched larvæ were fed on crushed Jowar mixed with 10% yeast. They later on pupated and the adults of the first generation emerged out, which were separated into pairs of male and female which were kept separately in specimen tubes for oviposition. The eggs laid daily were kept separately for hatching. The newly hatched larvæ were reared in glass jars (6 inches × 4 inches) containing crushed jowar mixed with 10% yeast. Similarly the life-history of the insect in the second generation was also studied.

In another set of experiments 100 freshly hatched larvæ of *C. cephalonica* were similarly irradiated for 24 hours with beta radiations giving the same dosages and the life-history up to two successive generations was studied. Unirradiated eggs and larvæ were kept as controls and their subsequent generations were simultaneously studied. All the life-history studies were carried out at 29 ± 4° C. and 70 ± 4% R.H.

EXPERIMENTAL FINDINGS

The observations from the foregoing experiments on the irradiation of eggs are incorporated in Table I and those of the larvæ in Table II. It is evident from the data in Table I that there is no embryonic mortality due to beta radiations in the parent generation in any of the treatments, as the per cent. viability of the eggs even in the treatment with a high dose of 3333 mrep/hr. is almost equal to that in the control. There is also no detrimental effect of these intensities of beta radiations on the development of the caterpillars hatching out of the treated eggs as the per cent. successful completion of development even in the highest dose is almost equal to that of the control.

TABLE I

	Treatment dose (mrep/hr.)				Control
	555	1111	2222	3333	
Parent generation					
No. of eggs exposed ..	250	250	250	250	250
Per cent. larvæ hatched ..	40·4	64·0	39·2	26·8	29·2
Per cent. larvæ pupated ..	52·0	85·6	71·4	76·1	65·7
Per cent. adults emerged	71·1	86·8	82·9	76·4	81·3
Per cent. successful completion of development	14·8	47·6	23·5	15·6	15·6
First generation					
Total No. of eggs laid ..	2957	1628	2396	838	1665
No. of females ..	13	8	10	4	7
Fecundity per female ..	227	203	239	209	223
Per cent. viability ..	11·36	51·3	11·95	26·85	17·52
Per cent. adults emerged	58·93	30·45	95·39	76·43	62·36
Per cent. successful completion of development	6·7	16·22	9·52	20·52	10·15
Second generation					
Total No. of eggs laid ..	2299	1487	2957	3173	2339
No. of females ..	11	10	11	11	10
Fecundity per female ..	209	149	268	286	234
Per cent. viability ..	14·03	26·36	30·10	13·23	13·28
Per cent. adults emerged	45·29	43·36	25·28	33·10	34·0
Per cent. successful completion of development	6·35	11·43	7·61	4·38	4·70

On the other hand, the 1111 and 2222 mrep/hr. dosages are more effective than the other two dosages as the per cent. successful completion of development in these two dosages is more than in the others. However, 1111 mrep/hr. dose is more effective than the 2222 mrep/hr. dose since the per cent. successful completion of development is distinctly higher in the former.

Dent and Amy (1950) have observed that when the eggs of *H. juglandis* are irradiated for 48 hours with beta radiations from radioactive phosphorus sources having activities between 1200 and 2100 microcuries, there is either no hatching or there is mortality in the larval stage. However, most of the individuals become imagoes when the eggs are exposed to low levels of radiation intensities (68–200 microcuries). This is probably due to: (*a*) The exposure period is longer (48 hours) and the distance between the radiation source and the eggs in their experiments is less than 2 mm. with the result that the dosages to which the eggs have been subjected are considerably higher than those used in the present investigation and, (*b*) the test insects were different in both the cases.

In the first generation the per cent. viability of eggs is again higher with 1111 mrep/hr. dose, whereas the per cent. adult emergence is more with 2222 mrep/hr. dose; but the per cent. successful completion of development increases in the case of 3333 mrep/hr. which is not markedly different from that of 1111 mrep/hr. dose. Further in the second generation the per cent. successful completion of development is higher with 1111 mrep/hr. dose, but there is no marked difference amongst different dosages and the control.

In the case of freshly hatched larvæ which are irradiated with the same intensities of beta radiation, the per cent. successful completion of development in parent generation is higher in all the treatments as compared to the control. Moreover, amongst the treatments it is distinctly higher with 1111 mrep/hr. dose (Table II). In the subsequent development of the two generations there is no apparent effect of these intensities of beta radiations as there is not much difference in the per cent. successful completion of development of the insect in the treatments and the control.

Contrary to the findings of Martin, Dent and Joseph (1948) and Blumel (1950) the present findings have indicated that exposure of the eggs and the first instar larvæ to the beta radiations does not appear to be detrimental, and the effect is dependent on the intensities of beta radiations. A dose of 1111 mrep/hr. is beneficial so far as the development of *C. cephalonica* is concerned. It, therefore, appears that the effect of these intensities of beta radiations from radioactive phosphorus (1111 mrep/hr.) on the eggs and

TABLE II

	Treatment dose (mrep/hr.)				Control
	555	1111	2222	3333	
Parent generation					
No. of larvæ exposed ..	100	100	100	100	100
Per cent. adults emerged	69	85	65	62	48
Per cent. successful completion of development	69	85	65	62	48
First generation					
Total No. of eggs laid ..	2808	2713	3490	2518	2405
No. of females ..	11	11	11	10	9
Fecundity per female ..	255	247	317	252	267
Per cent. viability ..	40·9	20·1	25·04	32·9	27·6
Per cent. adults emerged	24·1	45·6	26·2	34·0	39·1
Per cent. successful completion of development	9·9	9·1	6·5	11·1	10·6
Second generation					
Total No. of eggs ..	2363	1147	1642	1971	2089
No. of females ..	11	9	11	9	11
Fecundity per female ..	215	123	149	219	190
Per cent. viability ..	41·9	27·3	38·3	30·9	19·8
Per cent. adults emerged	34·0	45·8	27·1	32·1	53·4
Per cent. successful completion of development	14·2	12·5	10·4	9·9	10·6

first instar larvæ of *C. cephalonica* is stimulating in nature, incidental rather than cumulative in character.

SUMMARY

The irradiation of eggs and first instar larvæ of *Corcyra cephalonica* Stainton with beta radiations from P^{32} has shown that even a dose as high as 3333 mrep/hr. does not produce any detrimental effect on the subsequent development of the parent as well as the two successive generations. However, the per cent. viability and per cent. successful completion of development in the parent generation are comparatively high with 1111 mrep/hr. dose than with 555, 2222 and 3333 mrep/hr. dosages and the control. Thus it may be concluded that the beta radiations of 1111 mrep/hr. intensity seem to be of stimulating nature for the eggs and larvæ of this insect.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. B. P. Pal, Director, Indian Agricultural Research Institute, New Delhi, for the keen interest he has taken in this piece of research work. Their thanks are also due to staff of the Parasitology Laboratory for the supply of the insects used in this investigation and to Shri Nathu Singh, Junior Scientific Assistant, for assistance in the routine work.

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