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CYTOGENETIC STUDIES FOLLOWING HIGH DOSAGE PATERNAL IRRADIATION IN THE MEALY BUG, PLANOCOCCUS CITRI

I. CYTOLOGY OF $X_1$ EMBRYOS * **

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With 41 Figures in the Text

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The mealy bug, Planococcus citri (Risso) (Coccoidea-Homoptera) has a “lecanoid” system of chromosome behavior (Hughes-Schrader 1948). The salient features of this system, as exemplified by $P$. citri, may be briefly summarized as follows: both males and females start development as diploids with 10 chromosomes each. The adult female goes through an aphid-coccid type of meiosis (Hughes-Schrader loc. cit.). In the male, one set of chromosomes becomes heterochromatic during early embryogeny and remains so until it is eliminated in the adult following spermatogenesis. In common with those of other coccids (Hughes-Schrader and Ris 1941), the chromosomes of the mealy bug are endowed with diffuse kinetic activity so that chromosome fragments persist through successive mitotic cycles.

By using radiation-induced chromosome fragmentation and dominant lethality, Brown and Nelson-Rees (1961) have recently reported their analysis of the lecanoid system in $P$. citri. Since the present report is an outgrowth of their experiments, their results will be briefly summarized.

Brown and Nelson-Rees tested the two hypotheses of the Schraders (Schrader and Hughes-Schrader 1931, Hughes-Schrader 1948) concerning the lecanoid male: that the heterochromatic set is paternal in origin and that it is genetically inert. After paternal irradiation (P. I.) chromosome fragmentation in the male embryos was limited to the heterochromatic set, thereby demonstrating its paternal origin. The inertness of the heterochromatic set was shown by the response of the $X_1$ ($F_1$) progeny following P. I. with low doses. Thus, following 2,000 to 16,000 r of P. I. the number of daughters declined drastically with increasing dose while the number of sons remained unaffected; at 16,000 r, for example, the number of daughters that survived was less than 5% of the control value while a preponderance of sons — about 120% of the control value — survived. The inability of damage to the heterochromatic set to induce lethality in males even after 30,000 rep (i. e., roentgens equivalent physical) of P. I. showed its considerable inertness.

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When Brown and Nelson-Rees tested higher doses (30, 60, 90, 120 × 10³ rep) of P. I., however, the number of daughters increased to about 40% of the unirradiated control value at 60,000 rep and stayed at about that level until 120,000 rep—the highest dose used by them after which a male was capable of mating. After 60,000 rep of P. I., the dose at which the increase in surviving daughters was first noticed, the number of surviving sons abruptly dropped to less than 10% of the control value and further decreased with higher doses (see Fig. 4 of Brown and Nelson-Rees 1961).

Cytological studies of adult females surviving these heavy doses of P. I. (Chandra 1963) showed that they all had unbroken chromosomes and were therefore gynogenetic in origin. Triploids, diploids, 3N/2N mosaics, and 2N/N mosaics were found among these X₁ gynogenetic females. In the following paper (Chandra 1963), the cytology of X₁ females, their fertility and related problems will be described. Meiosis in triploid females is of special interest because of the holokinetic nature of the chromosomes and has been reported separately (Chandra 1962). In addition, Nelson-Rees (1962) has recently reported on his studies of sons that survived heavy doses of P. I., with particular reference to spermatogenesis and fertility.

It is the purpose of this paper to describe the cytology of X₁ embryos following 90,000 rep P. I. in order to clarify the chromosomal mechanisms responsible for the production of gynogenetic females and the lethality of most of the X₁ male progeny.

Materials and Methods

 Cultures of mealy bugs were grown on potatoes in glass jars according to the methods described by Nelson-Rees (1961). The dose chosen as standard for studying X₁ embryos cytologically was 90,000 rep. The gamma radiation was delivered from a cobalt⁶⁰ source belonging to the Bio-organic Group of the University’s Lawrence Radiation Laboratory. Irradiated adult males were immediately mated to virgin females from stock cultures; appropriate controls were kept.