

- 1204 Brown, E.H., King, R.C. THE OCCURRENCE OF OVARIAN TUMORS IN Drosophila melanogaster HETEROZYGOUS FOR AN UNSTABLE CHROMOSOME. (Abstr.) Genetics 46, 8 (1981) 854.

During normal oögenesis about one developing egg chamber in 20 000 becomes tumorous. Irradiation of newly emerged females with 4000 r of  $Co^{60}$   $\gamma$ -rays increases the frequency of tumour about 26 times. Ionizing radiation is known to result in chromosome breakage and subsequent loss of the acentric fragments. This fact suggests that deletion of segments and chromosomal elimination may lead to the production of tumours. To check this point a study was made of the reproductive systems of individuals heterozygous for an unstable, ring X chromosome. A total of 3893 egg chambers from 53 ovaries (representing 31 gynandromorphs) were examined, and 125 (8,21%) of the chambers were found to be tumorous. These tumours were distributed among 11 of the gynandromorphs examined. The gynandromorphs were obtained by crossing  $In(1)X^{c2}, w^{vc}/ywm^4$  females to  $ywm^4$  males. Cytological study of the tumours indicates that at least some arise through the invasion of the egg chamber by cells arising from the follicular envelope, as tongues of these cells are often observed which extend from the follicular epithelium into the chamber. In cases where the chamber is filled with small tumour cells (and no nurse cells or oöcyte are present) the tumour may be of germ cell origin. A study of the karyotype of the tumour cells is under way.

- 1205 Bumer, B. THE ACTION OF TUMORIGENIC TREATMENTS AND PROTECTIVE AGENTS ON MELANOTIC TUMOUR FORMATION IN D. melanogaster. (Abstr.) Heredity 18, 4 (1963) 554.

The  $tu\ bw: st\ su-tu$  strain of Drosophila melanogaster carries a melanotic tumour gene on the second chromosome and a specific tumour suppressor on chromosome three. Plaine and Glass (Science 126: 1957, 683) showed that penetrance of this tumour is greatly increased by x-ray treatments or by an excess of I-tryptophan in the diet, and that the effect of these treatments can be counteracted by L-cysteine. They suggest that both tumorigenic treatments act upon the tryptophan peroxidase-oxidase mediated reaction, the product of which, formylkynurenine, interferes with the action of the suppressor gene. Current investigations using chemically defined germ-free media do not support these propositions since tryptophan and x-ray treatments operate through temporally distinct developmental events, and studies on the protective effect of L-cysteine, L-methionine and cystamine point rather to a genetically controlled defect of sulphur metabolism.

- 1206 Ghéziiovitch, S. INFLUENCE OF X RAYS ON THE DEVELOPMENT OF MELANOTIC TUMORS IN Drosophila (Drosophila melanogaster). Bull. Ass. franç. Cancer 48 (1961) 151-73.

Irradiation of the embryos or larvae considerably increases the incidence of melanotic tumours in these flies. Irradiation of germinal cells does not influence development of tumours in flies developing from the cells. The presence of the tumour gene in the genotype of the egg or larva is an essential condition for the tumorigenic action of irradiation. The statistical distribution of tumours in irradiated populations conforms to Poisson's law, and it is independent of the stage of ontogenesis at the time of irradiation. The effects of several irradiation treatments are additive, and the incidence of tumours increases with the dose to an upper limit of 600 to 800 r. Beyond 1200 to 1500 r the incidence of tumours decreases as mortality increases. Between doses of 0 and 800 r the incidence of tumours rises linearly from 10% to 95%, respectively. In contrast, the slope of the curve of induction of tumours depends neither on the incidence nor on the level of tumour gene; it seems to be influenced by cytoplasmic and maternal factors. When irradiation increases the number of tumours, it simultaneously increases their size and rapidity of their appearance. Irradiation does not modify the histologic appearance of the tumours. Occasionally tumours were observed in the leucopoietic tissue of the larva. The phagocytic activity of blood cells was not affected by irradiation. The increased incidence of tumours in irradiated Drosophila cannot be attributed to selective mortality or to inhibition of defense factors against tumour cells. The failure of irradiation to have a tumorigenic effect in older larvae indicates that it does not affect the development and growth of tumours once formed. It is suggested that irradiation increases the sensitivity of larval cells to a tumour-inducing agent controlled by the tumour gene. (NSA 16: 1962, 1273).

- 1207 Sang, J.H. EFFECTS OF ENVIRONMENTAL MANIPULATION ON THE PENETRANCE OF MELANOTIC TUMOURS IN SUPPRESSED AND UNSUPPRESSED STRAINS OF D. melanogaster. (Abstr.) Heredity 18, 4 (1963) 554-5.

If x-rays and excess tryptophan both increase tumour penetrance in the  $tu\ bw: st\ su-tu$  strain by inhibiting the action of the suppressor gene, it should follow that strains not carrying the suppressor would have a different reaction to environmental treatments. Tests with germ-free, synthetic diets containing excesses

or deficiencies of individual nutrients show that the majority of treatments affect tumour penetrance in the same way, whether or not the *su-tu* gene is present. This suggests that these treatments influence the expression of the tumour gene directly, rather than through the suppressor. Since many metabolically unrelated treatments are similarly effective, it also seems unlikely that they operate directly through a specific metabolic pathway. The general implications of these results for tumorigenesis will be considered.

See also:

- 840 The "Brown spot" character in *Drosophila melanogaster* and their response to x rays. (DiPasquale, 1960)

# I-A-10 SPECIES, STRAINS, LINES (COMPARATIVE STUDIES)

- 1208 Centeno, A.J., Reguly, M.L., Cordeiro, A.R. CHANGES OF REPRODUCTIVE PERFORMANCE OF *Drosophila willistonii* AT TWO INBREEDING LEVELS. (Abstr. 5.61) p.75-6 in "Genetics Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963, Vol.I". Geerts, S.J., Ed. Oxford, Pergamon Press, 1963.

From 608 wild inseminated females 123 outbred strains with inbreeding of 0.28 and 124 sibmating strains with  $f=0.85$  (at 6th generation) were obtained. At the 5th generation each strain was divided in two strains each with 15 pairs of flies. For each strain one culture was submitted to 600 r of a  $Co^{60}$   $\gamma$ -source. The relatively outbred strains gave a total of 40 126 flies in the control (K) and 41 383 from the irradiated parallel cultures (R). An hierarchical analysis of variance showed no significant difference between treatments ( $F=0.002$ ,  $F_{.05}(1244)=3.89$ ). The same non-significant result was obtained at the more inbred strains in a total of 28 158 flies in the control and 27 100  $F_1$  of irradiated strains.

A paired analysis of irradiated-control failed to show any significant overall increase of the irradiated or the control. Considering all the paired strains in which a betterment of reproductive performance was observed after radiation, a parcel of 51.22% among 123 strains and 45.18% among 124 strains, contributed to a significant t value. We have indications that several strains do increase performance after radiation. The average effect on the total population is certainly counterbalanced by the others that shows a significant decrease.

- 1209 Jucci, C. SULL'EVOLUZIONE DEL PARASSITISMO SOCIALE NELLE FORMICHE. TENTATIVI DI INTERPRETAZIONE GENETICA E PROGETTI DI ANALISI SPERIMENTALE. (Study on the evolution of social parasitism in the ant. Attempts of genetic interpretation and plans for experimental analysis). p.389-420 in "Symposia Genetica et Biologica Italica. Atti del IV Congresso dell'U.I.E.I.S., Pavia, 9-14 Settembre 1961. Vol.XII". Pavia, Tipografia del Libro S.A.S. 1963. (In Italian).

A critical review and assessment of the problems presented by social parasitism in ants is presented. The chances of using (radiation-)induced mutations for investigating the evolutionary and species aspects of differentiation are discussed (p.407-).

- 1210 Kidwell, J.F. GENOTYPE X ENVIRONMENT INTERACTION WITH ISOGENIC LINES OF *Drosophila melanogaster*. *Genetics* 48 (1963) 1593-1604.

Two experiments which exploit some of the peculiar genetic properties of *D. melanogaster* were conducted to study the nature of the interaction of genotype x environment. All possible crosses were made among 4 isogenic lines, each representing a different mass mated stock. A sample of virgin females from each line, line cross, and original mass mated stock was irradiated (6000 r or 4000 r) at about 48 h of age. A similar non-irradiated sample was also measured. The traits measured were number of eggs and live larvae produced by days 4, 6, and 8, and the number of adults eclosing from eggs deposited on days 9, 10 and 11. The analysis provides a comparison of three breeding types, and estimates of inbreeding depression, heterosis, general and specific combining ability, maternal and reciprocal effects and their interaction with treatment. Significant effects were observed for treatments, breeding types, mass mated stocks and isogenic lines in both experiments. Differences in general combining ability were found for egg and larva number but not for number of adults in both experiments. Large interactions of treatment x breeding type, treatment x mass mated stock, and treatment x isogenic line were observed for all traits at 6000 r, whereas at 4000 r only 2 of these interactions were significant. (NSA 18: 1963, 5046).

- 1211 Kitzmiller, J.S., Keppler, W.J. SALIVARY GLAND CHROMOSOME MAPS IN Culex p. pipiens. (Abstr.) Genetics 46, 8 (1961) 875-6.

Salivary gland chromosome maps have been prepared for the mosquito Culex p. pipiens. The strain used was originally collected in the field in Champaign, Illinois. The salivary chromosome complement consists of three pairs of synapsed, polytene, banded chromosomes. Each pair is usually closely synapsed but asynaptic regions have been observed in all 3 pairs. The bands vary in intensity of staining and occur in definite patterns. All chromosome ends can be recognized by shape and banding patterns. Each pair consists of an indistinctly banded central portion, probably the centromere region, and two arms of approximately equal length. Average measurements in microns for each chromosome are: I, left arm, 150; centromere, 20; right arm, 165; II, left arm, 170; centromere, 20; right arm, 225; III, left arm, 200; centromere, 30; right arm, 225. The shorter arm has in each case been arbitrarily called the left arm. Following the Drosophila convention, each chromosome has been divided into numbered regions, with subdivisions of each region designated by letters. Chromosome I contains regions 1-22; chromosome II, 23-50; and chromosome III, 51-80. Each arm contains several prominent banding sequences which provide distinct identification. Each chromosome contains a central, "double bulb", with indistinct bands. This region has tentatively been identified as the centromere region, and good preparations show bands suggestive of a reversed repeat pattern. Meiotic chromosomes (testis, metaphase I) measure 6.2, 7.7 and 8.5 microns, with median centromeres and arms of approximately equal length. There are no recognizable heterochromosomes. The salivary maps herein reported have been designated as "standard" maps and are being used for comparison of the patterns in Culex p. fatigans and in several x-ray mutants.

- 1212 Ooi, H. DIFFERENCE OF RADIATION SENSITIVITY BETWEEN INBRED LINES AND THEIR HYBRIDS IN THE SILKWORM. (Abstr.) Jap. J. Genet. 37 (1962) 408. (In Japanese).

- 1213 Shapiro, N.I., Strashenko, S.I., Plotnikova, Ye.D., Smalikov, V.I. A COMPARATIVE ASSESSMENT OF THE INJURIOUS EFFECT OF IONIZING RADIATION ON HEREDITY IN MOUSE AND Drosophila. (Abstr.) Soviet Bloc Mainland China Tech. J., Ser. VI Bio-Sci. 61-11 145, 28 (1963) n.p. English abstract.

The rate of the formation of dominant lethals was used as an indicator of the effect of radiation. Gonads in 2  $\frac{1}{2}$ -4 month-old male mice were irradiated with x-rays at 134, 268, 402 and 670 r, followed by mating with 2 females for 3 d. On the 14-16th day of pregnancy these were opened and the number of yellow bodies, implantation sites and embryos assessed. Embryos killed both before and after implantation were determined, due to dominant lethals in the spermatozooids or the irradiated males. Similar data for maximum and minimum radiosensitivity in different lines of D. melanogaster were used from previous studies. Comparison of the rates of formation of dominant lethals in mice and D. melanogaster indicated that mice are 5-9 more radiosensitive than D. melanogaster. (Auth.)

- 1214 Sokoloff, A. PRELIMINARY STUDIES ON THE EFFECT OF X-RAY ON Tribolium IMAGOS. (Abstr.) Genetics 46, 8 (1961) 899.

3-d-old imagos of T. castaneum and T. confusum were exposed to x-ray dosages of 1500, 3000 and 6000 r administered in 2, 5, 5 and 10 min, respectively. The various studies lead to the following conclusions: (1) Productivity (measured in terms of  $F_1$  adults produced) of T. castaneum irradiated females  $\times$  non-irradiated males was greater for the 1500 r experimentals than for the controls; 3000 r resulted in 75% and 6000 r in 100% drop in productivity (assuming productivity of controls to be 100%). (2) The lethal effect of the high dosages of irradiation takes place at the egg stage. Mortality of larvae emerging from zygotes of irradiated males  $\times$  non-irradiated females or from zygotes of the reciprocal cross is not greater than of larvae from unirradiated controls. (3) Dominant-lethal frequency generally increases with heavier irradiation until at 6000 r 99% or more of the eggs fail to hatch. (4) Males of T. castaneum appear to be more sensitive to x-rays than females, and T. confusum males more sensitive than T. castaneum males: productivity of the latter was only 11.6% of the controls at 3000 r, and 0.5% at 6000 r; for T. confusum corresponding values were 8.0% and 0.2% of the controls. (5) The drop in productivity persists for at least one generation after exposure: T. castaneum controls produced 95  $F_2$  per female;  $F_1$  of 3000 r irradiated males  $\times$  non-irradiated females produced only 63  $F_2$  per female. Comparable values for T. confusum were 90  $F_2$  per female for the controls and 32 for the experimentals. (6) No sex-linked lethals were obtained. One visible mutant (pink eye) was probably induced by x-rays.

- 1215 Sokoloff, A. IRRADIATION EXPERIMENTS WITH Tribolium. Tribolium Inform. Bull. 4 (1961) 28-33.

The main effect of x-rays appears to be at the egg stage. Females are highly susceptible to high doses. Although they may survive at 6000 r to lay eggs, none of these proves viable. To study recovery pheno-

mena, groups of males were exposed to 0, 3000 and 6000 r, and mated to non-irradiated females. T. confusum is more susceptible to 6000 r than T. castaneum. T. castaneum produces more offspring, and for a longer period, it may even recover after 8 weeks. After 3000 r, irradiated males of both species experienced the same recovery phenomenon, at the same time for both species. Throughout, data obtained are compared with those reported by Park et al. (Physiol. Zool. 31: 1958, 151). The above support and supplement the Park data. Post-irradiation fertility drops only to 70% as compared to 60.4% (Park), probably due to the fact that egg mortality increases if the eggs are not covered with flour, once they have been counted. No sex-linked lethals could be confirmed. A visible (pink eyes) mutation may have been induced by x-rays acting on the pre-meiotic stages of the irradiated female.

- 1216 Strömnaes, Ø. ARE THERE REAL STOCK DIFFERENCES IN X-RAY INDUCED MUTABILITY IN Drosophila melanogaster? Hereditas 50 (1963) 264-8.

Literature on the type and frequency of radio-induced mutations in Drosophila is reviewed with particular reference to the variations found among various strains. (NSA 18: 1964, 11733).

- 1217 Vorobisova, I. E. COMPARATIVE STUDY OF RADIATION SENSITIVITY OF DIFFERENT STRAINS OF Drosophila melanogaster. Dokl. Akad. Nauk SSSR 153 (1963) 943-6. (In Russian).

The radiation sensitivity of 7 strains of wild type D. melanogaster was compared. In experiments with 50- to 500-kr irradiation doses, 100 kr was shown to be sufficient for 100% death of the flies in a time suitable for comparative studies. Averaged lifetimes of irradiated flies varied from 11.6 to 18.5 d; with statistically significant differences; the 7 strains were considered classifiable into 2 groups: one relatively radiation-resistant and the other, relatively radiation-sensitive. The curves of percentage of deaths versus time were similar for all strains, the rate increasing slowly at first, then very rapidly, but slowing down again near 100% mortality. These curves are considered to reflect not so much the differences in radiation sensitivity of individuals as differences in the processes causing destruction of the flies at different times after the irradiation. Coefficients of regression were calculated for the first two parts of the curves, and showed that the average length of life and rate of dying were inversely dependent in the 1st part but were not obviously related in the 2nd part. (NSA 18: 1964, 9851)

- 1218 Ward, C. L., Bowman, T., Burnham, D. GENETIC STUDIES OF Drosophila STRAIN DIFFERENCES IN SENSITIVITY OF THE TESTIS TO THE MUTAGENIC ACTION OF X-RAYS. (Abstr.) p. 156 in "2nd International Congress on Radiation Research, Harrogate, Yorkshire, England, 5-11 August 1962". London, Silver End Documentary Publications, Ltd., 1962.

Stocks of single chromosome interchanges between the Oslo and Iso-Amherst strains of Drosophila melanogaster were constructed in an effort to localize factors responsible for differences in sensitivity patterns. Comparative measurements of the rates of induction of sex-linked recessive lethal mutations by 2000 r of x-radiation were made on sequential samples of sperm from males of the stocks of X, second, and third chromosome interchanges between the two strains. The stocks were constructed in such a way as to bring the single chromosome of one strain through the male line, thus placing it in the cytoplasmic environment of the other strain. Third chromosome interchange stocks do not differ in sensitivity patterns from the Oslo and Iso-Amherst strains, i. e. the Oslo damage peak precedes the Iso-Amherst peak. In the X-chromosome interchange stocks the damage peaks coincide. There is a marked difference in peak level of damage between the second chromosome interchange stocks. The X-chromosome seems to have an effect on the time of the occurrence of the most sensitive cell stages, while the second chromosome affects the level of sensitivity.

- 1219 Ward, C. L., Bird, M. A. COMPARATIVE STUDIES OF CYTOCHROME C OXIDASE ACTIVITY AND MUTABILITY IN TWO STRAINS OF Drosophila. Genetics 47 (1962) 99-107.

A comparative study of the cycles of cytochrome c oxidase activity during pupal and adult life of two strains of Drosophila showed that the cycle of enzyme activity in the more rapidly developing strain precedes the slower strain, thus alternating the relationship of the enzyme activity during the time of development of the irradiated germ cells. The relationship of the differences in radiation sensitivity of the developing cells to the enzyme cycles is discussed. It was necessary to postulate at least two factors other than the protective effect of the cytochrome system in order to explain the entire sensitivity pattern of the two strains. (Auth.)

This paper has been included since the genetic control of the cytochrome oxidase system, either directly or indirectly, is of considerable interest in relation to genetic sensitivity to irradiation. The numerous experiments indicating the effect of CO and cyanide poisoning on the genetic sensitivity to irradiation and the results of irradiation in  $O_2$  certainly would suggest that some of the differences in level of genetic damage in strains and in cell types may well be determined by the activity of the cytochrome system. Cytochrome oxidase determinations on the chromosome interchange stocks of the Oslo and Iso-Amherst strains of *D. melanogaster* show that the activity level of the terminal oxidase system is generally higher in the strains carrying the Oslo second chromosome. However, the hemizygous Iso-Amherst X chromosome in the strain otherwise derived from the Oslo female seems to reduce the effectiveness of the Oslo second chromosome in producing an organism with a higher level of cytochrome oxidase activity.

See also:

- 758 The effects of radiations on the genetic systems of organisms in relation to their physiological and biochemical systems. (Alexandert, 1959)
- 772 The susceptibility of the rust-red flour beetle, *Tribolium castaneum* (Hbst.) to gamma radiation. (Crook, 1962)
- 805 Some effects of gamma radiation on the lesser grain borer (*Rhizopertha dominica* F.), tropical warehouse moth (*Cadra (Ephestia) cautella* Wlk.), Indian meal moth (*Plodia interpunctella* Hübner.), and the cigarette beetle (*Lasioderma serricorne* F.). (Pendlebury et al., 1962)
- 819 R-locus factor homologies in *Mormoniella*. (Whiting, 1962)
- 837 Differences in sensitivity to gamma radiation in *Drosophila* of the *willistoni* group. (Carvalho and da Cruz, n.d.)
- 864-6 Mutation rates at specific loci in *Drosophila melanogaster*. (Hannah-Alava, 1961, 1962)
- 894 Interspecific hybridization and gynogenesis in mealy bugs. (Nur and Chandra, 1963)
- 910 The mutation rate at specific autosomal loci in different species of *Drosophila*. (Turku Univ., Finland, n.d.)
- 940 Mutation rates at specific autosomal loci in different species of *Drosophila*. (Hannah-Alava, 1963)
- 947 Studies on the distribution of breakage sites of natural and radiation-induced chromosome dislocations in *Drosophila subobscura* Coll. (Kunze-Muehl, 1961)
- 982 Increased recombination from female *Drosophila* irradiated as larvae without oocytes. (Whittinghill and Davis, 1961)
- 983 Unchanged recovery of crossovers after x-irradiation of pupal *Habrobracon*. (Whittinghill and Allen, 1961)
- 991 Contrasts in radiation-induced mutation rates at different meiotic stages. (Whiting, 1962)
- 1016 Spermatogenesis of the silkworm and its bearing on the radiation induced sterility. (Sado, 1961)
- 1024 Considerations on the changes in observed mutation rates in the silkworm after irradiation of various stages of gametogenesis. (Tazima, 1961)
- 1049 The effects of nitric oxide on radiation damage in *Drosophila virilis* and *Drosophila melanogaster*. (Capps, 1961)
- 1186 Virus-host relationship and the effects of x-ray induced mutants in heterozygous condition. (Baumiller, 1963)
- 1310 Changes in quantitative traits under selection and irradiation. (Bartlett, 1963)
- 1375 The importance of competitiveness of radiosterilized males in mosquito-control programs. (Dame and Schmidt, 1962)
- 1385 Research in genetics. (Stone, 1963)
- 1394 Restoration, without selection, of balanced genetic load by radiation of *Drosophila* inbred strains. (Cordeiro et al., 1963)
- 1497 Les possibilités d'emploi des radiations dans la lutte contre les insectes. (Nardon, 1963)
- 1499 Utilisation des radiations ionisantes ( $^{60}\text{Co}$ ) pour la protection des denrées contre les insectes nuisibles. Recherches relatives à la détermination des doses utiles pour assurer la stérilité des insectes. (Pesson, 1963)

## I-B Developmental Effects and Effects on the Organism

### I-B-1 DEVELOPMENTAL STAGE RESPONSE. DELAYED DEVELOPMENT

#### I-B-1-a GENERAL

- 1221 Day, M.F., Oster, I.I. 2. PHYSICAL INJURIES. F. RADIATION. p.44-8 in "Insect Pathology. An Advanced Treatise. Vol.I". Steinhaus, E.A., Ed. New York, Academic Press. 1963.

The radio-resistance of adult, pupae and larvae of an insect is discussed. Sufficiently high doses of x-rays given at larval stages have been shown to (1) prolong the larval period, (2) produce phenocopies, (3) cause some deaths during the subsequent pupal or imaginal stages, and (4) reduce fertility in the surviving adults. Work in the field is cited.

- 1222 LaChance, L.E. EFFECTS OF RADIATIONS ON INSECTS. Proc. N. Cent. Br. ent. Soc. Amer. 17 (1962) 11-14.

Some of the variables affecting the results of radiation treatments are discussed. The female of *Cochliomyia hominivorax* (Coquerel) has proved ideal for determining the correlation between reproductive development and radiosensitivity. All eggs develop synchronously so that all are irradiated at the same stage of development (very different from the case of *Habrobracon juglandis* (Ashmead)). From studies on these two insects belonging to very different species from different orders, and from many other studies two general conclusions may be drawn: (1) development of the ova can be inhibited more easily if radiation treatment is administered in that sensitive period of endomitotic growth during which the nurse cells are becoming polyploid, and (2) once the oocytes have differentiated, their development is not readily arrested by even large doses of radiation, but egg hatchability will depend on the meiotic stage of the nucleus at irradiation. In the irradiation of males, the relative sensitivity of the various stages of development poses similar problems. It also remains to be determined whether sterility is due to: (1) gametes containing dominant lethal changes but retaining motility and vigour, (2) inactivation of the sperm, or (3) damage to the immature cells to such an extent that mature sperm are not produced at all. Fractionation, dose rate and temperature also affect the results of irradiation, and particular environmental atmosphere may act as radiation protector or enhancer.

- 1223 Алимджанов, Р.А., Султанходжаева, З. ВЛИЯНИЕ ГАММА-ЛУЧЕЙ НА РАЗВИТИЕ ПОЧВОБИТАЮЩИХ НАСЕКОМЫХ. Докл. АН Узб. ССР 1 (1962) 59-60. Р. Ж. Биол. №8ЕЗ. 1963.

Alimdzhanov, R.A., Sultanhodzhaeva, Z. EFFECT OF GAMMA RADIATION ON THE DEVELOPMENT OF SOIL INSECTS. Dokl. Akad. Nauk Uzb. SSR 1 (1962) 59-60. R. Zh. Biol. No. 8E3. 1963.

Eggs of curculios of the genus *Sitona* were irradiated with  $Co^{60}$ ; 3.3% of the eggs failed to develop at doses of 1000 r, with 7.4% of the eggs producing larvae. About 9% of the eggs perished outright at doses of 3000 to 10000 r, with larval development entirely absent. A total of 1.4% of the eggs failed to develop in the control group, while 16.5% produced larvae. (BA 45: 1964, 40631)

- 1224\* Арифов, У.А., Гуманский, Г.А. и др. ДЕЙСТВИЕ ГАММА-ЛУЧЕЙ НА ЖИВЫЕ КУКОЛКИ ТУТОВОГО ШЕЛКОПРЯДА. Докл. АН Узб. ССР 4 (1957) 9-12.

Arifov, U.A., Guman'skii, G.A. et al. EFFECT OF GAMMA RADIATION ON LIVE COCOONS OF THE MULBERRY SILKWORM. Dokl. Akad. Nauk Uzb. SSR 4 (1957) 9-12.

- 1225 Babos, L., Gubicza, A., Lukacsics, F., Molnar, I. EFFECT OF GAMMA-RADIATION ( $Co^{60}$ ) ON THE PUPAE OF *Bombyx mori* L. Tifany. Biol. kul. Int. Evkon. 29 (1962) 3-9. (In German).

- 1226\* Balock, J.W., Jr., Burditt, A.K., Christenson, L.D. EFFECTS OF GAMMA RADIATION ON VARIOUS STAGES OF THREE FRUIT FLY SPECIES. Citrus Ind. 44, 8 (1963) 9-12.

*Dacus dorsalis*, *D. cucurbitae*, and *Ceratitis capitata* are considered.

Balock, J. W., Jr., Burditt, A. K., Christenson, L. D. EFFECTS OF GAMMA RADIATION ON VARIOUS STAGES OF THREE FRUIT FLY SPECIES. *J. econ. Ent.* 56, 1 (1963) 42-6.

Radiation effects on development of eggs, larvae, and pupae were determined for the oriental fruit fly (*Dacus dorsalis* Hendel), the melon fly (*D. cucurbitae* Coquillett), and the Mediterranean fruit fly (*Ceratitis capitata* (Wiedemann)). Increasing dosages were required to prevent hatch as eggs became more mature except that eggs about 1/8 developed were more sensitive than younger ones. The LD<sub>50</sub> for hatch of newly laid eggs was about 1300 r and for nearly mature eggs from 86 000 to 125 000 r. Pupation was reduced by 95% when eggs were exposed to 13 000 r and 1-d-old larvae to 30 000 r. More than 160 000 r was required to prevent pupation of mature larvae. Dosage required to prevent 99% emergence of adults was 8500 r or less when eggs, larvae, or 1- to 3-d-old pupae were irradiated. Older pupae became more resistant to radiation, and when fully developed required more than 100 000 r to prevent emergence of adults. Emerging adults were sterile after exposure as mature pupae to 10 000 r. Adults from 1st-instar larvae exposed to 2500 r developed and laid eggs but hatch was reduced 64% in the parent stock and pupation 38% in the F<sub>2</sub> generation. When irradiated in water, 100% CO<sub>2</sub>, or N<sub>2</sub>, the effect on eggs and larvae was 40% to 47% less than in air. The results suggest the feasibility of use of comparatively low dosages in the range of 15 000 to 20 000 r as a quarantine treatment for fruit fly-infested fresh fruits and vegetables. (Auth.)

- 1228 Banham, E. J. THE SUSCEPTIBILITY OF THE CONFUSED FLOUR BEETLE (*Tribolium confusum* Duv.) TO GAMMA RADIATION. AERE-R-3888, United Kingdom Atomic Energy Authority, Research Group, Isotope Research Div., Wantage, Berks., England, 1962. 32p.

The susceptibility to  $\gamma$ -radiation from Co<sup>60</sup> of all developmental stages of *T. confusum* was examined under controlled environmental conditions, (in a culture medium of 30°C and 60% relative humidity, at 4000 r/h) with respect to the emergence of adults, survival and production of progeny. *T. confusum* is more resistant than *Sitophilus granarius* to the killing effects of  $\gamma$ -radiation but more susceptible to radiation sterilization. A dose of 16 000 rads, evaluated for complete sterilization of grain and rice weevils, is equally effective for the control of *T. confusum*.

- 1229 Bartlett, A. C., Bell, A. E. RADIATION EFFECTS ON REPRODUCTION IN PLATEAUED AND UNSELECTED STRAINS OF *Tribolium castaneum*. (Abstr.) *Genetics* 46, 8 (1961) 850.

The effects of various levels of x-radiation on reproductive fitness of a plateaued population of *T. castaneum* and its unselected base population were investigated. The plateaued population had been selected for increased body weight for 44 generations and weighed approximately 5500  $\mu$ g in contrast to 2100  $\mu$ g for the unselected strain. Two components of fitness (eggs laid during a standard 48-h period and number of resulting progeny) were observed. While the two strains did not differ in egg production, the unselected strain had superior hatchability. Within each of 9 doses (ranging from 200 r to 5000 r) the beetles were partitioned so that in one set only males were irradiated, in another set only females and in the third both males and females were irradiated. Irradiation of males was shown to have no effect on the ability to excite egg laying in their mates, but number of progeny was reduced with the higher doses. Egg production was not affected for doses up to 1000 r applied to females but a marked decrease was seen beyond that level. A decline in number of progeny from irradiated females was observed at doses as low as 600 r. The initial superiority of the unselected strain for number of progeny persisted over-all doses. A linear response to irradiation was not shown for either egg production (somatic effects) or number of pupae hatching (somatic effects and dominant lethal effects) for the dose range employed in this study.

- 1230 Bartlett, A. C., Bell, A. E. THE EFFECT OF IRRADIATION ON REPRODUCTION IN TWO STRAINS OF *Tribolium castaneum* Herbar. *Rad. Res.* 17 (1962) 864-77.

The effects of x-radiation on the reproductive performance of two strains of *T. castaneum* were measured. The two strains differed in body weight, one strain being 2½ times as heavy as the other. Females of the heavier strain were more resistant to somatic damage than were females of the light strain. Genetic damage, as measured by a reduction in fertility of irradiated individuals, was not so great in the heavy strain as in the light strain, especially when both parents were irradiated. When only one parent in a mating was irradiated, no sex differences in response to increasing dose were found. The effect of irradiating both parents can be predicted from the results obtained when only one parent is irradiated. The response curve for somatic damage showed a linear decline at high doses (1000 and 5000 r) but no significant effect at low doses (0 to 800 r). The response curve for genetic damage, as measured by an orthogonal polynomial analysis, was sigmoid in shape with a linear decline at low doses and a curvilinear decline at the high doses. The genetic response curve over all doses can be fitted to a function of the type

$Y = a + bX + cX^2$ , where the different coefficients of  $X$  and  $X^2$  change with the strain. The coefficients also depend on whether one or both parents are treated. The drop in fertility at doses over 5000 r was an average of 66.9% for irradiated foundation adults (summed over mating combinations) and an average of 58.6% for irradiated selected adults. (From Auth.)

- 1231 Baumiller, R.C. PREPUPAL EFFECTS OF X-RAY-INDUCED, EUPLOID AND NEAR-EUPLOID MUTANTS IN HETEROZYGOUS CONDITION IN Drosophila melanogaster. (Abstr.) Genetics 46, 8 (1961) 850.

The effect of euploid and near-euploid heterozygous mutants in D. melanogaster has already been studied in the egg and larval stages separately. The present work studies both stages in the same individual in order to estimate the minimal total effect of such mutants. Wild-type, Oregon-R males were treated (I) or not (C) with 3000 r of x-rays and mated to virgin, untreated, sibling females. Eggs were collected at  $\frac{1}{2}$ -h intervals, and each hour, starting the 21st hour after oviposition, the numbers of larvae hatching were scored. Of all larvae, the percentages hatching late (more than 1 h after the largest hourly percentage hatched in C) were: C,  $2.9 \pm 0.3$  (of 2950 larvae); I,  $8.8 \pm 0.9$  (of 1057 larvae). The induced difference in delay, of  $6.1 \pm 0.9\%$ , is attributable to newly arisen (near-) euploid mutants in heterozygous condition. Not-delayed larvae (obtained from the hour when the largest percentage hatched in C) and delayed larvae were studied for retarded pupation and for death before pupation. The induced difference between not-delayed C and I was  $9.7 \pm 0.8\%$  for retarded pupation and  $6.7 \pm 0.7\%$  for death before pupation. Among delayed larvae the induced difference between C and I was  $23.6 \pm 0.7\%$  and  $19.4 \pm 0.7\%$ , respectively. Thus, about 10% ( $6.1 + 9.7$ ) of the larval population which carry x-ray-induced, euploid and near-euploid, heterozygous mutants show a detrimental effect of these mutants in either the egg or the larval stage, of which approximately 1.4% were affected in both stages.

- 1232 Baumiller, R.C. THE EFFECTS OF X-RAY-INDUCED EUPLOID AND NEAR-EUPLOID MUTANTS IN HETEROZYGOUS CONDITION UPON DEVELOPMENTAL STAGES OF Drosophila melanogaster. Diss. Abstr. 22 (1962) 2950-1.

This study required the development of techniques by which the duration of the egg and larval stages as well as the ability of larvae to pupae could be employed as criteria for detecting these heterozygous effects. In interstrain crosses these mutants were found to produce delay in pupation in about 9% of larvae under nutritional stress, and the killing of approximately 6%. The effect was less, about 7% delayed and 5% killed, when there was excess nutrient. Irradiation of sperm or oocytes caused approximately equal amounts of detriment, doubtless partly by different types of mutation; no effect of delay or death in the larval stage was detected when oögonia were irradiated. In interstrain crosses about 5% of all hatching larvae were delayed in the egg stage by the mutants produced by x-raying  $P_1$  males who were mated to sibling females. Of larvae not delayed in the egg stage, about 10% were delayed in the larval stage, of which 70% were killed. Of all larvae hatching, about 15% showed an effect in either the egg or the larval stage, while 1.4% were affected in both stages. After males from stocks containing heavier than normal genetic loads were irradiated, a greater than additive effect of heterozygous mutants was noted upon egg hatching. Thus, newly induced heterozygous mutants produced about 15% of effect when added to the heavier genetic load, but produced only about  $\frac{1}{4}$  this effect when added to the smaller (normal) load. The detrimental effects of euploid or near-euploid mutants in heterozygous condition detected were quite large. No evidence was found in support of the balance hypothesis of heterozygote advantage. However, all the results obtained could be explained by the classical hypothesis.

- 1233 Baumiller, R.C. DEVELOPMENTAL EFFECTS OF X-RAY INDUCED EUPLOID AND NEAR EUPLOID MUTANTS IN HETEROZYGOUS CONDITION IN Drosophila melanogaster. I. DELAY IN EGG HATCHING AND LARVAL DELAY AND DEATH PRIOR TO PUPATION. Genetics 48, 2 (1963) 263-71.

D. melanogaster males were treated with 3000 r x-rays, and the first released sperm were used to produce the  $F_1$ . The  $F_1$  that hatched from the egg comprised the population studied with respect to time of egg hatching and delay and death prior to pupation. Results of the egg-hatching experiments were analysed by 2 methods. By the first, the curves were compared with respect to only one extreme. This showed a radiation-induced effect of about 6.1% more individuals with delayed egg hatching. The second method of analysis compared the total curves, and indicated a radiation-induced delay in egg-hatching time in about 20% of the larvae. The effects of delay and death studied here are attributed to euploid and near-euploid mutants in heterozygous condition. The basis for this conclusion is discussed briefly, as is the relation of these results to the detection of a heterotic effect of x-ray induced mutants.



- 1234 Beck, J.S. EFFECTS OF RADIATION UPON DEVELOPMENT OF *Tribolium confusum*. (Abstr.) Rad. Res. 14 (1961) 443-50.
- T. confusum*, a holometabolous beetle, was chosen as a convenient system for the study of development and of aberrations in development produced by irradiation. Dose-response studies have repeatedly demonstrated the onset of induced deformity in wings (adults) at 500 r and a maximum incidence of 90% at 2000 r, with smoothly varying incidences at intermediate doses. Irradiation of pupae at various ages during the 7-d pupal life has revealed a sharp fall in deformity incidence over an age span of a few hours for pupae irradiated beyond a sensitive period in development. Experiments are under way to determine an onset in larval life of this particular radiosensitivity. Other experiments have been designed to locate the sensitive site within the organism by means of collimated beams of x-rays and by utilizing the Bragg peak of heavy ion beams. Current experiments have revealed no definite inheritance of the induced deformities. (From abstr.)
- 1234-a Beck, J.S., Manney, T.R. NEUTRON ACTIVATION ANALYSIS FOR PHOSPHORUS IN A STUDY OF DEVELOPMENT IN A BEETLE WING. Science 137 (1962) 865-6\*
- In order to quantitate differences between normal and radiation-induced wings at different stages of development, a method was developed for reproducibly isolating the (<20 µg) membranous wings of *Tribolium confusum*. Neutron activation analysis was used to measure P in individual beetle wings during pupal and early adult stages. By counting neutron-induced P<sup>32</sup> radioactivity it was possible to measure 0.005 ± 0.001 µg of P. The P content of the wings rises to maximum at eclosion and subsequently decreases with loss of cells.
- \* See previous reports of work in UCRL-10389 and -10683, California, Univ., Berkeley.
- 1235 Brande, J. van den, Woestijne, N. van de EFFECT OF GAMMA-RADIATION ON THE MEDITERRANEAN FLOUR MOTH *Ephestia kuehniella* Z. IN DIFFERENT STAGES OF DEVELOPMENT. p. 563-7 in "XI. Internationaler Kongress für Entomologie, Wien, 17. bis 25. August 1960. Verhandlungen, Band II (Symposien)". Wien, Organisationskomitee des XI. Internationalen Kongresses für Entomologie, Wien 1960, 1962. (In English).
- A Co<sup>60</sup> source was used; 20 pairs consisting of a treated male pupa and an untreated female were used per dose. The influence of γ-rays in the pupal stage was tested on male pupae aged 15, 12, 9, 6, and 3 d. A 60 000 rad dose results in complete sterility of the male; 20 000 rad produce 50% and 40 000 rad 93.7% sterility, the sterility produced gradually increasing with dosage rate. The younger the pupa at the time of irradiation, the greater the effect. At 6 d, complete sterility is produced by 30 000 rad and no copulation occurs after 40 000 rad. At 3 d, no offspring is produced from 10 000 rad onwards. All males have a shrivelled appearance and their life span is much reduced. After irradiating fully grown female pupae with 60 000 rad, the emerging adult females do not accept copulation and no eggs are laid. Experiments with full grown larvae, 17-d-old larvae and 4-d-old eggs indicated that dosage rates < 2500 rad do not seem to have any unfavourable effects; that some slight damage occurs (apparent mostly in the F<sub>1</sub> generation) above 4500 rad; and that pupation occurred only to a very limited extent on irradiating full grown larvae with 9000 rad, and not at all after 18 000 rad.
- 1236 Brownell, L.E., Yudelovitch, M. EFFECT OF RADIATION ON MEXICAN FRUIT-FLY EGGS AND LARVAE IN GRAPEFRUIT. p. 198-201 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency, 1962.
- A limited study has been made of the effect of γ-radiation from Co<sup>60</sup> on the eggs and larvae of the Mexican fruit fly, *Anastrepha ludens*. Various doses from 5000 to 90 000 rad were given to fruit 1 and 12 d after infestation to explore the effects of irradiation on the egg and 1st-instar larval stage. Fruit containing fully grown larvae and larvae at intermediate stages was also irradiated with similar doses. Frequent examination and dissection of the fruits were used to determine larva mortality, larval damage to fruits, presence of pupae and presence of adult flies. Dissected fruits given radiation doses of 5000 rad or more during the egg or 1st-instar stage revealed no insects or trace of insect damage. Fruit infested with adult larvae produced numerous pupal recoveries but no adults emerged from pupae recovered from fruits receiving 5000 rad or more. It is concluded that a γ-radiation dose of 5000 rad (and possibly less, based on limited tests of 2000 rad) will break the life-cycle of the fly although the larval stage may survive appreciably greater dosages. A design for a railway mobile γ-irradiator for treating infested fruits is proposed. (From auth.)

- 1237 Bull, J.O., Wond, T. CONTROL OF THE MEDITERRANEAN FLOUR MOTH *Anagasta kuhniella* Zell BY STERILE MALE RELEASE. II. SUSCEPTIBILITY TO GAMMA RADIATION. AERE-R-8967, United Kingdom Atomic Energy Authority, Research Group, Isotope Research Div., Wantage, Berks., England, 1963, 42p.

The susceptibility of all developmental stages was studied. Eggs 0-24 h old were the most susceptible stage, another at the transition from larva to pupa (32 d). Total emergence was reduced as the dose increased in all age groups (up to 36 d), and development retarded throughout up to 32 d, the degree of retardation depending on dose. Wing deformities occurred throughout up to 36 d, particularly between 10 000 and 12 000 rads. Females were most sensitive at 30 d. Increasing resistance resulted in equal or even greater longevity of irradiated females versus controls. Males were more resistant to sterilization than females, at all stages of development (sterilizing doses: 25 000 rads and 45 000 rads for female and male pupae, respectively). Percentage mating was reduced by radiation in all groups up to 36 d. The optimum age and dose for sterilization while retaining near normal longevity and mating behaviour were worked out. Susceptibility in general decreased as age increased but young pupae were more susceptible than old larvae, pupae on the point of eclosing being least susceptible. The use of the sterile male technique to control moth infestations of flour mills is precluded by economic and ecological considerations.

- 1238 Carney, G.C. SOME EFFECT OF GAMMA RADIATION ON THE BIOLOGY AND MORPHOLOGY OF THE KHAPRA BEETLE, *Trogoderma granarium* Everts. Proc. N. Cent. B. ent. Soc. Amer. 17 (1962) 31-2.

Subjecting larvae and young pupae to a dose of 10 000 r of  $\gamma$ -radiation interfered with their normal metamorphosis. The extent of the damage incurred (mostly in the form of incomplete sclerotization of the elytra, arrested wing development, reduction of ovarioles, absence of eggs) depended on the age of the pupae at the time of irradiation. Irradiation of pupae of *Tenebrio molitor* had very similar effects on the adults, resulting in deformed and unsclerotized elytra and a retention of pupae characters in the abdomen. Difficulties in interpretation and further research required are discussed.

- 1239 Chatterji, S., Rattan Lal, Rahalkar, G.W., Sethi, G.R., Saxena, P.N. STUDIES ON THE EFFECTS OF BETA RADIATIONS ON INSECTS. III. THE EFFECT OF BETA RADIATIONS (IRRADIATION OF EGGS) ON THE DEVELOPMENT OF *Dysdercus koenigii* Fabricius. Indian J. Ent. 22 (1961) 40-5.

With increase in dose the viability of the eggs decreased. When the eggs were subjected to a total dose of 100 r given over 6 different exposure periods ranging from 1 to 24 h embryonic mortality was more in longer exposure periods than in shorter ones. When adults which emerged from 1, 2, and 4 h exposure periods were mated separately, the females laid more eggs than those laid in the control. However, their viability was lower than that in the latter. When the treated females were mated with normal males they laid more eggs than those mated with males from the corresponding treatment and the viability of these eggs was also greater. (BA 41: 1963, 4622)

- 1240 Dennis, N.M. EFFECT OF CATHODE-RAY IRRADIATION ON THE RICE-WEEVIL IN WHEAT. US, Agric. Marketing Res. Rep. 531 (1962) 1-14.

- 1241 DeFries, J.C., Touchberry, R.W. GENETIC EFFECTS OF  $\gamma$ -IRRADIATION ON THE PERCENT ADULT EMERGENCE OF *Drosophila melanogaster*. (Abstr. 5.64) p. 77 in "Genetics Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963. Vol. I". Geerts, S.J., Ed. Oxford, Pergamon Press, 1963.

Newly emerged males and females from two populations (randombred and inbred) derived from Luce's wild type strain were subjected to various dosages of  $\gamma$ -irradiation (0, 500, 1000 or 1500 r) and mated in all possible combinations within populations, resulting in a four  $\times$  four factorial arrangement of treatments. Three mating pairs were included in each subclass of two replicate experiments, requiring a total of 96 mating pairs per generation in each experiment. Eggs were collected over a 10-d period following treatment and the percent of the offspring to emerge as adults was determined. In addition to these data of generation 1 (offspring of treated flies), similar data were obtained for generations 2 and 3 resulting from full-sib matings of generations 1 and 2, respectively. Somatic and genetic effects would be expressed in generation one, whereas only genetic effects would be expressed in subsequent generations. Highly significant linear depressing effects resulting from treatment of both males and females were observed in the data of generation 1, with the magnitude of the effect being greater for males than females. Highly significant effects resulting from treatment of the original males, although smaller in magnitude than in the 1st generation, were again found in the data of generations 2 and 3; however, no effect was evident from treatment of the original females in these later generations.

- 1242 Dixon, E.B. SOME EFFECTS OF IRRADIATION ON Cochliomyia hominivorax. J. econ. Ent. 55, 6 (1962) 828-7.
- Pupae of C. hominivorax (Coquerel), 1-, 29-, 52-, 76-, and 97-h of age, were exposed to equal multiple and single doses of irradiation varying from 800 to 7800 r x-rays. Newly emerged eggs were exposed for 1-, 2-, 3-, and 4-min at 531 r/min. Five-hour-old eggs were exposed in minute intervals from 1 to 15 min at 539 r/min. Unfertilized ova and sperm were exposed to 531 r, 600 r, and 1062 r by irradiation of 8-d-old flies. Generally multiple irradiation was more harmful to pupae than an equal single dose. Unfertilized eggs seemed more susceptible to radiation than newly laid eggs. Five-hour-old eggs appeared less susceptible than unfertilized or newly laid eggs. (Auth.)
- 1243 Ducoff, H.S., Bosma, G.C. RESPONSE OF Tribolium confusum TO RADIATIONS AND OTHER STRESSES. p.83 in "XVI International Congress of Zoology, Washington, 20-27 August 1963. Vol. 2". Moore, J.A., Ed. Washington D.C., XVI International Congress of Zoology.
- A number of workers have examined the acute lethal responses of x-irradiated Tribolium adults; the midlethal dose (MLD) range is 6-12 kr. Our laboratory's investigations reveal a MLD for larvae of 2.5-5 kr; x-irradiation of larvae leads to two other effects, a delay in pupation and, when very late larval stages are irradiated, morphological abnormalities in the resulting adults. First day pupae are about as sensitive as larvae, but by the 3rd day, pupae are as resistant as adults. Eggs are more sensitive than larvae, and the sensitivity of the egg is an inverse function of its age: 2 kr causes 100% lethality in eggs less than 24 h old. In addition, sublethal irradiation of eggs markedly inhibits the subsequent rate of growth and development. X-ray effects on eggs and on pupae are mimicked by ultraviolet radiation; larvae, however, appear less sensitive than adults to the stress of high oxygen pressure. A demonstration included the dose-response curves of the various stages of the life cycle, examples of the induced developmental abnormalities, and a simple apparatus for exposure to high oxygen pressure. (Essentially auth, abstr.)
- 1244 Erdman, H.E. ARRESTED DEVELOPMENT IN X-RAYED LARVAE OF Ephestia kuehniella Zeller (LEPIDOPTERA: PHYCITINAE). HW-SA-2281, General Electric Co. Hanford Atomic Products Operation, Richland, Wash. 1961. 8p.
- Arrested development was induced by massive doses of x-rays in Ephestia larvae and biological interpretations are proffered. Adverse influence upon neurosecretory interactions and/or upon the imaginal discs was demonstrated. No genetically explainable effects were noted between the sexes. The instantaneous lethal dose for larvae within 3 to 5 d of pupation is in excess of 50 kr. For most practical purposes death occurred at 15 kr because at this dose and those higher further development ceased. Increased incidence of disease, apathy toward food, lethargy, uncoordinated movements when probed, and wing abnormalities were other radiation induced effects noted. (Auth.)
- See also 1250.
- 1245 Erdman, H.E. DEVELOPMENTAL ARREST OF IRRADIATED Ephestia LARVAE. p.102-3 in "Hanford Biology Research Annual Report for 1961." HW-72500, General Electric Co. Hanford Atomic Products Operation, Richland, Wash. 15 Jan. 1962.
- Massive doses of x-rays (20 kr or more) to moth larvae caused irreversible developmental arrest. Various radiation-induced effects were observed. Damage to mitotically active imaginal discs and/or to the neurosecretory complex was implicated. (Auth.)
- 1246 Erdman, H.E. X-RAY EFFECTS ON DIFFERENT LIFE STAGES OF TWO FLOUR BEETLE SPECIES (Tribolium confusum, Tribolium castaneum). Summer Meeting of American Society of Zoologists, Oregon State University, Corvallis, Oregon, August 1962. Amer. Zool. 2, 3 (1962) 407.
- 1247 Erdman, H.E. COMPARATIVE X-RAY SENSITIVITY OF Tribolium confusum AND T. castaneum (COLEOPTERA: TENEBRIONIDAE) AT DIFFERENT DEVELOPMENTAL STAGES DURING THEIR LIFECYCLE. Nature, Lond. 195 (1962) 1218.
- The x-ray sensitivities of two ecologically similar species of flour beetles were compared at 8 different ages in the life cycle. The doses required to induce sterility and lethality were determined. The egg was found to be the most radiosensitive stage, and T. confusum was consistently more radiosensitive than T. castaneum. Radiosensitivity was approximately constant during the larval stages, but it increased for the 15-d-old larval stage of T. castaneum and dropped back to normal thereafter. (NSA 16: 1962, 31525)

- 1248 Erdman, H.E. BEGINNING OF REPRODUCTION DETERMINED BY AGE OF THE FEMALE FLOUR BEETLE, Tribolium confusum (COLEOPTERA: TENEBRIONIDAE). HW-SA-2576, General Electric Co. Hanford Atomic Products Operation, Richland, Wash. 9 May 1962, 5 p.
- Adult males of the confused flour beetle, T. confusum, were fertile within 24 h of eclosion whereas females were fertile after the 6th day of adult life. To determine the influence of environmental factors on all stages of oögenesis it was therefore necessary to use adult females at least 9 d old. Developmental differentiation and degree of reproductive-tissue differentiation determine not only the onset of fertility but also influence the radiotolerance of these cells and tissues. Various temporal sequences proposed by other authors are discussed, together with observations on differential radiosensitivity.
- 1249 Erdman, H.E. BEGINNING OF REPRODUCTION DETERMINED BY AGE OF THE FEMALE FLOUR BEETLE, Tribolium confusum (COLEOPTERA: TENEBRIONIDAE). Naturwissenschaften 49, 18 (1962) 428.
- The daily fertility of different age combinations during the first 2 weeks of adult life is shown graphically. Males were fertile within 24 h after eclosion whereas pairs with young females were not fertile before day 6. Fertility values of old x old pairs were approached by old x young and young x young pairs by day 8 and 10, respectively. Old x old pairs were fertile day 1 and their fertility remained high through the experiment. Young x old pairs were fertile on day 1, their fertility decreased on day 2, and then gradually increased to old x old values by day 6.
- See also 1248.
- 1250 Erdman, H.E. ARRESTED DEVELOPMENT IN X-RAYED LARVAE OF Ephestia kuehniella Zeller (LEPIDOPTERA: PHYLLOPHAGAE). Amer. Midl. Nat. 69, 1 (1963) 34-7.
- See 1244 (same title and auth. abstract)
- 1251 Garson, I.L. PRELIMINARY RESULTS ON THE EFFECT OF HIGH ENERGY PHOTONS ON LETTUCE ROOT GROWTH AND ON Musca domestica. (Abstr.) p. 5 in "2nd International Congress on Radiation Research, Harrogate, Yorkshire, England, 5-13 August 1962". London, Silver End Documentary Publications, Ltd. 1962.
- The effect of the 40 kVp x-rays on lettuce roots has been studied, using mean relative growth rate of homogeneous groups of roots, or time of first growth depression, as measures of radiation response. Larvae of Musca domestica were also exposed to irradiation in 2 doses at 300 r/sec. When the percentage of larvae which form cocoons was plotted against dose in the 2nd irradiation (150-3000 r), curves were obtained which were displaced according to the 1st dose (150-900 r). When eclosion was taken as a measure of damage the same analysis gave groups of similar curves. Irradiation of cocoons of Musca domestica with two doses (150-600 r followed by 1500-1800 r) showed that the percentage of eclosion is related to the 1st dose in a manner independent of the interval (2-20 h) between the doses. (From abstr.)
- 1252 Ghosh, S.M., Hati, A.K. EFFECT OF GAMMA RADIATION ON THE FIRST INSTAR LARVAE OF Culex fatigans. Bull. Calcutta Sch. trop. Med. Hyg. 10, 3 (1962) 119.
- 1253 Hati, A.K., Ghosh, S.M. EFFECT OF GAMMA RADIATION ON MOSQUITOES: ANOMALIES IN DIFFERENT STAGES OF DEVELOPMENT. Bull. Calcutta Sch. trop. Med. Hyg. 10, 1 (1962) 17-8.
- 1254 Henneberry, T.J., Sullivan, W.N. THE EFFECT OF GAMMA RADIATION ON SILKWORM EGGS. (Abstr. 275) Bull. ent. Soc. Amer. 8, 3 (1962) 168.
- Silkworm (Bombyx mori (Linnaeus)) eggs 1, 4, and 7 d post diapause were exposed to various doses of  $\text{Co}^{60}$   $\gamma$ -irradiation in single or fractionated dosages. Eggs in early post diapause were more susceptible to radiation than those in later stages of development.
- 1255 Henneberry, T.J., Sullivan, W.N. EFFECT OF GAMMA-RADIATION ON EGGS OF THE SILKWORM. Nature, Lond. 200 (1963) 1121-2.
- Follow-up of work outlined in 1254. 1-, 4- or 7-d-post-diapause Bombyx mori eggs were exposed to a series of  $\gamma$ -radiation doses of 0.8 kr - 51.2 kr at 320 r/min. Exposure to 3.2 kr killed 100% of the 1-d (post-diapause) eggs but only 50 and 3%, respectively, of the 4-d and 7-d eggs. Similar results, but smaller differences, were obtained with 1.6 kr. Dosage mortality curves for 1, 4, and 7-d eggs are given. Mortality of 1- or 4-d eggs increased with increasing exposure, but no significant increase in mortality for

the 0.8-3.2 kr range was found in 7-d eggs. Total exposures of 0.8 or 1.6 kr, delivered in 1 irradiation period, or 2 irradiation periods with  $\frac{1}{2}$  the total dose administered at a time were equally damaging to 1-d eggs. A total of 1.6 kr delivered in fractions of  $\frac{1}{2}$  the dose at 90-min intervals was less damaging than when administered in 1 or 2 periods. Exposure to 3.2 kr in 1, 2, or 4 irradiation periods led to 100% mortality of 1-d eggs.

- 1256 Hoover, D.L., Floyd, E.H., Richardson, H.D. EFFECTS OF 300 kV X-RAY RADIATION ON *Sitophilus oryzae*. *J. econ. Ent.* 56, 5 (1963) 584-6.

All developmental stages of the rice weevil, *S. oryzae* (L.), were subjected to radiation by x-rays at dosages ranging from 1000 r to 12 500 r. It was found that resistance to the effects from x-ray radiation exhibited by this species increased as development increased. Relative to adult emergence there was but little difference in resistance by pupae regardless of dosage administered. However, adult mortality following emergence correlated closely with dosage administered. The LD<sub>50</sub> and the point of complete sterility for the adult stage were found to lie between 7500 r and 10 000 r. (Auth.)

- 1257 Hough, W.S. EFFECTS OF GAMMA RADIATION ON CODLING MOTH EGGS. *J. econ. Ent.* 56, 5 (1963) 660-3.

In 1957 and 1958 eggs of *Carpocapsa pomonella* (L.) were exposed to  $\gamma$ -radiation to establish a strain designated Va.-Gr. Most of the eggs were 4 d old when irradiated. During each of the next 4 seasons the Va.-Gr strain was reared through 2 generations on unsprayed apples. Principal effects on biological performance were (1) temporary increase in incubation period of the egg, (2) increase in average number of eggs deposited by Va.-Gr females, and (3) slight increase in longevity of Va.-Gr moths. Sensitivity to  $\gamma$ -rays declined with aging of the eggs. Susceptibility to DDT and lead arsenate was not altered by irradiating eggs 4 d old, but in 1962 increase in DDT resistance followed irradiation on Va.-Gr eggs less than 1 d old. Susceptibility to weak concentrations of Guthion® (O, O-dimethyl S-(4-oxo-1, 2, 3-benzotriazin-3-(4H)-ylmethyl) phosphorodithioate) or Sevin (1-naphthyl N-methylcarbamate) was not affected. (Auth.)

- 1258 Hsu, P., Li, C., Chen, H. THE EFFECT OF IRRADIATION WITH  $\gamma$ -RAY: Co<sup>60</sup> ON THE DEVELOPMENT AND REPRODUCTIVE POWER OF *Trombicula akamushi* var. *deliensis*. *Acta ent. sin.* 12, 5/6 (1963) 578-86. (In Chinese, with English summary).

In experiments in China, exposure to  $\gamma$ -radiation from a Co<sup>60</sup> source was found to affect the development of well-fed larvae of *Trombicula deliensis* Walch. The effect of treatment at 5000 r was indefinite, but higher doses decreased the number of nymphs obtained, and at 20 000 r almost all the larvae failed to give rise to nymphs. When the nymphs were irradiated, a dose of even 2500 r had a definite effect, and one of 20 000 r prevented the emergence of any adults. Observations on the reproductive ability of adults from treated immature mites showed that, within limits, the reduction increased with the dose applied, was greater when the treated individuals had not fed, and decreased with increasing age at time of treatment. Irradiation was most effective when applied to unfed larvae and almost ineffective when applied to engorged adults. (RAE-B 52: 1964, 137)

- 1259 Ийрковский, Г.Г. ВЛИЯНИЕ ИОНИЗИРУЮЩЕЙ РАДИАЦИИ НА РАЗВИТИЕ НЕКОТОРЫХ НАСЕКОМЫХ. Стр. 85-6 в сб. "Тезисы 3-ей Всесоюзной конференции молодых ученых-биологов". М. 1961.

Iirkovskii, G.G. EFFECT OF IONIZING RADIATION ON THE DEVELOPMENT OF VARIOUS INSECTS. p. 85-6 in "Papers presented to the Third All-Union Conference of Young Biologists", Moscow, 1961.

- 1260 Japan, Sericultural Experiment Station, Tokyo. STUDIES ON THE BREEDING METHOD TAKING ADVANTAGE OF  $\gamma$ -RAYS IN THE SILKWORM. *Nucl. Sci. Abstr.*, Japan 2, 2 (1963) 132-3 (In English).

Physiological damage from  $\gamma$ -irradiation is reduced if the insect is maintained at low temperature (post-irradiation); the longer it remains at low temperature the less damage occurs. This is true for irradiation at the embryonic and the pupal stages. To obtain an equivalent effect at 15°C post-irradiation and at 25°C at least double the dose is required with 15°C. Five F<sub>1</sub>-hybrids were reared at 5 different stations and tested. Small relative differences in viability existing among controls were greatly increased on irradiation. It may be possible to predict differences in viability for the whole life-cycle (post-developmental stages, etc.) from the extent to which hatchability is reduced by  $\gamma$ -irradiation.

- 1261 Jefferies, D.J. THE SUSCEPTIBILITY OF THE SAW-TOOTHED GRAIN BEETLE, Oryzaephilus surinamensis L. TO GAMMA RADIATION. AERE-R-3891, United Kingdom Atomic Energy Authority. Research Group. Isotope Research Div., Wantage, Berks., England. 1962. 32p.

An investigation was made into the susceptibility to  $\gamma$ -radiation of eggs, larvae, early and late pupae and adults of O. surinamensis, to examine the efficiency of 16 000 rads for radiation disinfestation of grain. Doses of 9600, 8600, 14 400, 30 800 and 20 600 rads are required, respectively, for 99.9% reduction in survival. Production of progeny was reduced by 99.9% by 8000, 6500, 7700, 12 000 and 16 300 rads, respectively. Calculations show that, under the conditions investigated, 16 000 rads control O. surinamensis for a period of 9 weeks. Several factors are discussed which suggest that this is likely to be the minimum possible degree of control effected by 16 000 rads. It is likely to be more effective in practice. (Auth.)

- 1262 Johansen, I. STUDIES ON THE RADIATION SENSITIVITY OF Drosophila EMBRYOS. (Abstr.) Hereditas 48, 8 (1962) 543-4.

The radiation sensitivity of the Drosophila embryo has been studied in relation to age of embryo, dose rate, and dose fractionation. The dose response curves for different ages show differences both in  $LD_{50}$  level, and in the shape of the dose response curve. Extrapolation numbers have been estimated by fitting theoretical curves to the experimental points. Dose rate effects have been studied by means of  $80 \pm 5$  min-old eggs. It was found that although the  $LD_{50}$  shows very little change, the estimated extrapolation number does change with dose rate. In experiments where the x-ray beam was interrupted by means of a rotating slotted steel disc, it was found that the  $O_2$  enhancement ratio was unchanged when compared with continuous irradiation, indicating that the efficiencies of  $O_2$ -dependent and  $O_2$ -independent mechanisms of radiation damage are not changed when the radiation is delivered in pulses of 40  $\mu$ sec duration.

- 1263 LaChance, L.E. RADIOSENSITIVITY OF THE VARIOUS STAGES OF OOGENESIS IN Callitroga hominivorax. (Abstr.) Genetics 46, 8 (1961) 877.

The female reproductive system of this insect affords an ideal opportunity to study a large number of germ cells all of which are in the same stage of oogenesis. The female usually will not oviposit until 7 d old. During this time approximately 250 germ cells are undergoing growth and maturation, each in a separate ovariole. Virgin females ranging in age from a few hours to 7 d old were irradiated with 2650 r of  $\gamma$ -radiation, then mated to untreated males and egged when they were 8 d old. At this time the females deposited approximately 250 eggs. Failure of the eggs to hatch was attributed to dominant lethal changes induced in the oocyte. Radiosensitivity of the developing oocytes varied considerably. Irradiation of the females less than 4 h old resulted in complete sterility. Mature oocytes were not formed. Observed hatchability for the other age groups was females 18-24 h old, 30%; more than 24 h old, 60%; 2 d old, 64%; 3 d, 78%; 4 d, 30%; 5 d, 14%; 6 d, 21%; and 7 d, 17%. Cytological investigations of the ovarioles indicated that the high radiosensitivity during the 1st day corresponds to changes taking place in nurse cell nuclei during the first 24 h of adult ovarian growth. Trophocyte units are completely differentiated after 24 h and this confers a degree of radioresistance to the oocyte-trophocyte group. After the 3rd day the oocyte is almost fully mature and nurse cells have disappeared. Increased radiosensitivity of the oocyte on the 4th day, and after, is then due to changes taking place within the oocyte nucleus.

- 1264 LaChance, L.E., Leverich, A.P. RADIOSENSITIVITY OF DEVELOPING REPRODUCTIVE CELLS IN FEMALE Cochliomyia hominivorax. Genetics 47, 6 (1962) 721-35.

In female Cochliomyia hominivorax,  $\gamma$ -radiation-induced dominant lethal changes in the reproductive cells (which develop synchronously) were measured by egg-hatchability tests and correlated with cytological observations of the stage of nuclear development. (1) In pupae 4-6 d old, only oögonial cells are present. Irradiation at this age reduced the number of mature oocytes produced as the dose increased, but the lowered hatchability of eggs that were produced indicated that some dominant lethals persisted through maturation to be detectable in the embryo. (2) In old pupae and newly emerged adults, differentiation of the oocytes and nurse cells takes place. Irradiation of adults less than 24 h old interfered considerably with egg production; the younger the female at irradiation, the fewer normal eggs were produced. (3) Irradiation of females older than 24 h resulted in production of normal numbers of eggs. In three-d-old females the oocyte nucleus is in prophase I, in 4-d-old females metaphase I, and in 5-d-old females anaphase I. Dosage-response studies indicated that the  $LD_{50}$  radiation dose for oocytes in metaphase I is 1309 r, anaphase I, 1639 r, and prophase I, 7939 r. For oocytes irradiated in the first meiotic division, the relation between dose and dominant lethals induced was linear for the range investigated. (Essentially auth.)

- 1265 LaChance, L.E., Bruns, S.B. OOGENESIS AND RADIOSENSITIVITY IN Cochliomyia hominivorax (DIPTERA: CALLIPHORIDAE). Biol. Bull. 124, 1 (1963) 65-83.
- In untreated Cochliomyia hominivorax females, (screwworm flies), gross ovarian growth correlated with the age of the adult female from emergence to sexual maturity was measured. The size of the ovary doubles between the 1st and 2nd day of adult life, increases more than 5-fold between the 2nd and 3rd day, and increases over 60-fold from emergence to sexual maturity. The cytology of the reproductive system, from 5-d-old pupae to sexually mature females is described. The effects of  $\gamma$ -radiation on gross ovarian growth indicated that newly emerged females are more radiosensitive than 5-d-old pupae, and that irradiation of 2-d-old females has little effect on subsequent ovarian growth. The cytopathology of the irradiated ovary was studied after similar doses of radiation were delivered to various developmental stages. The most radiosensitive stage encountered was that period during which the egg chambers contain nurse cells undergoing endomitotic replications of chromosomal material. (Auth.)
- 1266 Larsen, W.P. A STUDY OF THE EMBRYOLOGY OF THE COCKROACH, Blaberus craniifer BURMEISTER. Diss. Abstr. 21, 11 (1961) 3565.
- In a study on the effects of x-irradiation on the embryos of Blaberus, dosages of 50 to 1000 r (from a 250 kV, 15 ma source) were administered to 26 gravid cockroaches containing developing embryos from 1-60 d old. After 30 d, embryos younger than 60 d were killed and fixed in Kahle's solution. The older embryos were allowed to complete their development. Whole mounts and paraffin sections were made of those embryos which, on gross observation, appeared to be affected by ionizing radiation. Although the oöthecal covering and the ovoviviparous habit limit the scope of some kinds of experimentation, Blaberus shows favorable possibilities for experimental embryology involving the developmental effects of radiation. The exploratory x-irradiation experiment of this study uncovered some pertinent facts. The younger the embryo, the smaller the amount of x-irradiation necessary to produce developmental effects. Dosages < 1000 r may have a sterilizing effect on developing germ cells. Specific abnormalities displayed after irradiation were dwarfing, inhibited growth in certain areas, restrained ventral flexure, and a change in the polarity of pleuropodial nuclei.
- 1267 Larsen, W.P. THE EFFECTS OF X-IRRADIATION ON THE EMBRYOS OF INVERTEBRATE ANIMALS. Progress Report. Period: May 1, 1961 to April 30, 1962. TID-14882, Division of Technical Information, AEC. 15 May 1962, 13p.
- Gravid females of Blaberus craniifer Burmeister, carrying embryos 1-52 d old, were treated with x-rays. The younger the embryo, the lower the dosage required to cause morphological change. Embryos at <28-30 d are affected at < 700 r; embryos > 30 d suddenly show resistance and continue development until dosages reach a level comparable to the lethal dose for adults (adult females die within 30 d after > 5000 r). Gross abnormalities are found; they are varied, ranging from individuals slightly retarded in growth to embryos represented by an amorphous mass. Other abnormal features are described. Embryonic membranes, yolk cells, and the dorsal organ continue to grow and multiply even in the face of high level radiation sufficient to have arrested embryonic growth.
- 1268 Larsen, W.P. SOME EFFECTS OF X-IRRADIATION ON EMBRYOS OF THE COCKROACH Blaberus craniifer. Ann. ent. Soc. Amer. 56, 4 (1963) 442-8.
- Gravid females of the ovoviviparous B. craniifer Burmeister were given x-ray dosages of 50 to 12 000 r, after which their included embryos were examined for changes in the growth of cells and tissues. Embryos were found to become resistant to x-irradiation suddenly just prior to the stage of dorsal closure. Embryos that had passed this stage when irradiated continued to develop normally until dosages reached levels of 2000 r to 5000 r. Extra-embryonic structures were found more resistant to irradiation than embryonic tissues. Cells of the serosa and dorsal organ continued to multiply after x-irradiation had stopped the division of cells in the embryo proper. (Auth.)
- 1269 Lassota, Z. ACTION OF  $\gamma$ -RAYS ON EGGS, LARVAE, AND PUPAE OF Bombyx mori. Acta biochim. polon. 10, 4 (1963) 379-88. (In English).
- Bombyx mori were irradiated with single doses of  $\gamma$ -rays. A dose of 10 000 r given to purgating larvae or to 3-d old cocoons altered metamorphosis. The effect of 2500 r applied at the same stages was revealed only in the 2nd generation. A dose of 10 000 r given to the diapausing eggs inhibited completely the hatching of larvae, and doses of 2500 and 5000 r delayed the hatching of larvae and reduced their number, respectively, to 50% and 10% of the observed population. The high radiosensitivity of the egg and pupa

stages in *Leipodoptera persidis*, even though at these stages the metabolic activity is minimal owing to the diapause. (A 60: 1964, 5860 c)

- 1270\* Лавров, М. Т., Богомаз, В. А. ВЛИЯНИЕ РАДИОАКТИВНОСТИ НА МАЙСКОГО ЖУКА. Зашч. Раст. 6 (1958) ?-?

Lavrov, M. T., Bogomaz, V. A. EFFECT OF RADIOACTIVITY ON THE MAY BUG. Zashch. Rast. 6 (1958) :-?

- 1271 Lefevre, G. Jr. THE INFLUENCE OF AGE AND MATING PATTERNS BEFORE AND AFTER IRRADIATION ON THE INCIDENCE OF INDUCED MUTATIONS IN *Drosophila melanogaster*. (Abstr.) Genetics 48, 7 (1963) 897-8.

Sex-linked lethal mutations were detected in successive broods following a 4000 r x-ray exposure of wild-type *D. melanogaster* males 2, 3, and 4 d old. In contrast with the usual procedure in mutation studies, each brood consisted of the progeny resulting from a single mating, and mutation frequencies were determined separately for successive matings during a period of several days after the irradiation. Further, some males were mated two or three times immediately before irradiation so as to diminish the store of fully mature sperm available upon exposure. The results of these experiments indicate clearly that: 1) the mutation frequency in the very first sperm used following irradiation is higher than commonly realized; 2) in younger males the mutation frequency drops from mating to mating during the 1st day, but not so in older males; and 3) premating strikingly reduces mutation frequencies even in the first mating following irradiation. (Essentially abstr.)

- 1272 Legay, J. M., Teulade, P. SENSIBILITÉ AUX RAYONS X DE LA DURÉE DE DÉVELOPPEMENT DES OEUFS DE *Bombyx mori* LORSQUE L'IRRADIATION EST EFFECTUÉE QUELQUES HEURES APRÈS LE DÉBUT DE L'INCUBATION. C.R. Acad. Sci., Paris 255 (1962) 1784-5.

Les variations du temps de développement (le temps qui s'écoule entre le début de l'incubation et le moment de l'éclosion) en fonction des doses administrées ont été mesurées. Les oeufs étaient irradiés aux doses suivantes: 0 (témoin), 500, 1000, 2000, et 3000 r. Le temps de développement croît avec la dose. La mortalité ne diffère significativement de celle des témoins qu'à partir de 1000 r. La durée de développement se révèle un critère sensible aux faibles doses; par contre, aux fortes doses, la mortalité augmente beaucoup plus vite. Il paraît que le temps de développement d'une part, et le pourcentage de mortalité d'autre part, sont directement proportionnels aux logarithmes des doses, donc proportionnels entre eux. Si l'irradiation a lieu après 5 j d'incubation, il n'y a aucun accroissement du temps de développement alors que la mortalité est très significativement supérieure à celle des témoins.

- 1273 Mossige, J. INVESTIGATIONS OF RADIOSENSITIVITY DURING SPERMIOGENESIS IN *Drosophila melanogaster*. p. 20-2 in "Fourth Report from Norsk Hydro's Institute for Cancer Research for 1961 and 1962". Oslo, Norsk Hydros Institutt for Kreforskning, 1963.

See 1087. The difference in radiosensitivity between mature sperm from young and old males was investigated by irradiating sperm in inseminated females. A lower sensitivity exists among sperm from young males but not as markedly as when irradiated in the male. A comparison was also made of the oxygen effect in brood patterns after irradiation with conventional x-rays and electrons (betatron). See 1085.

- 1274 Nair, K. K. PRELIMINARY STUDIES ON THE EFFECTS OF GAMMA-RADIATION ON HOUSEFLY PUPAE WITH SPECIAL REFERENCE TO THE CRITICAL PERIODS IN RELATION TO THE MECHANISM OF EMERGENCE. p. 207-10 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency, 1962.

Studies on the radiation sensitivity of housefly pupae in different stages of development have been carried out with special reference to the mechanism of emergence. The different dose levels employed were 500, 1000, 2000, 2500, 5000, and 10 000 r. The data obtained on percentage emergence in each group indicated that the early stages of development were most sensitive to radiation, since a dose of 2000 r and above applied to 30-80-h-old pupae did not appreciably affect the mechanism of emergence in these groups. Development in the 2-5-h-old irradiated pupae was found to be complete, but the flies failed to emerge. The significance of the findings is discussed. (Auth)



- 1275 Nair, K. K., Rahalkar, G. W. STUDIES ON THE EFFECTS OF GAMMA RADIATION ON THE DIFFERENT DEVELOPMENTAL STAGES OF THE KHAPRA BEETLE, *Trogoderma granarium* EVERTS. p. 465-77 in "Radiation and Radiolotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963", Vienna, International Atomic Energy Agency, 1963.
- The effects of various doses of  $\gamma$ -radiation on different developmental stages were investigated. Females were found to be more susceptible than males. Doses of 6000 rad female pupae as against 18 000 rad for males were required to induce complete sterility. The influence of post-irradiation temperature on radiation damage was investigated. In larvae, the influence was considerable, the LD<sub>50</sub> (3 d) at 30°C, 34°C and 38°C corresponding to 59 980, 26 360 and 24 100 rad respectively. The stage at which radiation damage manifests itself is largely dependent on the ambient temperature. In irradiated larvae maintained at 30°C, pupation was arrested above 8000 rad; at 34°C and 38°C doses of 10 000 rad and 12 000 rad respectively were required. A reduction of ambient temperature is known to prolong the larval stage, which is reflected by the fact that at low temperature mortality occurred at the larval stage itself, as against the pupal stage at higher temperature.
- 1276 Nakajima, S., Shimizu, K., Nakajima, K. STUDIES ON THE BIOLOGICAL INFLUENCE OF THE TERMITES EXPOSED TO Co<sup>60</sup> GAMMA SOURCE. I. INFLUENCES ON THE ADULT OF FORMOSAN TERMITE AND ITS OFFSPRING. *Miyazaki Daigaku Nogakubu, Kenkyu, Jihou* (Bull. Fac. Agric. Univ. Miyazaki) 8, 2 (1963) 340-6. (In Japanese, with English summary).
- Formosan termites were exposed to Co<sup>60</sup>  $\gamma$ -source with a dosimetry of 1020 r/h. The following sets were made: irradiated female with irradiated male (female r X male r), non-irradiated female with irradiated male (female X male r) and irradiated female with non-irradiated male (female r X male), and exposures were made, giving dosages of approximately 3000, 8000, 9000 and 12 000 r. The results are summarized as follows: The longevity of the termite was reduced in proportion to the increase of the radiation dosage from 3000 to 12 000 r, but the reduction was not remarkable in the female r X male r and the female X male r exposed to 3000 r. In proportion to the radiation dosage from 3000 r to 12 000 r, the number of the sets depositing eggs as well as the total egg deposits were reduced. The emergence of the soldier caste in the female r X male r decreased with the increase of the radiation dosage same as the above column. In the emergence of soldiers, there were no prominent differences among the radiation dosages, but the number of soldiers were smaller than that of control. The degree of the biological influence of the termites exposed to Co<sup>60</sup> from 3000 r to 12 000 r is in the following order: female X male r < female r X male < female r X male r. (Auth.)
- 1277 Ofstedal, P. RADIOSENSITIVITY OF *Drosophila* SPERMATOGONIA. (Abstr.) *Hereditas* 48, 3 (1962) 543.
- Brief note describing investigation aimed at establishing the dose-effect relationship for *Drosophila* spermatogonia in the range of 0-165 r. Embryos about 18 h old were irradiated with 55 r, 110 r, and 165 r. The results indicate that the initial slope of the dose-effect curve may be quite close to that obtained by Spencer and Stern after irradiation of mature sperm. With increasing dose, the curve flattens out. (From abstr.)
- See also p. 19 in "Fourth Report from Norsk Hydro's Institute for Cancer Research for 1961 and 1962". Oslo, Norsk Hydros Institutt for Kreftforskning, 1963.
- 1278\* Olenov, Yu. M., Galkovskaya, K. F., Pushnitsyna, A. D. MATERIALS FOR DESCRIBING THE EFFECT OF IONIZING RADIATION ON INDIVIDUAL DEVELOPMENT. *Tsitologiya* 1 (1969) 293-305. (In Russian).
- Roentgen exposure of larvae and pupae of *Drosophila melanogaster* causes the destruction of part of the cells of the imaginal disks, the rudiments of definite organs of the insect. X-ray mutations are the result of the incomplete repair of this injury. Their frequency depends upon the time of repair. The data obtained permit one to give a new interpretation of the concept of the sensitive period in ontogenesis. The stage for which the repair process caused by the inflicted injury coincides with sensitive period for a given indication, for a given external influence. The destruction of part of the undifferentiated cells and the deviations caused by it in the further course of ontogenesis are obviously a general characterization of the effect of ionizing radiation on the developing organism. One should have this picture in mind when working out a theory of the biological action of ionizing radiation. (Auth)
- 1279\* Oster, I. I., Cicak, A. Z. MORTALITY OF IRRADIATED PRE-IMAGINAL STAGES OF *Drosophila*. *Drosophila Inform. Serv.* 32 (1958) 143-4.

- 1280 Palii, V.F., Iirkovskii, G.G. STUDIES ON THE EFFECT OF IONIZING RADIATION ON THE DEVELOPMENT OF INSECTS. Vsesoyuz. Enl. Obshch., Kirgizskoe Otd. Sborn. Enl. Rabot 1 (1962) 70-9. (In Russian).
- Musca domestica and Pieris spp. are considered.
- 1281 Pelereuts, C., Brande, Van den, J. INVLOED VAN GAMMASTRALEN OP EITTES VAN Ephestia kuehniella ZELL. (The effect of  $\gamma$ -rays on eggs of Ephestia kuehniella Zell.) Meded. LandbHogesch. Gent 26, 3\* (1961) 1401-8. (In Flemish).
- In further tests on the effect of  $\gamma$ -rays on eggs of Anagasta (Ephestia) kuehniella (Zell.) eggs 6, 4 and 2 d old were used. Doses of 9000 and 14000 rad caused significant reductions in the hatching of eggs 6 and 4 d old, respectively; doses of 1000 and 2500 rad stimulated the hatching of eggs 2 d old, and doses of 4000 rad reduced it. A dose of 20000 rad reduced the hatching of eggs 6 and 4 d old to 24.2 and 0%, respectively, and one of 6000 rad prevented all 2-d-old eggs from hatching. Doses of 1000-2500 rad increased adult emergence from surviving 6-d-old eggs, doses greater than 2500 rad reduced that from 4-d-old eggs, and one of 2000 rad reduced that from 2-d-old eggs. Sterility was increased in the eggs laid by the females, the threshold doses for eggs 6 and 4 d old being 2500 and 2000 rad; adults from eggs treated when 2 d old with 3000 rad or more laid few or no eggs. (RAE-A 51: 1963, 50-1).
- \* Dertiende Internationaal Symposium over Fytofarmacie en Fytiatrie, 9 Mei 1961 (Thirteenth International Symposium on Phytopharmacy and Phytiatry, 9 May, 1961) p.981-1729. Ghent, 1961.
- 1282\* Подольян, В.Я. ВЛИЯНИЕ ИЗЛУЧЕНИЯ РАДИОАКТИВНОГО КОБАЛЬТА НА РАЗНЫЕ СТАДИИ РАЗВИТИЯ МУХ. Стр. 210-1 в сб. "Первая зоологическая конференция Белорусской ССР — Тезисы докладов". Минск. 1958.
- Podolyan, V. Ya. EFFECT OF RADIOCOBALT IRRADIATION ON THE VARIOUS STAGES OF DEVELOPMENT OF FLIES. p.210-1 in "Papers presented to the First Zoological Conference of the Byelorussian SSR", Minsk, 1958".
- 1283 Proverbs, M.D., Newton, J.R. INFLUENCE OF GAMMA RADIATION ON THE DEVELOPMENT AND FERTILITY OF THE CODLING MOTH, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). p.65-81 in APCL-1890, Vol. 3, 1964.
- See 1284
- 1284 Proverbs, M.D., Newton, J.R. INFLUENCE OF GAMMA RADIATION ON THE DEVELOPMENT AND FERTILITY OF THE CODLING MOTH, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). Canad. J. Zool. 40, 3 (1962) 401-20.
- Exposure of the mature pupa or the newly emerged adult of the codling moth, Carpocapsa pomonella (L.), to 40000 rads of  $\gamma$ -radiation induced dominant lethality in at least 98% of the sperm without affecting adult emergence, mating behaviour, or adult longevity. Higher dosages decreased the frequency of mating. Irradiation of eggs, mature larvae, or young pupae induced dominant lethality in a high percentage of the sperm, but caused prohibitively high mortality and frequently reduced mating. The female was more radiosensitive than the male. In general, sensitivity decreased as development progressed from the egg to the adult stage (Auth.)
- See 1283
- 1285 Quraishi, M.S., Metin, M. RADIOSENSITIVITY OF VARIOUS STAGES OF Callosobruchus chinensis L., p.479-84 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency. 1963.
- Insects were reared on mung (Phaseolus mung L.) seeds at a temperature of  $29 \pm 1^\circ\text{C}$  and a humidity of 70-75%. Under these conditions the insect life cycle was 18-22 d. Eggs were irradiated at dose-rates of 80 kr/h at 0.5 cm, and larvae, pupae and adults at 20 kr/h, at 1 cm from a 4-c  $\text{Ir}^{192}$  source. A dose of 15 kr gave 100% mortality in eggs. A sensitive stage may exist for a short period during the 1st 24 h of egg development. In 8-d-old larvae 100% mortality was obtained with 20000 rad. The pupae seem to be less radiosensitive than eggs or larvae, and 47000 rad were required for 100% mortality. Although mating took place after irradiation, the eggs produced when either parent had been irradiated with 42000 rad did not

hatch. Such eggs continued to be produced even when either or both parents had been subjected to 67 000 rad (the highest dose tested).

- 1286\* Rattan Lal, Rahalkar, G.W., Sethi, G.R., Saxena, P.N. STUDIES ON THE EFFECT OF BETA-RADIATIONS ON INSECTS. II. THE EFFECT OF BETA-RADIATIONS (IRRADIATION OF FULL-GROWN CATERpillARS AND FRESHLY-FORMED PUPAE) ON THE LIFE-HISTORY OF Corcyra cephalonica STANTON Indian J. Ent. 22, 1 (1960) 15-21.

Beta-radiation was supplied by  $P^{32}$  in the form of  $H_2P^{32}O_4$ . Intensities of 555, 1111, 2222, and 3333 mrep/h for 24 h were used. A dosage of 1111 mrep/h applied to eggs, 1st-instar and full-grown caterpillars, and freshly-formed pupae proved to be the most beneficial and stimulating with regard to the development of progeny up to completion of the 2nd generation. The usefulness of such treatment of pre-imaginal stages for mass rearing is pointed out. The effects of  $\beta$ -radiation depend on radiation intensity and the developmental stage irradiated. Thus, whereas 3333 mrep/h is to some extent detrimental to full-grown caterpillars and freshly-formed pupae, it does not produce adverse effects on eggs and 1st-instar caterpillars.

- 1287 Ray, D.T. FECUNDITY STUDIES ON X-RAYED Mormoniella vitripennis. (Abstr.) Genetics 48, 7 (1963) 906.

X-rayed Mormoniella have shown, with few exceptions, a marked reduction in fecundity. This has been measured as the number of offspring per female, and appears greater as radiation dosage increases. Differences in total offspring may result from many variations in fecundity, such as sterility, permanent diapause, or inability to pupate or eclose. Using the "Damp Chamber" technique, eggs were counted and observed from the time of laying until the completion of metamorphosis. Results obtained by use of this technique indicate that reduced egg production shows little, if any, relationship to radiation dosage. Eggs laid by treated females are equal or, in a few cases, greater in number than those of controls. Raying the eggs in various stages of meiotic development produces many lethals which exert their effect primarily during the early embryonic development. Eggs complete their development and are laid but show little inclination to begin or complete cleavage activities. Over 90% show no activity. Another 7% progress only through various cleavage stages, and in the remainder, a cessation of metabolic activity during later stages of metamorphosis occurs. Reduced fecundity appears to be due primarily to the effects of induced lethal genes rather than to a reduction in the number of eggs laid.

- 1288 Сидорова, В.Р. О ВЛИЯНИИ ГАММА-ЛУЧЕЙ  $Co^{60}$  НА МАЛУЮ НАЗЕМНУЮ СОВКУ (Laphygma exigua Hb.). Стр. 154-8 в сб. "Вопросы биологии и краевой медицины", №3. Ташкент. 1962. Р. Ж. Биол. №13Е182. 1963.

Sidorova, V.R. EFFECT OF  $Co^{60}$  GAMMA RAYS ON THE SMALL CUTWORM, p.154-8 in "Voprosy biologii i kraevoi meditsiny", No.3. Tashkent, Akad. Nauk Uzb. SSR, 1962. R. Zh. Biol. No. 13E182. 1963.

A preliminary survey was made on the effect of  $\gamma$ -irradiation on the cutworm moth, Laphygma exigua. Irradiation of larvae in the 3rd instar with 10 000 and 50 000 r  $Co^{60}$  caused 40% mortality in the 1st 7 d. Higher dosages (100 000 - 250 000) killed 100% of the larvae. No unfavourable effect was found when larvae fed on irradiated cotton leaves (10 000 and 50 000), but there was a reduction in the respiratory rate of these larvae. Irradiated phosphoorganic preparations (10 000 and 50 000 r) in a 0.2% concentration retained their toxic unchanged properties. (BA 45: 1964, 21089)

- 1289 HISTOLOGISCHE UNTERSUCHUNG ZUM "FRÜHTOD" RÖNTGENBESTRAHLTER Drosophila-EIER. (Histological investigation on the "premature death" of x-irradiated Drosophila eggs.) Naturwissenschaften 48 8 (1961) 310.

A histological study was made of the premature death of Drosophila eggs, 1.5 h old, exposed to doses of x-radiation from 250 to 3000 r. At various times after the irradiation the embryos were fixed by the Huetner method, and the development stage was microscopically determined. The results show that after a dose of 3000 r 75% of the eggs have the histological state of 1.5-h controls. The distribution of the development stages, compared to the development of controls, is tabulated. None of the irradiated eggs attain the development of the controls. (NSA 15: 1961, 20804)

- 1290 Taage, M. UNTERSUCHUNGEN ÜBER SPERMATOGENESE UND KEIMESENTWICKLUNG NACH BESTRAHLUNG DER MÄNNCHEN VON *Calliphora erythrocephala* MEIG. DIPTERA, CALLIPH. (Investigations on the spermatogenesis and embryonic development following irradiation of *Calliphora erythrocephala* Meig. Diptera, Calliph. males.) *Dtsch. ent. Z.* 10 (1963) 335-77. (In German).

Male adults were given 250-5000 r x-rays 1 d before eclosion; testes were examined for any histological effects. Numerous disturbances in the meiotic and mitotic processes were observed. Judging by the purely physiological damage of spermatogonial tissue (dissolution of nuclei, pycnosis, nuclear vacuoles) there appears to be a particularly radiosensitive stage during the spermatogonial growth phase. No changes were found in sperm motility or fertilizing ability, nor in the vitality of irradiated males. Dominant lethals were induced in male germ cells following sufficiently high doses, deduced from the exponential dose/egg-survival curve obtained for irradiated males mated with non-irradiated females. To determine differences in radiosensitivity during spermiogenesis, irradiated males were mated at intervals with non-irradiated females but this method, successful with *Drosophila*, proved unsuitable for *Calliphora*. A cytological investigation was made of eggs fertilized with irradiated sperm. The majority died at the 8-16 blastomere stage. The morphogenetic function of nuclei in early spermiogenesis of *Calliphora* is discussed.

- 1291\* Takeda, H., Tanaka, T., Asano, K. STUDIES ON THE AFTER-EFFECTS OF X-RAYS ON THE LARVAL DEVELOPMENT AND THE COCOONS DURING THE EMBRYONIC STAGES. *Res. Repts. Fac. Text. Sericult. Shinsu Univ.* 9 (1969) 60-78.

5000 r caused many deformed adults whose wings expanded incompletely. Their incidence apparently increases when the eggs are irradiated in the older embryonic stage. Poor hatching and quite irregular larval growth after the 3rd instar followed irradiation (4000 and 5000 r) of 7-9 d eggs. Some dwarf larvae produced were similar to the precocious larvae resulting from the removal of corpora allata. Cocoon fibre quality deteriorated. Many kinds of abnormal cocoon were produced. The silk layer of the round cocoon was generally loosened. A greater quantity of silk wadding was found in irradiated cocoons than in controls. X-irradiation of the developing embryo evidently damages the functions of various organs related to cocoon formation such as muscles and the nervous system. The fibres of the cocoon and its wadding are remarkably thick and contain a great deal of sericin; the shape of fibroin, in fibre cross-section, is non-uniform in the silk wadding and triangular in the cocoon.

- 1292 Tobias, C.A. STUDIES ON HEAVILY IONIZING PARTICLES - HILAC STUDIES. (Abstr. A1A1124) p.7 in "Research and Development in Progress. Biology and Medicine. Issue No. 2". TID-4201, Division of Technical Information, AEC. Nov. 1963.

The biological effects of heavy particles have been under study in the Lawrence Radiation Laboratory since 1935. The accelerators currently being used are the Heavy Ion Linear Accelerator (HILAC), the 184" Cyclotron, the new 88" Cyclotron and the LPT at Livermore. The HILAC is the source of heavy ions, including deuterons, alphas, lithium, boron, carbon, nitrogen, neon, and argon. Larvae and pupae of the confused flour beetle, *Tribolium confusum*, are eminently suited for investigations concerning the developmental effect of heavy ion radiations. Preliminary data taken in the current year indicate that strong steady magnetic fields (3500 gauss) can anneal the radiation damage initiated in the pupae by heavy radiation.

- 1293 Valencia, R.M., Valencia, J.I. STUDIES OF THE GENETIC EFFECTS OF IRRADIATION DURING THE PERIFERTILIZATION STAGES OF *Drosophila melanogaster*. p. 179-84 in "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy - Mexico City, 9-13 April 1962". Washington, D.C., Pan American Union, 1962.

Stage 14 oöcytes, recently fertilized eggs and early embryos were found to be about equally sensitive to an x-ray dose of 500 r. All gave about 60% embryonic mortality. Mature sperm, on the other hand, irradiated with the same dose, conferred a relatively low (10%) mortality upon the eggs fertilized by it. This difference suggests that the major cause of death in irradiated eggs is not chromosome breakage. The damage must, nevertheless, be nuclear. It is proposed that a key biochemical entity, closely associated with the genetic material, could be the target. The lack of difference in mortality among the three egg stages probably indicates that 500 r is a saturating dose for the event concerned in the death of these cells. (Auth).

- 1294 Würgler, F.E. EXPERIMENTAL ANALYSIS OF A LINEAR DOSE EFFECT CURVE RESULTING FROM X-IRRADIATION OF Drosophila EGGS. (Abstr.) p.199 in "2nd International Congress on Radiation Research, Harrogate, Yorkshire, England, 5-11 August 1962". London, Silver End Documentary Publications, Ltd, 1962.
- In earlier experiments, Ulrich (1954) found a dose-effect curve of the form  $y = 1 - \exp(-kD)$  for the embryonic mortality of  $15 \pm 5$ -min-old Drosophila eggs after a 3-min exposure to x-rays. Improvements in the egg-collecting procedure enabled us to shorten the collecting period to 3 min and thus to reduce the age variability of the egg samples to  $\pm 1.5$  min. With this short collecting time one obtains an ample number of eggs homogeneous in division stage as shown by cytological studies. Thus, it becomes possible to get four dose effect curves (exposure 5 sec) with egg age variation of 10-13; 13-16; 16-19; 19-22 min. The four curves are very different in shape as well as in slope, but the summation of all four leads to a straight line. The steepness of the summation curve is (within the experimental limits) the same as was found in a control experiment irradiating 10-22-min-old eggs. Consequently, it was possible to show that in this particular case the linear dose effect curve cannot be interpreted as a "one-hit-curve".
- 1295 Würgler, F.E. THE RADIOSENSITIVITY OF EARLY DEVELOPMENTAL STAGES OF Drosophila. (Abstr.) Int. J. Rad. Biol. 6, 4 (1963) 378-9.
- Egg samples of different mean ages ( $10.5 \pm 1.5$ ;  $11.5 \pm 1.5$  min, etc.) were subjected to a fixed dose (exposure 5 sec) and the rate of embryonic mortality scored. The rate of killed embryos varies with the age of the eggs at the moment of irradiation. It seems that this fluctuation of mortality-rate is the expression of different radiosensitivities of different division stages. In his earlier experiments with  $15 \pm 5$  min (exposure 3 min) old eggs Ulrich found a linear dose-effect curve. The same curve shape was found in a similar experiment irradiating  $16 \pm 6$  min (exposure 5 sec) old eggs. With the technique of the 3-min samples it became possible to subdivide the latter arrangement and to get 4 dose action curves with an egg-age variation of  $11.5 \pm 1.5$ ;  $14.5 \pm 1.5$ ;  $17.5 \pm 1.5$ , and  $20.5 \pm 1.5$  min, a summarization of which would be expected to lead to the linear curve found for the  $16 \pm 6$  min samples. The 4 curves are very different in shape as well as in slope and the sum curve is a straight line with a slope which is - within experimental limits - the same as found for the  $16 \pm 6$  min curve. Consequently, it was possible to show that in this particular case the linear dose-effect curve cannot be interpreted as a "one-hit-curve". (From abstr.)
- 1296 Ytterborn, K.H. X-RAY SENSITIVITY OF SPERMATOGONIA AND SPERMATOOA IN Drosophila melanogaster. Nature, Lond, 194 (1962) 797-8.
- Experiments were conducted to determine if, after irradiation of young spermatogonia, other mutations behave in a manner similar to the induced crossing-over work of Sävhaugen. A chromosome free from lethals was isolated and x-ray doses of 900 r used. Spermatogonia were irradiated in larvae, and after eclosion the males were mated in two periods for lethal tests. Spermatozoa in adult males were also irradiated for comparison. The rate of chromosomes with lethals is  $\sim 3$  times higher for spermatozoa than for spermatogonia after irradiation. A higher rate of independently induced lethals and a lower rate of clusters were found in the mating period 0 to 3 d than in the period 15 to 18 d after eclosion, while there is no significant difference in the rates of chromosomes with lethals; the results agree well with those of Sävhaugen. Possible explanations of the results are discussed. (NSA 16: 1962, 20197)
- See also:
- 748 Mutagenic effect of x-rays on moths. (Kortschak, 1962)
- 768 A comparison of the susceptibility of the grain weevil (Sitophilus granarius L.) to accelerated electrons and  $^{60}\text{Co}$  gamma radiation. (Bull et al., 1961)
- 771 Developmental-genetic study of the effect of x-ray irradiation in Drosophila virilis and Bufo valliceps. (Clayton, 1961)
- 772 The susceptibility of the rust-red flour beetle, Tribolium castaneum (Herbst.) to gamma radiation. (Crook, 1962)
- 773 The use of ionizing radiation in the preservation of cereal products. (Dal Monte, 1969)
- 778 Effects of irradiating single and mixed species of beetles. (Erdmann, 1961)
- 779 X-ray tolerance of two related species of beetles. (Erdman, 1962)
- 782 The effect of ionizing radiation on the biology and ecology of Rhodnius prolixus, the principal vector of Schizotrypanum (i.e. Trypanosoma) cruzi in Venezuela.
- 790 Influence de l'irradiation sur les adultes de Sitophilus sasakii Takahashi (Curculionidae) et leurs descendants. (Laviolette and Nardon, 1963)
- 791 Action des rayons  $\gamma$  du cobalt-60 sur la mortalité et la fertilité des adultes d'un charançon du riz. (Laviolette and Nardon, 1963)

- 797 X-irradiation of the developing male germ cells of Tribolium confusum. (McDonald, 1961)
- 801 Genetic sensitivity and differential killing in irradiated Drosophila spermatogonia. (Ofstedal, 1963)
- 804 Quelques résultats supplémentaires concernant l'influence des rayons gamma sur les chrysalides et les oeufs de la teigne de la farine "Ephestia kuehniella Z." (Pelereys, 1963)
- 806 La protection des denrées contre les insectes ravageurs par l'emploi des radiations ionisantes en vue d'obtenir la stérilité des insectes adultes. Étude particulière de la réaction des gonades de "Sitophilus granarius". (Pesson and Vernier, 1963)
- 809 Sterilization of the codling moth by gamma-irradiation. (Proverbs, 1962)
- 810 Action des rayons  $\gamma$  sur la stérilité d'une noctuelle du coton (genre Laphygma exigua). (Rasulov, 1963)
- 811 Effect of gamma radiation on the reproductive potential of the Mexican fruit fly. (Rhode et al., 1961)
- 815 Sterilization of Dacus oleae by gamma radiation. (Thomou, 1963)
- 816 X-ray induced "dominant lethals" in inseminated eggs of Drosophila. (a) Experiments in the stage between completion of meiosis and beginning of cleavage. (Ulrich, 1963)
- 884 Similarity of x-ray-induced mutation rate in gonia of Drosophila females and males. (Meyer and Muller, 1961)
- 892 A study of sex predetermination in the mealy bug Planococcus citri (Risso). (Nelson-Rees, 1960)
- 900 The cell lineage of the sternopleura in Drosophila melanogaster. (Stern, 1963)
- 901 Radiation and mutation rate. (Stern, 1963)
- 910 The mutation rate at specific autosomal loci in different species of Drosophila. (Turku, Finland, n.d.)
- 917 The effect of x-irradiation on somatic crossing-over in Drosophila melanogaster. (Abbadessa and Burdick, 1963)
- 968 The genetic basis of somatic damage produced by radiation in third instar larvae of Drosophila melanogaster. (Ostertag, 1961)
- 973 Effects of x-rays on salivary-gland chromosomes during early stages of development. (Sengfin, 1958)
- 980 The effect of maternal age and radiation on the rate of non-disjunction in Drosophila melanogaster. (Uchida, 1962)
- 982 Increased recombination from female Drosophila irradiated as larvae without oocytes. (Whittinghill and Davis, 1961)
- 983 Unchanged recovery of cross-overs after x-irradiation of pupal Habrobracon. (Whittinghill and Allen, 1961)
- 1002 Effects of x-ray irradiation in Drosophila virilis at different stages of spermatogenesis. (Clayton, 1961)
- 1009 Methods for estimating differential radiosensitivity. (Oster and Fooley, 1963)
- 1013 A cytogenetic study of the effects of x-irradiation on Aedes aegypti. (Rai, 1963)
- 1019 Cell stages and differential sensitivity to irradiation in males of Drosophila melanogaster. (Sävhaugen, 1963)
- 1030 Variation of radiosensitivity during meiosis and early cleavage in newly laid eggs of Drosophila melanogaster. (Würgler et al., 1963)
- 1043 Modification effects with magnetic fields. (Amer, 1963)
- 1049 The effects of nitric oxide on radiation damage in Drosophila virilis and Drosophila melanogaster. (Capps, 1961)
- 1055 Some effects of oxygen on the insect Anagasta kuehniella and Tenebrio molitor. (Clark and Cristofalo, 1961)
- 1075 Ultrafractionation and biological efficiency of fast electrons. Investigations on "eggs" of Drosophila melanogaster of different stages of development. (Künkel and Oberheuser, 1962)
- 1078 The action of 14-MeV electrons, 14-MVp and 200-KVp x-rays and the influence of the energy spectrum of 14-MeV electrons on eggs of Drosophila. (Markus and Sticinsky, 1962)
- 1079 The effect of the energy spectrum from 14 MeV electrons, and the relative effects of 14 MeV electrons, and of 14 MV and 200 kV x-rays on Drosophila eggs. (Markus and Sticinsky, 1963)
- 1082 Tolerance of gonial cells of Drosophila melanogaster for heavy x-ray doses divided into installments. (Meyer et al., 1959)
- 1090 The influence of radiation in altering the incidence of mutations in Drosophila. (Muller, 1963)
- 1095 Ultrafractionation and relative biological effectiveness of fast electrons. Experiments on Drosophila embryos at different stages of development. (Oberheuser and Künkel, 1963)
- 1106 Effect of a low temperature on the development of radiation injury in eggs of the silkworm Bombyx mori L. (Paulov, 1961)
- 1118 The relative biological effect of  $P^{32}$   $\beta$  radiation. I. Comparison of  $P^{32}$   $\beta$  radiation and x-rays as to their biological effects on Drosophila melanogaster. (Rudnicki, 1961)

- 1122 The effect of oxygen concentration on the frequency of induced XO males and non-disjunction females after irradiation of Drosophila males. (Sävhaugen, 1961)
- 1143 Two types of dose-rate dependence on radiation-induced mutation rates in spermatogonia and oögonia of the silkworm. (Tazima et al., 1961)
- 1147 Further studies on dose-rate dependence of radiation-induced mutation rates in spermatogonia and oögonia of the silkworm. (Tazima and Kondo, 1962)
- 1148 Studies on the genetic effect of radiation 1959-1960. II. Studies on the genetic effect of radiation with silkworm. (2) Two types of dose-rate dependence of radiation-induced mutation rate in spermatogonia and oögonia of the silkworm. (Tazima et al., 1962)
- 1149 Further studies on two types of dose-rate dependence of radiation-induced mutation rates in spermatogonia and oögonia of the silkworm. (Tazima and Kondo, 1962)
- 1151 A study of dose-dependence of radiation-induced mutation rates in Drosophila melanogaster, allowing for the degree of maturity of the germ cells. (Traut, 1962)
- 1154 The relationship between dosage and mutation rate in x-radiation of Drosophila zygotes. (Ulrich, 1960)
- 1155 Oxygen effect in newly laid Drosophila eggs. (Ulrich and Würgler, 1962)
- 1156 Partial irradiation of Drosophila zygotes by X-rays. (Ulrich, 1963)
- 1210 Genotype X environment interaction with isogenic lines of Drosophila melanogaster. (Kidwell, 1963)
- 1298 Effects of x-irradiation upon cell population and morphogenesis in the developing beetle wing. (Beck and Hayes, 1962)
- 1299 Effects of x-irradiation upon cell population and morphogenesis in the developing beetle wing. (Beck and Hayes, 1962)
- 1300 Cell differentiation and radiopathology in the wing of Tribolium confusum. (Beck, 1962)
- 1301 Effects of x-irradiation upon cell population and morphogenesis in the wing of Tribolium confusum. (Beck, 1962)
- 1302 Effect of x-irradiation on cell differentiation and morphogenesis in a developing beetle wing. (Beck, 1963)
- 1303 Temperature dependence of wing abnormality in Tribolium confusum. (Slater et al., 1963)
- 1314 Répercussion de l'influence des rayons  $\gamma$  dans la descendance de Sitophilus sasakii Takahashi (Coléopt. Curcul.). (Nardon, 1962)
- 1316 Effects of x-rays on meal worm embryos. (Po-Chedley, 1963)
- 1317 The effects of x-irradiation on the free A-amino nitrogen fraction of the meal worm, Tenebrio molitor, ova. (Po-Chedley, 1963)
- 1324 Some effects of x-irradiation on longevity in Habrobracon females. (Clark, 1961)
- 1325 The modification by x-irradiation of the life span of haploids and diploids of the wasp, Habrobracon sp. (Clark and Rubin, 1961)
- 1326 Life span differences between haploid and diploid males of Habrobracon serinopae after exposure as adults to x-rays.
- 1327 The effect of gamma radiation on the viability and fertility of Lucilia sericata Mg. (Dipt.) irradiated as pupae. (Donnelly, 1960)
- 1337 The effect of x-radiation on longevity, emergence, and DDT-susceptibility of the house fly. (Varzandeh and Moos, 1963)
- 1341 Response of Tribolium larvae to x-irradiation. (Ducoff and Walburg, 1960)
- 1343 Effects of gamma radiation on Culex fatigans egg rafts. (Ghosh et al., 1961)
- 1344 Lethal effects of X-rays on the housefly, Musca domestica L. (Grasso et al., 1962)
- 1345 Lethal effects of X-rays on Musca domestica L. (Grasso et al., 1963)
- 1347 Preliminary studies on irradiation of some common stored-grain insects in Pakistan. (Huque, 1963)
- 1353-a The genetic basis of somatic damage produced by radiation in third instar larvae of Drosophila melanogaster. I. Death before maturity. (Cstertag, 1963)
- 1354 Some early effects of ionizing radiation on the German cockroach, Blattella germanica. (Ross and Cochran, 1963)
- 1356 Effects of gamma radiation on three species of Philippine insect pests. (Viado and Manoto, 1963)
- 1359 Biological effectiveness of 30-MeV electrons in dependence on the tissue depth and in comparison with 180-keV and 31-MeV photons. I. Lethality test on one-hour Drosophila embryos. (Fritz-Niggli and Schinz, 1961)
- 1360 Biological effectiveness of 30-MeV electrons depending on tissue depth and in comparison with 180-keV and 31-MeV photons. II. Lethality tests on four-hour old Drosophila embryos. (Fritz-Niggli and Schinz, 1962)
- 1362 Determination of the RBE of 14-MeV neutrons using 14-day-old grasshopper embryos (Chortophaga viridifasciata and Encoptolophus sordidus). (Hansen, 1963)

- 1363 The effects of continuous and fractionated doses of gamma-radiation on the survival and fertility of Sitophilus granarius (Calandra granaria L.). (Jefferies, 1962)
- 1364 The effects of continuous and fractionated doses of gamma radiation on the survival and fertility of Sitophilus granarius (Calandra granaria) L. (Jefferies and Banham, 1961)
- 1366 Radiosensitivity of the Drosophila embryo. (Johansen et al., 1963).
- 1368 Modification of radiation response during embryonic development by the use of elevated temperatures. (Slater et al., 1962)
- 1369 Oxygen dependence of the lethal and mutation rates induced by x-irradiation of Drosophila zygotes. (Würgler, 1960)
- 1370 Modification of x-ray induced embryonic mortality by different anoxia conditions before and during irradiation of uncleaved Drosophila melanogaster eggs. (Würgler, 1961)
- 1371 Resistance of Sitophilus granarius and Sitophilus oryzae at different stages of their development to  $\gamma$ -irradiation from cobalt-60. (Bruel and Bollaerts, 1960)
- 1372 X-ray effects on single and mixed species populations of Tribolium confusum and Tribolium castaneum (Coleoptera: Tenebrionida.) (Erdman, 1962)
- 1375 The importance of competitiveness of radiosterilized males in mosquito-control programs. (Dame and Schmidt, 1962)
- 1382 The effects of gamma radiation on the biology and behaviour of forest insects and the possibility of their control by means of irradiation techniques. (Stark, 1963)
- 1407 Developmental homeostasis in x-rayed populations of Drosophila pseudo-obscura. (Tantawy, 1963)
- 1414 Effects of radiation on ecological systems. (Erdman, 1963)
- 1416 Ecological effects of ionizing radiation on organisms, communities and ecosystems. (Platt, 1963)
- 1456 Sterilization of the Mediterranean fruit fly and its application to fly eradication. (Katiyar and Valerio, 1963)
- 1456 The application of nuclear energy to agriculture. (Moh, 1963)
- 1464 Could this be death to the codling moth? (Proverbs and Newton, 1961)
- 1465 Effect of gamma rays on insects. Progress on the use of induced sexual sterility for the control of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). (Proverbs, 1961)
- 1466 Control of the codling moth, Carpocapsa pomonella (L.) by the release of sexually sterile males. (Proverbs, 1963)
- 1473 Irradiation. A sterilization weapon against the corn borer. (Springeli, 1963)
- 1481 Disinfestation of dried figs by gamma radiation. (Papadopoulou, 1963)
- 1486 Effect of gamma radiation on some wood-boring insects. (Bletchly, 1961)
- 1493 Irradiation of fruits and vegetables in a mobile cobalt-60 unit. (Harvey, 1963)
- 1498 Some experimental data on cobalt-60 radiation doses capable of arresting insect infestation of cereals and flour. (Pesson, 1963)
- 1499 Utilisation des radiations ionisantes ( $^{60}\text{Co}$ ) pour la protection des denrées contre les insectes nuisibles. Recherches relatives à la détermination des doses utiles pour assurer la stérilité des insectes. (Pesson, 1963)
- 1512 Study on the development of parasites Coleophora laricella Hbn. by means of x-ray photography. (Eldmann, 1962)

# I-B-2 MALFORMATIONS

- 1297 Annan, M.E., Reitan, P.J. EFFECTS OF DESICCATION OF Drosophila FEMALES ON THE FREQUENCIES OF IRRADIATION INDUCED EMBRYONIC ABNORMALITIES. (Abstr.) Genetics 46, 8 (1961) 848.  
Virgin D. melanogaster females were desiccated immediately prior to exposure to 4000 r units of  $\gamma$ -irradiation from a  $\text{Co}^{60}$ -source. The effects of this treatment were observed on egg hatchability. The results confirm the findings of Herskowitz in that desiccation enhances the irradiation-induced reduction in egg hatchability. In addition, observations were made on late stage embryos (16 or more hours of development) in order to determine whether or not the desiccation effects could have been due to effects on fertilization. The embryos were classified as either (1) normal, (2) grossly abnormal, or (3) showing no development. Preliminary results indicate that there is no difference in the developmental picture between embryos from irradiated flies whether they were desiccated or not. Further observations are being made to substantiate these results and to determine whether or not more subtle embryonic abnormalities might be contributing to the desiccation effects on irradiation-induced "dominant lethals."



- 1298 Beck, J.S., Hayes, T.L. EFFECTS OF X-IRRADIATION UPON CELL POPULATION AND MORPHOGENESIS IN THE DEVELOPING BEETLE WING. (Abstr., E4) Rad. Res. 16 (1962) 573.  
See 1299.
- 1299 Beck, J.S., Hayes, T.L. EFFECTS OF X-IRRADIATION UPON CELL POPULATION AND MORPHOGENESIS IN THE DEVELOPING BEETLE WING. (Abstr.) P. 61 in "Biology and Medicine. Semiannual Report, Spring 1962". UCRL-10211, California. Univ., Berkeley, Lawrence Radiation Lab. June 1962.  
Recent studies have disclosed the dose-incidence relation, the time course of radiosensitivity and the location of the sensitive site for the wing deformity in Tribolium confusum. The membranous wing consists of a flat, closed envelope of cuticle around a double layer of cells of a single type that form the cuticle with its spines. The total mass of the deformed and normal wings are equal within limits of error. To determine their relative total C content, wings were exposed to 800 MeV  $\alpha$ -particles, producing the  $C^{12}(\alpha, n)C^{14}$  reaction. The positron-emitting  $C^{14}$  was then counted. No significant difference was found. The total P content was explored by the thermal neutron reaction,  $P^{31}(n, \gamma)P^{32}$ . Individual wings were compared (measuring down to 0.03  $\mu$ g P). The deformed wing contained  $2.3 \pm 0.7$  times as much P. By quantitatively removing the imaginal wing from the pupal cuticle, the P content at various stages of development was determined. A general increase in density to electrons and in osmophilic foci were found by electron microscopy, and also a 50% decrease in the number of spines in the maldeveloped wing. Studies are under way to prove the hypothesis of a 1:1 correspondence between cells and spines, thus furnishing a permanent record of cell population and morphogenetic activity. (From abstr.)
- 1300 Beck, J.S. CELL DIFFERENTIATION AND RADIOPATHOLOGY IN THE WING OF Tribolium confusum, p. 122-59 in "Biology and Medicine. Semi-annual Report, Spring 1962". UCRL-10211, California. Univ., Berkeley, Lawrence Radiation Lab. June 1962.  
Data are presented from studies on cell differentiation and pathological effects observed in the wing of the flour beetle, T. confusum, after exposure of larvae, pupae, and adults to various doses of x-radiation. Observations were correlated on microscopic transverse sections and whole wing preparations. The only consistently apparent deformities elicited by x-irradiation were deformities of membranous wings and the elytra. This response was found to be reproducible and proportional to dosage. The characterizing nature of the deformity was investigated in neutron-activated and control wings. The deformed wings showed 1.7 times as much phosphorus as control wings and 1.3 times as much carbon as control wings. Morphological differences in the developing wings were observed by both light and electron microscopy. Morphogenesis of the wing was shown to be quite radiosensitive at certain critical times. Radio-induced aberrations in timing and development are described. 143 references. (From NSA 16:1962, 32653)
- 1301 Beck, J.S. EFFECTS OF X-IRRADIATION UPON CELL POPULATION AND MORPHOGENESIS IN THE WING OF Tribolium confusum. (Abstr.) p. 226 in "2nd International Congress on Radiation Research, Harrogate, Yorkshire, England, 5-11 August 1962" London, Silver End Documentary Publications, Ltd. 1962.  
The membranous wing of the confused flour beetle develops almost entirely by the activity of a single type of cell which forms a highly refined, uniform structure, consisting of a multi-layered cuticle with regularly spaced projections (spines). Cell differentiation and cuticle and spine formation occur for the most part in the first 3 d of the 7-d pupal period. X-irradiation of the pupa on the 1st day of pupal life causes a specific deformity of the wing, which becomes apparent upon eclosion. The induction of this deformity begins at 1000 r and occurs in over 95% of animals at 2200 r. The radiosensitive period ends sharply at 30 h after pupation. Spatially, the radiosensitive region is in the body anterior to the wing, as shown by collimated x-ray beams and microbeams of heavy fions. The nature of this deformity, which grossly appears as a warping and failure of folding, has been explored with light microscopy, electron microscopy, and activation analysis. The remarkable thinness of the wing (0.5  $\mu$  or less) makes rapid scanning and precise orientation possible with the electron microscope. Such studies have revealed ultramicroscopic lesions, an overall thickening, and a relative paucity of spines in the affected wings (and there is some evidence for a one-to-one correspondence between cells and spines). By the  $C^{12}(\alpha, n)C^{14}$  reaction, no difference in carbon content was found. However, activation of phosphorus by thermal neutrons  $P^{31}(n, \gamma)P^{32}$  revealed a striking increase (more than doubled) of phosphorus in the affected wings. This divergence of phosphorus content has been traced during the course of development. (From abstr.)
- 1302 Beck, J.S. EFFECT OF X-IRRADIATION ON CELL DIFFERENTIATION AND MORPHOGENESIS IN A DEVELOPING BEETLE WING. Rad. Res. 19 (1963) 569-81.

The membranous wings of the confused flour beetle, *Tribolium confusum*, are subject to an apparently specific gross deformity induced by x-irradiation of 1000 to 2000 r during the first 37 h of the 6-d pupal stage. The incidence of wing deformity as a function of dose was determined, the survival curve showing a shoulder to about 1000 r (semi-log plot) and a  $D_0$  of 110 r (where  $D_0$  is the number of deformed pupae, following exposure). The radiation damage was manifest microscopically and chemically as a morphological transformation of some of the hypodermal cells in the wing; disorder of the spine array in regions; malformation, absence, and iteration of spines; delays in some developmental events; and disruption of the normal loss of cellular material from the wing. The amount of phosphorus in control and experimental wings was determined by measuring the  $P^{32}$ -radioactivity in following neutron activation, and gave 0.03  $\mu$ g and 0.08  $\mu$ g of P/wing respectively at 1 d after eclosion, i.e. phosphorus-retention by the radiation-damaged wing.

- 1308 Slater, J. V., Rescigno, A., Amer, N. M., Tobias, C. A. TEMPERATURE DEPENDENCE OF WING ABNORMALITY IN *Tribolium confusum*. *Science* 140 (1963) 408-9.

When *T. confusum* pupae were exposed continuously to temperatures from 10°C to 40°C, the adults which finally emerged exhibited wing abnormalities typical of those obtained with x-irradiation. The data indicate the implication of two processes. Two mathematical models are suggested to account for this phenomenon. (Auth.)

See also:

- 208 Neutron activation analysis for phosphorus in a study of development in a beetle wing. (Beck and Manney, 1962)
- 472 The genetic and developmental effects of ingested radioactives in *Habrobracon*. (Grosch, 1960)
- 789 Preliminary experiments on the sterilization of the pupae of the Khapra beetle by irradiation with gamma rays. (Kansu, 1962)
- 804 Quelques résultats supplémentaires concernant l'influence des rayons gamma sur les chrysalides et les oeufs de la teigne de la farine "*Ephestia kuehniella* Z.", (Pelerents, 1963)
- 854 The action of radiation and other mutagenic agents (1) in inducing mutation in *Drosophila* females, and (2) in controlling the action of specific genes responsible for suppressing uncontrolled growth. (Glass, 1961)
- 957 The preliminary investigation of salivary gland chromosomes of *Chironomus tentans* Fabr. from the Clinch river. (Nelson and Blaylock, 1963)
- 1047 Influence of penicillin on frequency of induced mutation. (Burdette, 1961)
- 1158 A study of the successive effect of roentgen rays and temperature upon the frequency of mutations and roentgenomorphoses. (Vatti, 1963)
- 1234 Effects of radiation upon development of *Tribolium confusum*. (Beck, 1961)
- 1237 Control of the Mediterranean flour moth *Anagasta kuehniella* Zell by sterile male release. II. Susceptibility to gamma radiation. (Bull and Wond, 1963)
- 1238 Some effect of gamma radiation on the biology and morphology of the Khapra beetle, *Trogoderma granarium* Everts. (Carney, 1962)
- 1244 Arrested development in x-rayed larvae of *Ephestia kuehniella* Zeller (Lepidoptera: Phycitinae). (Erdman, 1961)
- 1266 A study of the embryology of the cockroach, *Blaberus craniifer* Burmeister. (Larsen, 1963)
- 1267 The effects of x-irradiation on the embryos of invertebrate animals. (Larsen, 1962)
- 1268 Some effects of x-irradiation on embryos of the cockroach *Blaberus craniifer*. (Larsen, 1963)
- 1291 Studies on the after-effects of x-rays on the larval development and the cocoons during the embryonic stages. (Takeda et al., 1959)
- 1353-a The genetic basis of somatic damage produced by radiation in third instar larvae of *Drosophila melanogaster*. I. Death before maturity. (Ostertag, 1963)
- 1356 Effects of gamma radiation on three species of Philippine insect pests. (Viado and Manoto, 1963)
- 1357 Synergistic action of x-irradiation and elevated temperatures on development. (Amer and Slater, 1961)
- 1358 Analysis of the combined influence of x-irradiation and elevated temperatures on development. (Amer et al., 1962)
- 1367 Comparative influence of accelerated heavy nuclei on anomalous development in *Tribolium*. (Slater et al., 1961)
- 1368 Modification of radiation response during embryonic development by the use of elevated temperatures. (Slater et al., 1962)
- 1473 Irradiation. A sterilization weapon against the corn borer. (Springell, 1963)

# I-B-3 TISSUE, ORGAN

## 1-B-3-a RETINA

- 1304 Baldwin, W.F., Sutherland, J.B., Habowsky, J.E.J. EFFECTS OF X-RAYS ON ELECTRICAL ACTIVITY IN THE EYE OF THE COCKROACH *Blaberus giganteus*. Nature, Lond. **199** (1963) 816.

Preliminary studies are discussed on the effects of x-rays on both the electroretinograms and the spontaneous electrical discharges in the eye of the cockroach, *B. giganteus*. Details of the manipulative and irradiative techniques are given, when 2000 r/min were administered. Large doses of radiation were observed to have a marked effect in reducing the amplitude and frequency of the electrical activity recorded from the cockroach eye. *B. giganteus* reacted to changes in light intensity in the typical "on-off" response of certain insects. An effect on the "on" response was observed. Recovery occurred in both cases, but at different rates.

- 1305 Демирчоглян, Г.Г., Аллахвердян, М.А., Мелик-Мусьян, А.Б., Оганджян, В.Г., Поросян, Р.И., Лалаян, А.А., Василян, В.В. О РЕЗУЛЬТАТАХ ИССЛЕДОВАНИЙ ПО ВОЗДЕЙСТВИЮ ИОНИЗИРУЮЩЕЙ РАДИАЦИИ НА СЕТЧАТКУ ГЛАЗА И НЕКОТОРЫЕ СВЕТОЧУВСТВИТЕЛЬНЫЕ СИСТЕМЫ. Радиобиология **2**, 3 (1962) 442-9.

Demirchoglyan, G.G., Allakhverdyan, M.A., Melik-Mus'yan, A.B., Ogandzhanyan, V.G., Pogosyan, R.I., Lalayan, A.A., Vasilyan, V.V. RESULTS OF A STUDY ON THE EFFECT OF IONIZING RADIATION ON THE RETINA OF THE EYE AND ON CERTAIN LIGHT-SENSITIVE SYSTEMS. Radio-biologiya **2**, 3 (1962) 442-9.

The reactions of the nervous system were studied by examining the effect of various kinds of ionizing radiation on the retina, considered as a special, peripheral part of the central nervous system. The methods used included electroretinography or the recording of electrical potentials of the retina by means of contact-lens electrodes, microelectrode techniques, amperometric determination of the hydrosulfide groups in the retina, and the determination of the absorption spectrum of the visual purple rhodopsin together with histochemical analysis. Moths were used for the study, exposing the test insects to radiations of 1, 5, 10, and 15 kr and using butterflies from unirradiated cocoons as controls. Results agree well with the previously established high radiation sensitivity of the retina, and indicate the importance of protecting it against exposure to ionizing radiation.

- 1306 Smith, J.C., Kimeldorf, D.J. THE BIOELECTRIC RESPONSE OF THE INSECT EYE TO BETA RADIATION. USNRDL-TR-698, 29 Nov. 1963. 30 p.

Moths of the family Noctuidae were used to determine the bioelectric responses of the compound eye to ionizing radiation. It was found that  $\beta$ -radiation can induce a bioelectric reaction in the compound eye of the insect. The electroretinographic pattern is indistinguishable from that produced in response to a light stimulus. The flickerfusion frequency threshold is also similar for the two stimuli. However, a difference exists between light and  $\beta$ -radiation in the time course of the dark adaptation process. It could be demonstrated that the disparity is dependent upon the interaction of visual pigment with the light stimulus. An electroretinogram response was elicited by a  $\beta$  dose of less than one milliroentgen at the radiation dose rate of 20 mr/sec. (Auth.)

## 1-B-3-b REPRODUCTIVE TISSUE

- 1307 Erdman, H.E. ANALYSES OF THE DIFFERENTIAL RADIOSENSITIVITY OF DEVELOPING REPRODUCTIVE TISSUES IN *Habrobracon juglandis* (ASHMEAD) TO IONIZING RADIATION. Int. J. Rad. Biol. **3**, 2 (1961) 183-204.

Significant developmental stages throughout the life-cycle of the holometabolous and ectoparasitic insect, *H. juglandis* (Ashmead) were x-rayed with 300 r increments until sterility was illustrated by adult performance. Because of parthenogenetic male production, attention was focused on females. Cytological examination of ovarioles from adults x-rayed at the different stages gave rise to three conclusions concerning the radiopathology of the reproductive system: (1) regardless of dose, somatic tissues functioned normally to produce 4 ovariole sheaths; (2) radiation of larvae adversely affected the trophocytes rather than the oocyte itself, apparently the damage is chromosomal; (3) radiation of pupae interfered with egg-nurse syncytia differentiation from oögonia. (Auth.)

- 1308 Larsen, W. SURVIVAL OF ISOLATED INSECT TISSUES FOLLOWING RADIATION. Ann. ent. Soc. Amer., 56, 5 (1963) 720-1.

Various tissues were excised, irradiated and their survival and the continuation of normal movement tested. Heart fragments from 40-d old embryos were obtained from gravid females of the cockroach Blaberus craniifer Burmeister. A series of 24 hearts were given from 1000 r to 12 000 r x-rays. All except 5 which succumbed to bacterial infection, continued to live and contract for 150 d after treatment. Whole embryos and adults have a lethal point of about 7000 r. Another series of 22 hearts, 11 clusters of Malpighian tubules, and 11 portions of hindgut were treated with Co<sup>60</sup> dosages up to 93 000 rads. The tubules continued to pulsate for 15 d, hearts to beat for 23 d, and hindguts to carry on gross movements for 80 d after maximum treatments. This extreme resistance to  $\gamma$ -radiation may be due to the very low O<sub>2</sub>-requirements of these tissues.

## I-B-3-d ABDOMEN (SEGMENTS)

- 1309 Lee, W.R. PARTIAL-BODY RADIATIONS OF QUEEN HONEY BEES. TID-20299, New Hampshire, Univ., Durham, 1963, 7p.

By shielding abdominal segments III through V queen honey bees survived otherwise lethal doses of x-radiation. In contrast, irradiating only segments III through V with 10 000 r killed all queens within 3 weeks, as did whole-body irradiations. Lead shields that protect segments III through V and permit irradiating either the spermatozoa in the spermatheca or the oögonia of the ovary with higher doses than could otherwise be administered are described. (Auth.)

See also:

- 806 La protection des denrées contre les insectes ravageurs par l'emploi des radiations ionisantes en vue d'obtenir la stérilité des insectes adultes. Etude particulière de la réaction des gonades de "Sitophilus granarius". (Pesson and Vernier, 1963)
- 879 Radiation induced viability mutations in the honey bee. (Lee, 1962)
- 880 Radiation induced viability mutations in the honey bee. (Lee, 1962, 1963)
- 1012 Radiosensitivity of the mitotic cycle of Aedes aegypti. (Rai, 1962)
- 1015 Histological studies of radiation sensitivity of spermatogenic cells of the silkworm (Preliminary note). (Sado, 1968)
- 1169 The effects of gamma radiation and apholate on the reproductive tissues of Drosophila melanogaster Meigen. (Cantwell and Henneberry, 1963)
- 1172 Some effects of gamma radiation and apholate on the reproductive tissues of Drosophila melanogaster. (Henneberry and Cantwell, 1962)
- 1184 Histochemical and ultrastructural modifications in the mesenteron of Dacus oleae Gmel. induced by ionizing radiations. (Baccetti et al., 1961)
- 1185 The effects of gamma radiation on the ovaries of Dacus oleae Gmel. (Baccetti and De Dominicis, 1963)
- 1187 Cytological interpretations of five types of induced modification in the oviposition-pattern of the wasp Habrobracon. (Grosch, 1963)
- 1218 Genetic studies of Drosophila strain differences in sensitivity of the testis to the mutagenic action of x-rays. (Ward et al., 1962)
- 1248 Beginning of reproduction determined by age of the female flour beetle, Tribolium confusum (Coleoptera: Tenebrionidae). (Erdman, 1962)
- 1249 Beginning of reproduction determined by age of the female flour beetle, Tribolium confusum (Coleoptera: Tenebrionidae). (Erdman, 1962)
- 1265 Oögenesis and radiosensitivity in Cochliomyia hominivorax (Diptera: Calliphoridae). (LaChance and Bruna, 1963)
- 1290 Investigations on the spermatogenesis and embryonic development following irradiation of Calliphora erythrocephala Meig., Diptera, Calliph., males. (Taeger, 1963)
- 1361 Nitrogen protection of fecundity and fertility in female Habrobracon treated with x-rays. (Grosch and Clark, 1961).

- 1310 Bartlett, A.C. CHANGES IN QUANTITATIVE TRAITS UNDER SELECTION AND IRRADIATION. Dis. Abstr. 23, 10 (1963) 3595-6.
- Selected lines from a highly heterozygous population of *Tribolium castaneum* had a high average body weight, up to a certain point beyond which continued selection had no further effect. Fitness was severely affected in the large lines and effects of irradiation on fitness were studied. Strain response (original foundation strain and large strains) of body weight to high selection and random selection along with response to 0, 100 r and 1000 r of radiation were tested. In both, high selection was still the most efficient way of changing body weight. Irradiation lowered the reproductive potential (progeny number per mating); in combination with high selection irradiation had a detrimental effect on the response. Even though irradiation has been used successfully to produce response to selection in other organisms, the lowered reproductive potential of *T. castaneum* restricts the use of this tool to bring about a response to high selection for increased fitness. The mutation rates of genes controlling the quantitative trait of body weight were estimated to lie between  $1.7 \times 10^{-3}$  and  $2.0 \times 10^{-3}$  mutations/r/locus, the number of loci controlling this trait to be about 600, and the average effect of each locus to be about 1/30 of the standard deviation of body weight.
- 1311 Duxbury, R.E., Sadun, E.H. EFFECTS OF GAMMA-RADIATION ON DEVELOPMENT OF *Dirofilaria uniformis* IN *Anopheles quadrimaculatus*. Proc. helm. Soc. Wash. 30, 2 (1963) 283-5.
- To determine the susceptibility of irradiated *Anopheles quadrimaculatus* to infection with *Dirofilaria uniformis*, female mosquitoes were exposed to  $\gamma$ -radiation of 10 000, 20 000 and 40 000 equivalent physical (rep) 24 h before they fed on infected cottontail rabbits. Ten days later a larger number of larvae was recovered from the irradiated groups as compared to non-irradiated controls, although the number was significantly greater only in mosquitoes given 10 000 rep. A similar experiment in which mosquitoes were irradiated at the same levels 24 h after infection, resulted in a significant reduction in the numbers and growth of larvae in irradiated mosquitoes as compared to their controls. With smaller doses there were no consistent differences in numbers, size, or location of developing larvae between experimental groups receiving 1000 and 2000 rep and the controls. At 4000 rep, however, significantly fewer larvae were recovered and most of them had developed only to the sausage stage. (Auth.)
- 1312 Kirmeldorf, D.J., Hunt, E.L. MOTOR RESPONSES OF MOTHS TO LOW-INTENSITY X-RAY EXPOSURE. Science 140 (1963) 805-6.
- A brief burst of x-rays elicited flight activity in moths placed in a darkened x-ray exposure room. Moths belonging to 8 species of Noctuidae and 1 species of Acrididae were used, amongst them *Agrotis ypsilon*. Wing-beat activity was recorded as an index of this behaviour. Wing-beat activity could be initiated in resting moths or amplitude augmented in active moths by x-ray dose rates of 0.01 to 1.5 r/sec, with a latency of < 1 sec after onset of exposure.
- 1313 Krinskii, G.A., Ch'iwei, C. NUCLEOTIDE METABOLISM OF *Galleria mellonella* L. CATERPILLARS, NORMAL AND AFTER X-RAY IRRADIATION. Biochemistry USSR 26 (1961) 224-7. (English Translation).
- In the composition of the acid soluble fraction of bee moth caterpillars there is found adenosine triphosphate, adenylic acid, and other low molecular weight purine and pyrimidine compounds. A day after x-irradiation of the caterpillars with a dose of 2000 r the total extinction of acid soluble compounds at 260 m $\mu$  decreases by 7%. The content of ATP falls by about 38%. Autolysis of the caterpillars in orthophosphate buffer solution a day after irradiation with a dose of 2000 r increases by about 86%. A considerable fall in ATP content and activation of autolysis in the period immediately after irradiation can be explained by the inhibition of oxidative phosphorylation after irradiation. (Auth.)
- 1314 Nardon, P. RÉPERCUSSION DE L'INFLUENCE DES RAYONS  $\gamma$  DANS LA DESCENDANCE DE *Sitophilus sasakii* Takahashi (Coléopt. Curcul.). C.R. Acad. Sci., Paris 254 (1962) 2464-6.
- Les expériences sont conduites à la température de 27, 5° et 76% d'humidité. Le poids n'a été mesuré que chez les descendants d'irradiés à 8000 r. Parallèlement à l'action sur le poids, on note une diminution de la fertilité chez les descendants d'irradiés, aussi bien à 5000 r qu'à 8000 r. L'irradiation des parents a pour conséquence de diminuer la fertilité et le poids des descendants, et d'augmenter leur durée de développement. Ces effets se transmettent d'une génération à l'autre sans qu'il soit besoin de recourir à la sélection.

Alors que les deux premiers tendent à disparaître, l'augmentation de la durée du développement est stable pendant au moins dix générations. (Aut.)

- 1315 Pelereuts, C. INVLOED VAN GAMMASTRALEN OP OVERWINTERENDE BIJEN. (The effect of  $\gamma$ -rays on overwintering bees). Meded. Landb. Opz. Gent 27, 3 (1963) 896-907. (In Flemish).

The mutagenic and stimulating effects of  $\gamma$ -rays were investigated with a view to possible improvement in bee genealogy. Unfertilized and fertilized queens were irradiated involving, in the latter, irradiated sperm in addition to egg stages. Since artificial insemination gives good results irradiation of drones at some later stage is also envisaged. Changes induced by doses from 10 000 - 100 000 rads in the feeding rate were investigated. The longevity-dose relation was illustrated graphically. A reduction in longevity of 0,5-0,6 d/10 000 rads was observed. The mean life span of 26 d dropped to 20,9-18,7 d after irradiation with 2000 rads; 10 000 rads caused a 30% and 80 000 rads a 65% reduction, down to a life span of only 3,5 d. Wax production decreased with increasing doses. Little difference was observed between the effects of 40 000 and 50 000 rads. As bees grow older an increase in wax production is noted, possibly due to the physiological maturation of the winter brood which, like the summer brood, has to perform successively a variety of functions before wax is produced. The construction of a queen cell can be observed when the dose has not exceeded 10 000 rads.

- 1316 Po-Chedley, D. S. EFFECTS OF X-RAYS ON MEAL WORM EMBRYOS. Progress report. TID-19463, D'Youville Coll., Buffalo, 1963. 6p

The 17 free amino acids and the 3 derivatives previously reported for the 1- and 4-d-old embryos were found represented for almost all the remaining days of embryological growth. These compounds showed, generally, an increase in concentration ranging from 152,7 mg per cent for 1-d through 178,7 mg per cent for 8-d-old embryos. Two major irradiation responses may be distinguished in the meal worm: (1) during the first 4 d of growth, irradiation affects the yolk proteins and free amino acid relationships, which results in general metabolic disturbance, preventing the build-up of the essential amino acid reserve, and culminates in the death of the embryo; (2) although irradiation of the embryo from the 4th day appears to institute amino acid variations from the normal, a recovery or restoration does occur. This positive response may be facilitated by the high reserve concentrations of free amino acids accumulated at this stage of embryological development. Two tables give changes in ninhydrin-positive compounds detected at various developmental stages, in controls and in irradiated embryos.

- 1317 Po-Chedley, D. S. THE EFFECTS OF X-IRRADIATION ON THE FREE  $\alpha$ -AMINO NITROGEN FRACTION OF THE MEAL WORM, *Tenebrio molitor*, OVA. (Abstr. D1B345) p. 78 in "Research and Development in Progress. Biology and Medicine, Issue No. 1". TID-4200, Division of Technical Information, AEC, July 1963.

The present project is directed towards the internal environment of the insect which is rich in free amino acids. Reportedly, as amino acids have some protective potential, the radio-resistance of insects may be interpreted, in part at least, by that bio-chemical consideration. The current aspect of the study is concerned with metabolic differences in biochemical properties detectable during various stages of embryological growth of the meal worm. Data obtained for the meal worm embryo indicates that radiation resistance increases with embryological age, that the ova are rich in free amino acids, that ova exposed to sublethal (damaging) doses of x-rays liberate a labile factor (protein) which disappears as the embryo continues its growth and development. These considerations of the internal mechanism operating for the replenishment of the metabolic pool via protein degradation and the interplay of amino acids with the associated recovery-restorative processes are being examined.

- 1318 Wharton, D. R. A., Wharton, M. L. EFFECTS OF RADIATION ON NITROGEN AND PHOSPHORUS EXCRETION BY THE COCKROACH, *Periplaneta americana* L. Rad. Res. 14 (1961) 432-43.

Starved male cockroaches exposed to 10 000 rads of  $\beta$ -rays consume more water than unirradiated controls. They excrete more  $N_2$  than controls. The difference is pronounced soon after irradiation and continues for several days, after which there is a rise in output by the controls while the  $N_2$  excretion by the irradiated cockroaches continues to decline. The adult excretes very little of its  $N_2$  as uric acid; the identity of the nitrogenous constituents remains to be investigated. P excretion by the irradiated cockroaches follows a different pattern from that of total  $N_2$  or uric acid. There is no significant difference between the 2 groups during the 1st week, however, during the 2nd week the irradiated insects excrete less than the controls. Excretion by the controls rises between the 7th and 12th day in the manner of  $N_2$ . The inorganic P excreted by the cockroach is orthophosphate. There is no strong evidence that the radiation injury is centered in the nucleic acids under the conditions of radiation used, and it is suggested that increased cellular permeability may be the primary lesion. (Auth.)

centered in the nucleic acids under the conditions of radiation used, and it is suggested that increased cellular permeability may be the primary lesion. (Auth.)

See also:

- 48 L'abeille et la radioactivité. (Nordau, 1962)
- 745 Entomological aspects of radiation as related to genetics and physiology. (Grosch, 1962)
- 994 Latent radiation damage and synchronous cell division in the epidermis of an insect. III. Spontaneous reversal of effects leading to delay during mitosis. (Baldwin, 1961)
- 1181 Mechanism of resistance to virus diseases in the silkworm Bombyx mori (IV) (V) (VI). (Aruga, 1958)
- 1182 Studies on the induction of nuclear and cytoplasmic polyhedrosis by treating with x-rays and ultra-violet light in the silkworm, Bombyx mori L. (Aruga and Yoshitake, 1961)
- 1183 15. Induction of virus infections. 2. Ultraviolet light and x rays. (Aruga, 1963)
- 1184 Histochemical and ultrastructural modifications in the mesenteron of Dacus oleae Gmel. induced by ionizing radiations. (Baccetti et al., 1961)
- 1188 On polyhedral disease in the silkworm induced by x-rays. (Karpov, 1959)
- 1244 Arrested development in x-rayed larvae of Ephestia kuehniella Zeller (Lepidoptera: Phycitinae). 1257 Effects of gamma radiation on codling moth eggs. (Hough, 1963)
- 1288 Effect of Co<sup>60</sup> gamma rays on the small cutworm. (Sidorova, 1963)
- 1306 The bioelectrical response of the insect eye to beta radiation. (Smith and Kimeldorf, 1963)
- 1321 A theory of the improved performance and survival produced by small doses of radiations and other poisons. (Sacher and Trucco, 1962)
- 1337 The effect of X-radiation on longevity, emergence and DDT-susceptibility of the house fly. (Varzandeh and Moos, 1963)
- 1372 X-ray effects on single and mixed species populations of Tribolium confusum and Tribolium castaneum (Coleoptera: Tenebrionidae.)
- 1374 Reactions to X-rays of a normal and a HCN-unsusceptible stock of Drosophila melanogaster. (Liers, 1963)
- 1414 Effects of radiation on ecological systems. (Erdman, 1963)

## I-B-5 SENESENCE AND LONGEVITY

### I-B-5-a GENERAL

- 1319 Muller, J.J. MECHANISMS OF LIFE-SPAN SHORTENING. p.236-45 in "Cellular Basis and Aetiology of Late Somatic Effects of Ionizing Radiation". A symposium held in 1962. Harris, R.I.C., Ed. New York, Academic Press, 1963.

Reasons are presented for concluding that spontaneous aging is a part of normal development caused, like most other developmental changes, by other factors than permanent genetic alterations such as point-mutation, deficiency, chromosome loss or inactivation, or segregation, even though it does involve the pointwise death of many individual somatic cells. These reasons comprise the partial reversibility of natural aging, and its independence of ploidy and of other features of chromosome structure. Judged by the same criteria, radiation-induced shortening of the life-span is an expression of point-wise losses of individual cells that are caused by actual genetic changes. That the changes are for the most part recessive, depending on either point-mutations, deficiencies, or whole-chromosome losses, is shown by results in Drosophila, Habrobracon, and plant material, when effects on individuals of different ploidy are compared. Tests of diverse kinds carried out with Drosophila having chromosomes of different structural constitution show clearly that the mechanism here at work is that of chromosome loss, caused by radiation-induced chromosome breaks. It is believed that the same basic mechanism accounts also for most of the acute damage that is produced by radiation. (Auth.)

- 1320 Oster, I.L. RADIATION EFFECTS ON GENETIC SYSTEMS. p.45-50 in "Proceedings of the Conference on Research on the Radiotherapy of Cancer, University of Wisconsin, Madison, Wisconsin, 16-18 June 1960". American Cancer Society, Inc. 1961.

Some of the consequences of x-ray-induced damage in the hereditary material of somatic cells is discussed. Sufficiently large doses applied to the larval stages will cause some deaths during subsequent pupal and imaginal stages. On the basis of survival rates of x-irradiated strains of Drosophila melanogaster, each containing chromosomes differing in structure, it has been suggested that premature aging in animals is

brought about by chromosome loss produced by radiation. The possibility that this phenomenon is also involved in other radiation-induced effects, such as tumour formation and tumour regression, is also considered.

- 1321 Sacher, G.A., Trucco, E. A THEORY OF THE IMPROVED PERFORMANCE AND SURVIVAL PRODUCED BY SMALL DOSES OF RADIATIONS AND OTHER POISONS. p.244-51 in "Biological Aspects of Aging". Schiöck, N.W., Ed. New York and London, Columbia University Press, 1962.

Recent evidence is reviewed on some paradoxical effects of ionizing radiations, especially as manifested in decreased disease incidence and increased expectation of life, based on observations on rats, mice and insects. A theory is proposed which accounts for the class of phenomena discussed. The characteristic damaging or depressant action of large doses is considered to be also produced by the smallest dosages known to produce paradoxical stimulation, and represents an essential step in the whole argument.

- 1322 Алимджанов, Р.А., Хакимова, Р. ДЕЙСТВИЕ ИОНИЗИРУЮЩИХ ИЗЛУЧЕНИЙ НА ЖУКОВ - ВСХОДОВЫХ СЛОНИКОВ. Докл. АН Узб. ССР 3 (1962) 65-8.

Alimdzhanov, R.A., Khakimova, R. EFFECT OF IONIZING RADIATION ON Sitona WEEVILS. Dokl. Akad. Nauk Uz. SSR 3 (1962) 65-8.

Beetles (Sitona humeralis and S. cylindricollis) were collected in the field and exposed to  $Co^{60}$  radiation in doses up to 100 000 r. Irradiation failed to show any substantial effect on either the fecundity or life-span of the beetles. (For more complete abstract see Referat. Zhur., Biol., 1963, 4E203)

- 1323 Baxter, R.C. RADIOBIOLOGIC STUDIES WITH Drosophila. (Abstr. AIB1006) p.14 in "Research and Development in Progress. Biology and Medicine. Issue No. 2". TID-4201, Division of Technical Information, AEC, Nov.1963.

Somatic studies of D. melanogaster are centred about the effects of irradiation upon accelerated aging and longevity. Some of the variables that have been or will be used are acute versus chronic irradiation, certain mutant genes singly or in combination, hybridization, stage of the life cycle, age of the adult, temperature, nutritional stage, and  $O_2$  tension. A few other species of Drosophila have been obtained and are being used for interspecific comparisons with D. melanogaster. (Auth.)

- 1324 Clark, A.M. SOME EFFECTS OF X-IRRADIATION ON LONGEVITY IN Habrobracon FEMALES. Rad. Res. 15 (1961) 516-9.

Habrobracon females, when exposed to x-rays as larvae, pupae, or adults, show a decrease in adult life span which is shortened in proportion to the amount of radiation delivered. Radiation damage to larvae and pupae, which cannot be detected simply by observing the incidence of adults that emerge, is revealed when adult life span is measured. Groups irradiated as adults at the doses delivered show no immediate mortality. The time of onset of death within the group depends on the amount of radiation delivered. Death is delayed for a longer time for smaller doses. Although adults will survive a dose of 200 000 r, as little as 5000 r causes a reduction in life span. (Auth. summary)

- 1325 Clark, A.M., Rubin, M.A. THE MODIFICATION BY X-IRRADIATION OF THE LIFE SPAN OF HAPLOIDS AND DIPLOIDS OF THE WASP, Habrobracon sp. Rad. Res. 15 (1961) 244-53.

Haploid males, diploid males, and diploid females (honey-water- or Ephesia-fed), were irradiated as larvae-in-ocoons, white pupae, and adults, and their adult life span obtained. The differential sensitivity of haploid and diploid adults to x-irradiation indicates that gene action is taking place in the adult stage and in non-dividing cells. Pupae after exposure to 10 000 and 15 000 r are not inhibited in their ability to develop into structurally normal adults which do, however, show a decrease in life span. This is much more apparent in the haploids. Larvae (after 2000 r) also develop into structurally normal adults, but with a decreased life span. The differential sensitivity of haploids and diploids is different for the larval, pupal, and adult stages. This is probably related to different types of genetic injury such as effects on cell division and on gene action occurring in different stages of development.

- 1326 Clark, A.M., Bertrand, H.A., Smith, R.E. LIFE SPAN DIFFERENCES BETWEEN HAPLOID AND DIPLOID MALES OF Habrobracon serinopae AFTER EXPOSURE AS ADULTS TO X RAYS. Amer. Nat. 97 (1963) 203-8.



The life span for haploid and diploid males was determined after exposure as adults to 60 kr of x-rays. The diploid males have a longer duration of life than the haploid males. This indicates that the decrease in life span after irradiation is related to damage to the chromosomal material. Non-irradiated diploid and haploid males have the same life span. The primary damage leading to a decreased life span is different for the irradiated and non-irradiated groups. The mechanisms involved in the normal aging process are different from those involved in the decreased life span from x-irradiation. (From auth. summary)

- 1327\* Donnelly, J. THE EFFECT OF GAMMA RADIATION ON THE VIABILITY AND FERTILITY OF Lucilia sericata Mg. (DIPT.) IRRADIATED AS PUPAE. Ent. exp. appl. 3, 1 (1960) 48-58.

Pupae were subjected to a range of  $\gamma$ -doses from a  $\text{Co}^{60}$ -source. Observations were made on the percentage subsequently emerging after each treatment, and their longevity. Fertility was measured by caging each sex with untreated flies of the opposite sex, the numbers of hatching egg clusters obtained providing an index of fertility of the treated component. Percentage emergence, in pupae more than 8 d old at irradiation, was normal up to 12 000 rep, and reduced by about 24% after 24 000 rep. Adult longevity was progressively reduced by doses from 1000 rep upwards, and was about 50% of the control value after 9000 rep. The percentage viability of eggs from treated females decreased in the dosage range 0-2000 rep without any decrease in total eggs produced, after 3000 rep and above females failed to lay any eggs. Male fertility was about 3% after 3000 rep; above 3000 rep males were completely sterile. Morphologically normal sperm was produced by males at all doses up to 24 000 rep, and showed motility up to 6000 rep at least. Pupae irradiated before completion of  $\frac{1}{2}$  of the total duration of the pupal stage failed to emerge after 3000 rep; those irradiated after that stage emerged normally after 12 000 rep. There was evidence that the transition from susceptibility to resistance was abrupt and that the physiological age of the pupae corresponding to this resistance threshold was independent of velocity of pupal development. (From auth.)

- 1328 Gowen, J.W., Stadler, J. A QUANTITATIVE STUDY OF LIFETIME SICKNESS AND MORTALITY AND PROGENY EFFECTS RESULTING FROM EXPOSURE TO PENETRATING IRRADIATION. Summary of Progress and Contemplated Work Program, Fiscal Year 1961-62. TID-13216, Iowa State Univ. of Science and Tech., Ames, 113p.

Progress is reported in studies on the effects of radiation on life shortening and aging. Data are included from studies on sex determination as illustrated by x-ray induced chromosomal and gene reorganization in Drosophila.

- 1329 Mahroua, M.A., Roston, Z.M.F. EFFECT OF X-RAYS ON THE DURATION OF LIFE OF THE RICE WEEVIL, Sitophilus oryzae L. Int. J. Rad. Biol. 5, 2 (1962) 191-3.

A highly significant shortening of the mean duration of life at 2000 r and at all larger doses was observed, irradiation being carried out on adults. On appropriate plotting of radiation data for both sexes it becomes clear that for doses of 5000 r and upwards an exponential relation exists between mean life span and dose. This relation, however, is not valid at <5000 r. Maximum life span was considerably increased by doses 1000-4000 r, as compared with unirradiated controls. The exponential relation between mean duration of life and dose fails just at the point where prolongation of the maximum life span begins.

- 1330 Nöthel, H. THE INFLUENCE OF X-RAYS ON LONGEVITY, FECUNDITY AND FERTILITY OF Drosophila melanogaster. Int. J. Rad. Biol. 6, 4 (1963) 381-2.

The effect of 17 different doses of x-rays (100 kV, 0-125 kr) on Berlin-wild stock were tested, treated at 24-48 h of age. Fertility:-Development of imagoes could no longer be detected after irradiation (11 kr,  $1.3 \times 10^4$  eggs) of both sexes. At lower doses, some fertility was recovered around the 13th day in males and the 5th day in females. Longevity:- (a) The mean survival-time of the males decreases nearly linearly from 37 d (0 r) to 2,6 d (125 kr) when plotted against a logarithmic raster of increasing doses. In the same raster the curve for the females decreases from 20 d (0 r) to 18 d (3 kr), increases to a maximum of 29 d (11 kr) and then decreases again, running above the curve of the males. (b) A maximum in percentage mortality at each dose lies around the days of mean survival-time. Beginning with 90 kr a 2nd maximum arises on the 3rd day, increasing with dose, and involving nearly 100% at 125 kr. A change in type of mortality apparently occurs at the highest doses. Fecundity:-In controls, fecundity increases to a maximum on the 3rd day, decreasing subsequently with age of ♀♀. After irradiation up to 6 kr, fecundity is characterized by values equal to controls in the first 2 d; a minimum on the 3rd day; a maximum on the 5th day (only at 2 kr equalling 0 r values again); a decrease with age of ♀♀ in the following days, broken by another maximum on the 8th day at 3-4 kr. At 11 kr and above, fecundity decreases from the first 2 d

to total sterility on the 8th day. Even at 90 kr a considerable amount of eggs can be found in the first 2 d. A comparison of data on fecundity and female longevity reveals a correlation between the doses at which fecundity ceases altogether and maximum life-span. Arrested fecundity appears to involve a factor for prolonging life-span. To test this, a dose of the mutagenic cytostaticum TEM, adequate for sterilization, was used in another experiment. The survival time was extended to 158% of the controls (11 kr). (From abstr.)

- 1331 Sacher, G. A. EFFECTS OF X-RAYS ON THE SURVIVAL OF Drosophila IMAGOS. TID-14624, Argonne National Lab., Ill, Oct. 1961. 41p.

See 1332.

- 1332 Sacher, G. A. EFFECTS OF X-RAYS ON THE SURVIVAL OF Drosophila IMAGOS. Physiol. Zool. 36, 4 (1963) 285-311.

Newly emerged male Drosophila melanogaster were exposed to x-rays at 1, 2, or 3 d intervals for the duration of life. Mean exposure rates ranged from 1 to 20 kr/d. Mean after-survival (MAS) of 10 control groups, comprising 3342 flies, was 28.9 d. The 5 exposure groups (1900 flies) at levels from 1.5 to 3 kr/d had pooled MAS of 38.5 d. From 3 to 20 kr/d MAS decreased steadily with increasing daily dose. Similar dosage-survival relations have been reported for Tribolium, Habrobracon and Drosophila. A detailed analysis of the components of variance of survival times within and between treatments is given. Control groups showed great heterogeneity of all variance components. A consistent effect of periodic exposure is to decrease variance and heterogeneity between treatments and between vials within treatments. The hypothesis is proposed that the increase in MAS is secondary to the decrease in the environmental variance components of exposed groups. The environmental variance is considered to measure the action of random environmental variables, primarily deleterious in nature, and radiation exposure reduces their effectiveness. It is not yet possible to decide whether the radiations act primarily by reducing the magnitude of the random variables or by increasing the resistance of the exposed insects. (Auth.)

- 1333 Sonnenblick, S. P., Grodis, J. CAN A DOSE OF 4-5000 r OF X RAYS DOUBLE THE LONGEVITY OF D. melanogaster? Drosophila Inform. Serv. 37 (1963) 130.

Attempts were made to confirm the report of Strehler that x-ray doses of 4000-5000 r double the longevity of D. melanogaster. Several tests were conducted on a Canton-S strain maintained in mass culture on standard media. Radiological factors were the same in all tests (90 kVp, 5 mA, no added filter, 960 r/min as measured in air), but other factors differed. In one study, 1-d-old flies of both sexes were exposed, while in the other 7-d-old flies were irradiated. They were kept for 3 or 4 d, respectively, in mass culture, etherized, and then two pairs of males and females were placed in separate vials. Unirradiated flies were similarly treated and observations were made regularly. After the 2nd week, vials were changed every 7 d. When 1-d-old flies were exposed to 4000 r of x-rays, it was found that the mean life span of combined females and males was 47.6 d and that of the controls was 46.2 d. When 7-d-old flies were treated, the mean longevity of irradiated (4000 r) adults of both sexes was 46.4 d while that of controls was 44.2 d. It is concluded that an x-ray dose of 4000 r does not double the mean life span of treated as against untreated flies, and that a dose as large as 4000 r does not seem to influence life span significantly. (NSA 17: 1963, 35501)

- 1334 Strehler, B. L. FURTHER STUDIES ON THE THERMALLY INDUCED AGING OF Drosophila melanogaster. J. Geront. 17 (1962) 347-52.

It was found that exposing Drosophila to ionizing radiation actually extends life expectancy, rather than shortens it. The effect of irradiation on the mortality rate, such as to produce an extension of life, was largely lost or absent when the flies were reared under absolutely aseptic conditions. It was also shown that the regular replenishment of the housing and food of individually housed Drosophila produces a considerable extension of the life span. Thermal shock exposures at 38.5°C for periods ranging from 1/2 to 3 h (in fractionated dosages) resulted in a significant increase in the age-specific mortality rate of the flies surviving beyond 7 d after the exposure. The results suggest that denaturative processes may mimic the effects of time on the aging of Drosophila as reflected in mortality rates.

- 1335 Taylor Univ., Upland, Ind. THE EFFECT OF X-RADIATION ON LONGEVITY IN Drosophila melanogaster. Technical Progress Report. TID-11562. 1961. 11p.

The length of life, in days post eclosion, has been investigated for irradiated and control groups of flies. The irradiated flies received 2450, 4000, 5000, and 10,000 r of x-radiation. The medium used is described. The longest mean life for females was 62.6 d (determined for 166 flies) at 2450 r, the shortest mean life for males was 34.13 d (for 133 flies) at 10,000 r. Lower amounts (2450 r and 5000 r) seem to increase life span, 10,000 r to decrease life span for all flies. Results are illustrated in 3 graphs.

- 1336 Taylor Univ., Upland, Ind. THE EFFECT OF X-RADIATION ON LONGEVITY IN Drosophila melanogaster. Technical Progress Report, (TID-14970, n.d., (1962?) 28p.

Data are presented for the length of life post eclosion for control and irradiated groups of flies from a crossed strain. The amounts of radiation used were 25 r for eggs; 250 r for larvae; 250, 2500, 7500 and 15,000 r for imagoes. Both mated and unmated groups were studied. The results indicate that (1) irradiation lowers the life of imagoes, although inconsistent results were obtained for imagoes from irradiated larvae and eggs, and that (2) females outlive males in both irradiated and control flies. (NSA 16: 1962, 11459)

- 1337 Varzandeh, M., Moos, W.S. THE EFFECT OF X-RADIATION ON LONGEVITY, EMERGENCE, AND DDT-SUSCEPTIBILITY OF THE HOUSE FLY. Proc. Ent. Soc. Amer. No. Cent. Br. 18 (1963) 55-9.

- 1338 Tobari, I., Moriawaki, D. RELATIONSHIP BETWEEN Y-CHROMOSOME AND LONGEVITY IN Drosophila melanogaster, ESPECIALLY IN TERM OF THE RADIATION EFFECT. p. 152-4 in "Proceedings of the Symposium on Genetic Effect of Radiation, Mishima, 7-8 November 1960". Jap. J. Genet. 36, Suppl. The Genetics Society of Japan, 1961. (In English).

The types of strains used are described. The suggestion is put forward, on the basis of the experimental data obtained, that fertility factors may exist together with longevity factors in the Y-chromosomes. 900 r (x-)irradiation of XXY females may cause the fertility factors to be destroyed in the Y-chromosome, whereas 1800 r may cause both to be destroyed.

- 1339 Wood, V.G. THE EFFECT OF X-RADIATION ON LONGEVITY IN Drosophila melanogaster. Technical Progress Report. Taylor Univ., Upland, Ind. Jan. 1963, n.p.

A suitable strain (wild P-1x4) was used. Radiation doses were 25, 250, 500 r for eggs; 500, 1000 r for larvae; 250, 1250, 5000, 7500, 15,000, 30,000, 45,000 r for imagoes. Both mated and unmated groups were studied. Eggs showed a significant life shortening for both males and females after 250 and 500 r, as did imagoes from irradiated larvae (250 r). Mated flies from such larvae showed a significant increase in life span (females lived 50.1 d, S.D. 13.3, when irradiated and 46.7 d, S.D. 14.1, in controls; males 52.0d (S.D. 18.98, and 45.5, S.D. 14.4). Longest mean life obtained in days post eclosion for irradiated imagoes was for unmated females, given 1250 r. With radiations > 5000 the life span is of the same order or longer than in controls, but there are significant decreases above that irradiation level. In general, females seem to outlive males both with irradiated and control flies, and unmated flies outlive mated flies. Males seem more vulnerable to radiation than females.

See also:

- 470 Effects of ingested  $Pu^{239}$  on fecundity, fertility and life span of Habrobracon (Hymenoptera: braconidae). (Erdman, 1962)
- 471 Effects of irradiation on the Mediterranean meal moth Ephestia kuehniella Zeller, cultured on  $Sr^{90}$ -spiked food. (Erdman, 1962)
- 476 Certain biological effects produced in the boll weevil by tagging it with  $P^{32}$ . (Mayer and Brazzel, 1961)
- 775 Irradiated parasitic wasps, the effect on progeny production and sex ratio. (De Bach and White, 1963)
- 778 Effects of irradiating single and mixed species of beetles. (Erdman, 1961)
- 781 Effect of gamma radiation on the fertility of Aedes aegypti. (Ghosh et al., 1961)
- 782 The effect of ionizing radiation on the biology and ecology of Rhodnius prolixus, the principal vector of Schizotrypanum (i. e. Trypanosoma) cruzi in Venezuela.
- 783 Effects of gamma radiation on the fertility and longevity of Drosophila melanogaster. (Henneberry, 1963)
- 790 Influence de l'irradiation sur les adultes de Sitophilus sasakii Takahashi (Curculionidae) et leurs descendants.
- 791 Action des rayons  $\gamma$  du cobalt<sup>60</sup> sur la mortalité et la fertilité des adultes d'un charançon du riz. (Laviolette and Nardon, 1963)

- 804 Quelques résultats supplémentaires concernant l'influence des rayons gamma sur les chrysalides et les oeufs de la teigne de la farine "*Ephestia kuehniella* Z.". (Pelereuts, 1963)
- 810 Action des rayons  $\gamma$  sur la stérilité d'une noctuelle du coton (genre *Laphygma exigua*). (Rasulov, 1963)
- 855 The action of radiation and other mutagenic agents (1) in inducing mutation in *Drosophila* females, and (2) in controlling the action of specific genes responsible for suppressing uncontrolled growth. (Glass, 1963)
- 973 Effects of x-rays on salivary-gland chromosomes during early stages of development. (Sengün, 1958)
- 1090 The influence of radiation in altering the incidence of mutations in *Drosophila*. (Muller, 1963)
- 1093 Phase cinematography studies on the effects of radiation on the cell, with special regard to the behaviour of the chromosomes in grasshopper spermatocytes in response to x- and beta-irradiations. (Nakanishi et al., 1961)
- 1217 Comparative study of radiation sensitivity of different strains of *Drosophila melanogaster*. (Vorobitsova, 1963)
- 1287 Control of the Mediterranean flour moth *Anagasta kuhniella* Zell by sterile male release. II. Susceptibility to gamma radiation. (Bull and Wond, 1963)
- 1257 Effects of gamma radiation on codling moth eggs. (Hough, 1963)
- 1260 Studies on the breeding method taking advantage of  $\gamma$ -rays in the silkworm. (Japan. Sericultural Experiment Station, Tokyo, 1963)
- 1276 Studies on the biological influence of the termites exposed to  $\text{Co}^{60}$  gamma source. I. Influences on the adult of Formosan termite and its offspring. (Nakajima et al., 1963)
- 1315 The effect of  $\gamma$ -rays on overwintering bees. (Pelereuts, 1963)
- 1344 Lethal effects of X-rays on the housefly, *Musca domestica* L. (Grasso et al., 1962)
- 1345 Lethal effects of X-rays on *Musca domestica* L. (Grasso et al., 1963)
- 1348 The LD<sub>50</sub> for gamma radiation in *Drosophila melanogaster*. (Ives et al., 1965)
- 1352 Different types of mortality including prolongation of female lifetime after x-raying *Drosophila melanogaster* imagines. (Nöthel, 1963)
- 1372 X-ray effects on single and mixed species populations of *Tribolium confusum* and *Tribolium castaneum* (Coleoptera: Tenebrionida). (Erdman, 1962)
- 1373 The differential sensitivity of flour beetles, *Tribolium confusum* and *T. castaneum* to x-ray alteration of reproductive abilities, induced dominant lethals, biomass, and survival. (Erdman, 1963)
- 1384 Effects of temperature and x-ray irradiation on intrinsic growth rate in populations of *Drosophila pseudoobscura*. (Tantawy, 1963)
- 1407 Developmental homeostasis in x-rayed populations of *Drosophila pseudoobscura*. (Tantawy, 1963)
- 1427 Effects of ionizing radiation on insects and other arthropods. (Stone, 1963)
- 1452 Possibilities of eradication of the Mediterranean fruit fly *Ceratitis capitata* Wied. from Central America by gamma-irradiated males. (Katiyar, 1962).
- 1455 Sterilization of the Mediterranean fruit fly and its application to fly eradication. (Katiyar and Valerio, 1963)
- 1469 Control of the Mediterranean flour moth *Anagasta kuhniella* Zell. by sterile male release. I. Biological studies related to large scale rearing. (Bull and Wond, 1962)

# I-B-8 LETHAL EFFECTS

- 1340 Dennis, N.M. THE EFFECTS OF GAMMA-RAY IRRADIATION ON CERTAIN SPECIES OF STORED-PRODUCT INSECTS. J. econ. Ent. 54, 1 (1961) 211-2.
- An exposure to 100 800 r at an average dose rate of 4200 r  $\gamma$ -rays/h killed all *Tribolium confusum* Dev. adults and larvae, *Oryzaephilus surinamensis* (L.) adults, *Rhizopertha dominica* (F.) adults, *Sitophilus granarius* (L.) adults, *Sitophilus oryzae* (L.) adults, *Plodia interpunctella* (Hbn.) larvae, and *Ephestia cautella* (Wlk.) larvae within 2 months. An exposure to 151 200 r killed *O. surinamensis* adults, *Tribolium* adults and larvae, and *P. interpunctella* within 6 d. *Tribolium* exposed to 8400 r did not reproduce during a 2-month period after exposure. Two tables are included.
- 1341\* Ducoff, H.S., Walburg, H.E., Jr. RESPONSE OF *Tribolium* LARVAE TO X-IRRADIATION. (Abstr. 140) Anat. Rec. 137 (1960) 351.
- The effects of x-rays on larvae of *Tribolium confusum* maintained in a flour-yeast medium are described. When young larvae are exposed to 5 kr and incubated at 23°C, deaths begin to occur in a few days, but are scattered throughout the larval period; with older larvae, death may occur during pupation or upon

emergence of the adult. Incubation at 30°C accelerates larval development and lethality to about the same extent, without significantly changing the proportion surviving. Conversely, incubation at 18°C delays both development and death. Doses  $\geq 4$  kr markedly delay onset of pupation. (From abstr.)

- 1342 Frizzi, G., Jolly, M.S. MUFIZIONI INDOTTE CON RAGGI X IN Anopheles maculipennis. (X-ray-induced mutations in Anopheles maculipennis) Atti Ass. genet. ital. 6 (1961) 285-90. (In Italian, with English summary).
- Adult males of A. mac. atroparvus were treated with x-ray doses of 2000 r, 2500 r, 4000r, 5000 r and 6000 r. The highest rate of chromosomal aberrations was obtained with 3500 r; 6000 r gave complete sterility. The most frequent types of mutations were inversions, both paracentric and pericentric; few deficiencies and translocations were found. The embryonic and larval mortality increases with the dose. Possible implications of applied radiogenetics of Anopheles are discussed. (Auth. summary).
- 1343 Ghosh, S.M., Hati, A.K., Basu, S.P. EFFECTS OF GAMMA RADIATION ON Culex fatigans EGG RAFTS. Bull. Calcutta Sch. trop. Med. Hyg. 9, 4 (1961) 156.
- Exposure of recently deposited egg-rafts of Culex pipiens fatigans Wied. to x-radiation in doses up to 1500 r had no effect on time of hatching, and most of the eggs hatched gave rise to normal adults in the same time as did eggs that had not been irradiated. Observation of progeny up to the 5th generation revealed no abnormality. When the dose was 2500 r, few eggs hatched and the larvae died during development. It is concluded that the lethal dose is much lower than that for the eggs of Aedes aegypti (L.) which require a minimum dose of 3000 r for lethal action. In irradiated C. fatigans egg rafts (2000 r), delayed effect of radiation was noticed. Death in every stage from egg to adult occurred. This was not seen in Aedes.
- 1344 Grasso, A., Boccacci, M., Quintiliani, M. LETHAL EFFECTS OF X-RAYS ON THE HOUSEFLY, Musca domestica L. Sci. Rep. Int. Super. Sanità 2, 3 (1962) 292-300.
- Musca domestica L. at the adult stage is highly resistant to x-rays, and males and females show almost the same radiosensitivity. 60 000 r reduces the life span to one half. The insect at the preimaginal stages is much more radiosensitive. The LD<sub>50</sub> is 800 r for 3rd stage larvae and 700 r for pupae. The lethal effects of x-rays can be reduced by anoxia (DRF = 1.6). Treatment with cysteamine or glutathione prior to irradiation is without influence. Iodoacetic acid, administered before irradiation, is able to enhance the lethal effects of x-rays (DRF = 1.39). (Auth.)
- 1345 Grasso, A., Boccacci, M., Quintiliani, M. LETHAL EFFECTS OF X-RAYS ON Musca domestica L. Int. J. Rad. Biol. 6, 4 (1963) 383.
- The insect at the adult stage is highly resistant to x-rays. The dose which reduces the life-span to one half is 60 000 r and the LD<sub>50</sub> at 24 h is 150 000 r. Males and females show the same radiosensitivity. The reduction of the average life-span shows a roughly linear correlation with the x-ray dose. The dose-reduction factor in the anoxic state (N<sub>2</sub>) is about 1.6. Cysteamine and glutathione, injected 20 min before irradiation into the thorax at doses of 0.33 and 0.68 mg per gram of body-weight, respectively, do not afford any protection. Iodoacetic acid, given by tarsal contact at sub-lethal doses, is able to enhance the lethal effects of irradiation. In flies treated with iodoacetic acid, a dose of 65 000 r produces an effect for which 85 000 r would otherwise be necessary. Experiments carried out with various strains of housefly resistant to the most common insecticides have shown that there is no correlation between resistance to the insecticides and radiosensitivity. The pre-imaginal stages are much more radiosensitive, with LD<sub>50</sub> of 800 r for 3rd-stage larvae and 700 r for pupae. (From abstr.)
- 1346 Gil y Gil, C. MEAN LETHAL DOSE FOR SILK WORM EGGS WITH RADIATION OF DIFFERENT WAVE LENGTHS. p.211 in "Book of Abstracts, No. 336(b)". Tenth International Congress of Radiology, Montreal, 26 August - 2 September 1962.
- 1347 Huque, H. PRELIMINARY STUDIES ON IRRADIATION OF SOME COMMON STORED-GRAIN INSECTS IN PAKISTAN. p.455-62 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.
- A dosage of 20 000 r  $\gamma$ -radiation produced 100% mortality of the adults of Rhizopertha dominica and Tribolium castaneum within a period of 11 d. A lower dose (10 000 r) was, however, effective in 23 d.

The adults of *Sitophilus granarius* evinced comparatively high susceptibility and when they were exposed to 10 000 r, total mortality was attained in 7 d. The larvae of *Trogoderma granarium*, however, proved to be the most resistant; they were not responsive to the lower dosages, and 100% control was attained only with 25 000 r in 26 d. The maximum dosage of 250 000 r gave an instant kill in all these cases, but apart from being too high it also adversely affected the viability of the grains. Since, however, their nutritive value remained unaffected, this treatment might be of use where immediate disinfestation of non-seeding edible grains was desired. Eggs of *Bruchus quadrimaculatus* failed to hatch when exposed to 2500 r. Studies on other stages and dosages are in progress. (From auth.)

- 1348\* Ives, P. T., Heilman, R. S., Plough, H. H. THE LD<sub>50</sub> FOR GAMMA RADIATION IN *Drosophila melanogaster*. (Abstr.) *Genetics* 40 (1955) 577.

Survival and mortality curves were constructed. Males proved relatively more sensitive to  $\gamma$ -radiation than did females. In terms of the median, mode and mean mortality for controls and 4 dosages (25 000 r to 100 000 r; at 255 r/min) the interpolated LD<sub>50</sub> is near 40 000 r for males and near 60 000 r for females. After receiving 100 000 r males live for about 2 weeks and females for nearly 4 weeks before "radiation sickness" (Loss of co-ordination) begins, leading to death within a few days. After receiving 150 000 r flies walked normally, none could fly, only a few females could feed and lived longer than 1 d, dying within a week. After 200 000 r or 250 000 r flies showed only small unco-ordinated movements (similar to those in mild anaesthesia) greater at the lower dose in females than in males, followed by death within a few hours. Preliminary tests suggest that less than 10 000 r prevents further germ cell production, but occasional mature sperm produced fertile F<sub>1</sub> after receiving as much as 16 000 r. (From abstr.)

- 1349 Lovellette, E., Ratty, F. J. COMPARISONS OF INBRED AND RANDOM BRED LARVAL SURVIVAL TO 1200 r. *Drosophila Inf. Serv.* 36 (1962) 87-8.

- 1350 Mead, H. E., Muller, H. J. MORTALITY INDUCED BY X-IRRADIATION OF EARLY *Drosophila* EMBRYOS OF STRUCTURALLY DIFFERENT GENOTYPES. (Abstr.) *Genetics* 47, 8 (1962) 970-1.

Earlier work (Lamy and Muller 1939; Muller and Pontecorvo 1939-1942), utilizing offspring of triploid females, has shown that most mortality induced by x-irradiation of early embryos of *Drosophila* is caused by some process other than chromosome loss. We have recently reinvestigated this problem, by determining the influence of a second-chromosome deficiency (vg<sup>-B</sup>) on this mortality. These experiments parallel those previously carried out in our laboratory by Ostertag (Thesis, 1961, and in press) and confirmed by ourselves on the influence of this deficiency on the mortality induced by x-irradiation of 3rd-instar larvae. 800 r were delivered to embryos in the polar-cap stage (extending from blastoderm formation to beginning gastrulation). The following rates of survival to the imaginal stage were obtained for the 4 genotypic classes of 2536 irradiated individuals, as expressed in terms of the frequencies of survivors after irradiation relative to (divided by) the frequencies of the same classes of imagoes obtained from 1094 non-irradiated (control) embryos derived from the same crosses: structurally normal females 48.4%, deficient females 55.5%, structurally normal males 62.4%, deficient males 63.1%. These results differ markedly from those obtained by Ostertag and by ourselves from irradiation of 3rd-instar larvae, which show much lower mortality among females than males and among nondeficient than deficient individuals. We conclude that irradiation kills these early embryos, unlike later stages, by a different process, for the most part, than chromosome loss. Our data show, moreover, that this mortality, unlike that induced by later irradiation, is concentrated within a relatively short postirradiation period.

- 1351 Nöthel, H. THE INFLUENCE OF X-RAYS ON THE VITALITY OF *Drosophila melanogaster*. STUDIES OF MORTALITY, FECUNDITY, AND FERTILITY AFTER VARIOUS DOSES. AFD-MISS-63-288, Gmelin Institut für Anorganische Chemie und Grenzgebiete, Frankfurt am Main. Thesis, Berlin. Freie Universität, 1963. 80p. (In German).

*D. melanogaster* of both sexes was irradiated with 100-kV x-rays using doses between 0 (controls) and 125 kr. Dose-effect curves for mortality are linear up to 90 to 100 kr. For higher doses other effects become important resulting in a higher mortality. Fecundity decreases with increasing doses up to 11 kr, when all females are sterilized. Mortality of offspring is proportional to dose. (Gmelin Inst.) (See 1330).

- 1352 Nöthel, H. DIFFERENT TYPES OF MORTALITY INCLUDING PROLONGATION OF FEMALE LIFETIME AFTER X-RAYING *Drosophila melanogaster* IMAGINES. (Abstr. 5, 52) p. 72-3 in "Genetics Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963, Vol. I". Geerts, S. J. Ed. Oxford, Pergamon Press, 1963.

The influence of x-rays on the lifespan of *D. melanogaster* imagoes has been studied by application of 17 different doses (100 kV, 0-125 kr) to 1-2 d-old males and females of the Berlin wild stock. A prolongation of female lifespan is induced by doses  $> 4$  kr, it culminates at 11 kr in 150% of the mean survival time of unirradiated females. The prolongation is not accompanied by alterations in locomotion or copulation of the females concerned and is independent from radiation effects in the males mated with them. Measurements of fecundity have proved the prolongation to be correlated with the radiation-induced sterilization of the females. This has been confirmed furthermore by investigations with unirradiated virgin females having a low fecundity, with females of a special strain showing a high radiation resistance with regard to fecundity, and with chemically (TEM) sterilized females. In the males mean survival-time,  $T_{50}$ ,  $T_{100}$ , and the time of the highest mortality decrease linearly when plotted logarithmically against a raster of linearly increasing doses. The  $LD_{50}$  of females (96 kr) appears to be twice that of males. The linearity of these curves is interpreted as an always identical type of damage. In both sexes the normal distribution of the post-irradiation mortality rate is altered at doses  $> 90$  kr. A 2nd peak appears at the 3rd day, increasing with doses with a corresponding increase in the gradient of the declining survival time curve at 90-100 kr. A new type of mortality is apparently manifested at high doses. In agreement with the radiation syndrome at these doses it is interpreted as a central-nervous-death. (From abstr.)

- 1353 Ogaki, M., Tanaka, E. INHERITANCE OF TOLERANCE TO GAMMA RADIATION IN *Drosophila melanogaster* (Abstr.) *Genetics* 48, 7 (1963) 904-5.

2 or 3d-old flies from two wild strains (Hikone-H, Mino-H), and two mutant strains (bw; st ss and vg<sup>8</sup>; se) of *D. melanogaster* were subjected to Co<sup>60</sup>  $\gamma$ -radiation in doses ranging from 80 000 r to 180 000 r at approximately 90 000 r/h. The flies were kept 40 /vial at  $24 \pm 1^\circ\text{C}$  and shaken to fresh food every 3 d. Survival and mortality curves were constructed. The sensitivity of males to radiation proved relatively higher than females. The interpolated  $LD_{50}$  of Hikone-H and Mino-H is near 150 000 r for females and near 130 000 r for males 7 d after irradiation; that of bw; st ss and vg<sup>8</sup>; se, (which are more susceptible than the former) is then about 120 000 r for females, 100 000 r for males. The  $F_1$  generation of a reciprocal cross between non-resistant and resistant flies was made. These hybrid flies showed almost the same resistibility as the resistant strains; the  $LD_{50}$  of the hybrid females was near 150 000 r. From the above experiment, it is ascertained that the radiation tolerance was dominant over susceptibility, and material or cytoplasmic effects were negligible. In order to analyse which chromosome is responsible for tolerance, three special synthetic strains, I: Hikone-H; bw; st ss, II: Hikone-H; st ss and III: Hikone-H; bw; st ss and I: Hikone-H, were made. The level of resistibility to Co<sup>60</sup> radiation in the original resistant and susceptible strains, and that of the special synthetic three strains, were tested. The  $LD_{50}$  of I: Hikone-H; bw; st ss and II: Hikone-H; st ss was almost 120 000 r for females, which is just the same level as the susceptible one, whereas only the I: Hikone-H; bw; st ss strain showed almost the same resistibility as Hikone-H resistant strains; the  $LD_{50}$  of this synthetic stock was 147 000 r for females. From this experiment we assume that the tolerance to Co<sup>60</sup>  $\gamma$ -rays in *Drosophila* is dominant and is controlled mainly by the 3rd chromosome.

- 1353-a Ostertag, W. THE GENETIC BASIS OF SOMATIC DAMAGE PRODUCED BY RADIATION IN THIRD INSTAR LARVAE OF *Drosophila melanogaster*. I. DEATH BEFORE MATURITY. *Z. indukt. Abstamm.-u. Vererb.Lehre* 94, 2 (1963) 143-62. (In English)

Third-instar larvae of different genotypes were exposed to x-radiation of various doses (at 160 r/min and 240 r/min). The onset of pupation was noticeably delayed by doses  $\geq 3500$  r, slightly by 3500-2800 r, and scarcely by 2450 r. Doses  $> 2800$  r also prolonged the duration of the pupal period. Mortality before pupation was high at  $\geq 3500$  r, negligible below. Most pupal deaths occurred immediately before eclosion. Serious deformities were also found, their number and extent increasing with dose. At  $> 4200$  r almost 100% of flies were deformed (mostly wing size and phenocopies of "cur", and head abnormalities). Survival was scored separately for the sexes and genotypes. Most of the observed correlations agree with the hypothesis that some somatic radiation damage was exclusively (or nearly) due to chromosome breakage followed by chromosome loss, cellular damage or death resulting whenever a portion of the genome was no longer represented in at least haploid condition. Monosomy for either of the long autosomes does not appear to be detrimental to somatic cells.

- 1354 Ross, M.H., Cochran, D.G. SOME EARLY EFFECTS OF IONIZING RADIATION ON THE GERMAN COCKROACH, *Blattella germanica*. *Ann. ent. Soc. Amer.* 56, 3 (1963) 256-61.

Large nymphs of the German cockroach have been exposed to ionizing radiation at two similar Co<sup>60</sup>-sources. The insects received dosages ranging from 100 r - 9600 r. A number of effects of these total body

irradiations became apparent shortly after exposure, and are described. Data are given on mortality occurring at the 6400 r and 9600 r levels, on male and female sterility at 3200 r, and on the progressive decrease in numbers of reproductive females, off-spring per egg case and normal ovarioles at the lower dosages. Dissections of both normal and irradiated males and females, showing visible effects of irradiation on the ovaries, testes and on spermatogenesis, are also described. An explanation of the decrease in reproductivity and the occurrence of sterility is made on the basis of the probable presence of dominant lethals and on information obtained from dissection. (Auth.)

- 1355 Strahler, N., Terzian, L. A. THE RESPONSE OF BLOOD-FED Aedes aegypti TO GAMMA RADIATION. J. econ. Ent. 56, 3 (1963) 416-7.

The study was undertaken to check whether the survival of blood-fed females was significantly different from that of the non-blood-fed groups after whole-body irradiation from Co<sup>60</sup>. Preliminary results are presented. The data clearly suggest an attenuation of radiation-induced lethality in blood-fed Aedes aegypti, whether one considers the blood-fed or the non-blood-fed groups as the controls.

- 1356 Viado, G. B., Manoto, E. C. EFFECTS OF GAMMA RADIATION ON THREE SPECIES OF PHILIPPINE INSECT PESTS. p. 443-53 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1968". Vienna, International Atomic Energy Agency. 1963.

Eggs, larvae, pupae and adults of Epilachna philippinensis Dieke on tomato, and adults of Sitophilus oryzae L. and Tribolium castaneum Herbst on corn were subjected to 1, 5, 10 and 20 kr  $\gamma$ -rays (Epilachna) and 10, 20, 40, 60 and 80 kr (Sitophilus and Tribolium), respectively. At 1 kr, the proportion of unhatched eggs in Epilachna was about 10%. There was no proportionate increase in mortality at 5 kr, but at 10 kr the mortality increased to more than 3 times that at 5 kr. Mortality at 20 kr was about 90%. The threshold dose seems to lie between 5 and 10 kr. The embryo of eggs that did not hatch failed to continue development. At 1 kr, over 20% of the larvae were killed, although some of these succeeded in pupating before they died. Most of the larvae attained the adult stage. All the larvae that survived the treatments above 1 kr, some for as long as 4 weeks, died without attaining the pupal stage. The pupae were more resistant than the larvae and the adults. Complete mortality was not attained even with 20 kr. Some adults which emerged in the 5-kr and 10-kr lots had abnormally developed wings and/or legs. In the adults, the 10 and 20 kr doses had an adverse effect, killing about 75% of the individuals subjected to the lower, and all subjected to the higher, dose 3 weeks after irradiation. No significant difference in susceptibility between the sexes was noted. About 40% of the S. oryzae in the lots treated with 60 and 80 kr were killed one week after irradiation, but only about 10% were killed with 20 kr and about 20% with 40 kr. The mortality with 40, 60 and 80 kr increased to about 75% two weeks after the start of the test. The mortality with 10 kr corresponding to this period was less than 10% and that with 20 kr was about 25%. The threshold dose seems to lie between 20 and 40 kr. The mortality trend in the T. castaneum was similar to that in the S. oryzae, except that the threshold dose seems to lie at about 40 kr. (From auth.)

See also:

- 472 The genetic and developmental effects of ingested radioactives in Habrobracon. (Grosch, 1960)  
 476 Certain biological effects produced in the boll weevil by tagging it with P<sup>32</sup>. (Mayer and Brazzel, 1961)  
 761 Study of the dose-dependence on the survival rate and the sexual sterilization of the granary weevil (Calandra granaria). (Andreev et al., 1962)  
 774 Exploratory studies on gamma radiation for the sterilization of the boll weevil. (Davich and Lindquist, 1962)  
 790 Influence de l'irradiation sur les adultes de Sitophilus sasakii Takahashi (Curculionidae) et leurs descendants. (Laviolette and Nardon, 1963)  
 791 Action des rayons  $\gamma$  du cobalt 60 sur la mortalité et la fertilité des adultes d'un charançon du riz. (Laviolette and Nardon, 1963)  
 814 Studies on the genetic effect of radiation 1959-1960. II. Studies on the genetic effect of radiation with silkworm. (1) Differences between times of death of the F<sub>1</sub> after irradiation of oögonia or mature oöcytes. (Tazima and Onimaru, 1962)  
 820 X-ray induced "dominant lethals" in inseminated eggs of Drosophila. (b) Experiments with different stages between insemination and end of second cleavage division. (Wüßler, 1963)  
 1013 A cytogenetic study of the effects of x-irradiation on Aedes aegypti. (Rai, 1963)



- 1030 Variation of radiosensitivity during meiosis and early cleavage in newly laid eggs of Drosophila melanogaster. (Würgler et al., 1963)
- 1039 Relative effectiveness of 14 MeV neutrons and 200 kVp x-rays for production of lethality in grasshopper embryos. (Bicker, 1962)
- 1103 The influence of temperature upon the radiation susceptibility of Sitophilus granarius L. Pendlebury et al., 1962)
- 1104 Pathogenic effect of low and medium doses of gamma-rays on the progeny of irradiated insects. (Podolyan, 1963)
- 1156 Oxygen effect in newly laid Drosophila eggs. (Ulrich and Würgler, 1962)
- 1217 Comparative study of radiation sensitivity of different strains of Drosophila melanogaster. (Vorobtsova, I. E.)
- 1228 The susceptibility of the confused flour beetle (Tribolium confusum Duv.) to gamma radiation. (Banham, 1962)
- 1233 Developmental effects of x-ray induced euploid and near euploid mutants in heterozygous condition in Drosophila melanogaster. I. Delay in egg hatching and larval delay and death prior to pupation. (Baumiller, 1963)
- 1238 Effect of radiation on Mexican fruit-fly eggs and larvae in grapefruit. (Brownell and Tudelovitch, 1962)
- 1243 Response of Tribolium confusum to radiations and other stresses. (Ducoff and Bowna, 1963)
- 1244 Arrested development in x-rayed larvae of Ephestia kuehniella Zeller (Lepidoptera: Phycitinae). (Erdman, 1961)
- 1247 Comparative x-ray sensitivity of Tribolium confusum and T. castaneum (Coleoptera: Tenebrionidae) at different developmental stages during their lifecycle. (Erdman, 1962)
- 1251 Preliminary results on the effect of high energy photons on lettuce root growth and on Musca domestica. (Garnou, 1962)
- 1255 Effect of gamma-radiation on eggs of the silkworm. (Henneberry and Sullivan, 1963)
- 1256 Effects of 300 kV x-ray radiation on Sitophilus oryzae. (Hoover et al., 1963)
- 1261 The susceptibility of the saw-toothed grain beetle, Oryzaephilus surinamensis L. to gamma radiation. (Jefferies, 1962)
- 1262 Studies on the radiation sensitivity of Drosophila embryos. (Johansen, 1962)
- 1267 The effects of x-irradiation on the embryos of invertebrate animals. (Larsen, 1962)
- 1272 Sensibilité aux rayons X de la durée de développement des oeufs de Bombyx mori lorsque l'irradiation est effectuée quelques heures après le début de l'incubation.
- 1275 Studies on the effects of gamma radiation on the different developmental stages of the Khapra beetle, Trogoderma granarium Evrta. (Nair and Rahalkar, 1963)
- 1279 Mortality of irradiated pre-imaginal stages of Drosophila. (Oster and Cizak, 1958)
- 1284 Influence of gamma radiation on the development and fertility of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). (Proverbs and Newton, 1962)
- 1285 Radiosensitivity of various stages of Callosobruchus chinensis L. (Quraishi and Metin, 1963)
- 1286 Effect of Co<sup>60</sup> gamma rays on the small cutworm. (Sidorova, 1963)
- 1289 Histological investigation on the "premature death" of x-irradiated Drosophila eggs. (Steenbeck, 1961)
- 1293 Studies of the genetic effects of irradiation during the periferilization stages of Drosophila melanogaster. (Valencia and Valencia, 1962)
- 1320 Radiation effects on genetic systems. (Oster, 1961)
- 1328 A quantitative study of lifetime sickness and mortality and progeny effects resulting from exposure to penetrating irradiation. (Gowen and Stadler, 1962)
- 1330 The influence of X-rays on longevity, fecundity and fertility of Drosophila melanogaster. (Nüchel, 1963)
- 1331 Effects of x-rays on the survival of Drosophila imagoes. (Sacher, 1961)
- 1359 Biological effectiveness of 30-MeV electrons in dependence on the tissue depth and in comparison with 180-keV and 31-MeV photons. I. Lethality test on one-hour Drosophila embryos. (Fritz-Niggli and Schinz, 1961)
- 1360 Biological effectiveness of 30-MeV electrons depending on tissue depth and in comparison with 180-keV and 31-MeV photons. II. Lethality tests on four-hour old Drosophila embryos. (Fritz-Niggli and Schinz, 1962)
- 1363 The effects of continuous and fractionated doses of gamma-radiation on the survival and fertility of Sitophilus granarius (Calandra granaria L.) (Jefferies, 1962)
- 1364 Ibid. (Jefferies and Banham, 1961)
- 1365 The effect of fractionated irradiation under various oxygen concentrations on the radiosensitivity of the Drosophila embryo. (Johansen, 1962)

- 1369 Oxygen dependence of the lethal and mutation rates induced by x-irradiation of Drosophila zygotes. (Würgler, 1960)
- 1370 Modification of x-ray induced embryonic mortality by different anoxia conditions before and during irradiation of uncleaved Drosophila melanogaster eggs. (Würgler, 1961)
- 1415 Ecological effects of ionizing radiation on organisms, communities and ecosystems. (Platt, 1963)
- 1447 Laboratory studies on the use of irradiated sterile males to reduce C. fatigans Wied. populations. (Ramakrishnan et al., 1962)
- 1481 Disinfestation of dried figs by gamma radiation. (Papadopoulou, 1963)
- 1482 The control of warehouse pests by gamma radiation. (Räszulov and Anastasiev, 1963)
- 1497 Les possibilités d'emploi des radiations dans la lutte contre les insectes. (Nardon, 1963)

I-B-7 MODIFYING FACTORS  
(INTENSITY, RBE, LET, TEMPERATURE, SYNERGISTS,  
CHEMICALS INCLUDING PROTECTIVE AGENTS,  
ENVIRONMENT AT IRRADIATION, Etc.)

- 1357 Amer, N.M., Slater, J.V. SYNERGISTIC ACTION OF X-IRRADIATION AND ELEVATED TEMPERATURES ON DEVELOPMENT. p. 144-6 in "Biology and Medicine. Semi-annual Report, Fall 1961". UCRL-9897, California. Univ., Berkeley, Lawrence Radiation Lab. Oct. 1961.

A study was made of the effects of x-irradiation at 1200 r and incubation temperatures of 30° and 38°C on the production of abnormalities in the development of Tribolium. The observations of the effects are given graphically as the percent abnormalities occurring as a function of time following irradiation in days. The abnormalities were classified according to the degree of deformity in the elytra and the membranous wings.

- 1358 Amer, N.M., Slater, J.V., Tobias, C.A. ANALYSIS OF THE COMBINED INFLUENCE OF X-IRRADIATION AND ELEVATED TEMPERATURES ON DEVELOPMENT. (Abstr. E5) Rad. Res. 16 (1962) 574.

Temperature studies have revealed that Tribolium incubated at 30°C are least affected in regard to the subsequent development of wing abnormalities. This kind of anomalous development produced by X-irradiation was first described by Beck. Incubation at temperatures other than 30°C significantly alters the production of abnormalities, however, and incubation at elevated temperatures has been found to produce abnormalities that are indistinguishable from those produced by whole body x-irradiation or a variety of accelerated heavy ions. The combined influence of x-irradiation and subsequent incubation at elevated temperatures was investigated. It was found that the combined effects of x-irradiation and elevated temperatures (38°C) were more than merely additive in the induction of wing abnormalities. (Controls incubated at 30°C → 1.6% total wing abnormalities; at >30°C → 4.5%; irradiated (1200 r), then 30°C → 15.2%. Pupae, after 3 d at 38°C → 60%; after 4-5 d at 30°C, then 38°C → 38%; irradiated and kept at 30°C → only 15.2%; controls, given 1200 r, at 38°C → 68%; irradiated, then 1-2 d at 30°C → most severe; 4-5 d at 30°C, then 38°C → mildest.) Mathematical analysis of the data using factorial analysis of variance showed that the differences between the irradiated animals and the controls were highly significant, the interaction between irradiation and high temperatures being found to be also highly significant. This supports the suggestion that the combined effects of irradiation and elevated temperatures are synergistic in this system. A mathematical model is suggested. (Based on abstr.)

- 1359 Fritz-Niggli, H., Schinz, H.R. BIOLOGISCHE WIRKSAMKEIT VON 30-MeV-ELEKTRONEN IN ABHÄNGIGKEIT VON DER GEWEBETIEFE UND IM VERGLEICH MIT 180-keV- UND 31-MeV-PHOTONEN. I. LETALITÄTSTEST AN EINSTÜNDIGEN Drosophilaembryonen. (Biological effectiveness of 30-MeV electrons in dependence on the tissue depth and in comparison with 180-keV and 31-MeV photons. I. Lethality test on one-hour Drosophila embryos.) Strahlentherapie 115 (1961) 379-93. (In German).

Equal ionization doses ( $\mu$ -measurement values) of 30 MeV electrons act the same, both qualitatively and quantitatively on  $1 \text{ h} \pm 10 \text{ min}$  embryos of D. melanogaster at different depths in the plexiglass phantom (0, 1.25, 5.25, 8.25, 10.25, and 12.25 cm). The dose effect curves (dose in rad noted) of 180 keV photons, 31 MeV photons, and 30 MeV electrons coincide. The relative biological effectiveness (RBE) is therefore 1, and the number in rad is the same as the number in rem. If the measurement values are  $\rho$  noted in the action curves of 180 keV photons, 31 MeV photons, and 30 MeV electrons draw apart somewhat. The chosen values of the factor k, with which  $\rho$  is converted into rads, possess therefore probably

a realistic value. 1-h *Drosophila* embryos register neither a difference in the linear ionization density nor the difference in the continuous application (180 keV photons) and the discontinuous megavolt radiation, which per second delivers 50 electron flashes in a period of 10  $\mu$ s. This independency of the ray effects in the 1-h *Drosophila* to the ionization density explains the concordance of the biological and physical transition curves of 30 MeV electrons. (Auth)

- 1360 Fritz-Niggli, H., Schinz, H.R. BIOLOGISCHE WIRKSAMKEIT VON 30-MeV-ELEKTRONEN IN ABHÄNGIGKEIT VON DER GEWEBETIEFE UND IM VERGLEICH MIT 180-keV- UND 31-MeV-PHOTONEN. II. LETALITÄTSTEST AN VIERSTUNDIGEN *Drosophila*-embryonen. (Biological effectiveness of 30-MeV electrons depending on tissue depth and in comparison with 180-keV and 31-MeV photons. II. Lethality tests on four-hour old *Drosophila* embryos) *Strahlentherapie* 118 (1962) 503-17 (In German).

It was found that 4 h ( $\pm 10$  min) old embryos of wild strains of *Drosophila* which are identical in their phenotype have different radiation sensitivity. The 30-MeV-electrons were significantly less effective biologically than 180-keV-photons for 4 h ( $\pm 10$  min) old embryos. The RBE was 0.7. The 31-MeV-photons were more effective than 30-MeV-electrons, but less effective than 180-keV-photons. The lesser effectiveness of the megavolt radiation is explained by its smaller ionization density in comparison with 180-keV-photons (100 ionizations/ $\mu$ ). The embryos register the difference between 8, 3 ionizations/ $\mu$  for 31-MeV-photons and 3 ionizations/ $\mu$  for fast electrons. The dependence of the effect of ionization density on the stage of development of the object irradiated can be explained by the fact that the 1 h old embryos (RBE-1) are damaged by direct effects and the 4 h old embryos are damaged rather by indirect effects (irradiation products of water). The biological depth dose curve for 4 h ( $\pm 10$  min) old embryos is in good agreement with the physical curve. (Auth).

- 1361 Grosch, D.S., Clark, A.M. NITROGEN PROTECTION OF FECUNDITY AND FERTILITY IN FEMALE *Habrobracon* TREATED WITH X-RAYS. *Nature, Lond.* 190 (1961) 546-7.

Virgin females of *Habrobracon juglandis* (= *Bräcon hebetor*) were irradiated. A  $N_2$ -atmosphere afforded nearly complete protection from 2500 r x-rays. A series of  $N_2$ -tests provided a family of curves which demonstrated that low egg production equivalent to that following 4500 r in air was attained between 12350 and 13600 r. Egg hatchability is summarized in tabulated form. Protection by the replacement of air by  $N_2$  is apparent not only in a significantly higher hatchability after 4500 r but also in hatchability approaching control values after the 11th day. The results demonstrate that the protective effect of gas replacement anoxia is afforded to all types of cells in the polytrophic ovariole. They comprise differentiated, transitional and primitive cells. The progress of meiotic prophase, mitosis, and interphase characterizes the respective periods, with mitotic activity explaining the radiosensitive 6-10 d period. Limitation of protection by SH compounds to the sensitive period and its possible interpretation is discussed.

- 1362 Hansen, W.R. DETERMINATION OF THE RBE OF 14-MeV NEUTRONS USING 14 DAY OLD GRASSHOPPER EMBRYOS (*Chortophaga viridifasciata* AND *Encyrtolophus sordidus*). TID-18723, Kansas Univ., Lawrence. Graduate School, May 1963, 85p.

The  $LD_{50}$  determined for 14-d, 15-d and 17-d *Chortophaga* embryos irradiated with 200 kVp x-rays was respectively 450 rad, 400 rad, and 580 rad. The mean lethal dose for 14-d, 15-d, and 17-d *Encyrtolophus* embryos irradiated with 200 kVp x-rays was respectively 510 rad, 580 rad, and 630 rad. The  $LD_{50}$  for 14-d *Chortophaga* embryos irradiated with 14 MeV neutrons was 370 rad. The RBE of 14 MeV neutrons was determined to be 1.22. The mean lethal dose determined for any group of *Chortophaga* and *Encyrtolophus* embryos was dependent on the stage of embryo development. The hatching time of the eggs irradiated with x-rays was delayed. The amount of delay was increased as the dose of x-rays was increased. The period of hatching was also spread over a greater length of time with increased doses of x-rays. (Auth)

- 1363 Jefferies, D.J. THE EFFECTS OF CONTINUOUS AND FRACTIONATED DOSES OF GAMMA-RADIATION ON THE SURVIVAL AND FERTILITY OF *Sitophilus granarius* (*Calandra granaria* L.). p.213-29 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960", Vienna, International Atomic Energy Agency. 1962.

The investigation was aimed at examining the biological efficiency of multiple pass systems for radiation disinfestation of grain. At 16500 rep there appears to be no loss in efficacy for any system likely to be met with in practice. Fractionation could, however, lead to inadequate control in packaged cereal commodities given low doses to prevent adult emergence. The following details of the study are of interest. Survival of all developmental stages was significantly increased by fractionation, particularly with larvae

and pupae. The difference in survival afforded by continuous and fractionated treatments must be attributed to recovery during the intervals between damage. Recovery was noted with intervals of 10 min and longer, the amount of recovery and final survival being governed by the number of fractions, fractional dose, interval time, and interval temperature, but not by over-all dose rate. Rate of recovery was greatest in the first hours after irradiation, and decreased with increasing number of fractions. Irradiation is followed by a period of reduced sensitivity to subsequent treatment. Recovery was obtained in the reproductive capacity of irradiated eggs, larvae, and pupae, but not adults. Pupae showed the highest capacity for recovery of somatic and reproductive cells. Adults require the highest dose to kill and sterilize by continuous and fractionated treatment and are potentially the most dangerous state in the event of inefficient control.

- 1364 Jefferies, D.J., Banham, E.J. THE EFFECTS OF CONTINUOUS AND FRACTIONATED DOSES OF GAMMA RADIATION ON THE SURVIVAL AND FERTILITY OF *Sitophilus granarius* (*Calandra granaria*) L. AERE-R-3608, United Kingdom Atomic Energy Authority, Research Group, Isotope Research Div., Harwell, Berks., England, 1961, 48p.

See 1363. An increase in survival of all developmental stages was noted on fractionation of the dose, the amount of the increase being governed by the number of fractions, interval time, interval temperature and the developmental stage of the insect. Recovery was also noted in the reproductive capacities of insects irradiated as eggs, larvae and pupae but not adults. Calculations showed that the commercial dose of 18 500 rep may be given in 2-4 fractions over a period of 3-5 d without reducing its efficiency for the disinfection of grain.

- 1365 Johansen, I. THE EFFECT OF FRACTIONATED IRRADIATION UNDER VARIOUS OXYGEN CONCENTRATIONS ON THE RADIOSENSITIVITY OF THE *Drosophila* EMBRYO. (Abstr.) p. 5 in "2nd International Congress on Radiation Research, Harrogate, Yorkshire, England, 5-11 August 1962". London, Silver End Documentary Publications, Ltd, 1962.

Lethal injury to cells following ionizing radiation may be a result of a stepwise created damage. If the radiation dose is given fractionated in time intervals of the same order as the lifetime of essential radiation-induced radicals, one may be able to interfere with the reaction patterns. Results will be presented and discussed from experiments on the effect of ultra-short fractionated x-irradiation combined with various oxygen concentrations on the radiosensitivity of the  $60 \pm 5$  min old *Drosophila* embryo. The x-ray dose is fractionated by means of a rotating disc, giving exposure times of 40  $\mu$ sec as a lower limit. A relationship between the dose rate and the mitotic division time is discussed in view of the synchronously dividing nuclei in the young *Drosophila* embryo.

- 1366 Johansen, I., Oftedal, P., Havin, E. RADIOSENSITIVITY OF THE *Drosophila* EMBRYO. p. 20 in "Fourth Report from Norsk Hydro's Institute for Cancer Research for 1961 and 1962". Oslo, Norsk Hydro Institutt for Kreftforskning, 1963.

Some results were reported in 1262 and 1365. Further studies concerned the oxygen effect and pulsed radiation, and the effects of chronic versus acute treatment and of variations in oxygen effect at ages corresponding to maximum and minimum sensitivities.

- 1367 Slater, J.V., Tobias, C.A., Beck, J.S., Lyman, J.T., Martin, M.E., Luce, J.R. COMPARATIVE INFLUENCE OF ACCELERATED HEAVY NUCLEI ON ANOMALOUS DEVELOPMENT IN *Tribolium*. (Abstr.) Rad. Res. 14 (1961) 503-4.

The radiation-induced wing deformity in *Tribolium confusum* was studied. The dose-effect relationship with x-rays is a multi-hit type, with 50% of the insects developing abnormalities at 1375 r and 100% at 2000 r. With heavier particles, the dose-effect relationship appears to have a lower hit number and possibly becomes a single hit phenomenon with boron nuclei when their Bragg peak is in the sensitive region of the body. Boron and C nuclei were found to produce severe effects at much lower surface doses than apparent with O and Ne. These effects included fluid-filled wing blisters, and exposure and extension of the underwings at wide angles. Boron and C nuclei penetrate further than do O and Ne, and may produce these abnormalities because the organism is probably not uniformly sensitive. Interpretation is further complicated by the existence of different linear energy transfer values at the Bragg peaks of different nuclei. In the initial phases of this study it was found with  $\alpha$ -particles that the region resulting in wing abnormalities is located near the ventral body surface at a depth of about 300  $\mu$ . Following irradiation of the pupae with various nuclei, the  $O_2$  consumption of the developing organism was decreased. (From abstr.)

- 1368 Slater, J. V., Amer, N. M., Tobias, C. A. MODIFICATION OF RADIATION RESPONSE DURING EMBRYONIC DEVELOPMENT BY THE USE OF ELEVATED TEMPERATURES. (Abstr.) p. 241 in "2nd International Congress on Radiation Research, Harrogate, Yorkshire, England, 5-11 August 1962". London, Silver End Documentary Publications, Ltd. 1962.
- The induction of anomalous wing-development in adult *Tribolium* by x-irradiation of newly formed pupae was first described by Beck (1961). Subsequent studies with a variety of temperatures have shown that post-irradiation incubation at 30°C results in minimal damage. Incubation at temperatures higher than 30°C was found, however, to alter the number of disturbances occurring. Post-irradiation incubation at 38°C, after subjecting pupae to as little as 50 r (250 Kvp x-rays), was found to increase significantly the percentage of abnormalities produced. When test organisms were irradiated with 1200 r and placed immediately afterwards at 38°C for variable time periods, it was discovered that the combined effects of x-irradiation and high temperatures were more than merely additive, with the maximum accumulative effect being reached only after 3 d incubation at that temperature. Irradiated pupae, incubated at optimum temperatures for development (30°C) for 4-5 d and then exposed to 38°C for as short a period of time as 2 d prior to eclosion as adults, were still found to exhibit a considerable increase in numbers of malformations. Factorial analysis showed that the interaction between radiation and incubation at elevated temperatures was highly significant ( $p=0.01$ ).
- 1369\* Würgler, F. E. DIE SAUERSTOFFABHÄNGIGKEIT DER ABTÖTUNGS- UND MUTATIONSRATE BEI RÖNTGENBESTRAHLUNG VON *Drosophila*-ZYGOTEN. (Oxygen dependence of the lethal and mutation rates induced by x-irradiation of *Drosophila* zygotes). *Rev. suisse Zool.* 87 (1960) 295-302. (In German).
- The oxygen effect noted by Ulrich on embryonic and post-embryonic mortality following whole-body irradiation of *Drosophila* zygotes (Berlin wild) could also be demonstrated in dose-effect curves of  $F_1$ -zygotes of the cross "Berlin wild" X Muller 5 (Base). Irradiation of zygotes in a  $N_2$ -atmosphere gave a linear increase in frequency of recessive sex-linked lethals with dose, when plotted semi-logarithmically. A mathematical analysis of the data shows that embryonic and post-embryonic mortality and also mutation rates could be lowered by half if irradiation occurs under conditions of anoxia.
- 1370 Würgler, F. E. MODIFICATION OF X-RAY INDUCED EMBRYONIC MORTALITY BY DIFFERENT ANOXIA CONDITIONS BEFORE AND DURING IRRADIATION OF UNCLEAVED *Drosophila melanogaster* EGGS. *Drosophila Inf. Serv.* 35 (1961) 102-3.
- See also:
- 1080 The effect of culture environment on the susceptibility of the grain weevil *Sitophilus granarius* L. to gamma radiation. (Martin et al., 1962)
- 1242 Some effects of irradiation on *Cochliomyia hominivorax*. (Dixon, 1962)
- 1243 Response of *Tribolium confusum* to radiations and other stresses. (Ducoff and Bosma, 1963)
- 1254 The effect of gamma radiation on silkworm eggs. (Henneberry and Sullivan, 1962)
- 1255 Effect of gamma radiation on eggs of the silkworm. (Henneberry and Sullivan, 1963)
- 1260 Studies on the breeding method taking advantage of  $\gamma$ -rays in the silkworm. (Japan, Sericultural Experiment Station, Tokyo, 1968)
- 1262 Studies on the radiation sensitivity of *Drosophila* embryos. (Johansen, 1962)
- 1272 Sensibilité aux rayons X de la durée de développement des oeufs de *Bombyx mori* lorsque l'irradiation est effectuée quelques heures après le début de l'incubation. (Legay and Teulade, 1962)
- 1285 Radiosensitivity of various stages of *Callosobruchus chinensis* L. (Quraishi and Metin, 1963)
- 1286 Studies on the effect of beta-radiations on insects. II. The effect of beta-radiations (irradiation of full-grown caterpillars and freshly-formed pupae) on the life-history of *Corcyra cephalonica* Stainton. (Rattan Lal et al., 1960)
- 1288 Effect of  $Co^{60}$  gamma rays on the small cutworm. (Sidorova, 1963)
- 1292 Studies on heavily ionizing particles - HILAC studies. (Tobias, 1963)
- 1294 Experimental analysis of a linear dose effect curve resulting from x-irradiation of *Drosophila* eggs. (Würgler, 1962)
- 1297 Effects of desiccation of *Drosophila* females on the frequencies of irradiation induced embryonic abnormalities. (Annan and Reitan, 1961)
- 1301 Effects of x-irradiation upon cell population and morphogenesis in the wing of *Tribolium confusum*. (Beck, 1962)
- 1303 Temperature dependence of wing abnormality in *Tribolium confusum*. (Slater et al., 1963)
- 1309 Partial-body radiations of queen honey bees. (Lee, 1963)
- 1323 Radiobiologic studies with *Drosophila*. (Baxter, 1963)

- 1341 Response of *Tribolium* larvae to x-irradiation, (Ducoff and Walburg, 1960)  
 1344 Lethal effects of X-rays on the housefly, *Musca domestica* L. (Grasso et al., 1962)  
 1345 Lethal effects of X-rays on *Musca domestica* L. (Grasso et al., 1963)  
 1355 The response of blood-fed *Aedes aegypti* to gamma radiation, (Strahler and Terzian, 1963)  
 1384 Effects of temperature and x-ray irradiation on intrinsic growth rate in populations of *Drosophila pseudoobscura*. (Taniaway, 1963)

# I-S-8 SPECIES. STRAINS. LINES (COMPARATIVE STUDIES)

- 1371\* Bruel, W.E. van den, Bollaerts, D. RESISTANCE OF *Sitophilus granarius* AND *Sitophilus oryza* AT DIFFERENT STAGES OF THEIR DEVELOPMENT TO  $\gamma$ -IRRADIATION FROM COBALT-60. Bull. Inst. agron. Gembloux Extra Vol. 2 (1960) 883-905. (In French).
- In grains of wheat, 1000 rad of  $\gamma$ -rays destroyed 89% of the eggs (2 d old) of *S. oryza*, but with eggs of *S. granarius* 2500 rad was required for 98% destruction. *S. granarius* showed a greater resistance to irradiation at all stages of development than *S. oryza*, but the differences in resistance decreased at later stages. With nymphs and young adults of *S. oryza* 3500 rad prevented development, but 5000 rad was required for the same stages of *S. granarius*. The  $\gamma$ -rays had some action in sterilizing adults at approximately 2500 rad, with *S. oryza* being somewhat less resistant than *S. granarius*. In both species, 5000 rad or more was required for complete sterilizing of adults. In some tests on adults U was used as the source of the  $\gamma$ -rays, and 10 000 rad killed all insects of both species. (CA 56: 1962, 5081c)
- 1372 Erdman, H. E. X-RAY EFFECTS ON SINGLE AND MIXED SPECIES POPULATIONS OF *Tribolium confusum* AND *Tribolium castaneum* (COLEOPTERA: TENEBRIONIDA). HW-SA-2886, General Electric Co. Hanford Atomic Products Operation, Richland, Wash. 24 July 1962; 8p.
- A difference in radiosensitivity of *T. confusum* and *T. castaneum* was found following exposure to doses of 2 to 8 kr x-radiation. Reproductive capacity and individual weights were used as criteria of radiosensitivity. Populations of flour beetles were cultured as single or mixed species. Sterility in both species and shortened life-spans in *T. confusum* occurred at 6000 r. All other groups exhibited increased reproductive abilities with time and no significant mortalities. Controls in single or mixed populations produced comparable numbers of F<sub>1</sub> adults. In irradiated single populations *T. castaneum* was significantly more productive, thus indicating greater resistance to x-radiation. Corroborative evidence was obtained from mixed populations, in which *T. castaneum* constituted 73, 90 and 94% of individuals, from controls 2000 and 4000 r, respectively. At 0 and 2000 r *T. castaneum* produced more progeny in mixed species cultures than alone, whereas the converse was true for *T. confusum*. At 4000 r, these traits were absent in both groups and *T. confusum* produced no progeny during the first 2 weeks. Within each species F<sub>1</sub> production was affected to the same degree in single and mixed cultures at a given radiation dose. A paper of the same title was presented at the 2nd International Congress of Radiation Research, held at Harrogate, Yorkshire, England, Aug. 5-11, 1962.
- 1373 Erdman, H. E. THE DIFFERENTIAL SENSITIVITY OF FLOUR BEETLES, *Tribolium confusum* AND *T. castaneum* TO X-RAY ALTERATION OF REPRODUCTIVE ABILITIES, INDUCED DOMINANT LETHALS, BIOMASS, AND SURVIVAL. J. exp. Zool. 153 (1963) 141-7.
- Some aspects of growth are reported for x-rayed populations cultured as single- or mixed-species. Irradiation with 250-kV x-rays was carried out at 1 kr/min to total doses of 2, 4, or 6 kr. Reproductive abilities, measured as the mean number of F<sub>1</sub> adults per female, for single-species populations of *T. castaneum* given 2 h approached control values after 1 month, whereas those of *T. confusum* persisted below controls. Four kr was almost sterilizing, over 90 and 99% sterilizing respectively for *T. castaneum* and *T. confusum*, while 6-kr doses induced complete sterility in both species. Dominant lethals induced by 2kr were approximately twice as abundant in *T. confusum* as in *T. castaneum*. Increased fertility with time was considered evidence that undifferentiated gametes were more radioresistant than mature ones. Selective elimination of a flour beetle species (*T. confusum*) in coexistence was indicated at exposures > 4 kr but < 6 kr. Interspecies antagonism and 2-kr irradiation, as an environmental stress factor, appeared additive in adversely influencing the reproductive ability of *T. confusum*. The dose-response curves for reproduction were linear up to 4 kr except for *T. confusum*. After 4 kr the dose-response curves departed from linearity for both species. Biomass (standard dry wt) of F<sub>1</sub> adults decreased with increasing dose; however, the weight of individuals was not altered. Parental mortality was not affected at 2 and 4 kr; 94-100% were alive at 10 weeks. In the 6-kr group, 75 and 58% of *T. confusum* were alive in the single- and

mixed-species populations, respectively, indicating that irradiation and coexistence reduced survival. Thus, these 2 organisms of similar biology differed radiologically, as seen by the overall greater radio-resistance of *T. castaneum* compared with that of *T. confusum*. The one more pair of chromosomes in *T. castaneum* probably does not satisfy a genetic interpretation of radioinduced damage, but physiologic and cytogenetic factors may be responsible. (NSA 18:1964, 9864). A report, under the same title, was published as HW-SA-2950, General Electric Co. Hanford Atomic Products Operation, Richland, Wash, 12 Mar. 1963, 18p.

- 1374 Lillers, H. REACTIONS TO X-RAYS OF A NORMAL AND A HCN-UNUSCEPTIBLE STOCK OF *Drosophila melanogaster*. (Abstr.) *Int. J. Rad. Biol.* 6, 4 (1963) 380.

Two stocks have been compared in respect to some reactions of the males to x-rays: the normal stock Berlin wild (+B), which is highly susceptible to HCN, and a 2nd (R II), derived from the former by selection, which is rather unsuceptible to HCN. Simultaneously the latter stock is resistant to DDT. The selection work had been done in respect of DDT-resistance. After giving HCN-gas the  $LT_{50}$  values (in minutes) for the susceptible stock are about 8.0 for the males, and 9.2 for the females; the corresponding values for the unsuceptible stock are 12.0 and 13.3. After these times of exposure there is 100% mortality in both sexes in the first stock. The males of these stocks have been irradiated with doses of 1.5; 3.0 and 4.5 kr (100 kV; 8 mA; 1.7 mm Al; 430 r/min) in air and individually and repeatedly crossed with one Basc female each in intervals of 3 d until the 3rd brood. In the  $F_1$  two characters have been studied; (a) the percentages of fertile cultures, (b) the numbers of progeny per fertile culture. It could be seen, that at all dosages and in all broods the males of the R II stock give higher values. In the (a) experiments the differences rise with rising dose in all broods showing P values  $< 10^{-10}$  for 4.5 kr. In the (b) experiments the absolute differences diminish with rising doses, especially in the 3rd brood with the lowest fertility. In the  $F_2$  giving the numbers of sex-linked recessive lethals no differences could be seen between the 2 stocks at the 3 dosages in the 1st brood. But in the 2nd brood (mainly spermatids during irradiation) the percentages of lethals are smaller in the R II stock at all dosages, the differences growing with rising dose. In the 3rd brood no sharp decrease in the rate of mutations can be seen in the R II stock giving somewhat higher rates than the +B stock. In the 3.0 kr experiment, for instance, the relative values of the mutation-rates in the two stocks in the 3 broods are: +B = 1.0; 1.2; 0.8 and R II = 1.0; 1.0; 1.1. In respect to the different brood patterns of the 2 stocks reference is made to the results of other authors, especially to the experiments of Sobels, who found a sharp rise of mutation-rates in the second brood (spermatids) of a normal stock, when the flies had been irradiated in an HCN-atmosphere. (Essentially abstr.)

See also:

- 773 The use of ionizing radiation in the preservation of cereal products. (Dal Monte, 1959)  
 778 Effects of irradiating single and mixed species of beetles. (Erdman, 1961)  
 779 X-ray tolerance of two related species of beetles. (Erdman, 1962)  
 1222 Effects of radiations on insects. (LaChance, 1962)  
 1226 Effects of gamma radiation on various stages of three fruit fly species. (Balock et al., 1963)  
 1228 The susceptibility of the confused flour beetle (*Tribolium confusum* Duv.) to gamma radiation. (Banham, 1962)  
 1229 Radiation effects on reproduction in plateaued and unselected strains of *Tribolium castaneum*. (Bartlett and Bell, 1962)  
 1230 The effect of irradiation on reproduction in two strains of *Tribolium castaneum* Herbst. (Bartlett and Bell, 1962)  
 1246 X-ray effects on different life stages of two flour beetle species (*Tribolium confusum*, *Tribolium castaneum*). (Erdman, 1962)  
 1247 Comparative x-ray sensitivity of *Tribolium confusum* and *T. castaneum* (Coleoptera: Tenebrionidae) at different developmental stages during their lifecycle. (Erdman, 1962)  
 1280 Studies on the effect of ionizing radiation on the development of insects. (Palii and Iirkovskii, 1962)  
 1320 Radiation effects on genetic systems. (Oster, 1961)  
 1323 Radiobiologic studies with *Drosophila*. (Baxter, 1963)  
 1338 Relationship between Y-chromosome and longevity in *Drosophila melanogaster*, especially in term of the radiation effect. (Tobari and Moriwaki, 1961)  
 1340 The effects of gamma-ray irradiation on certain species of stored-product insects. (Dennis, 1961)  
 1343 Effects of gamma radiation on *Culex fatigans* egg rafts. (Ghosh et al., 1961)  
 1347 Preliminary studies on irradiation of some common stored-grain insects in Pakistan. (Huque, 1963)  
 1349 Comparisons of inbred and random bred larval survival to 1200 r. (Lovelllette and Ratty, 1962)

- 1356 Effects of gamma radiation on three species of Philippine insect pests. (Viado and Manoto, 1963)  
 1481 Disinfestation of dried figs by gamma radiation. (Papadopoulos, 1963)  
 1493 Irradiation of fruits and vegetables in a mobile cobalt 60 unit. (Harvey, 1963)

## I-C Radiation Effects on Insect Populations

### I-C-1 MALE COMPETITION

- 1376 Dame, D.A., Schmidt, C.H. THE IMPORTANCE OF COMPETITIVENESS OF RADIOSTERILIZED MALES IN MOSQUITO-CONTROL PROGRAMS. p. 165-8 in "Proceedings of the 49th Annual Meeting of the New Jersey Mosquito Extermination Association, 1962".
- The failure of 2 mosquito (Anopheles quadrimaculatus) eradication trials was analyzed for contributing factors such as sexual vigour, competitiveness, flooding ratios, etc. Differences in pupal mortality and adult viability in Aedes aegypti depend on age of pupae at irradiation. Data are tabulated on effect of exposure to  $\gamma$ -radiation in the pupal stage on adult emergence and viability. Effect of radiosterilization on competitiveness was examined in the two species. Pupal age at irradiation also markedly affects post-irradiation competitiveness of quadrimaculatus. In order to check on the mating of laboratory-reared males with wild females sperm of quadrimaculatus were labelled by exposing larvae to  $P^{32}$ . Such adults are not harmed by their ingested radioactivity and mate normally under laboratory conditions. Labelled sperm in the spermathecae readily identify females after mating with labelled, laboratory-reared males. The technique should allow such inseminated females to be identified in the field.
- 1376 Henneberry, T.I., McGovern, W.L. EFFECTS OF GAMMA RADIATION ON MATING COMPETITIVENESS AND BEHAVIOUR OF Drosophila melanogaster MALES. J. econ. Ent. 56, 6 (1963) 739-41.
- Immediately after treatment 3- to 4-d old males of D. melanogaster Meigen exposed to 16 kr of  $\gamma$ -radiation did not mate as readily or as many times with virgin females as untreated males or males exposed to 8 kr. However, males exposed to 16 kr recovered within 24 h and normal mating frequency and behaviour occurred. When male flies exposed to 16 kr were held for 24 h before mating, the number of matings per day was not affected and there was very little effect on mating competitiveness of these males as compared with untreated males. (Auth. summary)
- 1377 Strömmeas, Ø., Kvelland, I. SEXUAL ACTIVITY OF Drosophila melanogaster MALES. Hereditas 48 (1962) 442-70.
- The experiments were divided into 3 groups (0, 24, 72) according to the (approximate) age in hours of the males at the time of irradiation. They were mated to several virgin females during two 12-h mating periods interrupted by a 12-h celibacy period. All matings were observed, the inseminated females isolated, and the offspring counted. Among very young males (during first 12 h after emergence from pupal case) a considerable portion copulate before being able to create offspring. Sexual activity is higher in the 1st hour after males are transferred from isolation to females (true for all males except group 0). Activity is almost the same during both mating periods for groups 24 and 72. The frequency of sterile matings seems to increase with the number of matings a male is capable of performing during a 12-h period. The average brood size seems to decrease with increased sexual activity of the male. Males with high activity have, in their 1st mating after a celibacy period, a much higher brood than males with low activity.
- 1378 Weidhaas, D.E., Schmidt, C.H., MATING ABILITY OF MALE MOSQUITOES, Aedes aegypti (L.), STERILIZED CHEMICALLY OR BY GAMMA RADIATION. Mosquito News 23, 1 (1963) 32-4.
- The effectiveness of males sterilized by apholate (2, 4, 4, 6, 6-hexahydro-2, 2, 4, 4, 6, 6-hexakis (1-aziridinyl)-1, 3, 5, 2, 4, 6-triazatriphosphorine) and of males sterilized by  $\gamma$ -rays is compared for reduction in reproductive potential among caged populations of the yellow fever mosquito, Aedes aegypti L. For irradiation, groups of male pupae > 24 h old, were given 8000 r and 10 000 r  $\gamma$ -rays ( $Co^{60}$ -source) at ~690 r/min. For chemosterilant treatment, groups of unirradiated males were fed for the first 3 to 4 d after emergence on 1% apholate in a 20% aqueous honey solution. Subsequent crossing tests and their results are described. Chemosterilants appear to offer an effective method of sterilization without damaging the mating ability of A. aegypti, but dosages of radiation sufficient for sterilization of males prevent them from competing fully with normal males. Further studies may develop a method of administering radiation at a time in the life cycle which will not decrease male competitive ability.



See also:

- 763 Radiation-induced sterility in the insect Rhodnius prolixus. (Baldwin and Shaver, 1963)
- 804 Quelques résultats supplémentaires concernant l'influence des rayons gamma sur les chrysalides et les oeufs de la teigne de la farine "Ephestia kuehniella Z." (Pelereyts, 1963)
- 807 Some effects of gamma radiation on the reproductive potential of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). (Proverbs and Newton, 1962)
- 1284 Influence of gamma radiation on the development and fertility of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). (Proverbs and Newton, 1962)
- 1427 Effects of ionizing radiation on insects and other arthropods. (Stone, 1963)
- 1445 Mass production of sterilized male Aedes aegypti. (Fay et al., 1963)
- 1455 Sterilization of the Mediterranean fruit fly and its application to fly eradication. (Katiyar and Valerio, 1963)
- 1458 The application of nuclear energy to agriculture. (Moh, 1963)
- 1476 On the role of lethal mutants in the control of populations. (Borstel and Buzzati-Traverso, 1962)

# I-C-2 BEHAVIOUR

- 1379 Hungate, F.P. RADIATION AVOIDANCE RESPONSES IN ANIMALS. (Abstr. AIA782) p.3 in "Research and Development in Progress. Biology and Medicine. Issue No.2". TID-4201, Division of Technical Information, AEC, Nov. 1963.

A variety of animal species were tested. Exposure to 500 r of  $\gamma$ -rays has failed to identify an avoidance response in Drosophila. Attempts to selectively breed a strain showing an avoidance response have as yet been unsuccessful, apparently because of an inadequate selection against those animals unable to detect the radiation.

- 1380 Хрушев, В.Г., Правдина, Г.М., Даренская, Н.Г. ПОВЕДЕНИЕ ПЛОДОВОЙ МУШКИ (Drosophila melanogaster) ВО ВРЕМЯ ЛУЧЕВОГО ВОЗДЕЙСТВИЯ. Радиобиология 2, 2 (1962) 272-9.

Khrushchev, V.G., Pravdina, G.M., Darenkaya, N.G. BEHAVIOUR OF THE FRUIT FLY (Drosophila melanogaster) DURING IRRADIATION. Radiobiology 2, 2 (1962) 150-60. AEC-tr-5429, March 1963. Translation from Radiobiologiya 2, 2 (1962) 272-9.

A marked drop was observed in the number of eggs laid by irradiated females. A series of experiments in which the disposition and combination of the radiation sources were varied showed that under existing conditions the females avoided ovipositing in the zone of irradiation.  $Co^{60}$  and  $P^{32}$  (2-0.2 mc/cm) were used. The threshold of sensitivity to  $\beta$ -radiation from  $P^{32}$  did not exceed 0.02 r/sec. The need is stressed for taking into account the character of the response reaction to irradiation when comparing the radio-sensitivity of different species.

- 1381 Pavan, C. A COMPARATIVE STUDY BETWEEN NATURAL LETHALS AND LETHALS INDUCED BY RADIATION IN POPULATIONS OF Drosophila willistoni. (Abstr. BID583) p.49 in "Research and Development in Progress. Biology and Medicine. Issue No.1". TID-4200, Division of Technical Information, AEC, July 1963.

Two types of experiments were set up to compare the behaviour of flies carrying radiation-induced and spontaneous lethals. In one experiment, flies heterozygous for 2 lethals, one natural and one induced by radiation, were released among the populations of 2 islands in the bay of Angra dos Reis in Brazil. On July 26 populations cages were set up, 3 consisting of N1R1, N1R2, N2R1 and N2R2, and 3 of N3R3, N3R4, N4R3 and N4R4. About 3000 crosses were made with the marked strains (i.e. 500 with flies from each cage). A detailed report is pending. (Based on abstr.)

- 1382 Stark, R.W. THE EFFECTS OF GAMMA RADIATION ON THE BIOLOGY AND BEHAVIOUR OF FOREST INSECTS AND THE POSSIBILITY OF THEIR CONTROL BY MEANS OF IRRADIATION TECHNIQUES. (Abstr. KIC139) p.165 in "Research and Development in Progress. Biology and Medicine. Issue No.1". TID-4200, Division of Technical Information, AEC, July 1963.

The project was initiated in 1963. The objectives are to investigate the feasibility of irradiation techniques for control of forest insects, particularly a bark beetle Ips confusus (LeConte) and a sawfly (defoliator)

Neodiprion fulvipes complex. A Model 2, Co<sup>60</sup> irradiator (1000 c) calibrated at 1000 r/3 min of exposure was used to irradiate various stages of the sawfly and adults of the bark beetle at dosages ranging from 5000 to 140 000 r. Irradiation of feeding larvae, ultimate instar larvae, and prepupal larvae of the sawfly at dosages of > 1000 r prevented successful development. Irradiation of pupae stimulated emergence, and significant mortality did not occur at < 100 000 r. Behavioural processes of larvae, particularly feeding and cocoon formation, were markedly affected. Sterilization effects cannot be determined until spring, 1984. Sterilization of both males and females of the adult bark beetle apparently occurs at low radiation levels (< 10 000 r). Gallery patterns, oviposition, mating behaviour and longevity seem to be little affected at this dosage level. Sterilization to aid in control appears to be a distinct possibility if used in conjunction with natural attractants. (From abstr.)

See also:

- 812 Study on houseflies sterilized with x-rays. (Saccà, 1981)
- 1209 Study on the evolution of social parasitism in the ant. Attempts of genetic interpretation and plans for experimental analysis. (Jucchi, 1983)
- 1376 Effects of gamma radiation on mating competitiveness and behaviour of Drosophila melanogaster males. (Henneberry and McGovern, 1983)
- 1377 Sexual activity of Drosophila melanogaster males. (Strømme and Kvelland, I.)
- 1471 Sterilization by gamma radiation for the control of the navel orangeworm Paramyelois transitella (Walker) (Lepidoptera: Phycitidae). (Hussey, 1983)

### I-C-3 POPULATION DYNAMICS

- 1383 Marques, E. K., Maciel, C. M. P. SOME COMPONENTS OF ADAPTIVE VALUES OF HETEROZYGOUS Drosophila willistoni FROM IRRADIATED NATURAL POPULATIONS. Experimentia 17 (1961) 404-5. (In English).

The analysis of some adaptive components (percentage of hatched eggs, viability, and sterility) in an isolated natural population of D. willistoni shows, after irradiation with Co<sup>60</sup>, reduced adaptive values during several generations after irradiation with progressive recuperation to the control level in successive generations. However, this population for 15 generations does not attain the percentage of hatched eggs of untreated populations. (Auth)

- 1384 Tantawy, A. O. EFFECTS OF TEMPERATURE AND X-RAY IRRADIATION ON INTRINSIC GROWTH RATE IN POPULATIONS OF Drosophila pseudoobscura. Genetica 34 (1963) 34-45.

An experiment was designed using populations of D. pseudoobscura with different gene arrangements on the third chromosome, to study the effects of various temperatures and different dosages of radiation on the innate capacity for increase. The innate capacity for increase was found to increase with temperature and decrease with higher radiation dosages. The mean generation length showed a decline with both treatments, with a greater decrease in the former treatments. Net reproductive rate showed a decrease in both cases while the finite rate of increase ( $\lambda$ ) showed an increase in the temperature experiment and a decrease in the radiation experiment. Percentage contribution of each age group to the rate of multiplication per generation depended on temperature and dosages of radiation as well as the genetic background of the population. (Auth.)

- 1385 Stone, W. S. RESEARCH IN GENETICS. (Abstr. B1D255) p.46 in "Research and Development in Progress. Biology and Medicine. Issue No. 1". TID-4200, Division of Technical Information, AEC. July 1963.

This research includes: 1) Population and evolutionary studies of Drosophila and 2) Direct and indirect effects of radiation and their modifications using dominant lethals, recessive lethals and translocations as a measure of genetic damage. The first part is concerned with the analysis of genetic population structure including concealed variability in the form of detrimental, sterile and lethal factors. This is investigated in small populations, large thin populations and in large dense populations. Further extensive tests of viability, fertility and fecundity utilizing other island populations where migration is minimum will provide a better understanding of the genetic structure of populations in relation to their size, distribution and isolation. Studies are being made with D. pseudoobscura, D. ananassae, D. melanogaster and others. Direct and indirect radiation effects are being studied with Drosophila and microorganisms. Experiments measure the relation between radiation damage and environmental variables such as temperature, gaseous environment of the organisms (argon, air, oxygen, helium, methane, carbon monoxide, nitric oxide, propane, etc.) under normal or increased gas pressure. We are studying these effects on both male and female D. melanogaster (recessive lethals) and in D. virilis (dominant lethals and translocations) over the full cycle of spermatogenesis and some stages of oogenesis. The amount of damage from the same dose of

radiation may be modified by a factor of 4, therefore they provide understanding of the relationships between radiation and organism.

- 1386 Sankaranarayanan, K. FITNESS OF IRRADIATED POPULATIONS OF *Drosophila melanogaster*. (Abstr. 5.58) p. 75 in "Genetics of Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963. Vol. I". Geerts, S.J., Ed. Oxford, Pergamon Press. 1963.

Males in experimental populations of *D. melanogaster* were treated with acute doses of x-rays (2000 r, 4000 r, 6000 r and 7000 r) and the effects of irradiation on population fitness were studied under conditions of relaxed selection, the relaxation being obtained mainly, by minimizing larval competition. In one population, males received an initial dose of 7000 r units and no further irradiation in subsequent generations. At other dose levels, there were populations where the males received x-irradiation (1) at generation 0 only and (2) at generation 0 and in every subsequent generation. From the latter, sub-populations were derived where irradiation was stopped after 5, 10 and 15 generations. The components of fitness investigated are (1) hatchability, (2) viability from the larval to the adult stage, and (3) viability from the egg to the adult stage. An important finding that confirms the results of earlier investigators is the observation that the radiation induced mortality (dominant lethal effect) is mainly (but not exclusively) at the egg stage. A second finding is the surprisingly rapid recovery to the control level in hatchability and viability rate following the cessation of irradiation. A detailed analysis of the second chromosomes is in progress to get an estimate of the radiation-induced genetic load and to gain an insight as to how much of the genetic load is adaptively incorporated into the gene pool of the population.

#### I-C-4 GENETIC CHANGES

- 1387 Almeida Toledo, S. F. VERIFICACAO PRELIMINAR SOBRE A FREQUENCIA DE GENS LETAIS EM POPULACOES DE *Drosophila willistoni* QUE VIVEM EM REGIOES DE ALTO NIVEL DE RADIACAO. (Preliminary study on the frequency of lethal genes in populations of *Drosophila willistoni* living in regions with a high level of background radiation). *An. Acad. brasil. Ciênc.* 35, 1 (1963) 103-7. (In Portuguese, with English summary).

*D. willistoni* were collected from regions with a radiation background 50 times above the normal level. The techniques used were those of Pavan et al. (Genetics 36: 1951, 13). The flies were then crossed with two marked stocks, and the homozygous individuals obtained in  $F_1$  analysed. Results are tabulated. No radiation effects could be detected by analysis under the sampling and testing conditions set out in the paper.

- 1388 Blaylock, B.G. CHROMOSOMAL ABERRATIONS IN A NATURAL POPULATION OF *Chironomus tentans* EXPOSED TO CHRONIC LOW-LEVEL ENVIRONMENTAL RADIATION. Thesis, Tennessee. Univ. Knoxville, 1963, 89p.

The salivary gland chromosomes of *Chironomus tentans* larvae collected from White Oak Creek, an area contaminated by radioactive waste from the Oak Ridge National Laboratory, and from six uncontaminated areas were examined for chromosomal aberrations. White Oak Creek populations were exposed to 230 rads per year or about 1000 times background. Chromosomal maps were constructed to make a general comparison of the banding pattern of the salivary chromosomes of the *C. tentans* in the East Tennessee area with those of Canada and Europe. These maps were used as a reference in scoring aberrations. Fifteen different chromosomal aberrations were found in 365 larvae taken from the irradiated population as compared with 5 different aberrations observed in 356 larvae from 6 control populations, but the mean number of aberrations per larva did not differ in any of the populations. The quantitative amount of heterozygosity was essentially the same in the irradiated and the control population, but there were three times the variety of chromosomal aberrations found in the irradiated area. From this evidence it was concluded that chronic low-level irradiation from radioactive waste was increasing the variability of chromosomal aberrations without significantly increasing the frequency. Five different inversions were found in both the irradiated and control populations; three inversions - 1Ra, 2Lab, and 3Ra - were found at a relatively high frequency and were used in testing the seasonal and geographic distribution. In the White Oak Creek population the frequencies of the heterozygous inversions did not change significantly for a three year period from 1960 to 1962. Also, no changes that could be attributed to seasonal change were detected in the frequencies of these inversions from June through December of 1961 and September through December of 1962. There was no significant difference in the frequencies of these same heterozygous inversions between three local geographic populations of *C. tentans*. It was concluded that the 3 inversions which occurred at the highest

frequencies are endemic to the population of East Tennessee and have been established in the population for a long time. The frequencies of the standard arrangement, the heterozygous inversion, and the homozygous inversion of 1Ra were significantly different from the expected frequencies as predicted by the Hardy-Weinberg Law. A deficiency of inversion heterozygotes was found which is contrary to the theory of balanced chromosomal polymorphism, but is consistent with a model proposed by Levene, where under certain assumptions genetic equilibrium can be obtained without the heterozygote being superior. The results show that chromosomal polymorphism can be maintained in a natural population without superiority of the heterozygote individuals. (Disc. Abstr. 24: 1964, 3022)

- 1389 Blaylock, B.G., Nelson, D.J., Auerbach, S.I., Griffith, N.A. POPULATION GENETICS AND RADIATION EFFECTS STUDIES ON *Chironomus tentans*. Health Physics Division Annual Progress Report for Period Ending June 30, 1963. p. 112-4 in ORNL-3492, Oak Ridge National Lab., Tenn. 30 Sep. 1963.

The salivary gland chromosomes of *C. tentans* larvae collected from White Oak Creek and from 6 uncontaminated areas were examined for chromosomal aberrations. White Oak Creek populations were exposed to a dose rate calculated as 230 rad/year, or about 1000 times background. Fifteen different chromosomal aberrations were found in 385 larvae taken from the irradiated population as compared with 5 different aberrations observed in 358 larvae from 6 control populations, but the mean number of aberrations per larva did not differ in any of the populations. The quantitative amount of heterozygosity was essentially the same in the irradiated and the control population, but there was three times the variety of chromosomal aberrations found in the irradiated area. From this evidence it was concluded that chronic low-level irradiation from radioactive waste was increasing the variability of chromosomal aberrations without significantly increasing the frequency.

- 1390 Carfagna, M., Solima, A., De Capos, A. NOTA PRELIMINARE SULLE VARIAZIONI DI ALCUNI FATTORI DI IDONEITÀ (FITNESS) IN POPOLAZIONI DI *Drosophila melanogaster* PERIODICAMENTE IRRADIATE. (Preliminary note on the variation of a fitness factor in a periodically irradiated population of *Drosophila melanogaster*.) Atti Ass. genet. ital. 6 (1961) 277-84. (In Italian, with English summary).

Two populations of *D. melanogaster* were irradiated periodically with small doses of x-rays (100 r and 500 r). These, and two controls, were maintained at  $19 \pm 1^\circ\text{C}$ . On the 150th and 225th day the hatchability and fertility were assayed on egg samples obtained from individuals which had not been irradiated directly, taken from each population. The relative data indicate a percentage diminution of these 2 fitness factors in the populations irradiated with 500 r and, to a smaller extent, in those irradiated with 100 r. The diminution in fitness is interpreted as being due to the accumulation of lethal genes induced by the irradiation. At 25-d intervals the numerical levels were determined, altogether 17 times. The totals obtained are significantly higher (with the  $\chi^2$  test) in the 500-r than in the 100-r population and in controls. The heterogeneity test was, however, positive. If confirmed, these observations could be interpreted as being due to a greater adaptability in the irradiated populations in a selective environment. (From auth. summary).

- 1391 Carson, H.L. TRANSITORY INCREASE IN GENETIC LOAD IN IRRADIATED LABORATORY POPULATIONS OF *Drosophila melanogaster*. (Abstr. 5, 57) p. 74 in "Genetics Today, Proceedings of XI International Congress of Genetics, The Hague, September 1963. Vol. I", Geerts, S.J., Ed. Oxford, Pergamon Press, 1963.

Four replicate populations (2 control and 2 experimental) of *se se e<sup>+</sup> k ro* stock were maintained for 3 years in vial populations in which food, space and change schedule were rigidly controlled. Populations produced by this design are small (not more than 200 adults) and are equilibrated under strong natural selection. Population size and production were measured weekly. The experimental populations received radiation treatment: the dose was given over a period of 2 years and totalled 65 000 r units of x-ray. Rate of administration was 1000 r/week with 3 periods of 10, 10, and 20 successive weeks during which radiation was suspended. No radiation was given in the final year. Genetic loads carried by each population were measured three times during the final year. Random lots of eggs from each population were collected, counted and then adults were reared from these eggs under ideal conditions. Yields of adults from the irradiated populations were significantly below those of the controls at the first measurement. This indicates that these populations were carrying genetic loads due to the history of radiation. These differences, however, were absent after one year, indicating that the loads due to radiation had disappeared. This effect is ascribed to the efficiency with which natural selection removes new deleterious mutants from small populations. At the termination of the experiment, population sizes of the experimentals did not differ significantly from the controls.

- 1392 Chung, C.S. RELATIVE GENETIC LOADS DUE TO LETHAL AND DETRIMENTAL GENES IN IRRADIATED POPULATIONS OF Drosophila melanogaster. Genetics 47, 11 (1962) 1489-1504.
- The effect of irradiation on the relative genetic loads due to detrimental and lethal genes expressed by inbreeding was studied by extracting 267 second chromosomes of D. melanogaster and by examining their effects on viability in homozygous and heterozygous conditions for one nonirradiated and 8 irradiated populations. These irradiated groups had been maintained in the laboratory for several years after cessation of the irradiation. No consistent relationship of these loads to the radiation history of the different population was found. The data indicated that the irradiated stocks are nearly at equilibrium for both detrimental (D) and lethal (L) loads. The overall mean ratio of D to L was estimated as .58. Slight increase of D but constant L with crowding condition of culture suggested that the D to L ratio may be underestimated under uncrowded laboratory conditions. The inbred genetic load effected through sterility has been expressed in terms of sterile equivalent with two components of partial and complete sterility. Over both sexes the two components were found to be equally important to their harmful effects. Approximately one fourth of the total inbred load manifested through lowered viability and sterility is contributed by sterility factors. The second chromosomes of the irradiated populations in heterozygous arrangement with  $cn\ bw^D$  or  $Cy\ O$  marker chromosomes caused significantly reduced viability below the similar combinations of nonirradiated population. This increased heterozygous load due to irradiation was in the magnitude of  $0.0225 \pm 0.0084$ . Implication of this finding relative to degree of dominance of detrimental genes is discussed. (Auth.)
- 1393 Cordeiro, A.R. CHROMOSOMAL POLYMORPHISM DECREASE DUE TO  $\gamma$ -RADIATION ON NATURAL POPULATIONS OF Drosophila willistoni. Experientia, 17 (1961) 405-6. (In English).
- In an isolated natural population of D. willistoni more than 70 000  $\gamma$ -irradiated flies were released within 7 months. A significant decrease of the mean inversion frequency per individual was established. Some inversions in the second chromosome and IIIc, IIId, IIIE, and IIIf were even rarer than in the non-irradiated natural control populations even 14 months (35 generations) after the last release. In the irradiated population two new inversions were found (one in the X and one in the third chromosome). (Auth)
- 1394 Cordeiro, A.R., Reguly, M.K., Centeno, A.J. RESTORATION, WITHOUT SELECTION, OF BALANCED GENETIC LOAD BY RADIATION OF Drosophila INBRED STRAINS. (Abstr. 5.62) p. 76 in "Genetics Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963, Vol. I". Geerts, S.J., Ed. Oxford, Pergamon Press. 1963.
- Starting with wild inseminated D. willistoni from natural populations, four levels of inbreeding were obtained: (a) outcross, about "zero level" (150 strains); (b) outcross with sib mating last (5th) generation, level: 0.39 (101 strains from 608); (c) sib mating 5 generations, level: 0.69 (116 strains from 608), and sib mating 41 generations, near level 1.0 (1 strain from 50). Significantly different egg-adult viabilities were observed among these series: (a): 68.5% (b): 46.9% (c): 29.7% (d): 32.8%. Levels (b), (c) and (d) strains were sub-cultured in two simultaneous and parallel series of replications, one (R) received 600 r from a  $Co^{60}$  source, the other (K) was submitted to the same conditions, except radiation. A total of 127 010 eggs have been counted in these experiments. The most pertinent results are: at the (b) and (c) levels the (K) did not differ from (R). Nevertheless at the (d) level radiation produced an overall enhancement of egg-adult viability; K (d) = 32.53%, R (d) = 44.44% for 10 650 eggs fertilized by control and irradiated spermatozoa. Nevertheless, the spermatozoa produced from irradiated spermatids and spermatocytes showed a slight decrease in a total of 11 230 eggs, K (d) = 32.5% R (d) = 30.8%. The increase of egg-adult viability among the (d) level "low" class is K (d) = 7.53%, R (d) = 40.85%, placing its average viability over that of "high" class after radiation: K (d) = 62.95%, R (d) = 33.74%. The variance increased significantly among the irradiated spermatozoid block, considering that the extremes (high and low) of viability regressed toward the average more among the radiated than between the control the median class showed the greater increase in variance. (From abstr.)
- 1395 Dobzhansky, T. PROGRESS REPORT (ON BIOLOGICAL RESEARCH), OCTOBER 1, 1962 - JUNE 1, 1963. TID-18792, Rockefeller Inst. for Medical Research, New York, 11p.
- Results are reported from studies on the nature and magnitude of the genetic load in natural populations of certain species of Drosophila. Results are included from experiments on the viability effects of genetic variants in natural populations in homozygous and heterozygous condition, a study of chromosomal variants in a natural population of Drosophila pseudoobscura, and genetic loads in irradiated populations of Drosophila. (NSA 17: 1963, 24897)

- 1396 Dobzhansky, T. GENETIC STRUCTURE OF NATURAL POPULATIONS, (Abstr. B1D496) p. 48 in "Research and Development in Progress. Biology and Medicine. Issue No. 1". TID-4200, Division of Technical Information, AEC, July 1963.

The aim of this research program is to fill some of the gaps in the basic knowledge on which the judgement of the magnitude of the genetic radiation hazards must rest. Among the crucial questions which are still awaiting solution are: (1) how widespread in natural populations are genetic variants which are detrimental in double dose while favorable (heterotic) in single dose; (2) are such genetic variants merely temporary adaptive expedients, soon to be replaced, as claimed by some authors, by highly fit homozygotes, or do they endure for a long time; (3) are the effects on fitness of the genetic variants found in natural populations more or less constant or dependent on interaction with other variants in the same populations; and (4) are many gene loci represented in natural populations by numerous alleles or only by a single or by two alleles.

- 1397 Marques, E.K., Winge, H., Napp, M., Maciel, C.M.P. PERSISTENCE OF LETHALS IN IRRADIATED NATURAL POPULATIONS OF *Drosophila willistoni*. (Abstr. 5.63) p. 76-7 in "Genetics Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963. Vol. I". Geerts, S.J., Ed. Oxford, Pergamon Press. 1963.

An isolated wood in the grassland region of R.G. Sul (Brasil) received during one year 6 releases of about 71000 individuals  $F_1$  of irradiated samples from a laboratory population originated from the same wood. A total of 45000 r from a  $Co^{60}$   $\gamma$ -source was delivered to these 6 samples. The  $F_1$  of the last irradiated sample,  $6R_1$ , as well as the samples collected in the isolated wood, 5 generations ( $N6R_1$ ) and 15 generations ( $3N6R_1$ ) after the release of  $6R_1$  have been genetically analyzed for the II and III chromosomes. The  $6R_1$  exhibited a significant overload of lethals (II chromosome: 69.75%; III chromosome: 30.87% in regard to its control values from another unirradiated isolated wood (II: 26.34%; III: 19.02%). The allelism increased for each sample: II:  $6R_1 = 6.39\%$  and Control = 1.02%; III:  $6R_1 = 4.00\%$  and Control = 0.29%. This increase persisted 15 generations in nature:  $N6R_1$ : II = 3.82%; III = 3.22%. This high allelic frequency was maintained in spite of the return to control values of the III chromosome lethals. The II chromosome lethal frequency was still significantly higher than the control (44.44%). The allelism tests intersamples ( $6R_1 \times N6R_1$ : II = 5.18%; III = 3.03% and  $6R_1 \times$  Control: II = 0.22%; III = 0.07% allowed us to estimate the radiation induced lethal persistence at the  $N6R_1$  to be 75.82% for the II and 88.51% for the III chromosome. The same type of calculations made for the  $3N6R_1$  gave 11.48% for the II and 5.30% for the III chromosome, as values of lethal persistence from the  $6R_1$ , 15 generations after under natural selection. There are indications that several components of the adaptive value were depressed (1) and that chromosomal inversions might "protect" some lethals (2). The persistence of some lethals suggests their complete recessivity as even some balanced effects.

- (1) 1383  
(2) 1393

- 1398 Mourad, A.-K., M. EFFECTS OF IRRADIATION IN GENETICALLY COADAPTED SYSTEMS. Genetics 47, 12 (1962) 1647-62.

(For abstract, see Mourad's thesis, ref. 1399.)

- 1399 Mourad, A.-K., M. EFFECTS OF IRRADIATION ON GENETICALLY COADAPTED SYSTEMS. Thesis, Columbia Univ., New York. 1962. 42p.

Experimental populations of *Drosophila pseudoobscura* kept in laboratory population cages, were used to study the effects of exposure to ionizing radiation. The populations were polymorphic for AR and CH gene arrangements in the third chromosomes. Only AR, or only CH chromosomes, were exposed to radiation. Since the gene arrangements were recognizable cytologically, it was possible to follow the destinies of the irradiated and the non-irradiated third chromosomes in the populations. Control experimental populations, with no radiation histories, were also studied. In populations Nos. 2 and 3, flies carrying the AR chromosomes of the foundation stock were exposed to 16000 r-units of x-rays, and the populations were allowed to breed without further irradiation. The frequencies of AR chromosomes declined at first, but subsequently recovered, and in one of the populations almost reached the same equilibrium state as in the control. In populations Nos. 4 and 5, the CH chromosomes of the foundation stock received 12000 r-units, and no further radiation was applied. The frequencies of CH chromosomes declined more rapidly than in the control. In populations Nos. 8 and 9, flies carrying the AR chromosomes were treated with 16000 r of x-rays, and thereafter the populations received in every generation an inflow of AR chromosomes exposed

to the same amount of radiation. Compared to the controls, the frequencies of AR chromosomes were depressed, but the polymorphism was nevertheless preserved. (Diss. Abstr., 23: 5: 1962, 1494).

- 1400 Mukai, T. A RADIATION-GENETICAL CONSIDERATION CONCERNING THE STRUCTURE OF NATURAL POPULATIONS. p. 155-65 in "Proceedings of the Symposium on Genetic Effect of Radiation, Misima, 7-8 November 1960". Jap. J. Genet. 36, Suppl. The Genetics Society of Japan. 1961. (In English).
- According to Dobzhansky's classification (Cold Spr. Harb. Symp. quant. Biol. 20 (1955) 1-15), there are two mutually contradictory hypotheses concerning the genetic structure of natural populations, i. e., the classical hypothesis and the balance hypothesis. From the present study it appears that there are 2 kinds of mutation in *Drosophila melanogaster*, the balance hypothesis applying to one (about 2/3) and the classical to the other (remaining 1/3). Heterosis seems to be destroyed by spontaneous mutations in the genetic background, but compensated by a high mutation rate. There may thus exist an equilibrium such that mutation at one locus supplies variability of its own but at the same time causes a decrease in variability at other loci.
- 1401 Oshima, C., Kitagawa, O. HETEROZYGOUS EFFECTS OF INDUCED LETHAL GENES ON PRE-ADULT VIABILITY IN *Drosophila melanogaster* AND THEIR PERSISTENCE IN EXPERIMENTAL POPULATIONS. p. 167-78 in "Proceedings of the Symposium on Genetic Effect of Radiation, Misima, 7-8 November 1960". Jap. J. Genet. 36, Suppl. The Genetics Society of Japan. 1961. (In English).
- A 2nd chromosome of Samarkand isogenic strain, which was irradiated by x-rays of 500 or 1000 r was isolated by C. M. I. method. The other major chromosomes were substituted by Samarkand chromosomes. 27 lethal genes were obtained and 2 of them were found allelic. These lethals have been maintained by Cy balanced system. The heterozygous effects of each lethal gene on pre-adult viability were estimated on heterozygous and on homozygous genetic background. The mean coefficient of selection on homozygous genetic background was 0.04536 and on heterozygous genetic background it was 0.01640. The genetic background, on which a lethal gene was placed, was proved to have a remarkable influence on the individual heterozygous effect of the lethal gene on viability. No correlation was observed between their coefficients of selection on both genetic backgrounds. Some lethal genes were introduced separately in experimental populations and their individual persistence was observed during about 30 generations. For 1st 10 generations, their decreasing frequencies seemed to depend on the magnitudes of selection coefficients, and later their frequencies gradually decreased at a similar rate that was theoretically assumed ( $s=0$ ). (Auth. summary)
- 1402\* Pipkin, S.B., Sullivan, W.N. A SEARCH FOR GENETIC CHANGE IN *Drosophila melanogaster* EXPOSED TO COSMIC RADIATION AT EXTREME ALTITUDE. Aerospace Med. 30 (1959) 585-98.
- In all, 10 761 *Drosophilae* were exposed as larvae to primary cosmic radiation during a balloon flight which remained from 78 000 - 82 000 feet for 16 h. The control series included 7742 individuals. No demonstration of X chromosome breakage or gene mutation at specific X chromosome loci was possible either because of the rarity of thindown hits or of nuclear collisions or because of lethal effects of the former. (Auth. summary).
- 1403 Bochnig, V. ALTERATIONS OF VIABILITY CHARACTERS IN AN IRRADIATED POPULATION OF *Drosophila*. (Abstr. 5.59) p. 75 in "Genetics Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963. Vol. I". Geerts, S.J., Ed. Oxford, Pergamon Press, 1963.
- Alterations of viability of *Drosophila melanogaster* have been studied after x-raying a population in its consecutive generations. The population used has been derived from the Berlin wild stock. In each generation 500 males and 500 females (1-5 d old) have been irradiated with an acute dose of 2100 r. Up to more than 30 generations of irradiation viability characters have been studied in intervals of about 5 generations by testing lifespan, fecundity, and fertility after application of different x-ray doses ranging from 0-100 kr. The results obtained show that in each of the 3 characters studied the irradiated population reached a significantly higher degree of viability than the Berlin wild stock under all experimental conditions. The higher fitness of the irradiated population is explained by an effect of heterosis. A great number of mutations must have been induced by the irradiations and accumulated in the population. As a consequence a higher degree of heterozygosity must have been reached.

- 1404 Reguly, M.L., Cordeiro, A.R. MUTATIONAL RECURRENCE OR GENETIC COMPENSATION OF LETHALS IN *Drosophila* NATURAL AND IRRADIATED POPULATIONS? (Abstr. 5, 60) p. 75 in "Genetics Today, Proceedings of XI International Congress of Genetics, The Hague, September 1963. Vol. I", Geerts, S.J., Ed. Oxford, Pergamon Press. 1963.

The total frequency of 30.3% lethal II chromosomes of *D. willistoni* from an irradiated "A" population do not differ from the control "E" population, 30.5% ( $\chi^2 = 2.17$ ) (714 strains). This analysis was made 77.5 generations after radiation. The "A" population exhibited 6 out of 10 retested lethals and the "E" 3 of these. Nevertheless, 3 lethal loci are exclusively found in "A" irradiated population. The allelism tests we performed and the calculated average mutation rate per locus in the II chromosome of *willistoni*, 0.000008 obtained from the data of Dobzhansky et al.\* allows the estimation, with Wright's formulae, of the equilibrium levels for each lethal assuming complete recessivity. According these calculations the 6 more frequent induced lethals, still present in population "A" and the 3 spontaneous alleles of "E" population are at 10 to 24.4 times above the expected values. The lethal survival in nature, at such high frequencies, can only be explained by mutation pressures many times above the normal average observed or by overdominant alleles providing genetic compensation or both, by mutational and balanced effects. We suggest that selection of modifiers and/or overdominant allelic forms, tends to buffer (balance) the recurrent lethal producing loci.

\* (Genetics 37: 1952, 650)

- 1405 São Paulo, Brazil. Universidade. Faculdade de Filosofia, Ciências e Letras. GENETICAL EFFECTS OF RADIATION: A COMPARATIVE STUDY BETWEEN NATURAL LETHALS AND LETHALS INDUCED BY RADIATION IN POPULATION OF *Drosophila willistoni*. Progress Report. TID-17699, 12 Jan. 1963, 15p.

The frequency of mutants in an island population after the introduction of natural and radio-induced mutants was studied. In natural populations lethal genes are eliminated rapidly and non-uniformly, and lethals have strong and variable effects in the heterozygotes. In cages, relatively high frequencies of lethals are still maintained even after 18 generations; the same genes have no deleterious effects in the heterozygotes and, in some cases, even appear to induce an increase in heterozygote viability. In the natural populations no difference was detected between natural and induced lethals and their elimination. In laboratory populations (in 6 out of 8 cases) the frequencies of the radiation-induced lethals dropped below that of the natural lethals after 15 generations of selection. Results are tabulated. Further genetical and statistical analyses are under way. Summarizing, 1) recessive lethals are far from completely recessive; 2) the effects of the lethals in heterozygotes are not absolute but vary with environmental conditions; and 3) recessive lethals, even when heterotic, are almost dominant when the environmental conditions are not too drastic.

- 1406\* Sperlich, D. POSITIVE HETEROSIS EFFECT IN THE STRUCTURALLY POLYMORPHIC SPECIES *Drosophila subobscura*. Z. Vererb. 90 (1959) 273-87. (In German).

A highly polymorphic race was irradiated once in each of 4 successive generations. The shifts found in the next generation in equilibrium frequency of structural heterozygotes were interpreted as due to disturbances of the adaptive gene complexes of the different types. A new inversion induced by the radiation was tested in competition experiment with other structural types and frequency of heterozygotes at equilibrium showed that these had a selective advantage. Here at least the positive heterosis effect must be due to position effect. The primary spread of a new rearrangement may depend on position effect, while with suppression of recombination secondary genic adaptation may occur, which later may mask completely the original position effect. (TID-3098, 4191)

- 1407 Tantawy, A.O. DEVELOPMENTAL HOMEOSTASIS IN X-RAYED POPULATIONS OF *Drosophila pseudoobscura*. Genetica 33 (1963) 222-43.

An experiment was designed to study the effects of various dosages of x-irradiation on different gene arrangements (AR and CH) of the third chromosome of *D. pseudoobscura*, with respect to quantitative characters. Egg production showed an insignificant decline at 1500 r and an increasingly strong reduction by 3000 and 4500 r. Other characters studied (emergence, longevity, body size, and weight) generally showed the same trend. Irradiation of both gene arrangements usually gave more reduction in fitness characters than did irradiation of one gene arrangement alone. Irradiation caused an increase in phenotypic variability as expressed by coefficients of variation. Heterosis in  $F_1$  was observed for most of the characters studied, and a breakdown of heterosis in  $F_2$ . Heterosis was enhanced by irradiation at higher dosages. Relative indices of general performance indicate that the adaptive values decreased with the



increase in radiation dosages. In all cases the heterozygous genotypes are the fittest while the CH/CH homozygote was the least fit. (Auth.)

- 1408 Торопанова, Т.А. ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ МУТАЦИОННОГО ПРОЦЕССА В ПОПУЛЯЦИЯХ. Ж. общ. Биол. 23, 5 (1962) 359-69.  
  
Tоропанова, Т.А. EXPERIMENTS ON MUTATION PROCESSES IN POPULATIONS. Zh. obshch. Biol. 23, 5 (1962) 359-69.  
  
Lines of Drosophila melanogaster from different ecological background have different natural mutation rates. These differences persist even after the population lines have been subjected to ionizing radiations. In heterozygotes, recessive lethal mutations lead to decreased resistance in the face of unfavourable conditions. (Inhaltsverzeichnis sowjetischer Fachzeitschriften, ser. IIB, 12, 1: 1963, 209, 4. Tr: MB)
- 1409 Wallace, B. FURTHER DATA ON OVERDOMINANCE. (Abstr. 5, 56) p. 74 in "Genetics Today. Proceedings of XI International Congress of Genetics, The Hague, September 1963. Vol. I". Geerts, S.J., Ed. Oxford, Pergamon Press, 1963.  
  
See 1410.
- 1410 Wallace, B. FURTHER DATA ON THE OVERDOMINANCE OF INDUCED MUTATIONS. Genetics 48, 5 (1963) 633-651.  
  
A study of x-ray induced mutations (exposures of 0, 250, 750 and 2250 r) in heterozygous condition on the viability of Drosophila melanogaster otherwise (1) homozygous for their second chromosomes, (2) heterozygous for 2 different second chromosomes of the same local populations, or (3) heterozygous for 2 second chromosomes of widely separate origins is described; the study comprises nearly 8200 cultures. The data indicate that the newly induced mutations affect the viability of otherwise homozygous individuals differently from that of heterozygotes; they suggest further that on the average the viability of homozygotes is enhanced by new mutations in heterozygous condition while that of heterozygotes is impaired. The differences in viability under analysis are extremely small. (Auth.)
- 1411 Wallace, B. THE INVESTIGATION OF THE GENETIC STRUCTURE OF POPULATIONS. Period covered: 1 Oct. 1960 - 31 Oct. 1961. TID-14463, New York State Coll. of Agriculture, Ithaca. 30 Nov. 1961. 15p.  
  
The viability effects of newly induced second-chromosome mutations are expressed in heterozygous condition. There appears to be very little effect. Three levels of irradiation (250, 750 and 2250 r x-rays) were used. One interesting point is that the regression of viability on radiation exposure has consistently been positive for flies homozygous for entire second chromosomes while it has been negative for flies carrying two different chromosomes from the same population. At one time, this difference bordered on statistical significance. An analysis of data obtained from Dobzhansky is described which is believed to prove the existence of over-dominance. In brief, if over-dominance does not exist, the viability of homozygous and heterozygous individuals should converge on a common point at the upper end of the viability distribution. In contrast to this expectation, the viabilities of homozygotes and heterozygotes diverge in the region of high viabilities. New work on the study of inversions and deficiencies is also described.
- 1412 Wallace, B. THE INVESTIGATION OF THE GENETIC STRUCTURE OF POPULATIONS. Period covered: 1 Nov. 1962 - 31 Oct. 1963. TID-19699, Cornell Univ., Ithaca, N.Y. Dec. 10, 1963. 27p.  
  
Results are summarized from studies on radioinduced and spontaneous mutations in populations of Drosophila melanogaster. Data are included from a study of the viability effects of spontaneous mutations, the rate at which second chromosome lethals arise by spontaneous mutation, and the effect of these lethals on the viability of heterozygous carriers in populations of D. melanogaster. A list is included of papers published as a result of these studies. (NSA 18: 1964, 6818)
- 1413 Winge, H., Maciel, C.M.P., Napp, M., Marques, E.K. GENETIC EFFECTS OF  $\gamma$  RADIATION ON NATURAL POPULATIONS OF Drosophila willistoni. Experientia 17 (1961) 406-8. (In English).  
  
An isolated natural population of D. willistoni for a year supported a considerable admixture of  $F_1 C_0^{80}$ -irradiated flies. The genetic analysis showed that the frequency of the lethal and semilethal alleles after 5 generations decreases rapidly to the normal. The frequency of the lethal alleles was still high. After

15 generations it decreases to the level of the natural control populations. Individual lethal alleles produced by irradiation remain in the population. (Auth.)

See also:

- 745 Entomological aspects of radiation as related to genetics and physiology. (Grosch, 1962)
- 790 Influence de l'irradiation sur les adultes de Sitophilus sasakii Takahashi (Curculionidae) et leurs descendants. (Laviolette and Nardon, 1963)
- 791 Action des rayons  $\gamma$  du cobalt 60 sur la mortalité et la fertilité des adultes d'un charançon du riz. (Laviolette and Nardon, 1963)
- 1050 Effects of a prolonged exposure of artificial populations of Drosophila melanogaster to  $MnCl_2$ . (Carfagna et al., 1963)
- 1208 Changes of reproductive performance of Drosophila willistoni at two inbreeding levels. (Centeno et al., 1963)
- 1310 Changes in quantitative traits under selection and irradiation. (Bartlett, 1963)
- 1314 Répercussion de l'influence des rayons  $\gamma$  dans la descendance de Sitophilus sasakii (Takahashi) (Coléopt. Curcul.) (Nardon, 1962)
- 1385 Research in genetics. (Stone, 1963)
- 1477 Control of insect populations through genetic manipulations. (LaChance and Knipling, 1962)

#### I-C-5 ECOLOGY

- 1414 Erdman, H. E. EFFECTS OF RADIATION ON ECOLOGICAL SYSTEMS. (Abstr. EIA774) p. 127 in "Research and Development in Progress, Biology and Medicine, Issue No. 2". TID-4201, Division of Technical Information, AEC. Nov. 1963.

Tribolium confusum and T. castaneum are excellent for studies of radiation effects upon populations in competition because they occupy the same ecological niche. T. castaneum is more tolerant to radiation than T. confusum except in the egg stage when their sensitivities are the same. Sterility is induced in T. castaneum by 8 kr x-rays and closely approached by 4 kr. After adults had been exposed to a single dose of x-rays, a decrease in lethals among progeny with time and a differential radiosensitivity of gametes for both species were observed. Twenty kr x-rays inhibit larval development in Ephestia and a difference was noted in the haemolymph protein fractions between x-rayed and control larvae 1 month after treatment. Ingestion of 0.03 - 0.04  $\mu$ Cu  $Pu^{239}$  /Habrobracon wasp induced temporary sterility; 0.11 - 0.14  $\mu$ Cu produced permanent sterility. Future studies are discussed.

- 1415 Platt, R. B. ECOLOGICAL EFFECTS OF IONIZING RADIATION ON ORGANISMS, COMMUNITIES AND ECOSYSTEMS. p. 343-55 in "Radioecology, Proceedings of 1st National Symposium on Radioecology, Colorado State University, Fort Collins, 10-15 September 1961". New York, Reinhold Publishing Corp. 1963.

Some mention of the differences in radiation sensitivity is made on p. 248, with special reference to the extreme case of Drosophila. Median lethal doses for embryos aged 3, 4, and 7½ h range from 170-200, 500 to 810 r, rising to 2800 and 85 000 r for pupae and adults, respectively.

- 1416 Stone, W. S., Wheeler, M. R., Wilson, F. D. GENETIC STUDIES OF IRRADIATED NATURAL POPULATIONS OF Drosophila. V. SUMMARY AND DISCUSSIONS OF TESTS OF POPULATIONS COLLECTED IN THE PACIFIC PROVING GROUND FROM 1955 THROUGH 1959. p. 1-54 in "Studies in Genetics. II. Research Reports on Drosophila Genetics, Taxonomy and Evolution". Wheeler, M. R., Ed. Austin, The University of Texas. 1962.

Samples of the circumtropical species, Drosophila ananassae, were collected in July and August for a 5-year period, 1955-9, from islands in the USAEC Pacific Proving Ground area. Estimates of the different dosages received by the various populations are given. The ecology of these island populations was studied to determine competitors, predators, food, and the effect of man-induced changes (destruction of habitat, insecticide sprays, etc.). The general and comparative sizes of the populations were determined as far as possible. Samples were tested every year for viability, fertility, and fecundity. A quite consistent finding was the great variability of the smaller atoll populations as compared to the relatively large population on Ponape. Part of this is due to lesser ability to resist fluctuation with environmental change. Another very interesting finding is that isolating factors which reduce fecundity in crossmatings and crossfertility had developed between several of these populations.

- 1417 Woodwell, G.M. ENVIRONMENTAL BIOLOGY: EFFECTS OF IONIZING RADIATION ON ECOSYSTEMS. (Abstr. EIA1086) p.132-3 in "Research and Development in Progress. Biology and Medicine. Issue No.2". TID-4201, Division of Technical Information, AEC. Nov. 1963.

Two principal field experiments have been established: one utilizing an old field in the Brookhaven  $\gamma$  radiation field and a second involving a new irradiation facility in a near climax forest. Secondary effects, especially those involving insect populations, could be shown to be of great importance in analyzing the effects of low-level irradiation on ecosystems.

See also:

- 1388 Chromosomal aberrations in a natural population of Chironomus tentans exposed to chronic low-level environmental radiation. (Blaylock, 1963)  
1389 Population genetics and radiation effects studies on Chironomus tentans. (Blaylock et al., 1963)  
1408 Experiments on mutation processes in populations. (Toropanova, 1962)



## II APPLICATIONS

### II-A Articles. Surveys

- 1418 Baccetti, B. L'ENERGIA ATOMICA NELLA LOTTA CONTRO GLI INSETTI. (Atomic energy in the fight against insects.) Acad. econ. agrar. Georgofili IX, 7 (1963) 1-18 and 319-24. (In Italian)  
Review article, dealing with applications of radiation (sterile male technique, mostly).
- 1419 Borroughs, H. THE USE OF IONIZING RADIATION FOR INSECT CONTROL IN LATIN AMERICA. Int. J. appl. Rad. Isotopes 13 (1962) 441-3.  
Review of small-scale projects, so far mostly under consideration.
- 1420 Borroughs, H. THE USE OF IONIZING RADIATION FOR INSECT CONTROL IN LATIN AMERICA. Turrialba 13, 1 (1963) 32-4. (In Spanish, with English summary).  
Review article, emphasizing work on radiation-induced sterility.
- 1421 Horne, T., Brownell, L. E. THE USE OF RADIATION SOURCES FOR INSECT CONTROL. p. 233-50 in "Radioisotopes and Radiation in Entomology: Proceedings of a Symposium, Bombay, 5-9 December 1960", Vienna, International Atomic Energy Agency, 1962.  
Review article. Different radioisotopes and electrical machine sources of radiation are briefly discussed, greater emphasis being placed on radioisotopes because of their greater reliability and ease of operation. The numbers of curies of the most suitable isotopes for various applications are tabulated. The general principles of source design covering radiation flux intensity, optimum dose distribution, and shielding requirements are outlined. Various procedures for the use of radiation in control of insect populations are reviewed, including the sterile-male release technique, direct irradiation of agricultural products, the combined use of insecticides with irradiation, and the possible use of radiation as an insect repellent. Possible new applications are suggested. A new method for storing grain for a long time without the need for periodic fumigation involves the use of a special grain container and radiation processing. Designs for various irradiators and some of the problems encountered are reviewed. Special reference is made to small semi-portable irradiators suitable for insect sterilization; to a flexible laboratory irradiation unit covering both research and field scale applications; and to some of the large production scale facilities proposed for commercial use. (From auth.)
- 1422 International Atomic Energy Agency, Vienna. INFORMATION CIRCULAR ON RADIATION TECHNIQUES AND THEIR APPLICATION TO INSECT PESTS. WP/31/A. Mar. 1963. 14p.  
The circular is aimed at disseminating research information to research workers in the field. The following topics related to the sterile male technique and allied problems will be covered: insect tagging techniques; tracer application in ecology, e.g. flight range determinations; insect population dynamics; development of mass rearing techniques; effects of radiation on insects; radiation sterilization applications; and irradiation of commodities and materials to control insects. The first 15 abstracts refer to papers presented at the 1963 Panel meeting (see Lindquist, 1434) abstracts 1-6 deal with insects affecting animals, 7-12 with fruit flies, and 13-15 with other insects. Items 16-22 are communications to I. A. E. A.
- 1423 International Atomic Energy Agency, Vienna. INFORMATION CIRCULAR ON RADIATION TECHNIQUES AND THEIR APPLICATION TO INSECT PESTS, Nr. 2. WP/31/2. July 1963. 27p.  
Summaries are presented of 46 papers covering various aspects of applications of radioisotopes in studies of insect pests of interest in agriculture. Emphasis is placed on the use of labeled insects and their parasites in studies of the migration, population density, and metabolism of insect pests. The effect of radiation on insects during various developmental stages, radioinduced mutations in insects, and the release of irradiated males as a means of control are also discussed. (NSA 18: 1963, 3439).

- 1424 International Atomic Energy Agency, Vienna. INFORMATION CIRCULAR ON RADIATION TECHNIQUES AND THEIR APPLICATION TO INSECT PESTS. WP/31/3. Dec. 1963. 19p.

Of the 51 communications listed, 5 covered ecological studies, 15 effects of ionizing radiations, 2 rearing techniques, 7 radiation sterilization, and 22 chemosterilants. As yet unpublished information was communicated by W. Kloft on carpenter ant colonies (*Camponotus* sp.), using  $^{14}\text{C}$ ; J. A. George on  $\gamma$ -radiation on the Oriental fruit moth, *Grapholitha molesta* (Busch); H. Huque on the susceptibility to  $\gamma$ -radiation of various developmental stages of the locust; K. P. Katiyar on the possible use of the sterile male technique for dealing with *Ceratitis capitata* in Central America; and some further trials by M. D. Proverbs of the sterile-male technique with the codling moth, *Carpocapsa pomonella*.

- 1425 Macko, V., Jasič, J. VYUŽITÍ GAMA ŽIARENIA V APLIKOVANEJ ENTOMOLOGII. (The use of  $\gamma$ -radiation in applied entomology). *Polnohospodárstvo* 8, 2(1961)139-47. (In Czech, with Russian summary)

The two main applications for pest control and eradication, in terms of direct action or the sterile male technique, are discussed.

- 1426 Rukavishnikov, B.I. POSSIBLE USES OF IONIZING RADIATION FOR STERILIZING AND DESTROYING INSECT PESTS. *Rastenievodstvo, sel'skoe hozjajstvo za rubežom* 3 (1963) 53-8.

- 1427 Stone, W.E. EFFECTS OF IONIZING RADIATION ON INSECTS AND OTHER ARTHROPODS. p. 301-8 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.

The influence of  $\gamma$ -radiation is described on the reproductive potential, sexual aggressiveness, vigour and longevity of the oriental fruit-fly, *Dacus dorsalis* Handel, the melon-fly, *Dacus cucurbitae* Coq., the Mediterranean fruit-fly, *Ceratitis capitata* Wied., the Mexican fruit-fly, *Anastrepha ludens* Loew, and *Anopheles quadrimaculatus* Say, and results of practical field trials of the sterile-male release method of population suppression. Progress in the campaign to eradicate the screwworm, *Cochliomyia hominivora* Cqrl. in the United States and in studies to develop vigorous genetically marked strains that will permit ready identifications of released sterile flies is reviewed. Results of irradiation research on additional species that infest fruit, vegetable, field and forest crops, that attack livestock, that largely affect man, the effects of irradiation on the scorpion, *Centruroides limpidus* Karsch, and the one-Star tick, *Amblyomma americanum* L., and ionizing radiation as a possible quarantine treatment for fruits and vegetables infested with fruit flies and mangoes infested with the mango weevil, *Sternonchus mangiferae* Fabricius, are also discussed. (From auth.)

- 1428 Waterhouse, D.F. INSECT CONTROL BY RADIATION STERILIZATION IN AUSTRALIA. *Int. J. appl. Rad. Isotopes* 13 (1962) 435-9.

A review article. The use of the method for grain disinfection is discussed. Consideration is also being given to sterilizing doses for controlling fruit fly in fruit moving into quarantine areas and *Sirex*- or *Hyloterpes*-infested timber entering Australia at mainland ports. 5-10 000r affect fly but not fruit, and 600 000c from a  $\text{Co}^{60}$  source are already used by a carpet manufacturer. Problems connected with *Dacus tryoni* (Frogg.), the Queensland fruit fly, and *Lucilia cuprina*, the Australian sheep blowfly, are discussed.

See also:

- 766 The application of nuclear energy to agriculture. (Borroughs, 1962).  
1570 Use of radioisotopes and radiation in the control of plant and animal insect pests. (Andreev, et al., 1963).  
1576 The use and limitations of isotopes and radiation sterility in meeting insect problems. (Knippling, 1962).

## II - B Population Control

### II-B-1 STERILE MALE TECHNIQUE

- 1429 Christenson, L.D. CONTROL OF INSECT PESTS BY RADIATION STERILIZATION TECHNIQUES. p. 169-88 in "Applications of Radioisotopes and Radiation in the Life Sciences 1961". Hearings before the Subcommittee on Research, Development, and Radiation of the Joint Committee on Atomic Energy, Congress of the United States. 87th Congress, 1st Session, 27-30 March 1961.
- Review article. Methods for mass production, sterilization, and distribution of insects are described. In addition to the screw-worm fly, the method was also used to control melon flies and fruit flies. Sterilization studies with mosquitoes, the pink boll worm, codling moths, corn earworm, fall armyworm, sugar-cane stalk borer, boll weevil, tobacco budworm, sheep blow fly, tsetse fly, and other insects are underway or planned. Radiation may also be useful as a quarantine treatment for insect-infested commodities. Dosages of 10 000 to 20 000 r were found to destroy the reproductive potential of immature stages of fruit flies in fresh fruit and vegetables.
- 1430 Чувашкин, В.С. ПОЛОВАЯ СТЕРИЛИЗАЦИЯ КАК МЕТОД БОРЬБЫ С ВРЕДНЫМИ НАСЕКОМЫМИ. Зашк. Раст. 2 (1961) 45-?
- Chuvashkin, V.S. SEXUAL STERILIZATION AS A MEANS OF CONTROLLING INSECT PESTS. Zashch. Rast. 2 (1961) 45-?
- 1431 Delattre, R. NOTE SUR LES POSSIBILITÉS DE LUTTE AUTRES QUE LES INSECTICIDES. p. 267-70 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency. 1962.
- Une nouvelle méthode de lutte par irradiation des mâles a récemment fait ses preuves aux États-Unis; il serait très intéressant et il paraît possible de partir de cette donnée pour l'appliquer au problème des *Dysdercus* en pays tropicaux. Élevage et expérimentation de base sont possibles en métropole, attractifs et mouvements des populations simplifieraient la mise en pratique de l'irradiation. L'intérêt économique final serait considérable pour les États d'Outre-Mer, en cas de réussite d'un tel projet. (Aut.)
- 1432 Féron, M. LA LUTTE CONTRE LES INSECTES PAR LES MÉTHODES AUTOCIDES. Rev. Zool. agric. 62, 4-6 (1963) 37-48.
- Discussion sur le contrôle contre les insectes au moyen de lâcher de mâles stérilisés par irradiation.
- 1433 Kansu, A. BÖCEKLER İLE SAVAŞTA YENİ BİR METOD: RAYASYONDAN YARARLANMA. (A new method to control insects: usage of radiation.) Sitki Koruma Bül. 2, 12 (1962) 40-60. (In Turkish, with English summary)
- Review article, with particular reference to work leading to the application of the sterile-male technique.
- Lindquist, A.W. INSECT POPULATION CONTROL BY THE STERILE-MALE TECHNIQUE. COMPREHENSIVE REPORT OF A PANEL, HELD IN VIENNA 16 - 19 OCTOBER 1962. Technical Reports Series Nr. 21. Vienna, International Atomic Energy Agency. 1963, 59p.
- After the successful work on screwworm eradication, the factors influencing the induction of sterility and some aspects of nutrition and the mass culture of insects are reviewed. The suitability for mass releases of sterile males is considered for the following species: the Australian sheep blowfly (*Lucilia cuprina* (Wied.) and *L. sericata*); the New Guinea screwworm (*Chrysomya bezziana* Villen.); the tropical ox warble (*Dermatobia hominis* (Linn.)); the tsetse fly (species *Glossina*); the fruit fly (*Anastrepha ludens*); the oriental fruit and melon flies (*Dacus dorsalis* (Hendel) and *D. cucurbitae* (Coq.)); the Queensland fruit fly (*D. tryoni* (Frogg)); the olive fly (*D. oleae* (Gmelin)); the codling moth (*Carpocapsa pomonella* (L.)); crop insects [sugar-cane borer: *Diatraea saccharalis* (Fab.), European corn borer: *Ostrinia nubilalis* (Häbn.), pink bollworm: *Pectinophora gossypiella* (Saunders), boll weevil: *Anthonomus grandis* Boheman, fall army worm: *Laphygma frugiperda*, and *Drosophila melanogaster*]; the Mediterranean flour moth, *Anagasta kuehniella* Zell; and some other grain pests. Results obtained by groups of scientists in different countries are reviewed and their problems discussed. Recommendations are made.

- 1435 Smith, C. N. PROSPECTS FOR VECTOR CONTROL THROUGH STERILIZATION PROCEDURES. Bull. World Hlth Org. 29, Suppl. (1963) 99-106.

Applications of radiosterilized insects for their own destruction are reviewed. The present position regarding vector control by sterilization procedures is discussed, with special reference to chemosterilants.

- 1436 Weidhaas, D. E., Schmidt, C. H., Chamberlain, W. F. RESEARCH ON RADIATION IN INSECT CONTROL, p. 257-63 in "Radiotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency, 1962.

A summary of the development and application of the sterile-male release technique, in which  $\gamma$ -radiation was used as the sterilant, in the eradication of the screwworm, Callitroga hominivorax (Cqrl.), is presented. Preliminary laboratory and field results on the application of this same technique to the control or eradication of mosquitoes, Anopheles quadrimaculatus (Say), and fruit flies, (Mediterranean), Ceratitis capitata (Weld.), the oriental fruit fly, Dacus dorsalis (Hendel) and the melon fly, Dacus curcurbitae (Coq.) are presented. Results are also given showing the lethal effects of radiation on some insects of medical importance, including the body louse (Pediculus humanus humanus L.), housefly (Musca domestica L.), American cockroach (Periplaneta americana (L.)), German cockroach (Blattella germanica (L.)), firebrat (Thermobia domestica (Pack.)), bed bug (Cimex lectularius L.), and the Pharaoh ant (Monomorium pharaonis (L.)). (Auth.).

See also:

- 54 Mating behaviour of Anopheles stephensi. (Quraishi and Arthur, 1963).
- 761 Study of the dose-dependence on the survival rate and the sexual sterilization of the granary weevil (Calandra granaria). (Andreev et al., 1962).
- 763 Radiation-induced sterility in the insect Rhodnius prolixus. (Baldwin and Shaver, 1963).
- 774 Exploratory studies on gamma radiation for the sterilization of the boll weevil. (Davich and Lindquist, 1962).
- 804 Quelques résultats supplémentaires concernant l'influence des rayons gamma sur les chrysalides et les œufs de la teigne de la farine "Ephestia kuehniella Zell" (Pelerents, 1963).
- 807 Somme effects of gamma radiation on the reproductive potential of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). (Proverbs and Newton, 1962).
- 808 Suppression of the reproductive potential of the codling moth by gamma irradiated males in caged orchard trees. (Proverbs and Newton, 1962).
- 809 Sterilization of the codling moth by gamma-irradiation. (Proverbs, 1962).
- 815 Sterilization of Dacus oleae by gamma radiation. (Thomou, 1963).
- 817 Evaluation of control of European corn borer, Ostrinia nubilalis (Hubner), by x-ray induced sterility. (Walker, 1962).
- 818 Effect of x-ray exposure on the European corn borer. (Walker and Brindley, 1963).
- 821 Gametogenesis in the sugarcane borer moth Diatraea saccharalis (F.) (Crambidae). (Virkki, 1963).
- 878 Mutations in the screw-worm fly. (La Chance and Hopkins, 1962).
- 1045 Influence of aeration during gamma irradiation of screw-worm pupae. (Baumhover, 1963).
- 1227 Effects of gamma radiation on various stages of three fruit fly species. (Balock et al., 1963).
- 1237 Control of the Mediterranean flour moth Anagasta kuehniella Zell by sterile male release. II. Susceptibility to gamma radiation. (Bull and Wond, 1963).
- 1283 Influence of gamma radiation on the development and fertility of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). (Proverbs and Newton, 1962).
- 1284 Influence of gamma radiation on the development and fertility of the codling moth, Carpocapsa pomonella (L.) (Lepidoptera: Olethreutidae). (Proverbs and Newton, 1962).
- 1375 The importance of competitiveness of radiosterilized males in mosquito-control programs. (Dame and Schmidt, 1962).
- 1378 Mating ability of male mosquitoes, Aedes aegypti (L.), sterilized chemically or by gamma radiation. (Weidhaas and Schmidt, 1963).



## II-B-1-a COLEOPTERA

### Scarabaeidae

#### *Melolontha vulgaris*

- 1437 Horber, E. ERADICATION OF WHITE GRUB (*Melolontha vulgaris* F.) BY THE STERILE-MALE TECHNIQUE. p. 313-31 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency., 1963.

Laboratory tests indicated that a minimum dose of 3000 r (or 3000-5000 r) x-rays was necessary to induce sterility in male cockchafer. During 2 flight period, sterilized males were released in a general farming region of north-western Switzerland. In 1959 five areas, each ~30 ha, were selected to serve as: (a) the treated area, where the males were captured, irradiated and released; (b) the "bank", where cockchafers were collected and the males irradiated for release in (a); and (c) control areas, where undisturbed gradation was observed. A therapeutical x-ray unit was used, and irradiated males hand-painted to estimate the ratio of sterilized males by the isotope dilution technique. In 1959, 81 sterilized males (~50% of male population) were released in (a). Infestation in grassland dropped to ~2/3 of that in other areas, reproduction rate to < 1 in (a) only, and (by 1962) reduction to 1/10 of that in (b) and (c). Greatest mortality (1959-1962) occurred in (a). In 1962, 171 irradiated males were released in (a) (~76% of population had been sterilized). Complete eradication was obtained in (a). The sterile-male technique may therefore also be applied successfully in an area which is not strictly isolated geographically, to a species where the females mate several times and where mass-breeding is not feasible because of the long breeding cycle.

## II-B-1-b DIPTERA

### II-B-1-b-i Calliphoridae

#### *Cochliomyia hominivorax*

#### *Lucilia sericata*

- 1438 United States Department of Agriculture, Agricultural Research Service. QUESTIONS AND ANSWERS ABOUT SCREW-WORM ERADICATION. ARS 91-38. November 1962.
- Brief but concentrated information bulletin on screwworm eradication dealing, in question-and-answer-form, with such aspects as damage, occurrence and spread, programs under way, sterile-fly production plant, release routine, barrier zones, and the livestock producers' role.
- 1439 Bushland, R.C. RESEARCH TO SUPPORT THE SOUTHWESTERN SCREW-WORM ERADICATION PROGRAM. (Abstr. 236). Bull. ent. Soc. Amer. 8, 3 (1962) 164.
- A team doing intensified research on screwworms has made progress in the development of: 1) new radiation techniques, 2) genetic markers for adults and larvae, 3) a chemically defined larval diet, and 4) inexpensive rearing media. Laboratory and field ecological observations are a guide to improved techniques in sterile-fly release procedures. (Auth).
- 1440 Hightower, B.G. NOCTURNAL RESTING PLACES OF THE SCREW-WORM FLY. J. econ. Ent. 56, 4 (1963) 498-500.

Large numbers of screw-worm flies, *Cochliomyia hominivorax* (Coquerel), the pupae of which had been exposed to 7500 r of  $\gamma$ -radiation on the 5th day following pupation, were marked with tracing powder fluorescent under ultra-violet light and released in the field in the afternoon and recovered during systematic searches on following nights. Flies tended to congregate at streams and pens of livestock, but recoveries from even the most favoured locations were not large. More than 90% of recovered flies were found resting on small leafless twigs in low-canopy trees. Essentially (Auth. summary).

- 1441 Hightower, B. G., Alley, D. A. LOCAL DISTRIBUTION OF RELEASED LABORATORY-REARED SCREW-WORM FLIES IN RELATION TO WATER SOURCES. J. econ. Ent. 56, 6 (1963) 798-802.

All the male and female screwworm flies released were reared in the laboratory on a standard diet and had been exposed to a sterilizing dose of  $\gamma$ -radiation as pupae. The techniques for rearing, holding, and sterilizing the insects remained the same throughout the experiments, but there were variations in the methods and rates of releasing the adults. However, all flies were more than 4 and less than 24 h old at the time of release. All the flies were marked with acetone-soluble or fluorescent dyes. Two series of field releases of marked laboratory-reared screwworm flies, Cochliomyia hominivorax (Coquerel), were carried out in southwest and central Texas to determine the local distribution of the flies in relation to stock ponds and streams. According to samples based on liver-baited trap catches, flies released in a semi-arid brushy area with no running streams tended to congregate around stock ponds. Flies released in an area crossed by running streams continued to disperse beyond a stream 0.8 to 1 mile from the release point to points on a second stream up to 1 mile beyond the first stream. Evidence is presented that the flies were channelled to some traps by terrain features. Local concentrations of flies on the stream nearest the release point persisted for 3 to 4 d. Peak catches of flies were noted on the third day following release. During the hot dry weather of late summer flies could not be detected along either stream.

- 1442 MacLeod, J., Donnelly, J. FAILURE TO REDUCE AN ISOLATED BLOWFLY POPULATION BY THE STERILE MALES METHOD. Ent. exp. appl. 4 (1961) 101-118.

In 1956 and 1957 pupae of Lucilia sericata were irradiated at 6000-7000 rep, and allowed to emerge at 3 points on Holy Island. The sterilized population was maintained in preponderant numbers by regular replenishments. A test in 1958 showed no reduction in the density of the species. Possible causes of failure of the method are examined, such as over-estimation of the field longevity of the sterilized flies; under-estimation of the native density; loss of radioactive label (e.g. through delay in pupation and emergence); reduced response of treated flies to bait-traps; inefficient sterilization; recovery of fertility; grossly reduced viability of sterilized animals; some specific unsuitability arising for physiological reasons; or failure for ecological reasons (e.g. losses from predators). It is concluded that either the sterilization was inadequate or that the sterilized males were unable to compete with the native males.

See also:

- 1227 Effects of gamma radiation on various stages of three fruit fly species. (Balock et al., 1963).

II-B-1-b-H Culicidae  
Aedes aegypti  
Anopheles quadrimaculatus  
Culex fatigans

- 1443 McCray, E. M., Jr., Jensen, J. A., Schoof, H. F. COBALT-60 STERILIZATION STUDIES WITH Aedes aegypti (L.). Proc. N.J. Mosq. Ext. Ass. 48 (1961) 110-15.

Exposure of A. aegypti pupae to 10 500 to 17 500 r of  $\gamma$ -irradiation caused complete sexual sterilization of both males and females (mortality < 10%). Caged populations containing 500 irradiated males, 25 normal males, and 25 normal females produced eggs of which < 2% were viable. At a ratio of 10:1:1 of sterile male: normal male: normal female, the viable egg production was < 10%. Rearing, sterilizing and shipping procedures were established by which about 110 000-160 000 sterilized male pupae were produced and sent by air twice weekly from July to November 1960 from Savannah to a release site about 450 miles away.

- 1444 Morlan, H. B., McCray, E. M., Jr., Kilpatrick, J. W. FIELD TESTS WITH SEXUALLY STERILE MALES FOR CONTROL OF Aedes aegypti. Mosquito News 22, 3 (1962) 295-300.

Tests in Escambia County, Florida, are reported and natural populations of A. aegypti are compared in 2 areas of sterile-male release and in 2 untreated check areas. The male pupae were sterilized by exposures to 11 000 to 18 000 r  $\gamma$ -rays, and were usually distributed within 24 h of irradiation. Results are tabulated. The extent of dispersion of sterile males from a limited distribution of irradiated pupae was unknown. Laboratory studies have indicated that a few days' difference in age of males favours mating success of the younger mosquitoes. Thus, the 1961 releases of only once a week, whilst desirable from the view-point of logistics, were probably less effective for A. aegypti control than the twice-weekly releases of 1960.

- 1445 Fay, R. W., McCray, E. M. Jr., Kilpatrick, J. W. MASS PRODUCTION OF STERILIZED MALE *Aedes aegypti*. Mosquito News 23, 3 (1963) 210-4.

For mass production of sterilized male pupae modifications are described in the rearing of large numbers of mosquitoes, in obtaining higher production of male pupae from the rearing trays, in separating the pupae from the larvae through the use of paraffin green or magnetic iron oxide dust, and in reducing the range of the irradiation dosage during the sterilizing process. Studies were also made on the mating competitiveness of sterile and normal adult males 2-7 d old. (From auth. summary).

- 1446 Weidhaas, D. E., Schmidt, C. H., Seabrook, E. L. FIELD STUDIES ON THE RELEASE OF STERILE MALES FOR THE CONTROL OF *Anopheles quadrimaculatus*. Mosquito News 22, 3 (1962) 283-91.

Geographical conditions under which releases were made are described, and the methods adopted for rearing and for evaluating egg viability, adult counts, etc. For sterilization, pupae < 24 h old were exposed to 12 000 r of  $\gamma$ -rays ( $\text{Co}^{60}$ ). The subsequent procedure is described. Monthly abundance of female *quadrimaculatus* was checked for the various locations. In the Lake Okeechobee experiment the release of sterile males may have influenced the abundance of *quadrimaculatus* during the first half of the experiment when the natural population was in a seasonal decline, but it had no effect when the natural population increased during the 2nd half of the test. Release of sterile males in the Lake Panasoffkee area did not conclusively demonstrate any induced sterility.

- 1447 Ramakrishnan, S. P., Krishnamurthy, B. S., Ray, S. N. LABORATORY STUDIES ON THE USE OF IRRADIATED STERILE MALES TO REDUCE *C. fatigans* Wied. POPULATIONS. Indian J. Malar. 16, 4 (1962) 357-64.

Irradiation of pupae (whether by x- or  $\gamma$ -rays) affected longevity. Tables give data on dosage (x-rays: 14 000 and 30 000 r;  $\gamma$ -rays: 2850 to 11 550 r); mortality of irradiated pupae, number of irradiated males crossed with normal females; number of egg-rafts from mated females; viability of egg-rafts; level of sterility obtained, experimental ratios used in mating, and mortality rates. Mosquito sterilization with minimum mortality was obtained with 7700 r of  $\gamma$ -rays. Maximum non-viability of eggs was obtained when the proportions of sterile to normal males to females was 9:1:1. A ratio of 2:1:1, which is more practicable, gave 38-40% non-viability.

- 1448 Krishnamurthy, B. S., Ray, S. N., Joshi, G. C. A NOTE ON PRELIMINARY FIELD STUDIES OF THE USE OF IRRADIATED MALES FOR REDUCTION OF *C. fatigans* (i.e. *Culex pipiens quinquefasciatus*) Wied. POPULATIONS. WHO/EBL/6, WHO/Vector Control/14. Geneva, World Health Organization. 9 Jan. 1963. 11 p.

In small-scale preliminary field trials undertaken by the Central Institute for Communicable Diseases, sterile male *Culex fatigans* were released with a view to assessing the effect on a wild population. Two villages, Ashtanagar for the releases and Karkarmandan for control purposes, were the test areas. No reduction was achieved in the adult or larval densities. The particular circumstances prevailing (non-cooperation of the local people) prevented the release of really large numbers of sterile males. The increase of sterile males in the *C. fatigans* population appeared to be followed by an increase in the percentage of rafts with embryonated but unhatched eggs. Thus, the possibility of using irradiated sterile males to effect reduction of *C. fatigans* populations in the field appears to be precluded.

Also published in Indian J. Malar. 16, 4 (1962) 365-73.

## II-B-1-b-iii Glossinidae Tsetse fly

- 1449 Knippling, E. F. POTENTIAL ROLE OF THE STERILITY PRINCIPLE FOR TSETSE FLY ERADICATION. WHO/Vector Control/27, WHO/EBL/9, World Health Organization, Geneva. 10 Apr. 1963.

A mathematical model was established on the basis of a low-level population of 200 flies/sq. mile. The time for one complete generation is taken as 3 months, maximum net increase potential 50%/generation. It is assumed that the releases are reduced by half for each period or generation, the natural male population being outnumbered 3:1 at the start. Theoretically, the rate of decline in the natural population is greater than the reduction in sterile males. On the basis of the population dynamics of tsetse flies in general, an initial release rate as low as 2:1 may be expected to start a downward trend in the natural population. \$500/sq. mile is necessary to achieve fly eradication by the application of selective residual

insecticides to the vegetation or for aircraft mist spraying. The sterility method might become practicable at already \$125/sq. mile. Economic and other considerations are discussed relating to various population densities and the prevention of re-infestation, mass rearing (difficulties and assumed high cost), and the use of sterile males as an adjunct to other tsetse fly control measures. Other methods for producing sterility, in particular the development of chemosterilants are reviewed. The kind of research needed at this stage is outlined.

II-B-1-b-iv Muscidae  
Musca domestica

- 1450 Rivoecchi, L. UN ESPERIMENTO SUL CAMPO CON MASCHI IRRADIATI DI Musca domestica IN UNA ZONA RURALE DELLA PROVINCIA DI LATINA. (An experiment in the field with irradiated male Musca domestica in a rural zone in the Province of Latium). Riv. Parasit. 23, 1 (1962) 71-4. (In Italian)

The chosen area was situated between the coast, the lakes Monaci and Caprolace, and included 4 country houses. Previous prolonged insecticide treatment had been applied. Sterile males were released in March. By April, sterile females had begun to appear and the population of females was greatly reduced over the following 2 months. No sterile males were released after early July. Tests for fertile females were made in August. Their number gradually increased until it became predominant within a month. It is not clear whether incomplete isolation of the test area or insufficient competitiveness of the irradiated males were responsible for failure of the treatment. - The optimum dose applied to pupae was 2000 r. Below are various ratios of normal female: irradiated male, and their results. 1:1:2 produced 50% sterility 1:1:4 - 60%, 1:1:6 - 70%, 1:1:10 - 20 - 90 - 99%, there was no improvement when the ratio was increased to 1:1:30 since some fertile eggs always remained.

II-B-1-b-v Tephritidae  
Ceratitis capitata  
Dacus (various)  
Dacus oleae

- 1451 Edwards, B. A. B. THE FRUIT FLY PROBLEM IN AUSTRALIA. Outlook Agric. 3, 4 (1961) 116-22.

General review. Two species of fruit fly, the Queensland fruit fly [Strumeta tryoni (Frogg.)], now well established in Queensland and coastal New South Wales and, to a lesser extent, in Victoria, and Ceratitis capitata (Wied.), now restricted to Western Australia, cause serious economic loss. So far, biological control (parasitic insects) has not proved very effective. The merits of dipterex, Rogor and Lebaycid sprays, and of male suppression by lure traps are discussed. According to J. G. Gellatley the release of irradiated sterile males is being investigated for S. tryoni control.

- 1452 Katiyar, K. POSSIBILITIES OF ERADICATION OF THE MEDITERRANEAN FRUIT FLY Ceratitis capitata Wied. FROM CENTRAL AMERICA BY GAMMA-IRRADIATED MALES. p. 211-17 in "4th Inter-American Symposium on the Peaceful Application of Nuclear Energy, Mexico City, 9-13 April 1962." Washington, D.C., Pan American Union. 1962.

Mass production of the fly in the laboratory is economically feasible. Owing to local topography and to the fact that at certain seasons the natural population density of this fly is extremely low, prospects for a successful application of the sterile male technique are very good. A cooperative project was started to study this problem on a field scale in a single region in Costa Rica. Preliminary experiments with the  $\text{Cs}^{137}$  irradiator in the gamma field have shown that when pupae (about 85-90% developed) are irradiated with 10-13 kr, sterility can be induced in adults without any deleterious side effects on longevity and mating. A  $\text{Co}^{60}$ -pool irradiator will be used for field experiments. The dispersal habit and longevity of the fly will be studied in nature by releasing radio-isotope labelled adults.  $\text{Sr}^{90}$  was tried in larval feeding tests but proved not very successful.  $\text{P}^{32}$  was adopted for labelling adults which could be achieved by adding the isotope to either the larval rearing medium or to adult food; the latter proved more effective and cheaper.

- 1453 Moh, C.C. THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE. A SUPPLEMENTARY REPORT. TID-16328, Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica. 1 July 1962. 28p.

Various studies are reported. The feasibility of releasing radiation-sterilized males in an attempt to eradicate the Mediterranean fruit fly, *Ceratitis capitata*, in Central America was investigated, and results of some preliminary radiation experiment are reported.

- 1454 Moh, C.C. THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE IN LATIN AMERICA. (Abstr. K18391), p.163-4 in "Research and Development in Progress. Biology and Medicine, Issue No. 1". TID-4200, Division of Technical Information, AEC. July 1963.

Apart from the training of Latin American students in the use of radioisotopes, various agricultural projects are under way. The relation between dosage and sterility in *Ceratitis capitata* Wied. was studied; 10 kr of  $\gamma$ -radiation is capable of inducing dominant lethal mutations in all sperm. Studies on the effects of different atmospheric conditions on the mating vigour and sperm production of the male, and the radiosensitivity of spermatogenesis at different stages are being carried out. (From abstr.)

- 1455 Kariyar, K., Valerio, S.J. STERILIZATION OF THE MEDITERRANEAN FRUIT FLY AND ITS APPLICATION TO FLY ERADICATION. p. 38-52 in "The Application of Nuclear Energy to Agriculture. Annual Report, 1 July 1963". Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica.

Egg and sperm sensitivities to  $\gamma$ -radiation were tested. Female pupae required 10 kr to ensure inhibited oviposition. This dose ensures almost 100% dominant lethals in all sperm, irrespective of pupal age. Tables show radiation effects (0, 1.25, 2.50, 5.00, 7.50, 10.00, 12.50 kr) on 7-, 8-, and 9-d pupae in terms of fertility, and a graph shows the percentage of dominant lethals induced in sperm at the 7-, 8-, and 9-d pupal stage. Radiation doses of 10 and 12 kr do not reduce longevity in irradiated adults. Doses > 20 kr were 100% lethal to pupae; 20 kr affect neither adult emergence nor longevity. Tables list radiation effects (0, 10.00 and 12.5 kr) on longevity of adults (male and female) and (for 0-90 kr, at 10 kr intervals) on adult emergence and longevity (applied at the 7-d pupal stage). From field tests adults do not appear to compete equally with normal males which are at least 8 times more aggressive. Overflooding of a wild population would necessitate a  $\approx$  39:1 (sterile : normal males) ratio. Dispersion and longevity studies were also carried out by tagging with  $P^{32}$ , following irradiation. "Trimedlure" was used in Steiner traps but appeals to males only. A recapture value of only 0.13% was obtained. For dispersal values, see 766.

- 1456 Moh, C.C. THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE. ANNUAL REPORT. TID-18986, Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica. 1 July 1963. 62p.

Progress is reported in basic and applied agricultural research using nuclear energy as a tool. Tracer studies have yielded some information on dispersion and longevity of *Ceratitis capitata* Wied. under natural conditions. The flies were sterilized at different developmental stages, and their subsequent efficiency for eradication measures investigated. A list of publications for the period covered by the report is included.

#### Dacus (various species)

Steiner, L.F., Mitchell, W.C., Baumhover, A.H. PROGRESS OF FRUIT-FLY CONTROL BY IRRADIATION STERILIZATION IN HAWAII AND THE MARIANAS ISLANDS. Int. J. appl. Rad. Isotopes 13 (1962) 427-34.

The course of experiments on *Dacus cucurbitae* Coq. (the melon fly), *D. dorsalis* Hendel (the oriental fruit fly) and *Ceratitis capitata*, Wied. (the Mediterranean fruit fly) is described. Factors which may affect successful application of the technique are discussed. Multiple mating (both sexes) occurs. Flight range is from 25-45 miles; sustained overwater flights of 12-42 miles have been observed. Fruit flies can now be reared in large numbers at reasonable costs. Irradiated flies tend to congregate in areas of greatest wild fly density. It is not necessary or economically feasible to separate sexes for release. Fly populations and fluctuations can be measured quickly throughout by powerful male lures. A genetic strain of white-marked oriental fruit flies is also being used to distinguish irradiated flies. Irradiation should be as low in the pupal period as possible. Dosages and cage tests are discussed. First field tests on the fly were partially successful. The Western Pacific experiments, initiated in 1960, are discussed. Data on infestation by area of medfly larvae in different fruit after release of irradiated flies at Waikiki are tabulated.

1458 Anonymous. ERADICATING THE MELON FLY. Agric. Res., Lond. **12**, 2 (1963) 5.

The pest attacks cucurbits (melons, cucumbers, and related crops) as well as string beans and tomatoes. Before the first release of sterile *Dacus cucurbitae*, (Coq), the borders of producing farms were sprayed 3 times with bait sprays to reduce the wild fly population by 90%, to lower the required flooding to manageable figures. In Sept. weekly releases of 4-10 million sterile flies were started, until a total of 180 million had been released. Within 3 weeks the sterile flies had flooded the native population by 18:1. By early December it was 50:1, by early January 100:1. Effective overflooding was considered to be > 10:1. Tests were carried out on Rota, a 33 square-mile island in the Mariana group, selected for its size and isolation (the nearest island, Guam, is 37 miles away).

#### *Dacus oleae*

- 1459 Mellis, A., Baccetti, B. METODI DI LOTTA VECCHI E NUOVI SPERIMENTALI CONTRO I PRINCIPALI FITOFAGI DELL'OLIVO IN TOSCANA NEL 1960. (Old and new experimental methods against the principal phytophagous pests of the olive in Tuscany in 1960). Redia **45** (1960) 193-217. (In Italian, with English summary)

Various techniques are discussed. A series of experiments were carried out bearing on the application of the sterile-male technique. Preliminary results of using irradiated males of *Dacus oleae* on trees to depress female fecundity were promising. Pupae were irradiated, the most effective doses being from 8000 to 12 000 r  $\gamma$ -rays, the optimum period for irradiation being 7 to 3 d prior to adult emergence. Hence resulted sterile females and very active males which were able to copulate but did not allow normal females to lay fertile eggs. When the method was applied to isolated and confined plants, in the ratio of 4 irradiated males to every normal couple, the succeeding generation was effectively annihilated. Results were less satisfactory when only 3 irradiated males were used.

- 1460 Baccetti, B., Cappellini, M. RICERCHE SULLA STERILIZZAZIONE DI INSETTI NOCIVI CON RADIAZIONI IONIZZANTI. (Investigations on the sterilization of pernicious insects with ionizing radiations). Nuntius radiol. **27** (1961) 600-3. (In Italian, with English summary)

The olive fly, *Dacus oleae* Gmel., was subjected to high doses of  $\gamma$ -rays from  $\text{Co}^{60}$  at the pupal stage. After establishing the dose sufficient to make the males sterile without depriving them of their capacity of copulation, the ratio between irradiated and normal males necessary to obtain an almost complete sterilization of an environment infested with the olive fly was obtained.

- 1461 Mellis, A. NUCLEAR ENERGY IN CONTROL OF *Dacus oleae*. Agricoltura Ital. **9**, 4 (1963) 11-18.

#### II - B - 1 - c LEPIDOPTERA

##### II - B - 1 - c - 1 *Lymantriidae* *Thaumetopoea pithyocampa*

- 1462 Baccetti, B., Zocchi, R. PROVE DI LOTTA CONTRO LA PROCESSIONARIA DEL PINO MEDIANTE L'USO DI RADIAZIONI IONIZZANTI. (Possible use of ionizing radiations against the pine processionary moth). Redia **47** (1962) 161-8. (In Italian, with English summary)

The possibility of applying the sterile-male technique to the pine processionary moth, *Thaumetopoea pithyocampa* Schiff. is examined. In laboratory experiments, males and females were sterilized by 4000 r  $\gamma$ -rays ( $\text{Co}^{60}$ -source), and the fecundity of normal couples was strongly depressed when sterile males were added in the ratio of 2 to every normal one. Irradiation needed to be carried out on the 15 d old chrysalis. As a sole means of control the technique appears to be impossible, theoretically, due to the difficulties of mass culturing *T. pithyocampa* in the laboratory of raising larvae on pine needles through many generations. The sterile-male technique would be worthwhile if integrated with biological control (the release of parasites emerged from collected nests).

H-B-1-c-11 Olethreutidae  
Carpocapsa pomonella

- 1463 Proverbs, M.D., Newton, J.R. COULD THIS BE DEATH TO THE CODLING MOTH? AECL-1329, Atomic Energy of Canada, Ltd. Commercial Products Div., Ottawa. 1961.

See also 1464.

Originally published in Br. Columbia Orchardist 1, 4 (1960).

- 1464 Proverbs, M.D., Newton, J.R. COULD THIS BE DEATH TO THE CODLING MOTH? Gamma Irradiation in Canada 2 (1961) 13-4.

The possibility of using the sterile-male method to control Carpocapsa pomonella (L.) was investigated. Both females and males were found to mate more than once frequently. Gamma irradiation was found to be more consistent in the induced sterility results than growth at high temperatures. A high sterility was obtained when male pupae were exposed to 40 000 rad ~ 1 d before moth emergence, and normal behaviour is unaffected until > 50 000 rad is reached. About 2% of the eggs resulting from the union of such sterile males and normal females hatch, as compared with ~ 80% in the control. Irradiation was found to kill female pupae more readily than male pupae, and a dose of 25 000 rad sterilizes > 99% of the eggs that they lay.

- 1465 Proverbs, M.D. EFFECT OF GAMMA RAYS ON INSECTS. PROGRESS ON THE USE OF INDUCED SEXUAL STERILITY FOR THE CONTROL OF THE CODLING MOTH, Carpocapsa pomonella (L.) (LEPIDOPTERA: OLETHREUTIDAE). Proc. ent. Soc. Ont. 92 (1961) 5-11.

Heat treatments induced sterility or near-sterility but caused considerable mortality. Gamma irradiation was more successful. Exposure of mature male pupae or newly emerged male moths to 40 000 rads induced about 98% sterility without affecting adult emergence, mating, or adult longevity. Higher dosages decreased mating. Irradiation of eggs, mature larvae, or young pupae also resulted in a high degree of sterility, but caused undesirable effects. The female was more radiosensitive than the male. Mating of a normal female with an irradiated male (40 000 rads), either before or after a mating with a normal male, did not prevent the laying of mostly viable eggs. When irradiated males (mature pupae exposed to 30 000 rads) were caged with normal males and females, in the proportion of 10:1:1, the sex ratio of the offspring was 1:1 and both sexes were mostly fertile. In laboratory experiments in which (a) irradiated males, or (b) irradiated males and females were added to cages containing normal male and female moths, in the proportion of 10 irradiated moths of each sex to 1 normal male and 1 normal female, the deposition of viable eggs was reduced 98% in (a) and 68% in (b). In an orchard experiment (cages over dwarf trees) in which irradiated males (mature pupae exposed to 40 000 rads) were caged with normal males and females, in the proportion of 10:1:1, the number of moths in the F<sub>1</sub> generation was reduced to approximately 1/3 of the number of normal moths in the parental generation. (Auth.).

- 1466 Proverbs, M.D. CONTROL OF THE CODLING MOTH, Carpocapsa pomonella (L.) BY THE RELEASE OF SEXUALLY STERILE MALES. p. 36 in "Radiation Biology in Canada 1962-63". CRB-1129, AECL-1701, Atomic Energy of Canada Ltd., Chalk River, Ont. Feb. 1963.

The release of sterile males (see 809) into the environment has given some promising preliminary results.

- 1467 Marshall, J. CAN WE ERADICATE THE CODLING MOTH? West. Fruit Gr. 17, 4 (1963) 19-20.

Popular presentation of the possibilities of applying the sterile male technique to Carpocapsa pomonella (L.).

- 1468 Brande, J. van den, Pelereants, C. QUELQUES EFFETS DES RAYONS GAMMA SUR LA TEIGNE DE LA FARINE ET SUR DIVERS NEMATODES. C.R. Rech., Brux. 1, 28 (1962) 11-47.
- Les auteurs traitent la biologie et l'élevage de la teigne de la farine, Ephestia kühnliella Zell., et donnent quelques résultats d'essais d'irradiation sur œuf, chenille et chrysalide. La stérilisation des mâles a été obtenue par irradiation des chrysalides adultes (15 j) avec une dose de 80 000 rad. Le nombre d'œufs stériles augmente assez régulièrement avec le nombre de mâles stériles. En réalité, le pourcentage observé est partout inférieur à celui attendu. La nécessité de certaines améliorations dans la technique est indiquée. - Plusieurs essais ont été réalisés sur d'autres insectes (Leptinotarsa decemlineata, Cacoecia rosana, Chortophila brassicae, Apis mellifera). Pour chaque insecte les doses létales et mutagènes diffèrent fortement, sans la moindre possibilité d'extrapolation. (En outre, une reine des abeilles a été marquée d'un fil d'argent 110). - Trois catégories de nématodes ont été étudiées: les nématodes libres, les nématodes des racines noueuses et les nématodes à kystes. Dans les nématodes de racines noueuses, Meloidogyne hapla Chitwood, l'infection ne diminue fortement qu'à partir de 180 000 rad. Sur le nématode doré de la pomme de terre, Heterodera rostochiensis Woll. les doses < 40 000 rad n'ont aucun effet. Une forte diminution est à observer à partir de 80 000 rad tandis que 320 000 rad préviennent toute infection.
- 1469 Bull, J.O., Wond, T. CONTROL OF THE MEDITERRANEAN FLOUR MOTH Anagasta kühnliella ZELL. BY STERILE MALE RELEASE. I. BIOLOGICAL STUDIES RELATED TO LARGE SCALE REARING. AERE-R-3895, United Kingdom Atomic Energy Authority. Research Group, Isotope Research Div., Waddington, Berke, England. 1962. 16p.
- The longevity, fecundity, viability and mating behaviour of a laboratory strain of A. kühnliella was determined. The strain was used to rear large numbers of the species. Females laid an average of 243 eggs, most being laid 2-3 d after the beginning of oviposition. The egg viability was 90%, of which 95% hatched in 5 d. Optimum rearing conditions are represented by inoculation of English coarse wholemeal flour at a density of 5000 eggs/kg, and incubation at 25°C. Production of the millions of insects required for sterile male release is easily achieved.
- 1470 Humelny, M.M. STERILIZATION BY GAMMA RAYS FOR THE CONTROL OF THE NAVEI ORANGEWORM. (Abstr. 273). Bull. Ent. Soc. Amer. 8, 3 (1962) 166.
- Laboratory tests to determine the possibility of controlling the navel orangeworm, Paramyelois transitella (Walker), by gamma irradiation were very promising, especially when both sterile males and females were used. Sterile but sexually active males and females were obtained by subjecting mature pupae to 50 000 rads of gamma irradiation.
- 1471 Humelny, M.M. STERILIZATION BY GAMMA RADIATION FOR THE CONTROL OF THE NAVEI ORANGEWORM Paramyelois transitella (Walker) (LEPIDOPTERA: PHYCITIDAE). Dis. Abstr. 24, 4 (1963) 1758-9.
- The insect is becoming an increasingly important pest of almond and walnut in California. A simple and economical method of mass rearing was accomplished in the summer of 1961, the main difficulty having been mating habits in the laboratory. Mating could be improved considerably by providing indirect air circulation, high relative humidity, cool temperature, preferably between 10-16°C, and light intensity similar to conditions prevailing in the early morning. A Co<sup>60</sup>-unit gave ~ 197-600 rads/h. Mature pupae (8 d old) were the most desirable stage to irradiate without causing appreciable damage to the insect, and was also the stage most convenient to handle and sex. At a dosage of 180 000 rads no adults emerged. At 80 000 rads, > 50% of both males and females were still able to mate but reduction in egg laying was considerable in the case of irradiated females. Complete sterility was obtained in both sexes when mature pupae were exposed to 50 000 rads. Longevity, egg laying, and mating habits did not seem to be affected at this dose. No effect on fertility was detected after 20 000 rads or less but drastic reduction in fertility was obtained at 30 000 and 40 000 rads. Eggs were more susceptible to radiation damage than mature larvae and the latter stage more so than mature pupae. Much better results may be obtained by using both sterile males and females for control and eradication. Most females were shown to mate but once in the field, only 8% mated twice.
- 1472 Madsen, H.F. PROGRESS REPORT ON THE NAVEI ORANGEWORM, MALE STERILIZATION PROJECT. Diamond Walnut News 45, 6 (1963) 12-13.



II-B-1-c-iv Pyraustidae  
Pyrausta nubilalis

- 1473 Springell, P.H. IRRADIATION. A STERILIZATION WEAPON AGAINST THE CORN BORER. Agric. Res. 12, 3 (1963) 6.

Adult males of Pyrausta nubilalis were sterilized by doses of 32 000 r 1 d after emergence. Only 1% or less of the eggs hatched when sterile males were mated with untreated females, 40% eclosion for 86% irradiated males. Sterility did not affect competitiveness for females, nor was longevity affected. Irradiation as pupae affected egg hatch, depending on age of pupa at time of irradiation, the younger pupae being more susceptible. Fertility decreased with increasing radiation dosage for both sexes, but female pupae were more susceptible. Deformity up to 50% occurred in pupae irradiated with 5000 r at under 24 h. At 48 h deformity was avoided.

II-B-1-c-v Chloridea obsoleta

- 1474 Андреев, С.В., Самойлова, З.И., Иванский, Н.Л., Мартенс, Б.К. ВОЗМОЖНОСТИ ИСПОЛЬЗОВАНИЯ ГАММА-ИЗЛУЧЕНИЙ ДЛЯ ПОЛОВОЙ СТЕРИЛИЗАЦИИ НАСЕКОМЫХ КАК МЕТОДА БОРЬБЫ С ВРЕДИТЕЛЯМИ СЕЛЬСКОХОЗЯЙСТВЕННЫХ КУЛЬТУР. Стр. 19-20 в сб. "Материалы Симпозиума по применению биофизики в области защиты растений". Л., 1961. Р. Ж. Биол. №18Ж326. 1962.

Andreev, S.V., Samoilova, Z.I., Ivanski, N.L., Martens, B.K. POSSIBILITIES OF USING GAMMA RADIATION FOR SEXUAL STERILIZATION AS A METHOD OF CONTROLLING PESTS OF AGRICULTURAL CROPS. p.19-20 in "Materials of the Symposium on the Use of Biophysics in the Field of Plant Protection". Leningrad, 1961. R. Zh. Biol. No. 18Zh326. 1962.

The biophysics laboratory of the All Union Research Institute of Plant Protection and the Azerbaidzhan Plant Protection Station are investigating the effect of gamma irradiation of male pupae of Chloridea obsoleta on moth sterilization.  $Co^{60}$  is used as the source of radiation. Based on results of laboratory tests (paired placement of irradiated moth males with untreated females), the sterilizing dosage of  $\gamma$ -radiation for pupae of C. obsoleta is approximately 8000 to 10 000 r. Procedures are being developed for mass propagation of Chortophila brassicae to obtain pupae for sterilization and liberation of sterile individuals. (BA 43; 1963, 20898).

- 1475 Андреев, С.В., Самойлова, З.И., Мартенс, Б.К., Иванский, Н.Л. ГАММА-ИЗЛУЧЕНИЯ И БОРЬБА С НАСЕКОМЫМИ. Заш. Раст. 9 (1962) 25-6. Р. Ж. Биол. №6Е212.1963.

Andreev, S.V., Samoilova, Z.I., Martens, B.K., Ivanski, N.L. GAMMA IRRADIATION IN THE CONTROL OF INSECTS. Zashch. Rast. 9 (1962) 25-6. R. Zh. Biol. No. 6E212. 1963.

Pupae of male Chloridea obsoleta were subjected to  $Co^{60}$  radiation in doses of 4000 to 15 000 r during exposures of 7 min or longer. Doses of 8000 r produced total sexual sterility in males. Females mating with the irradiated males deposited smaller quantities of eggs which were infertile. (BA 45; 1964, 30747).

II-B-2 CONTROL BY INDUCED GENETIC CHANGES

- 1476 Bostel, R.C. von., Buzzati-Travenço, A.A. ON THE ROLE OF LETHAL MUTANTS IN THE CONTROL OF POPULATIONS. p.273-8 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency. 1962.

Since radiation induces dominant lethal mutations in sperm, it can be shown that monogamy is not requisite for eradicating a population through the introduction of irradiated males. An outline is presented for experimental analysis of population collapse by the irradiation-of-male method where females mate more than once. Possible effects on populations of release of males containing recessive lethal mutations or mutations for female sterility are briefly discussed, the possibility of genetic induction of population extinction is explored.

- 1477 LaChance, L.E., Knippling, E.F. CONTROL OF INSECT POPULATIONS THROUGH GENETIC MANIPULATIONS. Ann. Ent. Soc. Amer. 55, 5 (1962) 515-20.

Calculations are presented that support the feasibility of using insects, with inherited lethal factors to control their own populations. The boll weevil, Anthonomus grandis Boheman, is used as an example, and the theoretical results of releasing males carrying recessive lethal genes into a natural population suggest that this method of control may prove valuable. (Auth).

## II-B-3 OVERLOADING RESOURCES

- 1478 Moore, J. POPULATION CONTROL IN ANIMALS BY OVERLOADING RESOURCES WITH STERILE ANIMALS. Science 140 (1963) 496-7.

Sterile animals might be introduced into a population to overload a resource. As a result, some of the original fertile animals might be lost by migration or death. This process could be repeated until the fertile population was eradicated without the mating required by Knippling's models. This method may be of use in ecology and in economic control of populations. A hypothetical example is given. If flushing is considered for use against pests, the resource to be overloaded should be carefully chosen in order to minimize the total damage done by sterile and wild animals during attempted eradication or control.

## II-C Infestation and Countermeasures

### II-C-1 STORED PRODUCTS

- 1479 Comwell, P.B., Bunson, D.M., Pendlebury, J.B., Martin, V.J., Bull, J.O. CONTROL OF WEEVIL POPULATIONS Sitophilus granarius L. WITH STERILISING AND SUBSTERILISING DOSES OF GAMMA RADIATION. AERE-R-3892, United Kingdom Atomic Energy Authority, Research Group, Isotope Research Div., Wantage, Berks, England. 1962, 37p.

The efficacy of 16 000 rads, recommended for industrial applications of  $\gamma$ -radiation for the control of insects in grain, is substantiated by the complete sterilisation and death of 10 million insects of a wild strain of S. granarius under conditions simulating bulk storage. Sub-sterilising doses of 10 000 to 14 500 rads suppress weevil populations to a very low level and prevent their increase for 4-8 months; this period of "short-term" control is related to the size of the population and  $O_2$ -tension at irradiation. The reproductive potential of fertile and sub-fertile grain weevils is depressed when added to large irradiated populations, partial protection to the grain against re-infestation is afforded by the insemination of contaminants with sterile sperm which remains competitive within the female and with fertile sperm subsequently inseminated, for periods > 4 months. A reduction in reproductive potential of weevils which may be understood at irradiation gives considerable flexibility to the requirement of dose uniformity in plant design for disinfection of grain. (Essentially auth).

- 1480 Cotton, R.T. THE POTENT FORCE OF RADIANT ENERGY. Northw. Miller 265, 7 (1961) 38, 40, 42-3.  
"its use to destroy and control pests in stored grain and milled cereal products remains highly experimental, but recent progress merits review." The author briefly reviews latest developments in the field of insect control, the possible uses of radiant energy commercially, and the limitations governing its use.
- 1481 Papadopolou, C.P. DISINFESTATION OF DRIED FIGS BY GAMMA RADIATION. p.485-90 in "Radiation and Radioisotopes applied to insects of agricultural importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency. 1963.

Preliminary experiments indicate that disinfection of figs by  $\gamma$ -radiation is a promising treatment since, at the moderate doses of 100-200 krad needed for the destruction of the different stages of the infesting insects, no significant changes result in the texture, appearance and nutritive value (related to carbohydrates) of the figs. The following species were studied: Plodia interpunctella, Ephestia cautella, Carpophilus hemipterus, Gryzaophilus aurinamensis and Lasioderma serricorne. In general, doses < 25 krad do not affect hatching of eggs, above it the reduction varies with the species, and no hatching is observed at 100 krad. The time required for 50% of an irradiated larva population to die was 2-3 d at 100 krad and 1 d at 250 krad. In general there was no eclosion of pupae with  $\geq 50$  krad. At a dose of 400 krad all insects were killed in < 48 h.

- 1482 Расулов, Ф.К., Анастасьев, С.А. БОРБА С ВРЕДИТЕЛЯМИ ЗАПАСОВ ГАММА-РАДИАЦИЕЙ. Вестн. с.-х. Наук 9 (1963) 34-5.
- Rasulov, F.K., Anastasiev, S.A. THE CONTROL OF WAREHOUSE PESTS BY GAMMA RADIATION. Vestn. sel'skokh. Nauk 9 (1963) 34-5.
- Gamma irradiation of technical seed and feed stuffs at the rate of 20 000, 25 000 and 30 000 rep resulted in 100% control of the granary and rice weevils, meal beetles, grain borers and confused flour beetles (Calandra granaria, C. oryzae, Sitovus surinamensis, Laemophloeus testaceus, Stegobium paniceum and Tribolium confusum).
- 1483\* Török, G., Parkas, J. A RAKTÁRI ROVARKÁRTEVŐK ELLENI VEDEKEZÉS NÉPGAZDASÁGI JELENTŐSÉGE ÉS A ROVARTALANÍTÁS ÚJ LEHETŐSÉGE: AZ IONIZÁLÓ BESUGÁRSÁS. (The importance of exterminating insects in warehouses from the viewpoint of national economy, and a new way of insect control: ionizing radiation). Élelmészeti Ipar 14, 7 (1960) 199-206. (In Hungarian, with English summary).
- Review article. The extent of the damage to stored products caused by insects is analyzed statistically, and the most frequently occurring insects discussed. After reviewing the known effects of ionizing radiations on insects their possible application in the food industry for insect eradication is considered. Attention is paid to the economic aspects involved.
- See also:
- 765 Effects on subsequent generations after  $\gamma$ -irradiation of larvae of Lyctus brunneus (Steph.) (Coleoptera, Lyctidae). (Bletchly, 1962).
- 768 A comparison of the susceptibility of the grain weevil (Sitophilus granarius L.) to accelerated electrons and  $\text{Co}^{60}$  gamma radiation. (Bull et al., 1961)
- 790 Influence de l'irradiation sur les adultes de Sitophilus sasakii Takahashi (Curculionidae) et leurs descendants. (Lavolette and Nardon, 1963).
- 791 Action des rayons  $\gamma$  du cobalt-60 sur la mortalité et la fertilité des adultes d'un charançon du riz. (Lavolette and Nardon, 1963).
- 805 Some effects of gamma radiation on the lesser grain borer (Rhizopertha dominica F.), tropical warehouse moth (Cadra (Ephesia) cautella Wlk.), Indian meal moth (Plodia interpunctella Hübner.), and the cigarette beetle (Lasioderma serricorne F.).
- 806 La protection des denrées contre les insectes ravageurs par l'emploi des radiations ionisantes en vue d'obtenir la stérilité des insectes adultes. Etude particulière de la réaction des gonades de "Sitophilus granarius". (Pesson and Vernier, 1963).
- 1108 The influence of temperature upon the radiation susceptibility of Sitophilus granarius L. (Pendlebury et al., 1962).
- 1228 The susceptibility of the confused flour beetle (Tribolium confusum Duv.) to gamma radiation. (Banham, 1962).
- 1236 Effect of radiation on Mexican fruit-fly eggs and larvae in grape-fruit. (Brownell and Tudelovitch, 1962).
- 1363 The effects of continuous and fractionated doses of gamma-radiation on the survival and fertility of Sitophilus granarius (Calandra granaria L.). (Jefferies, 1962).
- 1364 The effects of continuous and fractionated doses of gamma radiation on the survival and fertility of Sitophilus granarius (Calandra granaria) L. (Jefferies and Banham, 1961).
- 1408 Some experimental data on cobalt 60 radiation doses capable of arresting insect infestation of cereals and flour. (Pesson, 1963).
- 1499 Utilisation des radiations ionisantes ( $^{60}\text{Co}$ ) pour la protection des denrées contre les insectes nuisibles. Recherches relatives à la détermination des doses utiles pour assurer la stérilité des insectes. (Pesson, 1963).
- 1500 Radiation preservation of grapes and some other Greek fruits. (Saravacos and Macris, 1963).
- 1526 The life history and behavior of an internal feeding stored grain insect, Rhizopertha dominica (Fab.), by use of x-ray. (Stemley, 1962).
- 1528 On the advantage of the x-ray examination of certain classes of materials for insects subject to plant quarantine regulations. (Yuasa, 1962).
- 1560 Travaux de recherches utilisant les isotopes et les rayonnements nucléaires en entomologie appliquée en France et dans les pays associés. (Pesson, 1962).

## II-C-2 DISINFESTATION MEASURES

(Sources, Conveyor Systems, Etc.)

- 1484 Anonymous. RADIATION DISINFESTATION OF GRAIN. Int. atom. Energy Ag. Bull. 4, 4 (1962) 18-20.

The process can be automated and operated safely. Electron accelerator and cobalt sources could be used for all the throughput rates utilized in most conventional grain handling installations. The experts recommended that, for a pilot plant study, electrical machines with electron energy in the range of 2-4 MeV to achieve uniformity of dose deposition and simplicity of grain handling for the throughput rate of 100-200 t of grain/h be used. For the throughput rate of 20-40 t/h, they recommended Co<sup>60</sup> sources, with which it is possible to achieve a radiation efficiency of 50-70%. (Auth).

- 1485 Anonymous. GAMMA RADIATION AS A MEANS OF INSECT CONTROL IN WHEAT AND WHEAT PRODUCTS. Appl. Atomic 413 (1968) 11-12.

The U. S. Food and Drug Administration (FDA) officially approved the use of  $\gamma$ -rays for insect control in wheat, according to a plan elaborated by L. E. Brownell. Co<sup>60</sup> is used for sterilizing insect eggs in the wheat. The road should now be clear for the construction of a prototype plant capable of handling 200 tons/h of wheat, possibly in India.

- 1486 Bletchly, J. D. EFFECT OF GAMMA RADIATION ON SOME WOOD-BORING INSECTS. Ann. appl. Biol. 49 (1961) 362-70.

Studies have been made on the effects of  $\gamma$ -radiation on eggs, larvae, pupae and adults. Oviposition was obtained on suitable egg-laying blocks-oak sapwood veneers for Lyctus planicollis Lec. (Bletchly, 1960), Corsican or Scots pine sapwood blocks with muslin surfaces for Anobium punctatum Deg. (Bletchly, 1952) and decayed oak sapwood for Xestobium rufovillosum Deg. Larvae were either irradiated free (Lyctus) or within oak sapwood blocks (Lyctus), or pine (Anobium) or decayed oak sapwood (Xestobium). Pupae were treated free (Anobium) or within decayed oak sapwood (Xestobium); adults were irradiated free or within infested wood. For studies on subsequent fertility and viability of eggs, treated pupae and immature and mature adults were provided with egg-laying blocks. In addition naturally infested material has been treated. Co<sup>60</sup> sources giving dose rates from 50 to 1300 r/min have been used as well as higher rates. A dosage of about 10 000 r is required to prevent completion of development or to produce sterile adults, although further information is required on the survival of larvae hatching from irradiated eggs. An additional safety margin would be desirable plus a further correction to allow for attenuation in the timber. The higher fertility exhibited when an individual of one sex is irradiated and mated to an untreated beetle of the opposite sex is somewhat academic, since both sexes would normally be irradiated simultaneously. Nevertheless, when 100% control is not achieved, this factor represents an additional risk with regard to re-infestation of susceptible wood. The use of radioactive substances for eradication and preservation is not feasible due to the mechanical difficulties involved in providing adequate shielding.

- 1487 Brookhaven National Lab., Upton, N. Y. and Vitro Engineering Co., New York. STUDY REPORT. COBALT-60 BULK GRAIN IRRADIATOR. BNL-810 (T-312). 30 June 1963. 37p.

Results are presented of a study to conceive, evaluate, review and estimate costs for a number of suitable designs for a Co<sup>60</sup> Bulk Grain Irradiator; select a preferred type; and establish required criteria for future detail design and construction of the selected concept. Three irradiator concepts are described. The irradiators discussed are sized to function as a pilot plant in an agricultural experiment station. Particular attention is given to scale-up capability, so that the same performance characteristics can be obtained for commercial utilization, without penalty to the usefulness of the irradiator as an experimental tool. A single concept, designated as the continuous-grid source concept, is selected as most promising because of its high efficiency, exceptional versatility, acceptable cost, ease of maintenance, good reliability and inherent simplicity. For the purposes of this study it has been assumed that a dose of 15 000 - 25 000 rads should be used giving a max. /min. dose ratio of 1.66. Scaling up of throughput was not to cause any basic change in this ratio. The immediate objective of the study was to develop criteria and concepts for a pilot plant with a through-put of 5000 lb/h. An economic study was also made.

- 1488 Brownell, L. E., Horne, T., Kretlow, W. J. PETITION FOR THE USE OF GAMMA RADIATION TO PROCESS WHEAT AND WHEAT PRODUCTS FOR THE CONTROL OF INSECT INFESTATION.\* NP-13640, Michigan. Univ., Ann Arbor and Curtis-Wright Corp., Princeton, N. J., July 1962. 162p.
- Applications of  $\gamma$ -radiation in the processing of wheat and wheat products for the control of insect infestation are discussed. Data are presented from studies of radiation dose necessary for insect control and the effect of these doses on the physical properties, nutritional value, and wholesomeness of wheat and wheat products. Results are summarized from feeding studies using rats and dogs. Methods are outlined for the radiation processing of wheat and wheat products, irradiation facilities are described, and an estimate on cost factors is included. 55 references. (NSA 18: 1964, 13446).
- \* Compiler's note: Not available to the general public. But see 1489.
- 1489 Brownell, L. E. GAMMA RADIATION FROM SOURCES WITH MAXIMUM ENERGY NOT TO EXCEED 2.2 MILLION ELECTRON VOLTS, TO PROVIDE AN ABSORBED DOSE FROM 20 000 TO 50 000 rads MAY BE SAFELY USED FOR THE IRRADIATION OF WHEAT AND WHEAT PRODUCTS FOR CONTROL OF INSECT INFESTATION. Federal Register, 21 Aug. 1963. 28 FR 9208. Washington, D. C., Government Printing Office.
- 1490 Brownell, L. E. THE POTENTIAL VALUE OF GAMMA RADIATION IN THE WHEAT INDUSTRY. 34p. in "Second National Conference on Wheat Utilization Research, United States Department of Agriculture, 28-30 October 1963". Peoria, Illinois.
- On Aug. 15, 1963 the Food and Drug Administration approved the use of  $\gamma$ -radiation to process wheat and wheat products for the control of insect infestation. Exhaustive tests to check the wholesomeness of irradiated wheat were carried out at the University of Michigan. A dose of 20 000 rad was used on a mixture of soft white wheat and winter durum, exposed to a  $\text{Co}^{60}$  source with a  $\gamma$ -flux of 180 000 rep/h, after storage at room temperature for 1-3 months. Adverse storage conditions (80-90°F for 6 months) on the nutritional values of irradiated wheat were also tested. Groups of 12 male and 20 female Holtzman-strain albino rats were used. Irradiated wheat fed to rats for 9 months or more had no effect on growth, reproduction or pathology. Lower and upper dosage limits for irradiating wheat commercially were specified as 20 000 rad (for breaking the reproductive cycle of the infesting insect) and 50 000 rad. No detrimental effects of the upper dose have been observed on nutritional value, wholesomeness and quality. Costs of preparing and operating a grain ship are tabulated. For a single treatment the use of  $\gamma$ -radiation will be more expensive than the use of fumigants. If more than 2 fumigations are required during storage the irradiation could be the more economical, as a single irradiation will suffice if the treated grain is protected against reinfestation (insect-proof cartons, bags with specially treated surfaces cans, jars)  $\text{Co}^{60}$  will probably be more economical than  $\text{Cs}^{137}$  as a  $\gamma$ -source if the period of amortization is  $\approx$  5 years. The geometry of the source is an important consideration in obtaining efficient use of the radiation sources and in keeping the dosage range between 20 000 and 50 000 rads. The gravity flow irradiator with a matrix of rod sources has an advantage for processing loose grain, the simulated plaque source for bagged wheat and packaged wheat products. If the irradiation capacity is seasonal and varies widely, such as 4 to 200 tons/h, mobile irradiators may be used in numbers sufficient to meet the demand. Mobile irradiators would consist of 130 elements at 6000 c, each capable of treating 9-10 000 tons of grain/week or 80 tons/h on a 120 h/week operation. Irradiators could be used on shipboard to treat grain on entry through a seaport. For continuous processing at fairly uniform rates, permanent irradiators would be preferred, possibly using the gravity flow design for loose grain and a bucket conveyor for bagged grain and packaged wheat products.
- 1491 Deschreider, A. R. RESEARCH IN GAMMA IRRADIATION OF WHEAT FLOUR. Conserva, The Hague 10, (1981-2) 115-7. (In Dutch). English Translation: AEC-tr-5773. 9p.
- Irradiation of wheat flour and cereal products with doses of  $\text{Co}^{60}$   $\gamma$ -radiation between 25 and 150 kilorad resulted in destruction of insect pests in all stages of development. Exposure of flour to doses between 25 and 150 kilorad improved the baking quality of wheat flour, and doses of 500 to 1000 kilorad improved the storage life of unrefrigerated pre-baked or partially-baked packaged products. Results are reported from studies of the chemical effects of  $\gamma$ -radiation on the proteins, enzymes, and other constituents of wheat flour. (NSA 17: 1963, 21980).

- 1492 Dietz, G.R. DEVELOPMENT OF IRRADIATION FACILITIES. p.135-54 in "Radiation Pasteurization of Foods". Summaries of Accomplishment. TID-7684, Division of Isotopes Development and Division of Biology and Medicine, AEC. 1963.

A major portion of the AEC food irradiation program is devoted to the development of a family of radiation facilities. First, research irradiators capable of supporting food irradiation studies were designed and constructed. Current emphasis is on proto-commercial facilities either under design or construction, or planned for construction as the program develops. Proto-commercial facilities are intended to translate laboratory data to semi-production or pilot plant operation to prove laboratory data on a near commercial scale, and to aid in the determination of the economics involved. Included in this category are mobile units, a Marine Products Development Irradiator (MPDI), and a grain irradiator. Types of irradiators classed as highly specialized, or applicable in unique situations, constitute another category. Detailed discussion is presented on a research irradiator, transportable units, the grain irradiator, central or implant irradiators such as the MPDI, on-board ship irradiators, the Hawaiian irradiator, and the U.S. Army Radiation Laboratory at Natick, Massachusetts. (NSA 18; 1984, 22201).

- 1493 Harvey, J.M. IRRADIATION OF FRUITS AND VEGETABLES IN A MOBILE COBALT 60 UNIT. p.55-7 in "Radiation Pasteurization of Foods". Summaries of Accomplishment. TID-7684, Division of Isotopes Development and Division of Biology and Medicine, AEC. 1963.

A mobile  $\text{Co}^{60}$  unit containing 40 000 c is described. A typical dose of 200 000 rad requires a dwell time of 40 min. Several fruits, vegetables, and insects have been treated with the unit; work done with insects is described at some length. About 120 insects at each stage of development were treated with 7 dosages, and 5 replications were available in each experiment. Findings indicate variations in radiosensitivity of the various species studied, the most sensitive being Tribolium confusum which requires < 10 000 rad for a sterilizing dose (one which will disrupt the life cycle). The cigarette beetle, Lasioderma serricorne, the black carpet beetle, Attagenus piceus, and Trogoderma beetle were found to be intermediate in susceptibility (< 15 000 rad); The Indian meal moth, Plodia interpunctella, was comparatively resistant, requiring 50 000 rad for a sterilizing dose. In general, the older a specimen was in each stage of development, the less susceptible it proved to irradiation.

- 1494 Horne, T. "THE GRAIN SHIP: A PROPOSAL FOR INCREASING THE WORLD FOOD SUPPLY". Princeton, N.J., Curtis-Wright Corporation. 1961.

An irradiator on board ship allows disinfection measures to be applied to grain in widely different locations, the advantages involved in this greater mobility being numerous. The design, potentialities and economics are discussed.

- 1495 Крейнберг, В.Е. КАРАНТИННАЯ ДЕЗИНСЕКЦИЯ ПРОТИВ ПЛОДОВЫХ МУХ. Заш. Раст. 11 (1961) 49-52. Р. Ж. Биол. №13Ж247. 1962.

Kreftberg, V.E. QUARANTINE DISINFESTATION FROM FRUIT FLIES. Zashch. Rast. 11 (1961) 49-52. Р. Ж. Биол. No. 13 Zh 247. 1962.

Imported oranges and tangerines in the USSR are disinfested against fruit flies by only one method; refrigeration for 3 weeks at temperatures of 0-1.5 °C. Descriptions are given of 5 physical and 5 chemical methods of disinfestation used abroad. These methods may find application in the USSR. Small shipments of fruits and vegetables crossing the border can be treated with x-rays with a portable apparatus. The refrigeration of imported fruits must be accomplished primarily en route, while non-refrigerated produce can be treated in several ways: fruits for immediate sale with warm saturated steam, dibromomethane, ethylenechlorobromide, and methylbromide; products for prolonged storage with refrigeration. Severely infested fruit, especially in the period of the emergence of the larvae, must be quickly frozen. (BA 41: 1963, 20582).

- 1496 Kuhl, O.A. IRRADIATOR DESIGN STUDIES AT BROOKHAVEN NATIONAL LABORATORY. p.81-2 in "Radiation Pasteurization of Foods". Summaries of Accomplishment. TID-7684, Division of Isotopes Development and Division of Biology and Medicine, AEC. 1963.

During the past year conceptual design studies for a Bulk Grain Irradiator and a Shipboard Marine Products Irradiator were carried out and reported in BNL 810 (T-312) and BNL 808 (T-311), respectively. Specifications are presented for both irradiators. (Auth).

- 1497 Nardon, P. LES POSSIBILITÉS D'EMPLOI DES RADIATIONS DANS LA LUTTE CONTRE LES INSECTES. Phytoma 144 (1963) 7-12.
- Les adultes de Sitophilus sasakii Takahashi sont exposés aux rayons  $\gamma$  ( $^{60}\text{Co}$ ) en présence de blé. Le seuil de sensibilité se situe à 5000 r pour les mâles, et entre 6000 et 8000 r pour les femelles. Dès 8000 r, les insectes sont anéantis en une dizaine de jours. L'examen des courbes de mortalité à différentes doses montre que celle-ci apparaît brusquement après une phase de latence d'autant moins longue que la dose est plus élevée. Pendant cette période, les insectes continuent à se nourrir. (Les espèces voisines (S. granarius et S. oryzae) ont une sensibilité tout à fait comparable.) 2000 r réduisent la fertilité de plus de la moitié. L'augmentation de la dose entraîne une inhibition supplémentaire de la fertilité. A 5000 r apparaît une phase de stérilité temporaire du 7e au 12e jour. Elle s'étend avec une dose plus élevée. A 15 000 r la stérilisation est totale. On peut donc stériliser et tuer assez facilement les charançons du blé. Le reste de la communication concerne la technique d'application, des résultats obtenus ailleurs avec des mâles stériles dans la lutte biologique contre Calitroga hominivorax, Musca domestica, Dacus et Ceratitis, Ephestia kuehniella, Carpocapsa, et Anthonomus grandis.
- 1498 Pesson, P. SOME EXPERIMENTAL DATA ON COBALT 60 RADIATION DOSES CAPABLE OF ARRESTING INSECT INFESTATION OF CEREALS AND FLOUR. Food Irrad. 3, 4 (1963) A18-A21.
- The study was aimed at determining the minimum effective doses of  $\gamma$ -radiation required to stop either the development of eggs or the larval stages, or to sterilize adult insects. The following insects, commonly found in cereals and flour, were investigated: Sitophilus (Calandra) granarius L., Sitophilus oryzae L., Tribolium confusum J. du V., Tenebrio molitor L., Gnathocerus cornutus F., Rhizopertha dominica Ol., Acanthoscelides obsoletus Say, Ephestia kuehniella Zell, and Sitotroga cerealella Ol. The effective minimum doses were found to vary with the species: Sitophilus granarius required 10 000 rads, Tribolium > 12 000 rads, larvae of Tenebrio - 8000 rads; Gnathocerus - 8000 rads; Rhizopertha - 12 000 rads; Acanthoscelides obsoletus - 20 000 rads; Ephestia - 16 000 rads. In general, 20 000 rads appears to be the minimum effective dose capable of arresting larval development or reproduction of all the species studied.
- 1499 Pesson, P. UTILISATION DES RADIATIONS IONISANTES ( $^{60}\text{Co}$ ) POUR LA PROTECTION DES DENRÉES CONTRE LES INSECTES NUISIBLES. RECHERCHES RELATIVES À LA DÉTERMINATION DES DOSES UTILES POUR ASSURER LA STÉRILITÉ DES INSECTES. Industr. agric. 80, 3 (1963) 211-25.
- Les doses stérilisantes, appliquées soit sur les stades larvaires soit sur les stades imaginaux, sont généralement d'un ordre de grandeur très voisin des doses létales. Un autre effet très général est le retard observé dans le développement larvaire ou nymphal. Les doses minima utiles relevées sont de 8000 rad pour Gnathocerus cornutus et les larves de Tenebrio molitor, de 10 000 rad pour les Calandres, 12 000 rad pour Rhizopertha et un supérieur à 12 000 rad pour Tribolium, de 16 000 rad pour Ephestia et de 20 000 rad pour la Bruche du haricot. En tenant compte des espèces les moins sensibles et de leurs stades les plus résistants, on peut considérer que des doses de 20 000 rad doivent donner une sécurité générale contre tous ces insectes susceptibles de s'installer et de pulluler dans les denrées (farines ou grains). Ces doses ne doivent pas produire des inconvénients secondaires (changements des caractères organoleptiques et des qualités nutritionnelles). L'efficacité générale satisfaisante de doses de l'ordre de 20 000 rad, pour assurer l'extinction des populations d'insectes ayant contaminé un produit, doit faciliter la mise au point de techniques permettant un traitement plus rapide sans avoir à disposer de sources de radiations particulièrement puissantes. Dans le domaine de la protection des céréales stockées, en particulier, cela peut avoir un intérêt primordial.
- 1500 Saravacos, G., Macris, B. RADIATION PRESERVATION OF GRAPES AND SOME OTHER GREEK FRUITS. Food Irrad. 4, 1-2 (1963) A19-A21.
- Preliminary results on the disinfection of dried figs have shown no significant changes in sugars (total and reducing) up to doses of 500 000 rad. The colour of the irradiated figs was not affected by  $\gamma$ -radiation at these doses. The radioresistance of certain species of insects which attack stored dried figs is reported under investigation.

- 1501 Schmidt, H. DIE WIRKUNG VON RÖNTGENSTRAHLEN AUF HOLZZERSTÖRENDE INSEKTEN. (The effect of x-rays on wood-destroying insects). *Holzforschung* 13, 1 (1961) 8-11. (In German)

The kind of radiation doses tolerated by larvae of *Hyloterpes bajulus* L. and working termites of *Reticulitermes* were investigated and, following on from that, the suitability of x-rays for combating the pests. Soft x-rays were found to be effective on insects when outside the wood. In view of the very high lethal dose required even then (~ 200 000 r for *Hyloterpes* and ~ 100 000 r for termites) and of the great protection afforded to them once the insects are inside the wood, there is no chance of applying x-rays for fighting the insects.

See also:

- 1484 Radiation disinfection of grain. (Anonymous, 1962).  
 1485 Gamma radiation as a means of insect control in wheat and wheat products. (Anonymous, 1963).  
 1487 Study report. Cobalt-60 bulk grain irradiator. (Brookhaven National Lab., Upton, N. Y. and Vitro Engineering Co., New York, 1963).  
 1488 Petition for the use of gamma radiation to process wheat and wheat products for the control of insect infestation. (Brownell et al., 1962).  
 1489 Gamma radiation from sources with maximum energy not to exceed 2.2 million electron volts, to provide an absorbed dose from 20 000 to 50 000 rads may be safely used for the irradiation of wheat and wheat products for control of insect infestation. (Brownell, 1963).  
 1490 The potential value of gamma radiation in the wheat industry. (Brownell, 1963).  
 1492 Development of irradiation facilities. (Dietz, 1963).  
 1494 "The Grain Ship: A Proposal for Increasing the World Food Supply". (Home, 1961).  
 1495 Quarantine disinfection from fruit flies. (Kreitsberg, 1962).  
 1496 Irradiator design studies at Brookhaven National Laboratory. (Kuhl, 1963).  
 1583 Present status and the future development of radiotechnology. (Stanković, 1962).

## II-C-3 ECONOMICS

- 1502 Cornwell, P.B. INSECT CONTROL BY GAMMA IRRADIATION - A TECHNICALLY FEASIBLE PROCESS, BUT IS IT DESIRABLE AND CAN IT BE APPLIED? *Food Irrad.* 1, 4 (1961) A9-A11.

Some of the fundamental problems and applied problems in the use of irradiation for the control of insects in grain are examined, and a comparison is made with conventional methods. A detailed appraisal was published earlier in *J. Sci. Food Agric.* 11: 1960, 754 (Cornwell and Bull, Insect control by gamma-irradiation - an appraisal of the potentialities and problems involved). Three major factors which discourage commercial exploitation at present are (1) sources of 1-2 Mc Co<sup>60</sup> are required to accommodate the product at 200 tons/h, the minimum handling rate demanded by the trade, (2) capital expenditure for these massive sources is prohibitive, and (3) operating costs are not competitive with conventional measures of insect control. With the significant advances made during the last 2 years in the development of electron machines, with considerably greater power outputs than the present accelerators, but with low beam energy, some of these factors should be resolved in the future.

See also:

- 1487 Study Report. Cobalt-60 bulk grain irradiator. (Brookhaven National Lab., Upton, N. Y. and Vitro Engineering Co., New York, 1963).  
 1490 The potential value of gamma radiation in the wheat industry. (Brownell, 1963).  
 1492 Development of irradiation facilities. (Dietz, 1963).

## II-C-4 DETECTION

- 1503 British Standards Institution, London. METHOD OF TEST FOR TOXICITY OF WOOD PRESERVATIVES TO THE WOOD-BORING INSECTS *Anobium punctatum* AND *Hyloterpes bajulus* BY LARVAL TRANSFER. British Standard No. 3651. 1963. 15p.

Details of a larval transfer method for use with *A. punctatum* and *H. bajulus* are given. It is applicable to tar-oil, water-borne and organic-solvent types of preservatives, though comparisons between these groups



are not necessarily reliable, and directions are given for selecting and preparing the wood blocks, impregnating them with the preservative, boring the holes into which the larvae are to be inserted, conditioning the blocks before use, maintaining the larvae before use and inserting them into the blocks, the maintenance of the infested blocks, their subsequent examination with or without x-rays, and the evaluation and reporting of the results. Appendices contain information on precautions against infestation by *Pyemotes ventricosus* (Newp.), which sometimes affects tests with *A. punctatum*, the method of obtaining young larvae of *H. bajulus* and the use of x-rays to detect living larvae within the blocks. (From RAE-A 52: 1964, 8)

- 1504 Berryman, A.A. RADIOGRAPHIC TECHNIQUES FOR THE DETECTION, SAMPLING AND BIOLOGICAL STUDIES OF FOREST INSECTS. Thesis, California Univ., Berkeley. 1961. 40p.

An x-ray study of cryptic insects (including *Ips confusus* (Le Conte)).

- 1505 Berryman, A.A., Stark, R.W. RADIOGRAPHY IN FOREST ENTOMOLOGY. *Ann. ent. Soc. Amer.* 55, 4 (1962) 456-66.

The use of radiography in the study of cryptic insects was investigated for several kinds of forest insect damage. Longwave or "soft" x-rays (5-35 KV) were found most suitable for the detection and study of insects infesting plant material. A portable industrial x-ray unit was used which had an output of up to 35 kV, 10 mA and variable exposure time. Excellent results were achieved in radiographs of western pine beetle larvae and pupae in ponderosa pine bark; adult gallery construction and larval development of *Ips confusus* (LeConte); red turpentine beetle *in situ* in sugar pine; buprestica, cerambycida, siricids, and lyctids infesting various thicknesses and kinds of timber; weevils infesting lodgepole pine tips and seed-infesting insects. Less satisfactory was the detection of insects in whole cones, although their galleries could be detected. (Auth.)

- 1506 Berryman, A.A., Stark, R.W., STUDIES ON THE EFFECTS OF TEMPERATURE ON THE DEVELOPMENT OF *Ips confusus* USING RADIOGRAPHIC TECHNIQUES. *Ecology* 43, 4 (1962) 722-6.

Limitations and possible improvements of the method are discussed. "Soft", low kV x-rays proved most satisfactory, providing penetration was adequate and the time exposure was short enough to minimize radio-graph blurring from insect movement. The rate of adult gallery construction and brood development at 5 constant temperatures (15°, 20°, 25°, 30° and 35° C) was observed. Maximum rate of brood development occurred at 30° to 25° C and a sharp reduction in activity occurred at 15° C. Greatest numbers of progeny were produced at 20° C and highest brood survival occurred at this temperature and at 25° C. The data on brood mortality were suggestive of high mortality in the egg and larval stages at all temperatures and a high mortality in pupal and adult stages at the lowest and 2 highest temperatures. Adults emerging from slabs at the 35° C level were significantly smaller than those reared at lower temperatures.

- 1507 Bletchly, J.D., Baldwin, W.F. USE OF X-RAYS IN STUDIES OF WOOD BORING INSECTS. *Wood* 27 (1962) 485-8.

After reviewing work in the field to date, and the effects of radiation on wood-boring insects, modern techniques are discussed. Recent advances in equipment design have made it possible to use x-rays for obtaining clear photographs of insect larvae [the death-watch beetle (*Xestobium rufovillosum*), the house longhorn beetle (*Hylotrupes bajulus*), and the common furniture beetle (*Anobium punctatum*)] within wood and to follow their development without destructive examination of their environment. This facilitates evaluation of wood preservatives as well as biological research. Short exposures at low-voltage x-rays are likely to have little effect on the viability of insects within wood. Nevertheless, there are certain difficulties, e.g. detecting certain larvae depends on their age and mineral content. The presence and distribution of parasites of wood-boring insects may also be revealed by x-rays as for the parasites *Pyemotes* (*Pediculoides*) *ventricosus* and *Theocolax formiciformis*. It is altogether doubtful if x-ray examination of structural timbers *in situ* could be relied on to determine whether or not attack was still active. In large timbers, the ratio of timber thickness to larval size would be too great to provide the necessary contrast, and other factors would complicate interpretation. Only in wood of small sectional thickness can these difficulties be overcome. It is unlikely that x-rays could be used economically in routine examinations for quarantine purposes.

- 1508 Brett, G.A., Hurlock, E.T., Gradidge, G.M.G. EFFECT OF MALATHION ON LARVAE OF THE GRAIN WEEVIL (*Sitophilus granarius* (L.)), p.11 in "Infestation Control. A Report on the Work of the Infestation Control Laboratory 1959-1961". Gt. Brit. Ministry of Agriculture, Fisheries and Food, London, H.M.S.O. 1962.
- S. granarius* were allowed to oviposit for 4 d on samples of sterilized wheat and then sieved off; 2 batches of the infested wheat were then treated with malathion dust at 12 ppm. All samples, incubated at 25°C and 70% R.H., were examined at intervals by the Howe-Oxley CQ production test and by x-ray photography. Adults were removed from controls as they emerged, but not from the treated samples in which they died quickly. High CO<sub>2</sub> figures were found throughout, but those in the treated samples (2.88%) were only 63% of those in the controls (4.55%). The presence of large numbers of immature stages was confirmed by x-ray. Sufficient larval development to cause heating therefore could take place in grain already attacked by *S. granarius* and subsequently treated by malathion. Malathion not only killed the adults on emergence but also reduced the population of immature stages.
- 1509 DeMars, C.J., Jr. A COMPARISON OF RADIOGRAPH ANALYSIS AND BARK DISSECTION IN ESTIMATING NUMBERS OF WESTERN PINE BEETLE. *Canad. Ent.* 95, 10 (1963) 1112-6.
- Estimates of the numbers of the western pine beetle, *Dendroctonus brevicornis* LeConte, in *Pinus ponderosa* Laws. bark samples were made by radiographs of 25 bark samples and by dissection counts of the bark. High correlations ( $r = > .9$ ) between the 2 methods were found for (a) live larvae, (b) live plus dead larvae, (c) live of all stages combined, and (d) live plus dead of all stages combined. The bark dissection method took 8 times as long and was 4½ times as expensive as the radiographic interpretation method of estimating bark beetle numbers. A Picker x-ray unit was used, and the samples classified by thickness ( $> \frac{3}{4}$  inch or  $< \frac{3}{4}$  inch). (Essentially auth.).
- 1510 Dennis, N.M., Decker, R.W. A METHOD AND MACHINE FOR DETECTING LIVING INTERNAL INSECT INFESTATION IN WHEAT. *J. econ. Ent.* 55, 2 (1962) 199-203.
- Of the many methods developed for detecting hidden insect infestation in grain, only the x-ray-radiographic and the cracking-floatation techniques have found any degree of acceptance. Technical difficulties involved, however, have led to the search for a simpler method. A promising chemical indicator technique uses the body fluids of the insects to produce a colour reaction with ninhydrin-impregnated filter paper. The accuracy of the x-ray technique was found to be inferior for low-level infestation. A table is given comparing the relative performance of the x-ray and ninhydrin techniques for wheat infestation. The unit described is a proto-type. An improved unit has been built which will be field-tested against the x-ray method.
- 1511\* Eldmann, H. OM LÄRKSOTTMALEN (*Argyresthia laevigatella* H.S.) I SVERIGE. (Study on the larch moth, *Argyresthia laevigatella* H.S., in Sweden). *Medd. Skogsforsöksv. Inst.* 49, 3 (1960) 225. (In Swedish)
- The development of insect larvae was studied by x-ray photography. The entire post-embryonic development of *A. laevigatella* takes place lengthwise inside the new shoots. It is quite impossible to detect infestation in the autumn by external inspection. By means of x-rays it is possible not only to detect infestation but also to observe the development and behaviour of the larvae. Pupation and eclosion can also be followed.
- 1512 Eldmann, H. UNTERSUCHUNGEN ÜBER DIE ENTWICKLUNG VON PARASITEN BEI *Coleophora laricella* Hbn. MIT HILFE VON RÖNTGENPHOTOGRAPHIE. (Study on the development of parasites in *Coleophora laricella* Hbn. by means of x-ray photography). *Z. angew. Ent.* 50, 1 (1962) 118-25. (In German, with English summary)
- In late autumn the larvae of the parasites *Epilamps boops* Thoms. and *Cirrospilus pictus* Nees (Eulophidae) attain full growth and kill their hosts, the larvae of *Coleophora laricella* Hbn. They do not normally pupate until the following spring, but in the laboratory adults can be reared during winter. The developmental patterns of the parasites were constructed from observations during rearing experiments combined with repeated x-ray photography. Differences in development among the two species and sexes were found. No difference between x-ray treated and untreated animals was detected. For x-raying, model TEA-25 (Schönander) was used. The tube is provided with a Be-window and produces very soft radiation. The object was placed at 25 cm distance, and optimum conditions for irradiation were a period of 1½ sec at

14 kV and 10 mA. A Gevaert OSRAY film was used. The results can have practical application in connection with control measures.

- 1513\* Gustafson, Å, Simak, M. X-RAY DIAGNOSTICS AND SEED QUALITY IN FORESTRY. p.398-413 in "Proceedings of the 12th Congress of the International Union of Forest Research Organizations, Oxford, 1956". Stockholm, Statens skogsforskningsinstitut. 1958. (Mimeographed).
- Data are summarized on x-ray diagnostics in relation to certain problems in forestry. Amongst other methods used, x-rays have been employed for studying insect attacks and mechanical damage to seeds, and in diagnostics of old and dead seed. Seed of *Picea abies* is often severely damaged by various insect species. The damaged seed is considered in two groups: A - seeds with larvae, and B - seeds without larvae. Each group (in Sweden) is represented by distinct species, such as *Platylabus abietis* Seitner and *Megastigmus abietis* Seitner for A, and *Enobius abietis* F., *Laspeyresia strobilella*, and *Diorctria abietella* for B. (A list of tree and shrub species so far examined by x-ray photography is included. The bulk of the paper is concerned with seed development and selection).
- 1514 Hurlock, E. T., Armstrong, M. T. MINOR ENTOMOLOGICAL INVESTIGATIONS. p. 16 in "Infestation Control. A Report on the Work of the Infestation Control Laboratory 1959-1961". Gr. Brit. Ministry of Agriculture, Fisheries and Food, London, H. M. S. O. 1962.
- Tests were carried out to detect and measure hidden infestation by *Araecerus fasciculatus* and *Lasioderma serricorne* in cocoa beans using the Howe-Oxley CO<sub>2</sub> production test and x-ray photography respectively. The latter proved to be much more reliable as the CO<sub>2</sub> test gave anomalous results, probably due to the presence of moulds.
- 1515 Hurlock, E. T. DETECTION OF INSECTS IN DRIED PEAS; X-RAYS SHOW MOST PROMISE AMONG 8 METHODS. *Food Manuf.* 38, 7 (1963) 367-9
- 1516 Jacquot, C. L'UTILISATION DES RAYONS X DANS LES RECHERCHES ET LES ESSAIS SUR LES INSECTES XYLOPHAGES. *Corros. et Anti-corros.* 9 (1961) 74-9.
- 1517 Johnson, N.E., Molatore, H.D. X-RAY DETECTION OF DOUGLAS-FIR BEETLES REARED IN SLABS. *Canad. Ent.* 93 (1961) 928-31.
- An improved method of rearing the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk., was recently developed by using wax-coated slabs of Douglas-fir. By means of a Diagnostic Keleket x-ray machine at a local hospital it was possible to detect the presence of various stages of the Douglas-fir beetle beneath the bark of infested test slabs. The detection of insects by x-raying the slabs achieved an accuracy of 98% for parent adults and their egg galleries; 92% for callow adults, pupae and mature larvae and 65% for immature larvae. It thus appears that x-ray negatives of the slabs can be interpreted reliably for all stages except immature larvae. This non-destructive technique should have considerable utility in studies of the development of bark beetles.
- 1518 Johnson, N.E. CONE-SCALE NECROSIS AND SEED DAMAGE ASSOCIATED WITH ATTACKS BY DOUGLAS-FIR CONE MIDGES. *For.Sci.* 9, 1 (1963) 44-51.
- Premature cone-scale necrosis was shown to follow, if not to result directly from attack of the Douglas-fir cone midge, *Contarinia oregonensis*. *Contarinia washingtonensis* was also shown to cause damage to *Pseudotsuga menziesii* seed, though normally of less consequence than that resulting from attack by *C. oregonensis*. Seeds from cones infested with *C. washingtonensis* were categorized into (1) seeds on a scale containing from 1-3 larvae, (2) seeds on a scale containing 4 or more larvae, and (3) seeds from uninfested scales of infested cones. In each category 300 seeds were examined by the use of x-rays and later tested for germination. Radiographs of seed from heavily-, moderately- and non-infested cones are shown. X-ray analysis and germination tests showed that *C. washingtonensis* has a detrimental effect on the seed of Douglas-fir. The number of midges per cone could be seen to be directly correlated with the number of necrotic cone scales, the number of galled seed, and the number of filled seed.

- 1519\* Kremser, K. RÖNTGEN-DIAGNOSTIK IN DER ENTOMOLOGIE. (X-ray diagnosis in entomology). Fortschr. Röntgenstr. 76 (1952) 393-6.  
Discussion of the possibilities and limitations of the method.
- 1520\* Křístek, J. POUŽITÍ ROENTGENU KE KONTROLE ZÁMOTKŮ PILATEK. (The use of x-rays for checking sawfly pupae). Lesnická práce 36 (1957) 270-3 (In Czech)
- 1521\* Oliver, A.C. USE OF X-RAYS IN THE DETECTION OF Teredo IN WOOD. Timb. Devl. Ass. Ltd. Test Record B/TR/2. London, 1959.
- 1522\* Piltz, H. DIE ROENTGEN-METHODE UND ANDERE METHODEN ZUR FESTSTELLUNG VON INNEREM KÄFERBEFALL BEI GETREIDE UND HÜLSENFRÜCHTEN. (The x-ray and other methods for detecting beetle infestation in corn and leguminous plant products). Anz. Schädlingsk. 28 (1955), 118. (In German)  
Various methods of detection used routinely are reviewed and the corresponding documentation cited. The development of the x-ray method is traced and an apparatus described which is equally suitable for checking grain and leguminous plant products (peas, beans, etc.). In the latter case, the test insect was Callosobruchus quadrimaculatus F. The advantages are speed of checking (1h), precise assessments of degree of infestation and the stage of development of the infesting pest, and the fact that the material to be examined is in no way damaged by the test. Drawbacks are difficulties in deciding whether the insect is still alive, and the need for more extensive sampling, since individual samples are very small and therefore not fully representative.
- 1523 Schmidt, H. RÖNTGENSTRAHLEN MACHEN HAUSBOCKLARVEN IM HOLZ SICHTBAR. (X-rays render visible Hylotrupes bajulus L. larvae in infested wood). Umschau 62 (1962) 82-3 (In German)  
A method is described for obtaining very clear x-ray photos of infesting larvae in wood up to a thickness of 50 mm. At 100 mm, a weaker picture is obtained which is, nevertheless, still interpretable. The usefulness of the technique is discussed, for detection and for studying insect behaviour.
- 1524\* Simak, M. BESTÄMNING AV INSEKTSKADOR PÅ GRANFRÖ MEDELST RÖNTGENFOTOGRAFERING. (Insect damage to seeds of Norway spruce determined by x-ray photography). Särtryck Norrlands Skogs- och Vårdsförbunds Tidskr. 3 (1956) 299-310. (In Swedish, with English summary)  
The damaged seeds fall naturally into 2 groups: A (seeds containing larvae) and B (seeds without larvae). The gall-fly Piemeliella abietina Seitner and Megastigmus abietis (group A) attack seed. Larvae of Piemeliella remain inside it for 2-3 years, also causing a reduction in seed size. Megastigmus does not alter the shape or colour of the seed. It has a life cycle of 1-2 years and becomes a chrysalis in the seed. Insects of group B can only be perceived by damage caused (e.g. puncture of the seed-coat, presence of frass), and are usually found further north than those of group A. The degree of infestation appears to diminish with increasing altitude. Insects influence the size of the cone and the all round quality of the seeds. X-ray photography is in every respect superior to other methods of macroscopic examination. Secondary insect damage, especially reductions in seed quality, can be determined exactly, and the method also gives wider scope for studies on evolution, occurrence, habits and ecology, etc. of the infesting insects.
- 1525 Stark, R.W., Adams, R.S. X-RAY INSPECTION TECHNIQUE AIDS FOREST TREE SEED EVALUATION. Calif. Agric. 17, 7 (1963) 6-7.  
A prime factor in seed production for reforestation is insect damage, which often is not visible externally. Proportions of empty and sound seeds and of deformed or diseased embryos can be rapidly estimated by x-ray examination. (Auth).
- 1526 Stanley, P.G. THE LIFE HISTORY AND BEHAVIOR OF AN INTERNAL FEEDING STORED GRAIN INSECT, Rhizopertha Dominica (FAB.) BY USE OF X-RAY. Diss. Abstr. 23, 3 (1962) 1131.  
The study was undertaken to determine life history, and habits of the insect inside wheat kernels. The rearing medium was Pawnee variety of hard red winter wheat, cleaned and adjusted to  $(12 \pm 0.5)\%$  moisture;

rearing was done at  $(80 \pm 2)^{\circ}\text{F}$  and at  $(70 \pm 2)\%$  R.H. A General Electric X-ray Grain Inspection Unit was used to record the growth, development, and activities inside the kernels. Kernels were also cut open to observe the developmental stages. Larvae bored into kernels within 5-8 h. When more than one larva entered the same kernel combat occurred and only one survived if they came into contact with each other. Mortality of 1st-instars increasingly reduced from 8.9 to 14.30% moisture. Radiographs showed the average duration of instars to be: 1st - 5.80 d; 2nd - 4.35 d; 3rd - 4.62 d; 4th - 4.00 d; prepupal stage - 1.56 d; pupal stage - 4.37 d. The larvae fed mostly lengthwise in kernels and pushed frass through the entrance hole with their heads.

- 1527 Варталович, А.А. РЕНТГЕНОГРАФИЯ СЕМЯН ДЛЯ ОБНАРУЖЕНИЯ ЗАРАЖЕННОСТИ ИХ ВРЕДИТЕЛЯМИ. Зашч. Раст. 4 (1958) 42-3.

Vartalovich, A.A. X-RAY EXAMINATION OF SEEDS FOR DETECTING INTERNAL INFESTATION BY PESTS. Zashch. Rast. 4 (1958) 42-3.

A special apparatus for x-raying seeds and a method for their entomological examination are described. The roentgenogram permits the stage of development of the pest to be established, as well as the extent of infestation, the efficacy of insecticides, and the presence of fungal and bacterial diseases. Roentgenograms are most important for the quarantine examination of imported cotton seeds, grains, and leguminous seeds. (See Referat. Zhur., Biol., 1959, 62854).

- 1528 Yuasa, H. ON THE ADVANTAGE OF THE X-RAY EXAMINATION OF CERTAIN CLASSES OF MATERIALS \* INSECTS SUBJECT TO PLANT QUARANTINE REGULATIONS. Proc. 3rd Pan-Pacif-sci. Congr. Tokyo, 1 (1962) 1141.

\* Compiler: for?

See also:

- 1556 Use of x-ray stereoscopy for examining shipworm infestation *in vivo*. (Crisp et al., 1953).  
1558 The use of x-ray photography in entomological studies. (Eldmann, 1959).

## II - D Sericulture

- 1529 \* Arifov, U.A., Klejn, G.A., Okun, G.S., Pashinskiy, S.Z., Osipova, L.Kh., Faerman, V.T. INVESTIGATION IN VACUO OF THE DEFORMATION OF NATURAL SILK IRRADIATED BY  $\gamma$ -RAYS. Izv. Akad. Nauk Uzb. SSR, Ser. fiz. mat. Nauk 3 (1960) 32-7. (In Russian)

Changes in dynamometric properties of  $\gamma$ -irradiated silk and raw silk fibers (produced from irradiated cocoons) in the presence of air and *in vacuo* ( $10^{-5}$  mm) were investigated. A  $\text{Co}^{60}$   $\gamma$ -ray source and  $3 \times 10^5 - 2 \times 10^6$  r equivalent physical irradiation doses have been used. Dynamometric tests *in vacuo* give less statistically disperse results, because of the stabilizing influence of the vacuum. Compared to the tests in the presence of air, with the same loads and deformation times, tests *in vacuo* show a sharp decrease of the absolute elongation of the fibers. The change in elongation is *in vacuo* proportional to the load (to 80 g), i.e., the plastic deformation for silk *in vacuo* is small and the elastic deformation predominates, while in presence of air the plastic deformation predominates. Irradiation of natural silk *in vacuo* ( $10^{-5}$  mm) with doses up to  $10^6$  r equivalent physical increases the strength of the fiber, i.e., a process of stitching of molecular chains predominates. Raw silk, in presence of air-irradiated cocoons (doses  $3 \times 10^5 - 2 \times 10^6$  r equivalent physical, did not show a decrease of strength. (CA 55:1961, 2114c).

- 1530 Hirobe, T., Ooi, H. A SILKWORM BREEDING METHOD, TAKING ADVANTAGE OF THE DIFFERENCE OF RADIOSENSITIVITY. II. THE COMPARISON OF HEALTHINESS (INVOLVING VIABILITY, LONGEVITY, FECUNDITY, ETC.) BY IRRADIATION BETWEEN  $F_1$ -HYBRIDS. 22nd Meeting of the Japanese Society of Breeding, 1962. Jap. J. Breed. 13, 1 (1963) 55. (In Japanese)  
(BA 44: 1963, 16935).

- 1531 Ibragimov, A.P., Brodskaya, G.A. ACTION OF GAMMA RADIATION ON THE AMINO ACID COMPOSITION OF SILK FIBROIN. p.5-10 in "Nekotorye Voprosy Prikladnoi Fiziki", Sbornik, Tashkent, Akad. Nauk Uzb. SSR. 1961. (In Russian)

Fibroin from hybrid cocoons of mulberry silkworms was irradiated with  $\gamma$ -rays ( $\text{Co}^{60}$ ) in doses of from 1 million to 50 million r. The acid hydrolyzates of irradiated and unirradiated fibroin were studied for changes in amino acid compound (chromatographic method) and for N content. A spectroscopic study

was also made. In the beginning of radiation the content of total and amino N decreased rapidly. At doses over 25 million r the rate of decrease dropped sharply. In the hydrolyzate of unirradiated fibroin the content of alanine, phenylalanine, tyrosine, glycine + serine, glutamic acid + threonine, valine, histidine + lysine, and arginine decreased with increase in the dose of radiation. The percentage of the relative decrease in the content of these amino acids increases in the sequence of their enumeration. At the same time, new unidentified amino acids were detected. Hydrolyzates of irradiated and non-irradiated fibroin have identical absorption max. at 271 m $\mu$ . From Ref. Zh., Khim. 1962, Abstr. No. 2P532 (CA 57:1962, 10154b).

- 1532 Inai, Y. THE EFFECT OF  $\gamma$ -RAY IRRADIATION ON PROTEIN. II. THE ESR (ELECTRON-SPIN RESONANCE) ABSORPTION OF PROTEINS, AMINO ACIDS, AND PEPTIDES. *J. Biochem., Tokyo* 50 (1961) 284-92.

Anaerobic  $\gamma$ -ray irradiation ( $10^5$  -  $10^7$  r) of albumin, fibrin, fibroin, and silk fibre produced asymmetric ESR signals closely related to those of cysteine and reduced glutathione. When irradiated silk fibre was examined for ESR by applying perpendicular magnetic field, a doublet signal resembling that of glycylglycylglycine was observed, presumably owing to interpeptide chain H bonding with free radicals. Aerobic irradiation of the proteins yielded a symmetric singlet ( $g = 2.003$ ) signal, presumably of peroxide radicals. Those signals of irradiated proteins were undetectable if irradiation was performed in the presence of  $H_2O$ . The addition of irradiated protein or cysteine to native albumin solution decreased the amount of titrable SH groups. (CA 56: 1962, 10515 d).

See also:

- 870 Difference of radiation sensitivity between male and female upon the egg colour-sex-limited, in the silkworm. (Hirobet and Yazaki, 1962).  
1067 Studies on the breeding method taking advantage of  $\gamma$ -rays in the silkworm. (Japan, Sericultural Experiment Station, Tokyo, 1962).  
1260 Studies on the breeding method taking advantage of  $\gamma$ -rays in the silkworm. (Japan, Sericultural Experiment Station, Tokyo, 1963).  
1583 Present status and the future development of radiotechnology. (Stanković, 1962).

## II - E Biological Control

- 1538 \* Evlakhova, A. A. EFFECT OF CERTAIN CHEMICAL AND PHYSICAL STIMULI ON THE GROWTH AND VIRULENCE OF ENTOMOPATHOGENIC FUNGI. BIOLOGICAL METHOD OF CONTROLLING PESTS. "Proceedings of the Joint Session on Plant Protection". Iz-stvo Akad. Nauk. SSSR. 1959. (In Russian).

- 1534 Евлахова, А. А. ИСПОЛЬЗОВАНИЕ ЭНТОМОПАТОГЕННЫХ ГРИБОВ В БОРЬБЕ С ВРЕДНЫМИ НАСЕКОМЫМИ. *Бот. Ж.* 46, 12 (1961) 1744-80. *Р. Ж. Биол.* №16Ж401. 1962.

Evlakhova, A. A. USE OF ENTOMO-PATHOGENIC FUNGI IN CONTROL OF HARMFUL INSECTS. *Bot. Zh.* 46, 12 (1961) 1744-80. *R. Zh. Biol.* No. 16Zh401. 1962.

Certain species of *Entomophthora* are host-specific and are capable of bringing about epizootics among many harmful insects. Their cultivation is difficult. Field tests in application of entomophthoraceous fungi were sometimes successful. Fungi imperfecti cause mycotic diseases. These fungi are cultivated on a large scale on steamed hay, grain residues, or on fallen leaves and other inexpensive base materials. A good yield of *Beauveria bassiana* was obtained on a mixture of corn and wheat extract with stimulants  $\alpha$ -naphthyl acetic acid, 2,4-D, DDT, and microelements ( $KMnO_4$  or  $MnSO_4$  in concentrations of 0.02 to 0.1%). The article describes experiments in colonization of the fungi at pest foci and the amplification of effect of the biological preparation by small additives of insecticides. The virulence of fungi can be increased by controlled orientation on a culture with chitin and in the presence of chemical (DDT, BHC, petroleum products) and physical  $\gamma$ - and x-rays effects. (BA 42:1963, 7891).

- 1535 Evlakhova, A. A., Martens, B. K. THE USE OF IONIZING RADIATIONS FOR INCREASING THE VIRULENCE OF ENTOMOGENOUS FUNGI. p. 20 - 21 in "Materials of the Symposium on the Use of Biophysics in the Field of Plant Protection". Leningrad, 1961. (In Russian)

Various processes were tested in experiments begun in 1957 for increasing the virulence of Beauveria bassiana and Aspergillus flavus, which give important control of insects. Virulent strains of the fungi were used and after treatment were tested in the laboratory on the noxious Pentatomid [Eurygaster integriceps Put. ] and the apple Tortricid [Cydia pomonella (L. )] in comparison with the untreated fungi. Ultra-sounds and ultraviolet rays applied twice had little constant effect, but exposure of B. bassiana to soft x-rays and  $\gamma$ -radiation from  $\text{Co}^{60}$  gave positive results in the range 1200 - 40 000 r, and the former were effective even at 40 r. The effect depended not only on the species of fungus and the dose, but also on the stage of development of the fungus. The best results were obtained with young cultures in the mycelial and early sporulating stage. Insect mortality from the treated strains was increased by 30 - 40%. There was no increase in the virulence of A. flavus subjected to such treatment. In B. bassiana, the effect persisted for 7 - 10 generations. (RAE-A 51: 1963, 523).

## II - F Insect Diseases

- 1536 Katznelson, H., Robb, J. A. THE USE OF  $\gamma$ -RADIATION FROM COBALT-60 IN THE CONTROL OF DISEASES OF THE HONEYBEE AND THE STERILIZATION OF HONEY. Canad. J. Microbiol. 8 (1962) 175-9.

Honey-comb and honey heavily contaminated with spores of Bacillus larvae were sterilized after exposure to a dose of  $1.5 \times 10^6$  to  $2.0 \times 10^6$  rad from  $\text{Co}^{60}$ . Sugar-tolerant yeasts were killed by  $10^6$  rad and cysts of Nosema apis by  $0.2 \times 10^6$  rad. (CA 57:1962, 26391).

See also:

- 1321 A theory of the improved performance and survival produced by small doses of radiations and other poisons. (Sacher and Trucco, 1962).





## TECHNIQUES



## A Autoradiography

- 1537\* Baeckeland, E., Chevremont, M. APPLICATIONS OF HISTO-AUTORADIOGRAPHY IN ANIMAL CELLULAR BIOLOGY. Bull. Inst. agron. Gembloux Extra Vol. 2 (1960) 708 - 19. (In French).
- The principle of the method is interpreted and applications in localization of radioactive isotopes are reviewed. The method is particularly valuable in determining the exact timing of deoxyribonucleic acid synthesis in mitosis. (CA 56; 1962, 2676 h).
- 1538 Branton, D. DRY, HIGH RESOLUTION AUTORADIOGRAPHY. Stain Tech. 37, 4 (1962) 239-42.
- Microtomed sections of freeze-dried, paraffin-embedded tissues are placed on pieces of thin sheet-Teflon backed by a felt pad. The sections are then pressure-mounted on dry photographic emulsion. After suitable exposure, the sections are firmly cemented to the emulsion with 0.45% cellulose acetate in a 10:1 mixture of 2-butanone and acetone. This prevents the specimens from falling off or moving during photographic processing, though the tissue can be stained through the cellulose acetate binder. The method has been tested with tissues containing tritium-labelled DNA, and it produced resolution comparable to that obtained with standard liquid emulsion or stripping film techniques. (Auth.).
- 1539 Falk, G.J., King, R.C. RADIOAUTOGRAPHIC EFFICIENCY FOR TRITIUM AS A FUNCTION OF SECTION THICKNESS. Rad. Res. 20, 3 (1963) 466-79.
- Data are presented relating radioautographic efficiency to section thickness which indicate that increased efficiency compensates in part for the decreasing radioactivity in increasingly thin sections. (In the tests, polymeric methacrylate was used as a substitute for tissue, together with Eastman Kodak NTB2 emulsion). The improved autoradiographic resolution obtainable in most cases by means of thinner ( $\sim 0.5 \mu$ ) sections subsequently coated with thin films of suitably diluted liquid nuclear emulsion is pointed out.
- 1540 Herrmann, W., Hartmann, G., Brust, R. DAS AUFLÖSUNGSVERMÖGEN MIKRO-AUTORADIOGRAPHISCHER AUFNAHMEN UND UNTERSUCHUNGEN ÜBER SEINE ABHÄNGIGKEIT VON DER ENERGIE DER VERWENDETEN BETA-STRALUNG [Teil I]. (The resolving power of microautoradiographic exposures and its dependence on the energy of  $\beta$ -radiation. I.). Atompraxis 7 (1961) 315-20. (In German)
- The energy dependence of local resolving power is discussed for microautoradiographic exposures, using  $\beta$ -radiation. Close agreement is obtained between calculated values and those measured with the model described.
- 1541 Herrmann, W., Hartmann, G., Brust, R. DAS AUFLÖSUNGSVERMÖGEN MIKRO-AUTORADIOGRAPHISCHER AUFNAHMEN UND UNTERSUCHUNGEN ÜBER SEINE ABHÄNGIGKEIT VON DER ENERGIE DER VERWENDETEN BETA-STRALUNG [Teil II]. (The resolving power of microautoradiographic exposures and its dependence on the energy of the  $\beta$ -radiation. II.). Atompraxis 8 (1962) 8-11. (In German)
- Experimental results are presented for radioisotopes  $Ni^{63}$ ,  $S^{35}$ ,  $P^{32}$ ,  $Au^{198}$ ,  $P^{32}$ , and  $K^{42}$ . The resolving power ranged from  $5.3 \mu$  for  $S^{35}$  to  $93 \mu$  for  $K^{42}$ . A graph shows three curves of resolving power plotted against energy, obtained from (1) calculated values, (2) the analogy model, and (3) experiment. It is thus possible to assess the suitability of an isotope, under the experimental conditions used, for a problem in which a particular resolving power is essential.
- 1542 Joffes, D.L. RADIOAUTOGRAPHY IN THE STUDY OF RADIOISOTOPICALLY-TAGGED SUBSTANCES IN INSECT CONTROL. p. 155-86 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.
- Review article illustrating the applicability of autoradiographic techniques to many different types of problems, since it can provide information on actual sites of deposition in tissues and even parts of cells. The technique places no restriction on the isotope used for labelling, since even the radiation from  $H^3$  and  $C^{14}$  will register on the nuclear emulsion. In fact,  $H^3$  and  $C^{14}$  (desirable since nearly every insecticide

contains C and H) have the advantage of yielding high-resolution radioautograms, and even long exposures present no difficulty. Staining can be done before or after application of the emulsion, depending on the stain. The recommended techniques and the simple, generally available laboratory equipment required are described.

- 1543 Kempner, E.S., Miller, J.H. AUTORADIOGRAPHIC RESOLUTION OF DOUBLY LABELLED COMPOUNDS. *Science* **135** (1962) 1063-4.

When the electrons emitted by the isotopes in a doubly labelled compound or a mixture of labelled compounds have sufficient energy differences, resolution can be achieved by autoradiography with 2 sheets of x-ray film. Thus,  $C^{14}$  or  $S^{35}$  will affect only the closer film while  $P^{32}$  will affect both films. (CA 56:1962, 15104c).

- 1544 Lima-de-Faria, A. PROGRESS IN TRITIUM AUTORADIOGRAPHY. p. 281-317 in "Progress in Biophysics and Biophysical Chemistry. Vol. XII". Butler, J.A.V., Huxley, H.E., Zirkle, R.E., Eds. Oxford, Pergamon Press. 1962.

This technique has permitted much information on DNA synthesis in chromosomes to be collected. It also lends itself to the study of the dynamics of chemical processes occurring within single chromatids and single chromosome loci. Tritium autoradiography has furnished clear-cut evidence of the occurrence of metabolic DNA in the giant chromosomes of Diptera where disproportionate synthesis of DNA has been found at certain loci, and in the *Tipula* nuclei, where a Feulgen positive body incorporates large amounts of tritiated thymidine. This body is formed by the sex chromosomes before meiosis and disintegrates at diplotene. Work on the following insects has been cited: *Tipula lateralis*, *Melanoplus differentialis*, *Drosophila melanogaster*, *Rhyncosciara*, and *Glyptotendipes*. (See p. 300-3, 306-7, 310-11, 313, and Figs. 9-13, 14 and 15).

- 1545 McGrath, R.A., Leach, W.M., Carlson, J.G. A SQUASH TECHNIQUE FOR AUTORADIOGRAPHY OF GRASSHOPPER NEUROBLASTS. *J. roy. microscop. Soc.* **82**, 1 (1963) 55-6.

A squash method, an autoradiographic procedure, and a staining technique designed primarily for study of grasshopper neuroblast chromosomes are described. Tissue is treated with 1% sodium citrate for 4-6 min to swell cells and separate chromosomes, fixed in 50% acetic acid for 5-30 min, and then squashed between a slide coated with potassium-chrome alum subbing and a No. 1 cover-glass. After further treatment slides are dipped into melted (39-40°C) Kodak NTB or NTB-2 emulsion, dried vertically and stored with silica gel at 4°C in light-tight boxes for the necessary exposure time. Processing is carried out at 17-18°C, with developer and fixer pre-filtered 1 h before use: full strength Kodak D-19 developer (4 min); distilled water rinse (15 sec); full strength Kodak acid fixer (5 min); running tap water (20 min). Slides are then rinsed (distilled water) and dried at room temperature. Squash preparations or autoradiograms are stained for 5-30 sec with 0.1% toluidine blue in citrate buffer at pH 5.0, rinsed in tertiary butyl alcohol (½-2 min) and air-dried. They are then mounted as described.

See also:

- 139 Autoradiography as a method of detecting tagged rodents and their ectoparasites in a study of migration problems. (Shura-Bura and Kharlamov, 1961).
- 153 Autoradiography as a technique for radioactive phosphorus, P-32, uptake in *Culex molestus* Forsk. (Abdel-Malek and Abdel-Wahab, 1961).
- 177 Incorporation of Iron-59 into the cells of different tissues of *Chironomus plumosus*. (Ökay and Sengün, 1963).
- 385 A micromethod for labeling steroids and ecdysone with tritium. (Karlson et al., 1963).
- 879 Tissue distribution of P<sup>32</sup>-labelled parathion. Autoradiographic technique. (Fredriksson and Bigelow, 1961).

## B Dosimetry

- 1546 Kloft, W. TECHNICAL PROBLEMS OF RADIOISOTOPE MEASUREMENT IN INSECT METABOLISM. p.183-70 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency, 1962.

When measurements are made of emission from intact insects of radioisotopes present as tracers, various factors must be taken into account. Technical and mathematical ways of determining the value of absorption and back-scattering for different insect tissues are described. Thus the substitution of Al-filters for the excised tissue layers represents an indirect method of measuring absorption by the insect body. Mention is made of the problem of cuticular excretion of  $P^{32}$  with subsequent changes in counting rates. All such complications are greatly reduced if  $\gamma$ -sources are used as tracers, and the measurements made with scintillation counters. If the  $\gamma$ - and  $\beta$ -radiations from the same insect are measured in close succession in the various experiments described, the size of the effects may be easily determined for the particular isotope used. (In this study experiments were carried out on Formica nigricans Em., Tenebrio molitor L., and Calliphora erythrocephala Meig.)

See also:

- 409 Detoxication mechanisms in the tick Boophilus decoloratus. (Hitchcock and Smith, 1963).  
532 Determination of the  $\gamma$ -isomer of hexachlorocyclohexane by isotope dilution. (Atalla and Lima, 1963).  
539 Determination of  $\delta$ -hexachlorocyclohexane by the method of isotope dilution. (Kulikova et al, 1963).  
704 Pesticides residues. Use of radioactive tracer method to determine possible residues in milk and meat from dairy cows. (Cutkomp, 1960).

## C Isotope Dilution

- 1547 Sieber, K., Jamar, A. AN ISOTOPE DILUTION TECHNIQUE WAS USED TO DETERMINE THE  $\gamma$ -HCH CONTENT IN COMMERCIAL MIXTURES. Symposium über Schädlingsbekämpfung, Magdeburg, 1962. DDR.

## D Labelled Pool Technique

See:

- 412 Radioactive tracer techniques in insect biochemistry. (Winteringham, 1962).  
421 Nucleotides and other phosphorus compounds of cockroach nerve. (Heslop and Ray, 1961).  
517 Drywood termite metabolism of Vikane fumigant as shown by labeled pool technique. (Meikle et al., 1963)

The method is used in a variety of studies. See also subject index under Amino acids, and Sterol metabolism.

## E Neutron Activation Analysis

- 1548 Castro, C.E., Schmitt, R.A. DIRECT ELEMENTAL ANALYSIS OF CITRUS CROPS BY INSTRUMENTAL NEUTRON ACTIVATION. A RAPID METHOD FOR TOTAL BROMIDE, CHLORIDE, MANGANESE, SODIUM AND POTASSIUM RESIDUES. J. agric. Food Chem. 10, 3 (1962) 236-9.

An entirely instrumental method of neutron activation analysis has been successfully employed to analyze directly the total bromine residues in raw navel orange peel and juice. The inorganic bromine found was the result of fumigation with the nematocide, 1,2-dibromo-3-chloropropane. Simultaneously, the amounts of Na, K, Mn and Cl were quantitatively determined from the same set of  $\gamma$ -ray spectra. No or-

ganic bromides were detected in these fruit, all of which had been harvested from trees 8 months after nematocide application. As a method of residue analysis for Br, the procedure outlined is non-destructive, the sample preparation required is minimal, and the method is extremely rapid. The sensitivity and wide scope of the technique are striking. The authors intend to explore the biochemistry of plant-parasitic nematodes and their host relationships utilizing this technique.

- 1549 Gunther, F.A. INSTRUMENTATION IN PESTICIDE RESIDUE DETERMINATIONS. p. 191-319 in "Advances in Pest Control Research. Vol V." Metcalf, R.L. Ed., Interscience Publishers, New York. 1962.

Comprehensive review article. A section (p. 263-72) is devoted to neutron activation analysis (theory; typical neutron-activation procedure; instrumental neutron-activation analysis; and instruments required).

- 1550 Schmitt, R.A. NEUTRON ACTIVATION ANALYSIS. p. 281-324 in "Analytical Methods for Pesticides, Plant Growth Regulators, and Food Additives. Vol. I, Principles, Methods, and General Application". Zweig, G., Ed. New York, Academic Press. 1963.

Very comprehensive review article, divided into sections on the theory of neutron activation, neutron activation procedure (sample preparation, irradiations, post-irradiation instrumental analyses, calculation of concentrations from  $\gamma$ -ray spectra), sensitivities for thermal-neutron activation, applications of neutron activation analysis (general, and specific applications to pesticide residues), and instrumentation and neutron sources. P.303-20 treat application to pesticide residues, and unpublished results by various authors are cited (p. 318-9). An attempt was made to correlate the total organic chloride content with chlorinated pesticide levels in milk butterfat. In 90% of the butterfat samples, the total organic chloride content was  $\geq 10$  times the chloride content determined for the pesticides DDT, DDE, BHC, and TDE by chromatographic techniques. The tremendous potentialities of neutron activation analysis in pesticide residue work is stressed, given its simplicity, the high sensitivities for such elements as Cl, Br, and I, multichannel quantitation from a single neutron irradiation, and the nondestructiveness of the analysis.

See also:

- 208 Neutron activation analysis for phosphorus in a study of development in a beetle wing. (Beck and Manney, 1962).  
 710 Total organic chloride content in butterfat by a rapid method of neutron activation analysis. (Schmitt and Zweig, 1962).  
 732 Bromine residues in wheat and milled wheat fractions fumigated with methyl bromide. (Lindgren et al., 1962).  
 1300 Cell differentiation and radiopathology in the wing of *Tribolium confusum*. (Beck, 1962).  
 1301 Effects of x-irradiation upon cell population and morphogenesis in the wing of *Tribolium confusum*. (Beck, 1962)  
 1302 Effect of x-irradiation on cell differentiation and morphogenesis in a developing beetle wing. (Beck, 1962)

## F Miscellaneous

- 1551 Bond, E.J., Call, F. APPARATUS FOR TREATING INSECTS WITH RADIOACTIVE FUMIGANTS. J. econ. Ent. 54, 4 (1961) 808-9.

$HC^{14}N$  was generated from  $KC^{14}N$ , of specific activity 0.2 mc/mM, and stored in a reservoir. The technique and apparatus are described. From there a known amount of fumigant could be introduced into the fumigation chamber. The rate of uptake of  $HC^{14}N$  is studied by incorporating and end-window GM-counter and measuring the decrease in concentration of radioactive gas as it is absorbed by the insect.

- 1552 Harrison, R.A. TOPICAL APPLICATION OF INSECTICIDE SOLUTIONS TO MITES AND SMALL INSECTS. N. Z. J. Sci. 4, 3 (1961) 534-9.

The construction and procedure for use of such an apparatus for topical application of insecticide solutions to mites and insects of a mass of approx. 20  $\mu g$  are described. The apparatus consists of a self-filling micro-pipette mounted and arranged in the field of view of a stereoscopic microscope. The doses delivered to individual insects ranged from 0.0005  $\mu l$  to 0.00005  $\mu l$  according to the size of the micro-pipette used. Replicable results have been obtained using this method of treatment. Calibrations is effected microscopically and checked radiometrically, using repeated doses of kerosene solutions of  $P^{32}$ -labelled tributyl phosphate. The volume of liquid delivered was within 5% of the estimated volumes. A check on the variation

of individual doses from the same capillary tube was also made radiometrically. The coefficient of variation for doses applied to paper was 5%, to mites 18% and to larvae 5%. The whole treatment of one insect takes a minute or less.

- 1553 Lewis, C. T. DIFFUSION OF OIL FILMS OVER INSECTS. *Nature*, Lond. 193, 4818 (1962) 904.

Measurements of the rate of uptake of oil by active flies (*Phormia terraenovae* R-D) were made by using  $^{131}\text{I}$ -labelled oil films. ( $^{131}\text{I}$ -labelled di-iodo-octadecane was added to a refined mineral oil - Riscella 17 - the specific activity being adjusted to  $3\mu\text{l}/\text{cm}^2$ .) Estimates of the rates of contamination of the insect with oil and of subsequent tissue absorption of tracer were made. Autoradiographs confirmed that oil films were established over the whole of the integument within a very few minutes after initial exposure. It was calculated that a monomolecular oil film was established within 5-15 min of the first contact of the fly with the oil deposit. The oil film advanced only when the integument was part of a living, active insect, and this is discussed. Similar results were obtained with *Dysdercus fasciatus*.

- 1554 Lewis, C. T. RADIOTRACER STUDIES OF OIL FILMS ON INSECTS. (Abstr.) p. 629 in "XI. Internationaler Kongress für Entomologie, Wien, 17. bis 25. August 1980. Verhandlungen. Band II (Symposien)". Wien, Organisationskomitee des XI. Internationalen Kongresses für Entomologie, Wien 1980. 1962. (In English)

Quantitative data concerning the uptake of oil by insects walking over fine deposits have been obtained by means of radioactive oil samples prepared by the addition of  $^{131}\text{I}$  to traces of an unsaturated hydrocarbon. For a range of species walking over a mineral oil (Riscella 17) deposit of  $3\mu\text{l}/\text{cm}^2$  on filter paper, the initial rate of flow on to the cuticle is found to be extremely small, varying from  $2.3 \times 10^{-8}\text{ml}$  to  $3.0 \times 10^{-7}\text{ml}/\text{min}$ . Nevertheless, an appreciable fraction of the oil thus transferred to the tarsi rapidly diffuses over the epicuticle, to cover the entire body surface with a fine film within a very few minutes, to which more oil accumulates at a steadily decreasing rate. The long-term approach to equilibrium between the oil on the substratum and the oil film on the insect has also been studied: a near approach to such an equilibrium is achieved in "crawling insect" biological assay techniques. For example, the film of oil taken up by *Carpophilus dimidiatus* larvae rises to a maximum level in 5 h; in contrast, *Tribolium castaneum* adults take about 24 h to approach equilibrium. (This work forms part of an investigation to be reported in detail elsewhere).

- 1555 Lewis, C. T. SOME APPLICATIONS OF RADIOISOTOPES TO THE STUDY OF THE CONTAMINATION OF INSECTS BY INSECTICIDE SOLUTIONS. p. 135-42 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency. 1963.

Preliminary work was carried out using di-iodo-octadecane- $^{131}\text{I}$  as a tracer in solution in oils. This substance proved useful for investigating the creep of oil films over insect epicuticle, but was unsatisfactory for critical work on oil absorption through the cuticle, being converted in the tissues to one or more water-soluble derivatives. *Phormia terraenovae* R-D was used in this work. In subsequent investigations, dieldrin- $^{14}\text{C}$  was used in solution in oils labelled with tritiated hexadecane. In comparative experiments with *Tribolium castaneum* exposed to 3 solutions of different viscosity, appreciable differences in both the rates of diffusion over the insects and in absorption through the cuticle have been found. After an initial period, dieldrin is absorbed relatively faster than solvent, the magnitude of the differential absorption varying with viscosity. (Essentially auth.).

See also:

- 303 Radiometric assay of acetylcholinesterase. (Winteringham and Disney, 1962).  
455 An apparatus for arthropod labeling by means of spraying them with radioactive isotopes. (Khudakov, 1961).  
500 A new bioassay technique, with special reference to the specific bioassay of DDVP insecticide. (Sun and Johnson, 1963).  
990 The grasshopper neuroblast culture technique and its value in radiobiological studies.

- 1556\* Crisp, D. J., Jones, L. W. G., Watson, W. USE OF X-RAY STEREOSCOPY FOR EXAMINING SHIPWORM INFESTATION IN VIVO. Nature, Lond. 172 (1953) 408-9.

The smallest portable x-ray set obtainable may be used, with Ilfex film. Infested blocks were scraped clean of surface growths and photographed in the laboratory, marked, and replaced in the sea. The whole course of attack could thus be followed in a series of experiments on infested blocks and information obtained on the times and preferred positions of settlement, on growth-rates, and growth habits. In order to interpret the arrangement of the burrows stereoscopy was introduced. Boring habits could be followed from the moment of entry of the individual shipworm, Teredo sp., into the wood.

- 1557 Davey, K. G., Treharne, J. E. STUDIES ON CROP FUNCTION IN THE COCKROACH (Periplaneta americana L.) I. THE MECHANISM OF CROP-EMPTYING. J. exp. Biol. 40 (1963) 763-73.

The structure and mode of action of the pro-ventriculus are described. X-ray photographs have shown that as the crop empties the decrease in volume of the fluid is partially compensated for by the swallowing of air. The effects of various factors upon the rate of crop-emptying have been studied using solutions of different osmotic pressures. Changes in viscosity, effected by the addition of methyl cellulose, produce only a minor reduction in crop-emptying. The frequency of opening of the proventricular valve is not proportional to the rate of crop-emptying over the whole range of concentrations used, and it is assumed that changes in other parameters must affect the process. (Auth. summary).

- 1558\* Eidmann, H. DIE VERWENDUNG VON RÖNTGENPHOTOGRAPHIE BEI ENTOMOLOGISCHEN UNTERSUCHUNGEN. (The use of x-ray photography in entomological studies). Ent. Ts. Arg. 80, 3/4 (1963) 85-90 (In German)

Very soft rays from x-ray model TEA-25 (Schönander) were used, at 25 cm from the object, and through a Be-window. Ilfex film and exposure times from 3-7 sec (14 kV, 10 mA) were used. No damaging effect from radiation was observed. Internal infestation of larch by Argyresthia laevigatella H. S. can be followed in its various stages of development, although the shoots themselves show no outward sign of attack. Pupation and emergence can be diagnosed, also whether a cocoon contains a live or dead insect. X-ray photographs are also shown of cocoons of Pristiphora laricis Htg. and P. erichsoni Htg., being attacked by a parasitizing wasp larva, and of a sexually mature grasshopper, Carausius morosus Br. where, apart from the eggs other anatomical details are easily recognized. The possibilities of the technique are pointed out.

- 1559 Goodhue, D. SOME DIFFERENCES IN THE PASSAGE OF FOOD THROUGH THE INTESTINES OF THE DESERT AND MIGRATORY LOCUSTS. Nature, Lond. 200 (1963) 288-9.

An x-ray technique (see Radiography 1958, p. 263) was used to study the passage of radiopaque foods through the intestine of the migratory locust, Locusta migratoria L. and F., and the desert locust, Schistocerca gregaria (Forsk.), prior to an investigation into the absorption of stomach poisons. Differences in the form of the colon, particularly the S-bend, in fed and unfed insects and changes during defaecation are described. The S-bend is present in both fed and unfed Locusta but is reduced in a hungry Schistocerca, the colon remaining almost straight. Its significance is discussed. In Locusta intestinal contents pass into both arms of the caeca at the anterior end of the midgut, in Schistocerca intestinal contents are only found in the posterior arms, the anterior arms remaining unfilled. A peritrophic membrane is found in the posterior arm.

- 1560 Green, G. W. SPONTANEOUS LOCOMOTOR ACTIVITY IN THE BLOWFLY, Phormia regina Meig. Dis. Abstr. 24, 5 (1963) 2193.

When active, starved flies are fed to repletion on sugar solutions, locomotor activity is immediately and markedly depressed. Upon subsequent deprivation, locomotor activity increases at a rate that is dependent upon the concentration of the sugar ingested. An x-ray technique was developed to measure the rate of crop emptying in individual flies after feeding to repletion. Activity experiments performed in conjunction with the x-ray studies showed that after feeding to repletion, locomotor activity remains at a low level until approximately 90% of the crop contents have been utilized. Thereafter, locomotor activity begins to increase. The shape of the activity curve upon deprivation is dependent upon fewer periods of complete locomotor inactivity as the deprivation period is extended, rather than on an increase in the speed of movement. An explanation is put forward of spontaneous locomotor activity on the basis of a neurohumoral mechanism involving foregut receptors and neurosecretory cells in the protocerebrum and/or the corpus cardiacum.



- 1561 Odum, E. P., Loughman, B. C., Martin, R. P. SCANNING SYSTEMS FOR THE RAPID DETERMINATION OF RADIOACTIVITY IN ECOLOGICAL MATERIALS. *Ecology* 43, 1 (1962) 171-3.

In many applications of radioisotopes to ecological problems it is more important to assay large numbers of samples at frequent intervals than to obtain detailed measurements at any one time. It was found that certain scanning systems, originally designed for paper chromatographic work, can be adapted for such rapid large-scale scanning. Two systems are described. A system at Oxford was very successfully used in a study of population density of  $P^{32}$ -labelled ants. Long strips of ants from recapture samples were attached to the endless belt that passed slowly in front of a shielded detector. The pen recorder located below the detector automatically recorded which individuals were tagged. Although it was only necessary to identify which ants in the sample had been previously marked, the actual amount of  $P^{32}$  present in the individuals could easily be determined by calibrating the setup in either of 2 ways: (1) by inserting in the strips ant bodies containing a known amount of isotope, or (2) by ashing and counting selected individuals which had already been scanned to determine  $\mu$ c amounts producing a given pulse height on the recorder. The 2nd system described involves only a simple modification of equipment commercially available in the U.S.A.

