

- 1147 Rossi, H.H., Goodman, L.J. ANNUAL REPORT ON RESEARCH PROJECT. Dosimetry of monoenergetic neutrons for *Drosophila*. p. 70-72 of "Annual Report on Research Project", NYO-2740-4, Columbia Univ., New York. Radiological Research Lab, 1 Jan. 1967.
- A pilot study is discussed aimed at determining the approximate proportion of dominant lethals in male *D. melanogaster* irradiated with several different doses but at a single neutron energy. In the preliminary study the flies are to be exposed to 1-MeV energy neutrons obtained from a Van de Graaff generator utilising 2.8 MeV protons. The aluminium/lucite irradiation cage is illustrated.
- 1148 Shazli, A. EXPLORATORY STUDIES ON FREQUENCY OF COPULATION IN *Prodenia litura* F. (LEPIDOPTERA: NOCTUIDAE). *Bull. Soc. ent. Egypte* 47 (1963) 65-73.
- The following is based on the author's summary of this account of laboratory investigations in Egypt to determine the practicability of releasing sterile males for the control of *Spodoptera littoralis* (Boisd.) (*P. litura*, auct.). Females stimulated by the presence of males that had been sterilised as pupae by irradiation with x-rays laid sterile eggs in regular batches. They had evidently paired, since others that were kept without males laid scattered eggs or eggs in small batches that were not covered in the normal manner. When the sterile males were replaced by fertile ones, the females paired again and deposited fertile eggs in batches. Exposure of male pupae to radiation at 5000 R increased pupal mortality and the percentage of abnormal adults, lengthened the pupal period and reduced fertility, but exposure to 3000 R had no adverse effects. The release of sterile males for the eradication of *S. littoralis* is considered to be impracticable because of the tendency of the females to pair more than once and difficulty in rearing large numbers of larvae. (RAE-A 55:1967, ref. 892)
- 1149 Shipp, E., Osborn, A.W., Hutchinson, P.B. RADIATION STERILIZATION OF SUGAR-CANE LEAFHOPPERS OF THE FAMILY DELPHACIDAE. *Nature*, Lond. 211 (1966) 98-99.
- Preliminary experiments have been carried out on the applicability of the sterile male technique to sugar-cane leafhoppers (*Perkinsiella saccharicida* (Kirk)), vectors of Fiji disease of sugar cane. 5th-instar nymphs proved the most suitable stage for irradiation with γ -rays from a ^{60}Co source. Females were sterilised at 3500 rad, males at 10 000 rad. No effects were observed at those dosages on adult longevity, mating behaviour and sperm motility. A percentage of sperm were rendered inactive at 12 000 rad, and at 23 000 rad adult longevity and wing development were also affected adversely. A large safety margin is indicated within which sterility may be produced without adverse effects.
- 1150 Smith, R.H., Whiting, A.R., Bostel, R.C. von, Cain, K.T., Goins, D.J., Sirota, E.S., Haye, M.L. x-RADIATION INDUCTION OF MUTATIONS IN *Habrobracon*. p.64 of "Biology Division Semiannual Progress Report for Period Ending July 31, 1966". ORNL-3999, Oak Ridge National Lab., Tenn. 1966, 217 p.
- Techniques have been developed which permit analysis of the entire genome for dominant lethality, recessive lethality and chromosomal translocations. Lemon males irradiated with 2000 R x-rays were crossed with Raleigh females of high hatchability. The frequency of dominant lethality (from egg hatchability, testing 6045 eggs) was 0.279. Tests for recessive mutations and translocations showed that mutation frequencies remained essentially constant for three replicates taken at approx. monthly intervals.
- 1151 Strømnaes, O. THE x-RAY SENSITIVITY OF TWO WILD TYPE STRAINS OF *Drosophila melanogaster*. p.196-200 of "Progress in Radiobiology". Proceedings of the "4th International Conference on Radiobiology. Cambridge, England, 14-17 Aug. 1955". Mitchell, J.S., Holmes, B.E., Smith, C.L., Eds. Edinburgh, Scotland, Oliver and Boyd. 1956, 557p.
- Two wild type strains of *D. melanogaster* were tested with respect to the induction of dominant lethals by x-rays. Eleven repeats of the same experiment were performed, and in 10 of them one strain consistently exhibited lower hatchability than the other after x-ray treatment of the males. Some of the repeats were performed in Berkeley, Calif., and some in Oslo, Norway. It is suggested that the difference in hatchability observed between repeats executed in the two places is mostly due to discrepancy in the technique of measuring and applying x-ray dosage. (Auth. summary)

- 1152 Strømnaes, Ø. MUTATION PATTERN IN TWO WILD-TYPE STOCKS OF *Drosophila melanogaster*. Paper presented at the "10th International Congress of Genetics. Proceedings, Vol. 2. Montreal, Canada, 1959".

The mutation pattern has been investigated in two wild-type stocks of *D. melanogaster*, one is Oslo, the other is Iso-Amherst. Males, 1-4 h old, from the two stocks were treated with 1800 R of x-rays, then mated individually to single females for 24 h and transferred to new females every 24 h for a period of 12 d. In testing for dominant lethals virgin hybrid females from a cross between cn bw: e¹¹ ♀ × Canton-S ♂ were used; in testing for sex-linked lethals the Muller-5 technique was employed, and in testing for 2-3 translocations a cn bw: e¹¹ stock was used. The daily brood pattern for dominant lethals for the two stocks shows up as similar curves. However, dominant lethal frequency is higher for Oslo stock than for Iso-Amherst stock in all first broods until the seventh brood where it is the same for both. From the 8th-12th brood the situation is reversed: max. frequency of dominant lethals for the Oslo stock appears in the sixth brood; for the Iso-Amherst stock in the 8th brood. Tests for sex-linked lethals and 2-3 translocations were carried out only for sperms coming on the third, sixth, and eighth day after irradiation of the males. The data observed for 2-3 translocations are in good agreement with the data found for dominant lethals. The observed data indicate an overall higher mutation rate in the Oslo stock than in the Iso-Amherst stock. It seems reasonable to assume that the different mutability of the stocks has been achieved by selection during the evolution of the two stocks in order to make them better adapted to their natural environment. (From abstr.)

- 1153 Subrahmanyam, U. SOME EFFECTS OF GAMMA IRRADIATION ON NAVEI ORANGE-WORM, *Paramyelois transitella* (Walker). Bull. ent. Soc. Am., 13, 3 (1967) 203. Abstr. 356, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

60 000 rad of γ -radiation induced 99% dominant lethality in navel orange-worm, *P. transitella*. Effects of irradiation were also studied on the male vigour, spermatozoa competition, spermatophore production and the F₁ and F₂ generations. (Abstr.)

- 1154 Tzanakakis, M.E., Tsitsipis, J.A., Papageorgiou, M., Fytizas, E. GAMMA RADIATION-INDUCED DOMINANT LETHALITY TO THE SPERM OF THE OLIVE FRUIT FLY. J. econ. Ent. 59 (1966) 214-216.

Research carried out in 1964-65 at the "Democritus" Nuclear Research Center has ascertained that when pupae of the olive fruit fly, *Dacus oleae* (Gmelin), are exposed to 8, 10, and 12 krad of γ -rays, permanent dominant lethality is caused to sperm to a degree which can be considered satisfactory for practical purposes. It has shown also that 6 krad was a satisfactory male-sterilizing dose. At these doses not more than 2.0% of the progeny of irradiated males mated with normal females reached the first larval instar, and not more than 0.3% reached the pupal stage, as compared with 82.3% and 41.4% in the control, respectively. The same doses caused permanent sterility to the irradiated females. They did not substantially affect the time or the percent of adult emergence, or the longevity of irradiated males. (Auth.)

- 1155 Volchkov, A., Vorobitsova, I.E. COMPARATIVE STUDY OF THE FREQUENCY OF OCCURRENCE OF DOMINANT LETHAL MUTATIONS IN DIFFERENT LINES OF *Drosophila melanogaster*. Vest. leningr. gos. Univ. 3, 15 (1964) 124-129. Translation Leningrad Univ.

The genetic radiosensitivities of 8 stocks of the wild type of *D. melanogaster* were compared. A dose producing 50% of dominant lethals in spermatozoa was taken as criterion of genetic radiosensitivity. On this basis the 8 stocks could be divided into two groups: the relatively radiosensitive were lines R-86, Tsentropit-1, D-18 and Kanton-S; the relatively radioresistant lines were Inozemtsevo, D-32, SH-15, and Magarach. Stocks with different correlation between induced and spontaneous mutation processes were discovered.

- 1156 Walker, D.W. RADIATION-INDUCED STERILITY FOR POPULATION CONTROL OF THE SUGARCANE BORER (*Diatraea saccharalis*) IN PUERTO RICO. PRNC-95, Puerto Rico Nuclear Center, Mayaguez. May 1966, 47p.

Progress is reported on studies concerned with radioinduced sterility of the sugarcane borer, *D. saccharalis* for population control. Research problems on development of a more efficient rearing medium; effects of yearly seasons on the life span of the cane borer; egg productivity and

mating behaviour of radiosterilized insects; γ -radiation dosimetric measurements; rate of larval growth and maturation during different seasons; seasonal population fluctuations; and stages of egg maturation are outlined and discussed. It was established that only adult stages of this species could be sterilized with γ -radiation without mortality and that radiosterilized females and males were as competitive in mating as normal adults. (NSA 21:1967, 22830)

- 1157 Walker, D.W., Quintana, V. INHERITED STERILITY IN SURVIVORS OF IRRADIATED *Diatraea saccharalis* (Fab.) (LEPIDOPTERA: CRAMBIDAE). *Bull. ent. Soc. Am.* 13, 3 (1967) 192. Abstr. 107, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Partial sterility and reduced survival was observed in the F_2 generation following exposure of P generation adults of the sugarcane borer moth, *D. saccharalis* to ^{60}Co γ -radiation. The sterility effect was noted in offspring from both irradiated males and females. (Abstr.)

- 1158 Walker, D.W., Quintana, V. GAMMA-INDUCED STERILITY IN THE SUGARCANE MOTH, [*Diatraea saccharalis* (Fab.) (LEPIDOPTERA: CRAMBIDAE)]. *Radiat. Res.* 31, 3 (1967) 612. Abstr. Eb-1, at "15th Annual Meeting of the Radiation Research Society. San Juan, Puerto Rico, 7-11 May 1967".

Immature stages of *D. saccharalis* are less radioresistant than the adult with over 50% mortality at exposure to 9 kR. Adult males are sterilized at 35 kR and adult females at 30 kR. Lifespan, mating behaviour and oviposition rate is not affected by sterilizing exposures given to adults. Response to substerilizing exposures is erratic, but appears to be logarithmic. The diffuse centromere in chromosomes of this species may be the explanation for inconsistent response at low exposure. (Abstr.)

- 1159 Yoshimaki, M., Newsom, L.D., Roddy, J. L. EFFECT OF HOST EGGS DERIVED FROM IRRADIATED PUPAE OF THE SUGARCANE BORER ON *Trichogramma* PARASITISM. *Bull. ent. Soc. Am.* 13, 3 (1967) 203. Abstr. 357, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Host eggs were derived from the irradiated pupae to obtain the sterile sugarcane borer moths for the pest control programme, and were exposed to the laboratory reared *Trichogramma* colony. The indirect effect of the radiation on the oviposition and the parasitism were compiled comparing different radiation intensities. (Abstr.)

See also :

- 918 Induction of nuclear damage by ionizing and ultraviolet radiation. (Borstel, R.C. von., 1961)
 919 Effects of radiation on cells. (Borstel, R.C. von., 1966)
 925 The cytogenetic basis of radioresistance in Lepidoptera species, *Trichoplusia ni*. (North, D.T. et al., 1967)
 927 A cytological study of radiation effects in testes of the screw-worm fly, *Cochliomyia hominivorax* (Diptera: Calliphoridae). (Riemann, J.G., 1967)
 928 Cytological evaluation of dose-rate effects of radiation on mutation frequency of silkworm gonads. 1. Kinetics of proliferation and killing of spermatogonia during chronic irradiation. (Sado, T., 1966)
 940 Radiomutability and heterogeneity of male germ cells of *Drosophila* before, during, and after meiosis. (Fritz-Niggli, H., 1966)
 948 Effect of gamma rays on development of the sex cells in the beet fly. (Klimtunya, A.Y., 1965)
 956 Relation between sensitivity to killing and mutation observed during a mitotic cycle of silkworm cleavage nuclei. (Murakami, A., 1966)
 959 Fifth report from Norsk Hydro's Institute for Cancer Research for 1963-1964. (Norsk Hydro's Inst. for Cancer Research, Oslo, 1965)
 963 Techniques for studying the effects of radiation on meiosis and related processes in mosquitoes with particular reference to *Aedes aegypti*. (Rai, K.S., 1968)
 972 Dose rate effect of radiation on spermatogonia of the silkworm. (Sugai, E. et al., 1967)
 982 Methods for radiation studies during oogenesis in *Habrobracon juglandis* (Ashmead). (Whiting, A.R. et al., 1968)

- 984 Induced mutations and lethality in *Drosophila* after x-irradiation of meiotic and post-meiotic stages of the egg. (Würgler, F.E., 1968)
- 1071 The radiologist and practitioner in relation to the supposed hazards of x-rays in radiodiagnosis. (Gros, C.M. et al., 1962)
- 1092 Mutagenic effects of massive acute x-irradiation in *Drosophila melanogaster*. (Nakao, Y. et al., 1965)
- 1093 Comparisons of mutagenic and cell-killing effects of radiation in the silkworm. (Nakao, Y. et al., 1965)
- 1191 Modification of induced genetic damage in *Drosophila melanogaster* by oxygen and argon treatments between two doses of x-rays. (Elequin, F.T., 1966)
- 1198 Occurrence of lethal mutations in the heterochromatic region of *Drosophila melanogaster* X chromosome depending on preradiation development temperature. (Kogan, Z.M., 1966)
- 1224 The effects of nitrogen and oxygen treatments on the frequencies of x-ray-induced dominant lethals and on the physiology of the sperm in *Drosophila melanogaster*. (Sankaranarayanan, K., 1967)
- 1233 Effect of aeration on gamma irradiation of house fly pupae. (Smittle, B.J., 1967)
- 1246 Genetic x-radiation damage and its modification by some gases and a time factor in *Drosophila melanogaster*. (Yoon, J.S., 1966)
- 1249 Retention of the blood-meal in *Aedes aegypti* following sterilization by chemicals and irradiation. (Akov, S., 1966)
- 1256 A comparison of the sterilizing effect of x-rays, quinacrine mustard and azaserine on *Drosophila* males. (Browning, L.S. et al., 1965)
- 1257 The sterilization of lepidopterous pests by radiation and chemosterilants. (Campion, D.G., 1967)
- 1258 Sterilizing effect of γ -rays and apholate on the Mexican bean beetle, *Epilachna varivestis* Muls. (Carillo, J.L. et al., 1963/1964)
- 1267 Effects of gamma radiation and chemosterilants on the cattle tick, *Boophilus microplus*. (Kitaoka, S. et al., 1967)
- 1268 Sterilization of boll weevils with combinations of chemosterilants and radiation. (Klassen, W. et al., 1967)
- 1279 Effect of temperature on radiation induced male sterility in the silkworm *Bombyx mori* L. (Sugai, E., 1965)
- 1281 Progress in the sterilization of the European pine shoot moth. (Taylor, K.B. et al., 1966)
- 1291 An attempt to obtain sterility of male rice hispa through gamma radiation. (Abdul Matin, A.S.M. et al., 1966)
- 1300 x-Radiation and temperature modification of reproductive performance of single-species and mixed-species cultures of *Tribolium confusum* and *Tribolium castaneum*. (Erdman, H.E., 1966)
- 1302 Effects of gamma radiation on fertility, mating and longevity of males of the oriental fruit moth, *Grapholitha molesta* (Lepidoptera: Tortricidae) (George, J.A., 1967)
- 1307 Laboratory and field cage studies of the effects of gamma radiation on codling moths. (Hathaway, D.O., 1966)
- 1308 Some effects of gamma radiation and apholate on the fertility of *Drosophila melanogaster*. (Henneberry, T.J. et al., 1967)
- 1309 Some irradiation studies and related biological data for *Culicoides variipennis* (Diptera: Ceratopogonidae). (Jones, R.H., 1967)
- 1331 Irradiation effects on midguts and testes of the adult boll weevil, *Anthonomus grandis*, determined by histological and shielding studies. (Riemann, J.G. et al., 1967)
- 1338 Observations on the behaviour of pupae of *Hyphantria cunea* Drury irradiated with γ -radiation. (Boguleanu, G., 1965)
- 1341 A study on the life history and the effect of radiation on rice weevil (*Sitophilus oryzae* L.) (Chettachai Baditsing, 1966)
- 1350 Ontogeny and x-radiation sensitivity of the flour beetle, *Tribolium*. (Erdman, H.E., 1967)
- 1354 Stérilisation de la mouche méditerranéenne des fruits, *Ceratitis capitata* Wied., par irradiation des pupes aux rayons gamma. (Féron, M., 1966)
- 1355 Gamma irradiation of pupae of the tobacco budworm. (Flint, H.M. et al., 1967)
- 1360 Effect of x and γ -radiation on the development of unmatched gypsy moths (*Oenieria dispar* L., Lymantriidae, Lepidoptera). (Kakhmanyuk, F.S. et al., 1967)

- 1366 Sterilization of onion maggots by irradiation with cesium-137. (McGlashan, R.J. et al., 1966)
- 1373 The effects of gamma radiation upon various stages of Fannia canicularis (L.) (Nelson, T.E., 1966)
- 1391 Effects of gamma radiation on Rhyzopertha dominica, Sitophilus oryzae, Tribolium confusum, and Lasioderma serricorne. (Tilton, E.W. et al., 1966)
- 1396 Effect of gamma irradiation on the development and sterility of Angoumois grain moth (Sitotroga cerealella Oliv.). (Yupares Permswang, 1968)
- 1430 Radiation effect on red flour beetle (Tribolium castaneum Hbst.). (Boontiam Disyam, 1966)
- 1431 Radiation sterilization of the black blow fly. (Bushland, R.C., 1966)
- 1439 Radiation studies with the boll weevil: lethal effects on larvae, pupae, and adults; male sterility and dose fractionation. (Flint, H.M. et al., 1966)
- 1444 Studies on the use of gamma radiation in the control of pea weevil (Callosobruchus chinensis L.). (Srisan Ruangopas, 1966)
- 1448 Mortality staging of dominant lethals induced in the sugarcane borer Diatraea saccharalis (F.) (Crambidae, Lepidoptera). (Walker, D.W. et al., 1966)
- 1471 The effects of gamma radiation on mating competitiveness and fecundity of Hippelates pusio Loew. (Flint, H.M., 1966)
- 1472 Effect of mating sequence on egg-hatch from female Aedes aegypti (L.) mated with irradiated and normal males. (George, J.A., 1967)
- 1477 Mating competition of gamma-irradiated and non-irradiated male Trogoderma glabrum Herbst. (Tilton, E.W. et al., 1966)
- 1479 The effects of gamma radiation on the biology and behaviour of adult Ips confusus (LeConte) (Coleoptera: Scolytidae). (Wood, D.L. et al., 1967)
- 1491 A study of the genetic processes in irradiated populations of Drosophila melanogaster. III. The fecundity and the concentration of lethal mutations. (Bileva, D.S., 1967)
- 1514 An estimate of the effects of fallout beta radiation on insects and associated invertebrates. (Teresi, J.D. et al., 1966)
- 1538 Prospects of integrated microbial and radiation control of harmful insects. (Jafri, R.H., 1967)
- 1559 Progress in insect control by irradiation induced sterility. (Cutcomp, L.K., 1967)
- 1563 Control of an insect population by means of the sterile male technique. (Katiyar, K.P., 1967)
- 1569 Radiation-induced sterilization. (LaChance, L.E. et al., 1967)
- 1578 Cobalt-60 sterilization studies with the European chafer. II. (Chung, S.L. et al., 1966)
- 1583 Studies on the eradication of Anopheles pharoensis Theobald by the sterile-male technique using cobalt-60. I. Biological effects of gamma radiation on the different developmental stages. (Abdel-Malek, A.A., et al., 1966)
- 1584 Studies on the eradication of Anopheles pharoensis by the sterile-male technique using cobalt-60. III. Determination of the sterile dose and its biological effects on different characters related to "fitness" components. (Abdel-Malek, A.A. et al., 1967)
- 1585 Studies on the eradication of Anopheles pharoensis Theobald by the sterile-male technique using cobalt-60. VI. Sperm activity in males irradiated with the sterilizing dose. (Abdel-Malek, A.A. et al., 1967)
- 1591 Laboratory and field studies with ⁶⁰Co sterilized horn flies. (Hoffman, R.A. et al., 1966)
- 1592 Control of fruit flies by gamma rays. (Huque, H. et al., 1966)
- 1593 Control of fruit flies Dacus zonatus Saunders by gamma-rays. (Huque, H. et al., 1967)
- 1598 Determination of the sterilization dose of the medfly with OIRSA Co-60 irradiator. (Katiyar, K.P., 1967)
- 1608 Study of the biology, breeding and sterilisation of the cabbage fly, Phorbia brassicae Bouché, with special reference to its occurrence in radish cultures. (Riedel, M., 1967)
- 1609 Study on mass breeding and sterilisation of the Mediterranean fruit fly Ceratitis capitata Wied. (Scherney, F. et al., 1967)
- 1610 Studies on eradication of Anopheles pharoensis by the sterile-male technique using cobalt-60. II. Induced dominant lethals in the immature stages. (Tantawy, A.O. et al., 1966)
- 1614 Sterile flies used, Enemy of olives subjected. (Whitney, D., 1966)
- 1618 Prospective use of radiation to control the hollyhock seed moth (Lepidoptera, Gelechiidae). (Azaryan, G.K. et al., 1965)
- 1619 Sterile moths in Canada - bewildered, but effective. (Madsen, H.F., 1965)
- 1620 Codling moth control. (Madsen, H.F. et al., 1967)

- 1622 Studies on the application of the sterility method in the tick *Omithodoros tholozani*. (Galun, R. et al., 1967)
- 1633 Can nuclear energy be used for the protection of cereal stores against insects? (Persson, P., 1965)
- 1657 Status of irradiation control of insects in grain. (Cornwell, P.B., 1966)
- 1662 Radiation disinfestation of grain and seeds. (Golumbic, C. et al., 1966)
- 1668 Food irradiation research and pilot facilities in operation or planning in India. (Kumta, U.S. et al., 1966)
- 1684 L'effort belge en matière d'irradiation des aliments. (Proost, M., 1965)
- 1686 Gamma irradiation of grain and other reserves for sterilizing and exterminating pests. (Rukavishnikov, B.I., 1964)
- 1696 Irradiation of mangoes for control of the mango seed weevil (*Sternuchus mangiferae*). (Upadhyay, M.D. et al., 1966)
- 1712 Central Africa. I. The USDA research team for the chemosterilisation of tsetse flies. III. The radio-sterilisation of tsetse. (2 papers). (Dame, D.A. et al., 1965)
- 1791 "Proceedings of FAO/IAEA Training Course on Use of Radioisotopes in Entomology, Gainesville, Fla., 4 Oct.-26 Nov. 1965". (International Atomic Energy Agency, Vienna/Austria/, et al., 1965)

2.1.7. Pesticide Resistance. Pathogen Susceptibility. Effects on Pathogens

- 1160 Berdjis, C.C. et al. VIRUS INFECTION AND x RADIATION: A COMPARATIVE STUDY OF INFECTION WITH AN ATTENUATED VENEZUELAN EQUINE ENCEPHALOMYELITIS VIRUS AND OF x RADIATION. *J. infect. Dis.* 109, 1 (1961) 62-70.
- 1161 Erdman, H.E. RADIATION AND DDT EFFECTS IN FLOUR BEETLES. p. 19-22 of "Pacific Northwest Laboratory Annual Report for 1965 in the Biological Sciences", BNWL-280, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Jan. 1966, 150p.

Modification of fitness parameters of homogenic populations singly or doubly stressed with x-radiation and DDT were specific for species and strains of flour beetles (*Tribolium*). (Auth.)

- 1162 Guenther, A.W., Ware, G.W. EFFECTS OF x-IRRADIATION ON TOXICITY OF MALATHION, HEPTACHLOR, AND TEMIK TO THE HOUSE FLY. *J. econ. Ent.* 60, 2 (1967) 369-373.

Dosage-mortality studies were conducted on both sexes of houseflies, *Musca domestica* L., the pupae receiving 5000 R x-irradiation. Single doses of the toxicant were applied to flies from pupae which had been irradiated with 7500 and 10 000 R, and to flies receiving 25 000, 50 000, and 75 000 R immediately before topical application. Generally, irradiation of pupae (1) increased toxicity of heptachlor to males and females; (2) reduced significantly the toxicity of malathion to females, with no effect on males; and (3) reduced significantly the toxicity of Temik® (2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl) oxime) to males, with no effect on females. Irradiation of adults (a) had no evident effect with heptachlor for either sex; (b) had no effect with malathion; and (c) increased significantly the toxicity of Temik to both sexes at 75 000 R. It is suggested that the phenomenal response observed in (2) may be attributed to altered ratios or increased levels of esterases involved in detoxication of malathion. (Auth.)

- 1163 Jafri, R.H. SUSCEPTIBILITY OF IRRADIATED INSECTS TO *Bacillus thuringiensis* INFECTION. p. 351-354 of "International Colloquium of Insect Pathology. Paris, 1962".

Experiments were performed on the susceptibility of x-irradiated *Tribolium* beetles to non-specific bacterial toxin or to *B. thuringiensis* infection. *Tribolium confusum* and *T. castaneum* beetles were exposed to x-ray doses of 100, 50 000 or 90 000 R. *T. confusum* beetles were offered wheat flour (containing spores of *B. thuringiensis*) immediately after treatment 24 h post irradiation, and on the 7th day after exposure to the x-ray dose. *T. castaneum* beetles, having latent infections of *Farinocystis tribolii* and *Nosema whitei*, were fed wheat flour (containing spores of *B. thuringiensis*) immediately after exposure. *T. confusum* beetles receiving nonspecific bacterial toxin immediately after

exposure to 100, 50 000, or 90 000 R showed a gradually higher rate of mortality and mortality time was shortened as the dose was increased from 100 - 90 000 R. Mortality time of x-irradiated beetles receiving bacterial toxin on 7th day after irradiation showed a gradual rise in mortality and a sharp decrease in total mortality time as the dose was increased from 100 to 90 000 R. The comparative mortality pattern indicated not only decreased resistance of the irradiated hosts and higher susceptibility to *B. thuringiensis* toxin but also suggested the significant role of the time factor in administration of pathogen or toxin to the irradiated insects. The total mortality time of beetles manifesting latent infections of *F. tribolii* and *N. whitei* was shortened as the dose was increased from 100 - 90 000 R. These findings indicated that protozoan-infected beetles were more sensitive to radiation. The total mortality pattern of the irradiated beetles developing *B. thuringiensis* vegetative cells and of beetles manifesting no infection depended on the radiation dose. However, overall mortality time of beetles with *B. thuringiensis* vegetative cells was considerably decreased after exposure to different x-ray doses as compared to control nonirradiated beetles. These results suggested new means of biological and radiation control of stored grain pests and showed the practical importance of exploring the potentialities of bacterial toxins and of protozoan diseases in controlling nonirradiated and irradiated insects of economic importance. (NSA 21: 1967, 24632)

- 1164 Jafri, R.H. SYNERGISTIC ACTION OF RADIATION AND OF *Bacillus thuringiensis* TOXIN ON PROTOZOAN DISEASES OF INSECTS. * *Int. Congr. Protozool.* (1963) 510-515. Also presented at "1st International Conference on Protozoology. Prague, Czechoslovakia, 22-31 Aug. 1961".

Experiments are reported on the synergistic action of x-rays and of *B. thuringiensis* toxin on flour beetles, *Tribolium castaneum* and *T. confusum*, that were infected with the coccidian *Adelina tribolii*, the macrosporidian *Nosema whitei* (in *T. confusum*), or the schizogregarine *Farinocystis tribolii* (in *T. castaneum*). The beetles were exposed to x-ray doses ranging from 100 - 90 000 R. The mortality rate in noninfected, infected, and doubly infected beetles was evaluated. Mortality of *Farinocystis*-infected beetles after x-ray treatment was most markedly increased after low doses of x-radiation. In comparison to the mortality of infected, nonirradiated beetles, the 100-R dose increased mortality 3 to 4-fold in *T. castaneum* during the 1st 40 d after treatment. The increase in mortality of beetles irradiated by higher doses (60 000 and 90 000 R) was less marked. The reaction of infected beetles to the 100 R dose during the 1st 15 d was the same as that of non-infected beetles exposed to 90 000 R. Similar synergistic effects were recorded for *A. tribolii*-infected *T. confusum* beetles. Mortality of non-infected beetles exposed to 60 000 and 90 000 R was lower than that of the infected ones. In general, diseased adults of both flour beetles were highly susceptible to x-rays. Only a low toxicity of the *B. thuringiensis* toxin for the flour beetles was seen. *Adelina*-infected adults were killed in half the time required for the death of the noninfected beetles when a concentration of 25×10^7 spores of *B. thuringiensis* was used in the feeding flour. In larvae, the effect of bacteria or the combination of bacteria and *Adelina* infection was much slower but still significant. (NSA 21: 1967, 26592)

* Originally cited without abstract (see III/890)

- 1165 Karpov, A.E. THE ROLE OF x-RAY IRRADIATION IN THE PATHOGENESIS OF NUCLEAR POLY-HEDROSIS OF INSECTS. (Bag30:1966, 88120) *Vop. Biofiz. Mekhanizma Deistviya Ioniz. Radiat.* (1964) 356-359.

- 1166 Podolyan, V.Y. THE PATHOGENIC EFFECT OF SMALL AND AVERAGE DOSES OF GAMMA-RAYS ON FUTURE GENERATIONS OF IRRADIATED INSECTS. *Trudy Inst. Zool.*, Alma-Ata 19 (1963) 220-235. (In Russian) Translation: *Referat. Zh. Biol.* (1964) 1E4.

Studies were made of the effect of γ -radiation at 100, 250, 500, 1000, and 1500 R given to irradiated imagoes of *Protophormia terrae-novae* in the F_1 to F_5 generations. Results show both large and comparatively small doses of γ -rays have a pathogenic effect. Small and intermediate doses of γ -rays are dangerous not only because of immediate somatic damage, but also because of injury to following generations (low fertility in the females, a large percentage of unfertilized eggs, a high death rate among larvae and cocoons). (BA)

- 1167 Stahler, N., Terzian, L.A. REPRODUCTIVE AND IMMUNOLOGICAL CHARACTERISTICS OF A STRAIN OF *Aedes aegypti* SELECTED FOR RESISTANCE TO GAMMA RADIATION. *Ann. ent. Soc. Am.* 59, 4 (1966) 763-765.

A strain of *A. aegypti* (L.), mass selected for resistance to γ -radiation, mated readily with the parent strain and showed no reproductive isolation. Oviposition rates, and usually susceptibility to malarial infection, were reduced in the selected strain, as well as in the parent stock, which had been irradiated as eggs. After 20 successive generations of inbreeding without exposure to radiation, the offspring of the selected strain continued to show a significantly greater radiation resistance than the parent strain. (Auth.)

- 1168 Terzian, L.A., Stahler, N. A SELECTED STRAIN OF *Aedes aegypti* RESISTANT TO GAMMA RADIATION. *Radiat. Res.* 28 (1966) 643-646.

Eggs (10-d-old) of both a selected strain and the parent NMRI strain of the mosquito *A. aegypti* were exposed to 2000 R γ -radiation at the rate of approx. 200 R/min in air. The eggs of the selected strain were found to be more resistant to the effects of this dose of γ -radiation than were the eggs of the parent strain, since a significantly higher proportion of the larvae from irradiated eggs survived to become viable adults. On the other hand, adults of the selected strain derived from eggs not exposed to radiation died more quickly and had a significantly shorter life span than the adults from the non-irradiated eggs of the parent colony. (NSA 20: 1966, 33032)

- 1169 Vashkov, V.I., Poleshchuk, V.D. EFFECT OF x-IRRADIATION ON INSECT SENSITIVITY TO INSECTICIDES. *Zh. Mikrobiol. Ėpidem. Immunobiol.* 43, 8 (1966) 9-11. (In Russian)

Female houseflies (*Musca domestica*) were irradiated with x-rays. Small doses of x-rays stimulated their viability. The LD 50 was 100 000 rad, the LD 100 was 130 000 rad. Sensitivity of flies to insecticides was determined after a topical application of alcoholic solutions of DDT, hexachloro-cyclohexane, and chlorophos. LD 50 values of DDT, hexachlorocyclohexane, and chlorophos were 8, 0.3 and 0.85 μ g/fly, respectively. After the irradiation, a 1.2-7-fold increase was observed in fly sensitivity to the insecticides, depending on the dose of irradiation. (CA 65: 1966, 14072e)

- 1170 Vashkov, V.I., Poleshuk, V.D. THE EFFECT OF x-IRRADIATION ON INSECT SENSITIVITY TO INSECTICIDES. *Zh. Mikrobiol. Ėpidem. Immunobiol.* 8 (1966) 9-11. (In Russian, with English summary)

The effect of x-irradiation on the sensitivity to DDT, hexachlorane and chlorophos was studied on 5-d-old domestic flies (female). Fly susceptibility to insecticides varied, depending on the x-ray dose absorbed. Following irradiation there was an increase in chlorophos sensitivity by a factor of 1.2-6, to hexachlorane of 1.2-9, and to DDT of 1.2-7 as compared with controls. Max. fly sensitivity to insecticides was observed after a particular dose: for hexachlorane - 10 000 rad, DDT - 30 000 rad, and chlorophos - 40 000 rad.

- 1171 Ware, G.W., Guenther, A.W. EFFECTS OF x-IRRADIATION ON TOXICITY OF INSECTICIDES. *Bull. ent. Soc. Am.* 12 (1966) 252. Abstr. 33, at "Portland Meeting. Portland, Oreg., USA. 28 Nov. -1 Dec. 1966".

Female flies from irradiated pupae were highly tolerant to malathion with no change in males. The opposite was found with Temik®. Irradiated adults showed no change in tolerance to heptachlor and malathion, but susceptibility to Temik increased greatly in both sexes. (Abstr.)

- 1172 Wood, R.J. RESPONSE OF INSECTS TO RADIATION. p.2 of "Pacific Northwest Laboratory Monthly Activities Report, July 1966, on AEC Division of Biology and Medicine Programs". BNWL-304, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab", Aug. 1966, 16p.

A data analysis was continued relative to deducing the genetic bases for changes in flour beetles grown under the influence of DDT and x-irradiation.

See also :

- 1159 Effect of host eggs derived from irradiated pupae of the sugarcane borer on *Trichogramma* parasitism. (Yoshimaki, M. et al., 1967)
1410 Modification of fitness in species and strains of flour beetles due to x-ray and DDT. (Erdman, H.E., 1966)
1443 Effect of gamma radiation on the larvae and the nuclear-polyhedrosis virus of the Eastern tent caterpillar, *Malacosoma americanum*. (Smirnov, W.A., 1967)

- 1501 Some new mutants of the house fly, *Musca domestica*, with notations of related phenomena. (Hoyer, R.F., 1966)
- 1538 Prospects of integrated microbial and radiation control of harmful insects. (Jafri, R.H., 1967)

2.1.8. Tumour Induction

- 1173 Baroche, C. POTASSIUM PHTHALATE AND TUMOR DEVELOPMENT IN *Drosophila*. II. *Bull. Ass. fr. Étude Cancer* 52, 3 (1965) 255-166. (In French)
- K phthalate (I) (0.625-35 mg/ml diet) o-phthalic acid (5 mg/ml), or fluorescein (10 mg/ml) suppressed the incidence of tumours in *Drosophila* strain *cl tu* (melanic-tumour sensitive) imagoes when fed to the larvae: a linear relation was shown between the probit of normal insects and the logarithm of the I concentration of the medium. However, treatment increased tumour incidence in the untreated offspring of treated parents: the incidence increased as a function of the number of treated parental generations, remained at a stable level ≤ 30 generations, and was irreversible. The offspring remained sensitive to I throughout the 30 generations. The effects of x-irradiation were examined: I suppressed the tumour-inducing effects of x-irradiation (600 R) of 24-h-old 1st generation larvae maintained on a medium containing I. A linear relation was shown between the probit of the level of normal insects and the log of the I concentration. However, x-irradiation diminished the sensitivity of the strain to I: in non-irradiated and irradiated insects, 1.62 mg and 10.2 mg/ml respectively, inhibited tumour formation in 50% of the insects. The effects of I on the descendants of these flies were similar to those in non-irradiated insects. The inhibitory action of I on tumour formation is due to its toxic effect and is active at the physiological level of tumour development: its action on tumour development in descendants of treated insects involves hereditary mechanisms. (CA 64: 1966, 20288c)
- 1174 Brooks, G.T. EFFECTS OF X-RAYS, TRYPTOPHAN METABOLITES, AND EYE COLOR MUTANTS ON THE TUMOR-SUPPRESSOR SYSTEM IN *Drosophila melanogaster*. *Diss. Abstr.* 27, 12 Pt.1 (1967) 4597-B.

Four stocks of *D. melanogaster* incorporating different combinations of tumour alleles on the II chromosome and tumour-suppressor alleles on the III chromosome were submitted to 1000 R of x-rays, dietary manipulations, and mutant eye colour gene substitutions in order to test the influence of x-ray action and tryptophan metabolism on the induction of melanotic tumours in 3rd-instar larvae. There was no significant difference between tumour incidence resulting from x-ray treatment in air and that resulting from x-ray treatment in 100% O₂; but both treatments produced a significant increase in tumour penetrance over control incidence for each of the four parent stocks: suppressor-erupt (*tu*: *su-tu*), *al b c sp*³(*tu*⁺: *su-tu*⁺), tumour (*tu*: *su-tu*⁺), and erupt(*tu*⁺: *su-tu*). Comparisons of tumour incidence in parent stocks, F₁ progenies, and certain backcross progenies revealed the existence of effective isoalleles of varying potency at both the tumour and tumour-suppressor loci. The *tu*⁺ and *su-tu*⁺ alleles, previously assumed to be ineffective wild-type alleles, are, in actuality, weakly effective alleles. The results indicate that a dominance relationship exists among the three tumour alleles such that the order of dominance is *tu*⁺ > *tu*^{er} > *tu*, while the effectiveness in producing the tumour phenotype is just the reverse: *tu* > *tu*^{er} > *tu*⁺. Of the two suppressor alleles, *su-tu*⁺, seems to be dominant over *su-tu*, which is a much stronger suppressor than the former. The *su-tu* allele appears to act as a recessive in the presence of homozygous *tu*, while the *su-tu*/*su-tu*⁺ combination is quite effective in suppressing the tumour phenotype produced by weaker tumour allele combinations. The increase in tumour incidence following x-ray treatment is attributed to a dual action of x-rays: enhancement of the expression of the tumour gene and inhibition of the expression of the tumour-suppressor gene. It was further postulated that x-ray action has a differential effect according to the potency of alleles present at the two loci. (From DA)

See also :

- 31 Effets tumorigènes de la leucine, de l'uridine et de la thymidine tritiées chez les larves de la drosophile. (Chelelovitch, S., 1966)
- 1263 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, H.B., 1966)

2.1.9. Modifying Factors
(Intensity. Mode of Irradiation. Ploidy. RBE. LET.
Temperature. Synergists. Chemicals including Protective Agents.
Environment at Irradiation. Medium. Irradiated Molecules. Etc.)

- 1175 Abeleva, E.A. INFLUENCE OF ARGININE OF RADIATION DAMAGE OF SPERMATIDS AND SPERMATOCYTES IN Drosophila. Genetika No.6 (1965) 115-119. (In Russian)
- The effects of arginine on spermatogenesis were investigated in γ -irradiated (1000 or 1500 R) D. melanogaster males. The crossing-over frequency was determined in the F_1 progeny of irradiated males crossed with virgin females. Neither the time nor the frequency of crossing-over were affected by arginine. Comparison of fertility curves of males both exposed and unexposed to arginine treatment suggested that arginine either removes or reduces the radioinduced delay of spermatogenesis. Protective actions of arginine were further shown to be very versatile. (NSA 20 : 1966, 22780)
- 1176 Abeleva, E.A. INFLUENCE OF 2,4-DINITROPHENOL (DNP) ON MUTATION FREQUENCY IN SPERM CELLS AND SPERMATIDS OF Drosophila IRRADIATED WITH GAMMA RAYS. Genetika No.1 (1966) 116-118. (In Russian)
- Studies showed that DNP treatment decreases frequency of recessive sex linked lethal mutations in γ -irradiated Drosophila spermatids at a dose of 1000 R. It is significant that in sperm cells of the same flies mutation frequency did not change. (NSA 20 : 1966, 33079)
- 1177 Abeleva, E.A. NORMALIZING EFFECT OF ARGININE ON THE RELATION BETWEEN THE IONIZING RADIATION DOSE AND THE FREQUENCY OF MUTATION GENERATION IN Drosophila SPERMATIDS. p.209-219 of "Vliyanie Ionizirovannykh Izlucheni na Nasledstvennost". Dubinin, N.P., Ed. Moscow. Izdatel'stvo Nauka, 1966. (In Russian)
- The effect of arginine (I) on the frequency of mutation generation was studied in Drosophila spermatids. Drops (5-6) of I solution (2 mg of I/ml water) were added to medium containing larvae of Drosophila D-18. The males born from these larvae (1.5 to 2 d old) were γ -irradiated with 1-3 kR (dose rate 326 R/min), and individually mated with five virgin females every day for 7 d. Mutation frequency and fertility of the males were determined. A bell-like form of the curve of frequency of mutations as a function of the irradiation dose was found in medium spermatids (5 d). Mean fertility was one descendant/male/d at this time interval, after the irradiation with 3 kR. Max. frequency of mutations following irradiation with 3 kR was noted in the late spermatids (4 d). Then it decreased together with the fertility (on the 7th day 0.3 descendant/male/d.). In males treated with I during the larval state the max. frequency of mutations was observed on the 5th day. A higher percentage of mutations together with about 2 times greater fertility was observed on the 5 - 7th day in males treated with I, in comparison with irradiated controls. The linear dependence of mutation frequency on the dose was observed in experiments with I. Possible mechanisms of I action on the radiation mutagenesis were discussed. (CA 67:1967, 8487r)
- 1178 Alexander, M.L. DIMETHYL SULFOXIDE TREATMENT OF Drosophila. p.505-516 of "Studies in Genetics. III," Wheeler, M.R., Ed. Austin, Tex., University of Texas, 1966.
- An investigation of the effect of dimethyl sulfoxide on radioinduced genetic damage in adult male D. melanogaster is described. Young adult male abdomens were dipped in concentrated dimethyl sulfoxide and exposed to x-ray doses of 4213, 1674, and 2000 R 4 to 5 h later. Others were injected with .0004 ml of a 10^{-1} M solution of dimethyl sulfoxide 4 to 5 h before exposure to a 2000-R x-ray dose. Others were developed from eggs on a diet supplemented with 0.5% dimethyl sulfoxide before exposure to a 2000-R x-ray dose. Genetic damage was evaluated by measuring dominant lethals, translocations, or sex-linked recessive lethals after mating treated males. None of the chemical treatments protected against radioinduced genetic damage. It is suggested that the 4-h period between chemical treatment and irradiation may be too long for the detection of radioprotective effects. (From NSA 21:1967, 34690)

- 1179 Antipov, V.V., Arsenyeva, M.A., Davydov, B.I., Delone, N.L., Lifshitz, N.N., Saksonov, P.P., Parfenov, G.P., Rybakov, N.I. INVESTIGATION OF THE COMPLEX EFFECT OF IONIZING RADIATION AND OTHER FACTORS OF SPACE FLIGHT ON THE ORGANISM. p.23 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, 26 Jun.-2 Jul. 1966, 283p." Abstr. 87.

The effect of complex factors of space flight on some functions of different organisms is considered. In experiments with fruit flies, vibration after and acceleration before irradiation enhances the radiation effect. A decrease in the rate of crossing-over was observed when vibration was used before radiation. (From abstr.)

- 1180 Antipov, V.V., Delone, N.L., Parfenov, G.P., Vysotskiy, V.G. RESULTS OF BIOLOGICAL INVESTIGATIONS CONDUCTED DURING FLIGHTS OF "VOSTOK" TYPE VEHICLES WITH THE PARTICIPATION OF COSMONAUTS A.G. NIKOLAYEV, P.R. POPOVICH, AND V.F. BYKOVSKIY. p.239-251 of "Problems of Space Biology. Vol.4. 1966". N66-19292, National Aeronautics and Space Administration, Washington, D.C.

Results are presented for experiments dealing with the reproductive processes in *Drosophila melanogaster* under conditions of weightlessness, and the study of space flight factors which affect the hereditary structure in *Tradescantia paludosa*. The hypothesis is advanced that chromosome rearrangements result from dynamic factors occurring during lift-off and descent of the spacecraft, and that weightlessness does not cause such rearrangements. The data do not eliminate, however, the possibility that weightlessness may cause disruptions of the mitotic mechanism. Also observed were the formation of excrescences in cells, giant cells and disrupted synchrony of microspore development, but the individual flight factors causing these cannot be determined. Experiments with the flies indicated that breeding time was increased from the usual 9 to 15 d for eggs laid during weightlessness. More females were hatched than males, and several ideas are advanced to explain this, including space travel effects on Y-chromosomes utility, a loss of Y-chromosomes during meiosis, or that the female larvae were more fit. (Scient. A. Techn. Aerospace Repts.)

- 1181 Asman, S.M., Rai, K.S. GAMMA RADIATION AND HETEROSIS IN *Aedes aegypti*. Bull. ent. Soc. Am. 13, 3 (1967) 201. Abstr. 310, at "New York Meeting of the Entomological Society of America, New York, N.Y., USA. 27-30 Nov. 1967".

Hybrid lines of *A. aegypti* demonstrate heterosis in their greater tolerance to the deleterious effects of ionizing radiation. Data also suggest that hybrid vigour can result in highly inbred strains by the induction of polygenic mutations using low doses of radiation. (Abstr.)

- 1182 Borstel, R.C., von. MUTAGENIC EFFECTIVENESS OF KNOWN DOSES OF GAMMA RADIATION IN COMBINATION WITH WEIGHTLESSNESS OF *Habrobracon*. Summary Progress Report, February 17, 1964 - June 30, 1966. ORNL-TM-1731, Oak Ridge National Lab., Tenn. Mar.1967, 26p.

Progress is reported on the following studies: preparation of the *Habrobracon* stocks for the biosatellite experiment; biosatellite preparatory experiments; spontaneous mutation frequencies in *Habrobracon*; *Habrobracon* experiments in simulated space-flight tests; x-radiation sensitivity of *Habrobracon* oocytes at diakinesis; time of death of a translocation segregant in *Habrobracon*; and x-ray induction of mutations in *Habrobracon*. (NSA 21: 1967, 22375)

- 1183 Borstel, R.C., von. MUTAGENIC EFFECTIVENESS OF KNOWN DOSES OF GAMMA RADIATION IN COMBINATION WITH WEIGHTLESSNESS ON *Habrobracon*. Quarterly Progress Report to the National Aeronautics and Space Administration, July 1-September 30, 1966. ORNL-TM-1732, Oak Ridge National Lab., Tenn. Mar.1967, 42p.

The report lists the types of genetic and cellular damage assayed in *Habrobracon* and the method of data analysis. The results of the Ames Research Center Biocompatibility Test are described, the radiation conditions surrounding the *Habrobracon* in the ARC Test, and the result of the Flight Vehicle Tests at General Electric Company. Some of the supporting experiments are reported, which are required continuously to keep improving the experimental system. A discussion is included that provides a theoretical foundation for the *Habrobracon* dominant lethality data that will come from the ground control for the Biosatellite experiment.

- 1184 Burditt, W.J., Yoon, J.S. EFFECTS OF ECDYSONES ON FREQUENCY AND DISTRIBUTION OF x-RAY INDUCED LETHALS IN *Drosophila melanogaster*. *Genetics* 56, 3 Pt.2 (1967) 547-548. Presented at the "1967 Meetings of the Genetics Society of America. Stanford, Calif., USA. 31 Aug.-2 Sep. 1967".

The possible alteration by hormonal action of the frequency and distribution of mutations induced by radiation was tested in a large series of experiments, utilizing ecdysones as hormone and lethal mutations on the X-chromosome as the indicator. Males were treated with ecdysones 20 min before radiation with a dose of 3000 R (140 kV and 5 ma) with and without oxygen. The data suggest that ecdysones may protect against genetic radiation damage in the presence of oxygen. When the 294 lethals obtained were localized by crossover analysis, no significant difference in the distribution ($P < 0.01$) of lethals along the X-chromosome in groups treated with and without ecdysones was found. (Abstr.)

- 1185 Close, P., Beischer, D.E. EXPERIMENTS WITH *Drosophila melanogaster* IN MAGNETIC FIELDS. AD-404251, Naval School of Aviation Medicine, Pensacola, Fla. 1 Aug. 1962, 10p.

No genetic effects were observed in *Drosophila* on exposure to homogeneous and inhomogeneous magnetic fields of high field strength and gradient. Synergistic effects of magnetic fields in combination with x-radiation, starvation, hyperoxia, and hypoxia were also not observed. (Auth.)

- 1186 Dauch, F., Apitzsch, U., Catsch, A., Zimmer, K.G. RBE OF FAST NEUTRONS BY THE RELEASE OF MUTATIONS IN *Drosophila melanogaster*. *Mutation Res.* 3 (1966) 185-193. (In German)

The RBE of fast neutrons (as compared with x-rays) was determined in *D. melanogaster* for various broods (stages of germ cells) and for sex-linked recessive lethals as well as for translocations between IIId and IIId-chromosome. A pronounced dependence of RBE on the stage of the germ cells was shown to occur and to account for most of the discrepancies reported in earlier work. Moreover, the RBE was demonstrated to be lower for recessive lethals than for translocations at all stages of spermatogenesis tested. These findings are discussed briefly as to their implications for problems of protection from radiation damage. (Auth.)

- 1187 Delahaye, R.P., Tabusse, E. SPACE REPORT. EXTRATERRESTRIAL RADIATIONS. I. BIOLOGICAL STUDIES. *Revue Méd. Aéronautique* 3 (1964) 593-597.

The authors review the findings and results of biological studies which bear upon the biological effects of extraterrestrial radiations. The four types of extraterrestrial radiations include galactic cosmic radiations, solar cosmic radiations, radiation of the Van Allen belt, and interplanetary plasma. The composition of these radiation areas is fairly well known. A wide variety of experimental animals and plants have been tested for radiobiological effects. These include mammals such as dogs, guinea pigs, rats, and pigs, *Drosophila*, grains and vegetables, *Chlorella*, microbiological samples, and DNA. Estimates of the relative biological effectiveness of radiations encountered have been made. Many of these measurements have been made below sea level, as well as at sea level, during balloon flights, or in satellites.

- 1188 Dickerman, R.C. FAST NEUTRON AND x-RAY IRRADIATION OF *Drosophila melanogaster* OOGONIA AND OOCYTES. *Genetics* 56, 3 Pt.2 (1967) 555-556. Also presented at "1967 Meetings of the Genetics Society of America. Stanford, Calif., 31 Aug.-2 Sep. 1967".

Female *D. melanogaster* were irradiated either with fast neutrons (0.2-0.3 MeV) from the Janus reactor of this Division or with x-rays. Oogonia and stage 7 oocytes were sampled from females irradiated when they were 0 - 4 h old. Virgin females were irradiated when they were 3 d old to provide both stage 14 oocytes and oogonia. The flies were exposed to x-ray doses of 960, 1920, 2880, and 3840 R (250 kVp, 30 ma, with 0.25 mm Cu plus 1.0 mm Al filtration, 155 rad/min). Neutron irradiations of 267, 533, and 1066 rad (at 45 rad/min) were performed on the central axis of, and 1 m from, the high flux face of the reactor. The γ -contribution averaged 8.7% of the neutron dose. Egg-to-adult viability and the induction of sex-linked recessive lethals were the end points. The oogonial stage is the least sensitive stage. Since an oogonial cell must undergo four synchronous mitotic divisions before becoming an oocyte, cell selection at this stage is rigorous. Stage 7 oocytes are intermediate in radiation sensitivity since they are metabolic-

ally active and some repair of chromosomal damage is possible. Stage 14 oocytes (mature eggs) are most sensitive to radiation damage because of their low metabolic rate and lack of cell selection processes. In terms of egg-to-adult viability, the neutrons used produce damage about three times more effectively than x-rays of similar doses. In the sex-linked lethal tests, neutrons were more effective than x-rays by a factor of < 2 . (Abstr.)

- 1189 Dickerman, R.C. MUTATIONAL RESPONSE OF *Drosophila melanogaster* OOCYTES AND OOGONIA TO x-RAY AND FAST NEUTRON IRRADIATION. *Radiat. Res.* 31, 3 (1967) 614. Abstr. Eb-7, at "15th Annual Meeting of the Radiation Research Society. San Juan, Puerto Rico, 7-11 May 1967".

Female 0-4 h old *D. melanogaster* were irradiated with either fast neutrons from the Janus Reactor or x-rays. The flies were exposed to x-ray doses of 960, 1920, 2880, and 3840 rad (250 kVp, 30 mA, with 0.25-mm Cu plus 1.0-mm Al filtration, 155 rad/min). Neutron irradiations of 267, 533, 800, and 1066 rad (at 45 rad/min) were performed on the central axis of, and 1 m from, the high-flux face of the Reactor. The neutrons have a mean energy of 0.2-0.3 MeV. The γ -contribution averaged 8.7% of the neutron dose. The end points studied were egg-to-adult viability and sex-linked recessive lethals induced in oögonia or Stage 7 oocytes. The data illustrates the role of cell repair versus cell selection on the ultimate expression of damage after irradiation by photons or neutrons. Oögonial cells, irradiated with x-rays, are damaged least; this suggests both effective cell selection and repair. Stage 7 oocytes, irradiated with neutrons are damaged most since there is little opportunity for cell selection; preliminary data indicate there is little or no repair in this stage. Oögonia, irradiated with neutrons, undergo rigorous cell selection and probably little repair, while x-irradiated Stage 7 oocytes undergo repair but show no selection. Hence, these latter two experimental groups exhibit damage intermediate between the low level seen in x-irradiated oögonia and the large amount of damage seen in neutron-irradiated oocytes. (Abstr.)

- 1190 Elequin, F.T., Yang, H.L., Yoon, J.S., Gerstenberg, V., Wilson, F., Stone, W.S. "Research in Genetics to Include: (1) The Direct and Indirect Effects of Radiations and their Modification on Genetic Systems. and (2) Population and Evolutionary Studies of *Drosophila*". Stone, W.C., comp. Final Report. 1 Jan. 1962 - 31 Dec. 1965. TID-23414, Texas Univ., Austin, 18p.

O₂ during irradiation increases net radiation damage above that found if radiation is carried out in an inert gas such as Ar. The data do not support a role of O₂ in healing genetic damage during intervals between radiation in *Drosophila melanogaster*, except in special conditions. Irradiation of 1000 R in nitric oxide does not increase or reduce genetic damage measured as translocations from that found in Ar. Irradiation of 3000 R in CO in the dark is similar to irradiating in Ar. The CO can be replaced with He, O₂, NO or CO+NO during the interval between the two 1500 R-radiations without changing the effect. Various sets of experiments are described and discussed. The results of comparisons of the rates of translocations and recessive lethals are tabulated. The relative frequency (translocations/recessive lethals) is higher in the more susceptible spermatid stages. It is also higher in experiments where more radiation damage was produced by a higher dose of radiation or the presence of O₂. At 3000 and 1000 R, the influence of cell sensitivity and environmental variables on recessive lethals is seen.

- 1191 Elequin, F.T. MODIFICATION OF INDUCED GENETIC DAMAGE IN *Drosophila melanogaster* BY OXYGEN AND ARGON TREATMENTS BETWEEN TWO DOSES OF x-RAYS. p.177-193 of "Studies in Genetics. III." Wheeler, M.R., Ed. Austin, Tex., University of Texas, 1966.

D. melanogaster males were x-rayed with two equal doses of either 500 or 1500 R separated by 20 min. They were irradiated in either O₂ or Ar at 1 atm. During the 20 min intervals flies were kept in O₂ or Ar. They were pretreated in the gases for 10 min and post-treated for 20 min. Each male was mated within an hour after treatment and remated every 2 d for 7 consecutive matings. The offspring carried chromosomes irradiated at different stages of spermatogenesis. Chromosome damage was measured by tests for sex-linked recessive lethals, dominant lethals, and translocations. When irradiated in O₂ the damage was greater in the spermatid stage if the flies were in Ar rather than O₂ in the interval between irradiations. When irradiated in Ar no significant difference was found in the degree of damage if the flies were in Ar or O₂ during the interval when the test was for sex-linked recessive lethals or translocations. The dominant lethal tests gave different results which are discussed. In O₂ radiosensitivity was at a peak during the

spermatid and meiotic stages. In Ar a differential response was less obvious. The Y-chromosome was involved in less than half the total translocations and showed no autosome preference. Chromosomes II and III were about equally affected by irradiation. (NSA 21; 1967, 34635)

- 1192 Erdman, H.E. EFFECTS OF DIMETHYL SULFOXIDE (DMSO) ON PRODUCTIVITY OF X-RAYED FLOUR BEETLES. Radiat. Res. 25 (1965) 186. Abstr.41, at "13th Annual Meeting of the Radiation Research Society, Philadelphia, Pa., USA, 23-26 May 1965".

The degree of injury to biological systems subjected to irradiations depends on the chemical as well as the physical environment. Radioprotection is known for sulphhydryl and sulfoxide compounds, although data on the latter are meagre. Germ cells are the predominantly actively dividing cells in adult insects; consequently, they are readily modified by radiation. Radiation increases the frequencies of chromosomal aberrations which may lead to illness or death and which may be modified by chemical protection. Sexually mature virgin female flour beetles, Tribolium castaneum (mutant: sooty), were treated in different ways to various concentrations of DMSO and then x-rayed with 0.5, 1, 2, and 4 kR. Survival and productivity data (fecundity and fertility) were collected. DMSO gave no radiation protection to x-rayed female germ cells whether fecundity or fertility was scored. Radiation at different time intervals after DMSO treatment was also ineffective. When females were cultured for 4 d on 100 g of dry food previously mixed with 10 cc DMSO and then placed on regular food, their reproduction began on the 3rd day. Under similar conditions but with 5 cc DMSO, productivity began on day 2. Controls reproduced on day 1. In both DMSO fed groups productivity was reduced compared to the controls. This experiment was repeated and a cytological description of the ovarioles will be presented to show the oviductal effect of DMSO. (Abstr.)

- 1193 Goldman, L.J., Saluk, P.H., Cromroy, H.L. NITROGEN EFFECT IN IRRADIATED Periplaneta americana. Bull. ent. Soc. Am. 13, 3 (1967) 192. Abstr.112, at "New York Meeting of the Entomological Society of America, New York, N.Y., USA, 27-30 Nov. 1967".

A strain of P. americana was exposed to a determined LD 50/24 h dose of 300 kVp x-rays to study the protective effect of N. The strain used initially demonstrated potentiation rather than protection. A 2nd strain showed the reverse effect. (Abstr.)

- 1194 Havin, E., Oftedal, P. RADIOSENSITIVITY OF Drosophila EMBRYOS IN AIR AND IN N₂. IN RELATION TO AGE. Radiat. Res. 25, 1 (1965) 196. Abstr.66, at "13th Annual Meeting of the Radiation Research Society, Philadelphia, Pa., USA, 23-26 May 1965".

D. melanogaster embryos show great changes in radiosensitivity with age. These changes occur during a period of rapid morphological development. It appeared possible that the relative importance of difference mechanisms of radiation injury might vary with age, leading to variations in the O enhancement ratio. Eggs were collected during 10 min periods, and x-rayed (200 keV, 0.5 Cu + 1 Al filter) in air at 14 stages between 1.0 and 3.5 h. Exposure time was 6 min in all experiments. The dose-effect curve for each age was determined with regard to hatching from the egg. Normal hatching time is 19.2 h. Counts were made at 17 h to eliminate early hatchers, and at 40 h to score non-hatchers. A stage of high radiosensitivity was found at 1.5-2 h, and a peak of low radiosensitivity at 2.7 h. The LD 50's are 186 R and 1670 R respectively. Subsequently, embryos at ages 1 h 38' and 2 h 38' were irradiated in air, or given 1 min N₂ pretreatment and then irradiated in N₂. The dose-effect curves obtained in four such series indicate that the O enhancement ratios at the LD 30, LD 50 and LD 70 levels were from 2.0-2.3, with no systematic trend. Thus, no difference in mechanism of radiation injury could be demonstrated by this method, in spite of the 9-fold difference in radiosensitivity between the stages investigated. (Abstr.)

- 1195 Hossain, M.M., Mollah, S.A., Mallik, M.U. STUDIES ON THE EXPERIMENTAL POPULATION OF Drosophila melanogaster RAISED ON IRRADIATED BANANA DIET. AECD-RB-4, Atomic Energy Centre, Dacca (Pakistan). Nov. 1966, 7p.

For abstract, see 1196.

- 1196 Hossain, M.M., Mollah, S.A., Malik, M.U. STUDIES ON AN EXPERIMENTAL POPULATION OF *Drosophila melanogaster* RAISED ON IRRADIATED BANANA DIET. *Fd Irrad.* 7, 3 (1967) 45-48.

Seven generations were fed irradiated banana diet. Bananas treated with 35 000, 45 000, and 55 000 rad were compared with untreated bananas in terms of their effect on egg-pupa ratio, percent adult emergence, longevity, egg-production, and viability in order to assess possible toxicity or changes in nutritive value, or mutagenic effects. In fertility tests 2500 flies were tested for each series. No case of sterility was observed. No effects were found which could be attributed to irradiated food.

- 1197 Khan, A.H., Alderson, T. AN ATTEMPT TO SENSITIZE *Drosophila* CHROMOSOMES TO X IRRADIATION AFTER 5-BROMODEOXYURIDINE INCORPORATION INTO DNA. *Drosoph. Inf. Serv.* 41 (1966) 135-136.

Substitution of 5-bromodeoxyuridine (BdU) for thymine in DNA enhances the sensitivity of cells to x-irradiation. Using an aseptic and chemically defined culture medium, the radiosensitivity (for sex-linked recessive lethal mutations) of chromosomes of *Drosophila* larval spermatogonia was compared in the presence and in the absence of BdU. *Drosophila* does not utilize pyrimidine bases unless they are supplied as the nucleoside. To increase the chance of BdU incorporation, larvae were cultured in the presence of the folic acid analogue, aminopterin, which inhibits thymine synthesis. A dose of 810 R of x-rays was delivered at 180 R/min. Males and females were examined for sex-linked recessive lethals by the Muller-5 method using a single brood by mating individual males to two virgin females for 3 d, and, in the case of females, by mating individual females to two males for 3 d. When larvae were cultured in the presence of either deoxyuridine or BdU for 48 h (with and without aminopterin), and followed by irradiation, or without irradiation, none of the sex-linked recessive lethal frequencies differed significantly from one another. There was no evidence for BdU-induced mutagenesis; and only a slight increase in mutation following x-irradiation of males. There was no evidence for an increase in mutational radiosensitization of the X-chromosomes in the presence of BdU, nor was there evidence for BdU incorporation, although the BdU + aminopterin cultures slowed down larval development compared with the deoxyuridine + aminopterin cultures. (NSA 21;1967, 22707)

- 1198 Kogan, Z.M. OCCURRENCE OF LETHAL MUTATIONS IN THE HETEROCHROMATINIC REGION OF *Drosophila melanogaster* X CHROMOSOME DEPENDING ON PRERADIATIONAL DEVELOPMENT TEMPERATURE. *Genetika* No.4 (1966) 38-44. (In Russian)

D. melanogaster males reared at 15°C (cold series) and at 28°C (warm series), respectively, were x-irradiated (at a dose of 6000 R). Subsequent crosses were carried out at 25°C. It was found that lethal mutation induction percentage in the heterochromatinic X-chromosome region (at the locus bobbed) was twice as high in the ripe sperm cells of the cold series in contrast to that of the warm series. Recessive sex-linked lethal and dominant sterility mutations also occurred more often at a lower development temperature though the difference between the temperature series in this case was far lower. In both temperature series a decrement of mutation frequency in spermatids in contrast to ripe sperm cells was observed. The decrement was highly stressed for *bb¹* in dominant sterility mutants and was far less manifest for recessive sex-linked lethals. (Auth.)

- 1199 Kondo, S. RBE OF FAST NEUTRONS TO γ -RAYS FOR MUTATIONS IN RELATION TO REPAIR MECHANISMS. *Idengaku Zasshi* (Jap. J. Genet.) Suppl. 40 (1965) 97-106. (In English) "Proceedings of the Conference on Mechanisms of the Dose Rate Effect of Radiation at the Genetic and Cellular Levels. Ōiso, 4-7 Nov. 1964". The Genetics Society of Japan. 1965, 280p.

A brief review of RBE for somatic and genetic damage is given for various organisms. A brief summary is given concerning comparative studies of mutation frequencies with silkworm irradiated with γ -rays, 14 MeV neutrons and fission neutrons. From the analysis of the silkworm data combined with the above mentioned review of RBE data for other organisms, the following hypotheses are proposed: (1) the overall mutation frequency in silkworm gonads depends on the interaction of radiation with the intercellular repair mechanisms connected with certain multicellular organs, and (2) the low mutation rate recovered on acute γ -irradiation of silkworm larvae of the late gonial stage is due to stimulation of repair by radiation. (Auth. summary)

- 1200 Leuthold, U. FÜTTERUNG VON STRAHLENSENSIBILISIERENDEN STOFFEN AN Drosophila. (The feeding of radiation-sensitizing substances to Drosophila.) Thesis, Eidgenössische Technische Hochschule, Zurich (Switzerland). 1966. (In German)
- 1201 Magdon, E., Winterfeld, G. INVESTIGATIONS ON THE INFLUENCE OF 5-BROMOURACILDESOXYRIBOSIDE (BuDR) ON THE RADIOINDUCED MUTATION RATE IN Drosophila melanogaster. Strahlentherapie 133 (1967) 137-148. (In German, with English summary)
- Using male D. melanogaster of the Berlin wild strain, the effect of 5-bromo-2'-deoxyuridine (BuDR) on the x-radioinduced rate of recessive and sex-linked lethal factors was investigated in different stages of spermatogenesis. It was shown that the mutation rate induced by irradiation with 1500 R was significantly increased in spermatogonia, when BuDR was given after irradiation; BuDR was not effective in sperm when administered prior to irradiation. A possible explanation seemed to be that BuDR incorporation into the DNA, sufficient for a significant increase of the radioinduced mutation rate, was possible only in germ cells that synthesize DNA, and after a radiation induced inhibition of the thymidylate synthesis. (Auth.)
- 1202 Matter, B. WIRKUNG VON H₂S AUF BESTRAHLTE UND UNBESTRAHLTE EIER VON Drosophila melanogaster. (The effect of H₂S on irradiated and non-irradiated eggs of Drosophila melanogaster.) Thesis, Eidgenössische Technische Hochschule, Zurich (Switzerland). 1966. (In German)
- 1203 Mittler, S. AET AND RADIATION INDUCED CROSSING-OVER IN MALE D. melanogaster. Drosoph. Inf. Serv. 40 (1965) 93.

A re-examination of the problem (Mittler and Hampel, Drosoph. Inf. Serv. 38) of whether AET has any effect upon radiation induced crossing-over in male D. melanogaster indicates that AET does afford significant protection to 9-12-d brood after irradiation. Adult males, 2-16 h old, heterozygous for ru h th st cu sr e^s ca, were injected with 1×10^{-7} l of 30 mg AET/10 ml buffered to pH of 7 and irradiated with 2000 R and then back-crossed to homozygous "mucua" females at ratio of one male to three females. The males were transferred to new group of females every 3 d.

Number Males	9-12-d brood			12-15-d brood		
	Crossover	Non	% Crossover	Crossover	Non	% Crossover
120 Treated	57	8502	.666	54	11361	.473
101 Control	49	5025	.966	29	4187	.688

(Auth.)

- 1204 Mittler, S. AET AND RADIATION-INDUCED CROSSING-OVER IN MALE Drosophila melanogaster. Biol. Bull. 130, 2 (1966) 228-234.
- Drosophila, heterozygous in the IIIrd chromosome for the traits roughoid, hairy, thread, scarlet, curled, stripe, ebony, and claret were injected with 3.33×10^{-5} mg of AET, irradiated with 2000 R x-ray and back-crossed to virgin flies. The controls were injected with saline. On the 9th day after irradiation, each male was isolated and mated again. This was repeated on the 12th day. There was a significant decrease in the number of γ_2 -type cross-overs (0.568%) in the older spermatogonia represented by the 9-12-d brood, compared to the controls (0.886%). No decrease was found in the early spermatogonia represented by the 12-15-d brood. The chromosomal breakage was mainly between scarlet and curled and included the centromere. AET did not influence the region of breakage. Post-treatment with N reduced the number of radiation-induced cross-overs in the controls to the level in the flies treated with AET. N post-treatment was without effect on those treated with AET. AET appeared to protect Drosophila against x-rays by inducing anoxia. (CA 65:1966, 4233d)
- 1205 Mittler, S., U. R. MODIFICATION OF RADIATION INDUCED CHROMOSOME LOSS BY ATP IN Drosophila. p.157 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966, 2630". Abstr.622.

Male *Drosophila melanogaster*, 2-16 h old, $X^{C2}yB$, $Yac^s y^+$ were irradiated with 2000 R of x-rays and then mated daily to *ywf* females at the ratio of one male to three females. The loss of the ring X-chromosome or the y^+ portion of Y resulted in the exceptional (XO) *ywf* male. Injection of 1×10^{-5} ml of 5 mg of ATP/ml in 0.85% NaCl per male fly either immediately before or after radiation resulted in a significant reduction in the percentage of XO males in certain broods. Those broods (days 7-8, 8-9, 9-10) which primarily represent cells in spermatogenesis that were in or about to go into meiosis at the time of radiation had less XO males and thus less chromosome loss as a result of pre-treatment with ATP. Post-treatment with ATP resulted in significantly less XO males in brood 7-8 d. There was no significant reduction of XO males due to ATP treatment in the postmeiotic broods days 1-4 and in the broods 10-12 d, which represent spermatogonia at the time of irradiation. It appears that exogenous ATP does aid in repair of radiation injured chromosomes at meiosis and prevents their loss. (Abstr.)

- 1206 Mittler, S., Arnesen, J.F., U, R. EFFECT OF URETHANE AND COLCHICINE ON RADIATION-INDUCED CHROMOSOME LOSS IN MALE *Drosophila*. *Int. J. Radiat. Biol.* **11** (1966) 161-170. (With French and German summaries)

Urethane or colchicine was injected, either before or immediately after 2000 R of x-rays, into male *D. melanogaster*. Urethane modified the radiation-induced loss of the ring X or $Ysc^s y^+$ chromosome, as determined by the number of XO male offspring. Urethane alone increased the loss of the ring X-chromosome primarily in the mature spermatozoa and older spermatids, whereas x-rays induced chromosome loss to a greater extent in those cells in or about meiosis. Pre-treatment or post-treatment with colchicine by means of injection near the testis gave an apparent protection against radiation-induced chromosome loss; but colchicine alone induced sterility by reducing the number of gametes available to form zygotes by affecting those cells in spermatogenesis that were in or about meiosis at the time of treatment. (Auth.)

- 1207 Mittler, S., U, R. ADENOSINE TRIPHOSPHATE: PROTECTION AGAINST RADIATION-INDUCED CHROMOSOME LOSS IN *Drosophila*. *Science*, N.Y. **152** (1966) 1087-1088.

Injection of 5 mg of adenosine triphosphate per milliliter into adult *D. melanogaster* $X^{C2}yB/sc^s y^+$ 4-8 h old either immediately before or after administration of 2000 R of x-rays protected those cells in spermatogenesis which were in or near meiosis from the loss of the ring X or the y^+ portion of Y-chromosome. The loss of the chromosomes was determined by appearance of exceptional XO males in the offspring. (Auth.)

- 1208 Mittler, S., Walsh, M.M. EFFECT OF ATP UPON RADIATION INDUCED CHROMOSOMAL ABERRATIONS IN *Drosophila*. *Genetics* **56**, 3 Pt.2 (1967) 577-578. Also presented at "1967 Meetings of the Genetics Society of America. Stanford, Calif., USA. 31 Aug.-2 Sep. 1967".

ATP at concentration of 5 mg/ml was injected (0.1 μ l) near the testis of adult *Drosophila* 2-6 h old prior to exposure of 1600 R of x-rays. The males were mated daily to a new group of virgin females at ratio one male to three females. This treatment did reduce the number of dominant lethals as determined by the failure of the larva to emerge within 24 h after the eggs were deposited. The ATP treatment reduced the dominant lethals in all broods represented by postmeiotic stages of spermatogenesis except those that were mature spermatozoa at the time of irradiation. Spermatogonia as represented by brood 9-10 d also had reduced number of dominant lethals. The decrease in radiation induced dominant lethals was probably due to the extra energy source available to aid in the repair of gross chromosomal aberrations by the exogenous ATP. Pretreatment with ATP and irradiation in air followed by a post-treatment of nitrogen limited the repair ability of the introduced ATP to brood 4-5 d which represented spermatids at the time of irradiation. The exogenous ATP, however, did not influence the radiation induction of sex-linked recessive lethals, translocations, and deletions of the X-chromosomes. (Abstr.)

- 1209 Mosse, I.B., Turbin, N.B., Freimanis, J. EFFECT OF CONJUGATE AROMATIC SYSTEMS ON HEREDITY. I. MUTAGENIC AND ANTIMUTAGENIC EFFECT OF CERTAIN INDENE COMPOUNDS. *Dokl. Acad. Nauk belorusk. SSR* **8**, 12 (1964) 827-829. (In Russian)

Male *Drosophila melanogaster* of a wild strain D-18 of high mutability and 0.35% spontaneous mutability were raised on media containing 0.12, 0.8, 4.0, or 25-35 mg/g, respectively, of 3-amino-2-phenyl-1-iminoindene-HCl(I), 3-amino-2-methyl-1-iminoindene-HCl(II), the Na

salt of 2-phenyl-1-carboxymethylaminoindene (III), and the p-carboxy anil of bindone (IV). Subsequently, some of the *Drosophila* were irradiated with 1500 R from a ^{60}Co source, as were some controls raised on a standard diet. I and III in association with irradiation caused a definite lowering of lethal mutations, compared with the sum of the frequency of such mutations induced separately by the chemicals and the irradiation, II, while by itself inducing a definite increase in the frequency of spontaneously emerging recessive lethal mutations up to 1.2%, brings about a lowering of the genetic effect of γ -irradiation, as does III, but to a smaller degree. IV, which is not toxic, produced the most significant lowering of the genetic effect of γ -irradiation. (CA)

- 1210 Mosse, I.B., Freimanis, Y.F. EFFECT OF VARIOUS COMPOUNDS ON SPONTANEOUS AND γ -RADIATION-INDUCED MUTABILITY OF *Drosophila melanogaster*. Vop. Eksp. Genet. (1965) 112-120. (In Russian)

Male *Drosophila* strain D-18 were grown on a medium containing indene compounds. The effect of these compounds on the frequency of occurrence of spontaneous and radiation-induced changes in chromosome I was studied. Four compounds: 2-phenyl-3-(carboxymethylamino)-1-indene, 3-amino-2-methyl-1-imino-2-indene-HCl, 3-amino-2-phenyl-1-imino-2-indene-HCl, and bindone p-carboxyanil, decreased the frequency of radiation mutations from ^{60}Co in a dose of 1.5 kR. However, the 1st 2 compounds increased the frequency of spontaneous mutations by 2.5-3.5-fold, while the latter 2 had no effect. Two other compounds, dibenzoylenedihydroisonicotinic acid and 2,6-dimethyl-3,5-dicarboethoxy-4-carboxy-1,4-dihydropyridine, were genetically inactive. (CA 66:1967, 82913z)

- 1211 Mukherjee, R.N. MODIFICATION OF RADIATION-INDUCED MUTATION FREQUENCIES BY ANTIBIOTICS IN *Drosophila melanogaster*. Diss. Abstr. 27, 4 (1966) 1040-B.

The experiments reported in the present dissertation were undertaken to obtain further evidence for the possible roles of protein, RNA, and DNA macromolecules in radiation-mutagenesis in *D. melanogaster*. Several antibiotics were tested for their modifying effects on the frequency of radiation-induced sex-linked recessive lethals. Pre-radiation treatment with actinomycin D significantly reduces the frequency of induced mutations in germ cell stages assumed to include spermatids and spermatocytes. These results are consistent with the hypothesis of a role of proteins in the stabilization (repair) of radiation-induced premutational lesions. Puromycin, a specific inhibitor of protein synthesis is ineffective in the modification of induced mutation frequencies in *D. melanogaster*. Mitomycin C is itself a potent mutagen in all germ cell stages, peak mutagenicity occurring in spermatid stages. In combination with γ -rays, mitomycin C shows an overall additivity of effect. Mutation frequencies due to mitomycin C are not altered by pre- or concurrent treatment with actinomycin D. This may indicate a different mechanism for mutagenesis by mitomycin C and radiation. (Auth.)

- 1212 Mukherjee, R.N. THE POTENTIATING EFFECT OF SODIUM FLUORIDE ON THE INDUCTION OF MUTATIONS BY x-RAYS IN MATURE SPERMATOCYTES OF *Drosophila melanogaster*. Int. J. Radiat. Biol. 12, 4 (1967) 395. Also presented at "Netherlands Radiobiological Society, Wageningen, 24 Feb. 1967".

Earlier studies by Sobels* have clearly established the operation of a post-irradiation repair phenomenon in fully mature spermatozoa of *Drosophila*. To analyse the possible role of metabolic processes in the postulated repair from genetic radiation damage, studies have been made on the effects of sodium fluoride, a specific inhibitor of glycolysis, in the modification of radiation-induced mutation frequency in mature sperm. 3-d-old males of *D. melanogaster*, with a ring X-chromosome of the genetic constitution $X^{C^2}yB/sc^8 Y$, were injected with 1×10^{-3} M NaF solution in physiological saline, or with saline alone. After 2 h the injected males were exposed to a dose of 2000 R x-irradiation, given at 46 R/sec (100 kV, 4 mA and 1 mm Al). The treated males were individually mated to single females ($y sc^{81}$ in 49 sc^8) for a 24-h period, and the progeny were tested for induced sex-linked recessive lethal mutations. In seven replicate experiments NaF has been found to enhance consistently the frequency of radiation-induced mutations, as compared with the saline controls. A total of 6134 treated X-chromosomes in the NaF + x-ray series

* see III/722

and 5213 chromosomes in the saline + x-ray series were tested, and the frequencies of mutations were 7.6% and 5.4%, respectively; the difference is highly significant ($P < 0.001$). Injection of NaF alone does not result in changes from the level of spontaneously occurring mutations. Studies on induced dominant-lethal frequencies did not show significant differences between the two groups receiving NaF or saline before irradiation. This presumably indicates that NaF does not affect the initial radio-sensitivity of the treated sperm. This point is being further clarified by a study of translocations induced by such treatments. A possible explanation for the above results is that NaF inhibits the repair of radiation-induced damage and thereby causes a greater yield of mutations in the mature spermatozoa. (Abstr.)

- 1213 Murakami, A. THE EFFECT OF 5-BROMODEOXYURIDINE (BUDR) ON THE FREQUENCY OF 14 MeV FAST NEUTRON INDUCED MUTATIONS IN THE GONIAL CELLS OF THE SILKWORM. Rep. natn. Inst. Genet., Misima No.17 (1966) 103-104.

- 1214 Nasrat, G.E. THE EFFECT OF PRETREATMENT WITH MALEIC HYDRAZIDE OF THE MUTATION RATE INDUCED BY GAMMA RADIATION IN Drosophila melanogaster. Idengaku Zasshi (Jap. J. Genet.) 42 (1967) 39-42.

Treatment with γ -radiation in combination with maleic hydrazide exhibits an additive effect on the formation of sex-linked recessive lethal mutations, when applied to D. melanogaster spermatozoa. (Auth.)

- 1215 Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk. PRESERVATION OF FOOD BY MEANS OF RADIATION. p.27-31 of "Application of Atomic Energy in Agriculture. Annual Report, 1963". EUR-1882.e. 1964, 46p.

Physiological and biochemical studies of soft fruits irradiated with 0.5-1.0 MeV electrons showed that the study of immediate physiological irradiation effects is significant only under precise conditions of environment. Apples, pears, soft fruit, and vegetables were used to determine the effectiveness of 1-3 MeV electrons in surface pasteurization. The radiomimetic effects of γ -irradiated glucose were studied in Allium cepa, Hordeum sativum, and Vicia faba, and in mice and Drosophila. (From NSA 18:1964, 4399)

- 1216 Oak Ridge National Lab., Tenn. AEC-NASA SPACE BIOLOGY PROGRAM. p.98-100 of "Biology Division Semiannual Progress Report for the Period Ending August 15, 1964". ORNL-3700, Oak Ridge National Lab., Tenn. Nov. 1964, 197p.

The preparation of stocks of Habrobracon and Neurospora conidia are reported for use in biosatellite experiments on the effects of known doses of radiation, weightlessness, and absence of diurnal cycle in plants and animals. (NSA 9:1965, 2074)

- 1217 Oak Ridge National Lab., Tenn. AEC-NASA SPACE BIOLOGY PROGRAM. p.105-110 of "Biology Division Semiannual Progress Report for Period Ending July 31, 1965". ORNL-3853, Nov. 1965, 222p.

The design of a radiation exposure chamber for use in the whole-body exposure of mice to 35- and 57-MeV protons is described. Results are reported from preliminary studies of lens opacification in mice following exposure to 35- and 57-MeV protons. Ground-based experiments were performed in preparation for the biosatellite experiment in 1966 to test the design of packages for Neurospora and Habrobracon, and to provide a preliminary biological assay of the effects of acceleration, impact, and vibrational parameters alone and in combination with low-level γ -radiation. (NSA 20:1966, 6783)

- 1218 Parkash, O. THYMIDINE TERATOGENESIS AND MUTAGENESIS IN Drosophila melanogaster. Experientia 23, 10 (1967) 859-861. (With German summary)

The investigation was undertaken partly in order to investigate the extent to which mutagenic effects due to labelled thymidine might be due to the thymidine rather than the radiation emitted. Unlabelled thymidine (1-2%) was therefore added to the nutrient medium, and proved to be teratogenic. In experiments using different strains of D. melanogaster, morphological malformations of a very specific type (increase in the number of scutellar bristles; wing margins clipped,

the number, size, and position of the cuts varying; venous anomalies; irregular abdominal bands; abdominal malformations; leg deformations) were observed in all cases. In addition, thymidine at those concentrations also proved mutagenic for sex-linked recessive lethals. The mutagenic effect can be reduced by x-irradiation of the thymidine prior to use. The possible causes of the teratogenic and mutagenic effects of thymidine in *D. melanogaster* are discussed.

- 1219 Parkash, O. MUTAGENIC EFFECT OF IRRADIATION DNA IN *Drosophila melanogaster*. *Nature*, Lond. 214 (1967) 611-612.

Fish sperm DNA was used. The experimental procedure, method of irradiation of DNA, and the dose were exactly as reported earlier (see III/710), except that the M-5 technique was used for scoring sex-linked recessive lethals. In 1242 chromosomes from 123 males grown on food mixed with un-irradiated DNA (2%), only 1 lethal (0.08%) was detected, whereas in 1623 chromosomes from 114 males grown on food containing irradiated DNA (2%), 17 lethals (1.04%) consisting of 4 clusters of 2 and 9 singles were scored. The results are statistically significant (not as high, 5.7%, as reported previously) and indicate that irradiated DNA is mutagenic. Discrepancies in the results of various workers are discussed, together with possible explanations.

- 1220 Rinehart, R.R. x-RAY INDUCED CHANGES IN *Drosophila* GERM CELLS. Three-Year Comprehensive Report September 1, 1964 - August 31, 1967. SAN-590-2, San Diego State Coll., Calif. 1967, 62p.

Possible mutagenicity of irradiated *Drosophila* food and food supplements was investigated. The data support the following conclusions: irradiated *Drosophila* medium is mutagenic; medium supplemented with DNA or autoclaved sucrose is mutagenic whether irradiated or not; irradiated or nonirradiated nonautoclaved sucrose is not mutagenic; aging the food or food supplements does not significantly alter the mutation frequencies. Earlier reports of decreasing survival with extended anoxic treatments were substantiated when either attached-X or ring-rod heterozygous females were irradiated and posttreated with helium. Detachment frequencies increase with increasing anoxia. Effects of anoxia on the frequency of x-ray induced sex-linked recessive lethality and x-ray induced chromosome loss are described. Data indicate that the Y-chromosome may be able to both suppress and enhance X-chromosome lethality. (NSA 21:1967, 36539)

- 1221 Rinehart, R.R. INFLUENCE OF HELIUM POSTTREATMENTS AND EXPOSURE FRACTIONATION ON x-RAY INDUCED DOMINANT OR SEX-LINKED RECESSIVE LETHALITY AND X-CHROMOSOME LOSS IN STAGE 7 OOCYTES OF *Drosophila melanogaster*. *Genetics* 56, 3 Pt.2 (1967) 583-584. Also presented at "1967 Meetings of the Genetics Society of America, Stanford, Calif., USA. 31 Aug.-2 Sep. 1967".

Newly eclosed (0-6 h) *Drosophila* females were exposed to 3000 R delivered in He and post-treatments of 15 min, 1 h, or 6 h of anoxia were given. In other experiments in an air atmosphere, 3000R-exposures were given acutely or in equal increments separated by 1 h. Only the 1st 24 eggs laid by each female were included in the experiments to limit the test of Stage 7 oocytes. A ratio of the number of surviving offspring to the total number of eggs laid gave the percent survival values reported. X-chromosome loss was measured among the F_1 progeny and appropriate females from this group of flies were mated for another generation to obtain sex-linked recessive lethal frequencies. - There was an increase in dominant lethality associated with prolonged anoxic treatments. There was a decrease, however, in sex-linked recessive lethality in the gametes that survived the x-ray and helium treatments to the F_1 . Exposure fractionations in air resulted in a decrease in both dominant and recessive lethality. Radiation induced X-chromosome loss was relatively refractory to the extended He or exposure fractionation treatments. A hypothesis is proposed in which it is suggested that a large part of both dominant and recessive lethality in Stage 7 oocytes may be due to a common lesion and that with prolonged anoxia some potential recessive lethal events may be changed to dominant lethals. (Abstr.)

- 1222 Rinehart, R.R., Ratty, F.J. MUTATION IN *Drosophila melanogaster* CULTURED ON IRRADIATED WHOLE FOOD OR FOOD COMPONENTS. *Int. J. Radiat. Biol.* 12, 4 (1967) 347-354.

The frequencies of sex-linked recessive lethal mutations were measured in germ cells from *Drosophila* males cultured on aged or non-aged, irradiated or non-irradiated whole food or food supplements. In the first series of experiments, herring sperm DNA of low mol. wt was given

150 kR of unfiltered x-rays from a constant-potential machine at ~5000 R/min. In the 2nd series a 30% non-autoclaved sucrose solution was irradiated with 3000 kR of γ -radiation from a linear accelerator at an exposure rate of 10^6 R/min. The experiments indicate that irradiated whole food, autoclaved sucrose, and heterologous DNA are mutagenic. Non-autoclaved sucrose whether irradiated or not, does not induce mutations. A large portion of the increased damage may be associated with the induction of gonial mutants. Aging the treated food or food components for three weeks before use does not alter the results.

- 1223 Saksonov, P.P., Antipov, V.V., Shashkov, V.S., Razgovorov, B.L., Murin, G.F. et al. ON THE BIOLOGICAL EFFECTS OF HIGH ENERGY PROTONS. p.1-5 of "Translations of Biophysics and Physiology". 1965, 27p. Translated from: Dokl. Akad. Nauk SSSR 162, 3 (1965) 688-693. N65-31039, Joint Publications Research Service, Washington, D.C.

The RBE of protons in comparison with γ -rays was analysed using various tests characterizing the vital activity and heredity of the cell or organism. The experiments showed that for protons with energies of 660 and 120 MeV, the RBE with respect to DL 50 for mice and rats was about 0.7. Clinical observations of animals also showed the somewhat lesser effectiveness of protons in comparison with γ -rays. The same results were obtained upon conducting a comparative analysis of chromosomal disturbances in the cells of the bone marrow of mice, in the growth of seeds in higher plants, and in determining recessive sex-associated and dominant lethal mutations in Drosophila melanogaster. Tests on mice were conducted to study the radiation protective effect of various compounds.

- 1224 Sankaranarayanan, K. THE EFFECTS OF NITROGEN AND OXYGEN TREATMENTS ON THE FREQUENCIES OF X-RAY-INDUCED DOMINANT LETHALS AND ON THE PHYSIOLOGY OF THE SPERM IN Drosophila melanogaster. Mutation Res. 4, 5 (1967) 641-661.

The induction of dominant lethals in D. melanogaster males with a ring-X chromosome was studied following irradiation with 4000 R under anoxia with N_2 and O_2 post-treatments. The post-radiation treatment with these gases varied from 25 min - 120 min. The frequencies of induced dominant lethals were found to be in the range of 67% - 73% in the different experiments with no significant differences resulting from the contrasting post-treatments. These frequencies increased linearly in the successive egg-collecting periods, the trend being independent of the different post-treatments. Following prolonged N_2 treatments, a sharp increase in the proportion of unhatched eggs was noticed. Examination of the ventral receptacles and spermathecae of females inseminated by N_2 -treated males revealed that with N_2 -treatment (1) there occurred a drastic reduction in the number of spermatozoa stored, the magnitude of reduction being dependent on the length of N_2 -treatment and (2) there was a decrease with time in the number of spermatozoa remaining in the storage organs, with the effect being pronounced with 96 and 120 h of storage following insemination. These findings are discussed in relation to physiological damage to the treated sperm and sperm exhaustion. (Auth.)

- 1225 Seecof, R., Kaplan, W.D. THE FAILURE OF IRRADIATED DNA TO PRODUCE MUTATION IN Drosophila melanogaster. Drosoph. Inf. Serv. 41 (1966) 101.

Om Parkash reported, Nature 205:1965, 312 (see III/710), that irradiated DNA was mutagenic when fed to D. melanogaster. We repeated this experiment, following his reported procedure as closely as possible. We subjected herring sperm DNA (Calbiochem) to 100 000 R of x-rays at 644 R/min at 100 keV, 7 ma, with filtration equivalent to 0.6 mm of Al. The irradiated DNA was added to a final concentration of 18 mg/ml into a food medium containing sucrose (5%), agar (1%), corn meal (6%), bran (1.5%), and propionic acid to pH 4.5. In series 1, 1- to 3-d-old Oregon-R flies (5 pairs) were introduced to treated food in a half-pint bottle and allowed to lay eggs for 12 d at 20°C. Series 2 was the same except that 20 pairs were used and were changed to fresh treated food every 2 d. Adult Oregon-R males, offspring of flies fed upon treated food were mated, each to five M-5 females, for detection of sex-linked lethals. Series 1 repeats the technique used by Parkash. Series 2 was designed to distinguish between mutations induced in the X-chromosome of the adult females feeding upon treated food for 12 d, and effects upon larval germ cells. Table 1 summarizes the data and shows that the rate of mutation was not elevated above the control rate which is at about 0.2% for our stock. A high sterility characterized the F_1 matings. This, however, is attributable to the males of the Muller-5 stock in use at

that time, rather than to an effect induced by the irradiated DNA upon the Ore-R chromosomes. (Auth.)

- 1226 Sharma, R.P. RADIOSENSITIZATION OF *Drosophila melanogaster* BY N-ETHYLMALAMIDE. Drosoph. Inf. Serv. 41 (1966) 112.

2.5 ml of 100 μ M solution (pH7) of N-Ethylmaleimide was mixed with 2.5 ml of basic medium, comprised of agar (3%), yeast (10%), glucose (10%), propionic acid (0.4%) and water (100 ml), to get 50 μ M concentration of the chemical. Freshly laid *Drosophila* eggs (Oregon-K) were transferred to this medium and allowed to develop up to adult stage. The newly emerged males were collected and kept for 2 d. One batch was kept as such, whereas the other batch was irradiated with 2400 R of x-rays. The males collected from the normal medium were irradiated with the same radiation dose to serve as control for the chemical-radiation combination treatment. The males were crossed with M-5 virgin females at the rate of one male and three females. The sex-linked recessive lethals were scored in F_2 . The combination treatment of chemical and radiation showed about 2-fold increase (5.4%) in the frequency of sex-linked recessive lethals over radiation (2.8%). The chemical alone is not able to produce any mutation. The possible explanation for such radiosensitizing effect produced by N-Ethylmaleimide may be due to its ability to combine and inhibit the sulphhydryl groups. (From abstr.)

- 1227 Shiomi, T. DIFFERENTIAL EFFECT OF PENICILLIN ON x-RAY INDUCED MUTATIONS IN *Drosophila melanogaster*. p.64-65 of "Annual Report 1964". NIRS-4, National Inst. of Radiological Sciences, Chiba (Japan). Dec. 1965, 94p.

The experiments were designed to test the effect of pre-feeding with penicillin on radiation effects at the mature sperm stage, using three successive 1-d-broods. Feeding with penicillin prior to exposure to 2000 R x-rays appears to reduce the induction of point mutations as recessive lethals but has no effect on chromosomal aberrations. In the case of mature sperm within the female penicillin produced no effect on the induction of either the recessive lethals or translocations, but was effective in the reduction of dominant lethals. The somewhat complicated results may be due to differences in physiological condition or metabolic processes within the mature sperm stage.

- 1228 Shiomi, T. EFFECT OF PENICILLIN FEEDING ON THE FREQUENCY OF x-RAY INDUCED MUTATION IN *Drosophila*. Genetics 54, 5 (1966) 1077-84.

Feeding of penicillin to larvae prolonged the larval growth period about 1 d. However, the rate of emergence was higher than in the control. Penicillin exhibited no mutagenic action at the concentrations used (20 000 units/ml culture medium). Sex-linked recessive lethal mutation in sperm x-rayed during the last 3 d of development was decreased about 50% when larvae were fed with penicillin, compared to the control raised on normal food. The relation between radiation dose and mutation remained linear in the penicillin-fed series, as in the control. Penicillin was more effective in reducing mutation when fed during the 1st half of larval stage than during the 2nd half. (Auth. summary)

- 1229 Shiomi, T. SENSITIVITY DIFFERENCES IN THE SUCCESSIVE STAGES OF SPERMATOGENESIS IN *Drosophila* AFTER IRRADIATION IN NITROGEN OR AIR. Mutation Res. 4 (1967) 323-332.

The influence of N_2 -treatment on the pattern of radiosensitivity in the successive stages of spermatogenesis in *Drosophila* was studied. x-irradiation was administered either in air or in an atmosphere of N_2 , and the frequencies of induced sex-linked lethals and II-III translocations in five successive 1-d broods (with 10 females per male per brood) were compared. Four levels of radiation exposure, namely 1000 R, 2000 R, 3000 R and 4000 R were used to irradiate the males. In the air controls, the observed frequencies of lethals and translocations in broods A to E, when plotted graphically, produce asymmetric "U"-shaped curves, with an initial high frequency in brood A, low frequencies in broods B and C, and then a sharp increase through brood D to a very high frequency in brood E. The differences between the frequencies in broods A and B are more pronounced at higher than at lower doses. After radiation exposure in N_2 , (1) a reduction in the mutation and translocation frequencies is observed, the effect in the latter being more pronounced, and (2) the frequencies obtained in broods A, B and C being nearly equal. This indicates that the differential yield of mutations between mature and almost mature spermatozoa originates from

differences in oxygenation. N_2 -treatment affects the fertility and fecundity of the treated males with the mean number of progeny produced by each fertile male being reduced by about 22 and 78% with 30- and 60-min exposure to N_2 , respectively. Some of the causal factors that might underlie the N_2 -effect are discussed. (Auth.)

- 1230 Sinkha, S.P. EFFECT OF ETHYLENE-DIAMINETETRAACETIC ACID SODIUM SALT ON THE PROCESS OF CROSSINGOVER IN DIFFERENT LINES OF *Drosophila melanogaster*. Vest. leningr. gos. Univ., Ser. Biol., 20, 2 (1965) 130-135. (In Russian, with English summary)

The modifying effects of EDTA on the amount of crossing over in the b₁cn₁vg region of the IInd-chromosome has been studied among heterozygous females of four wild strains, Maharaj, D-32, D-18 and R-86 of *Drosophila melanogaster*. In early studies it was shown that two of the strains, Maharaj and D-32, have comparatively lower spontaneous crossover frequency and are more radio-resistant to x-rays than the strains D-18 and R-86 which are radiosensitive to x-rays and have higher spontaneous crossover frequency. In the present study it has been found that EDTA increases the crossover frequency in two radio-resistant lines Maharaj and R-86, whereas no statistically significant increase is marked in the two radio-sensitive strains D-18 and R-86. The increase reported in the strains Maharaj and D-32 is mainly due to increase in the euchromatic cn₁vg region. The heterochromatic region b₁cn₁, which encloses the centromere, does not show any increase. EDTA decreases the fertility of heterozygous females in all 4 strains, but more in the strains R-86 and D-18 than in Maharaj and D-32. Chelating the metallic ions like Ca and Mg, necessary for the chromosomal integrity, EDTA breaks the linear continuity of the chromatids leading to crossover. It has been proposed that the strains Maharaj and D-32, where increase in crossover frequency is found, contain comparatively more amount of Ca^{++} and Mg^{++} ions in its chromosomes, than the strains R-86 and D-18. This is why in the first 2 strains EDTA could remove Ca^{++} and Mg^{++} inducing crossingover, whereas in the last 2 strains R-86 and D-18 this removal of ions appeared to be lethal for the cell and hence caused a great decrease in the fertility. The increase of crossover frequency in the euchromatic cn₁vg region may be due to the reason that in this region the degree of spiralization of chromatids is comparatively poor, and thus EDTA gets more scope for its chelating action. In the light of these data, it has been possible to propose that these 4 different strains may be differing with each other in the degree of spiralization of their chromatids. (Auth.)

- 1231 Sisakyan, N.M., Antipov, V.V., Saksonov, P.P., Yazdovskiy, V.I. INVESTIGATION OF BIOLOGICAL EFFECT OF COSMIC RADIATION UNDER CONDITIONS OF SPACE FLIGHTS. "14th Congr. Intern. Astronaut, Paris, France, 1963". Polish Scientific Publishers, Warszawa, Poland, 1965.

Présentation des résultats de l'étude radiobiologique effectuée sur sept vaisseaux spatiaux soviétiques (vaisseaux 2, 4 et 5 et Vostok 1, 2, 3 et 4). Emploi, aux fins de l'étude, de l'effet traumatisant des rayonnements, d'objets présentant diverses radiosensibilités. Description des expériences effectuées sur des mammifères (chiens, souris, rats, etc.), des insectes, des plantes d'espèce supérieure, etc. (Bull. signalétique)

- 1232 Sisakyan, N.M., Antipov, V.V., Saksonov, P.P., Yazdovskiy, V.I. STUDY OF THE BIOLOGICAL ACTION OF COSMIC RADIATION UNDER CONDITIONS OF COSMIC FLIGHTS. Radiobiologiya 4 (1964) 337-343. (In Russian)

The effect of ionizing radiation on the hereditary structures of cells was studied in various organisms: *Drosophila melanogaster*, seeds of higher plants, lysogenic bacteria (*Escherichia coli*), microspores of *Tradescantia paludosa*, and others. The studies were carried out on the Sputnik and Vostok flights. At the altitudes of 180 - 320 km, for 1.5 - 96 h, total radiation doses were 1.5 - 60 mrad, respectively. 90% of the radiation was from cosmic radiation and 10% from the earth's radiation field because of the 65° inclination of the orbit. Slight but statistically significant damage was observed in the hereditary structures of the cells. However, comparison with data obtained in the laboratory indicates that these results are due to the complex effects of vibration, acceleration, and weightlessness as well as to radiation. The type of data obtained were the frequency of dominant and sex-linked recessive lethal mutants in *Drosophila*, for example. The results are compared with those on human and animal tissues, seaweed, and bacteria carried in Discoverer XVII flights. These organisms received 30 to 35 rad but only the bacteria showed any damage. (NSA 18:1964, 33351)

- 1233 Smittle, B.J. EFFECT OF AERATION ON GAMMA IRRADIATION OF HOUSE FLY PUPAE. *J. econ. Ent.* 60, 6 (1967) 1594-1596.

When 3-d-old pupae of the housefly, *Musca domestica* L., were exposed to O_2 , CO_2 , and air during γ -irradiation, aeration had no effect on eclosion, but eclosion was reduced as much as 10% by exposure to 6000 R. The percentage sterility produced by the γ -rays in males and females was reduced by CO_2 . The other treatments had no apparent effect. (Auth.)

- 1234 Sobels, F.H. THE CONTRASTING EFFECTS OF O_2 AND N_2 IN DETERMINING INITIAL SENSITIVITY AND POST-RADIATION RECOVERY IN *Drosophila* SPERM AND SPERMATIDS. *Int. J. Radiat. Biol.* 7, 5 (1964) 505. Also presented at "Meeting of the Netherlands Radiobiological Society, Rijswijk, (ZH), The Netherlands, 1964".

- 1235 Sobels, F.H. PROCESSES UNDERLYING REPAIR AND RADIOSENSITIVITY IN SPERMATOCYTES AND SPERMATIDS OF *Drosophila*. p.49-64 of "Genetical Aspects of Radiosensitivity: Mechanisms of Repair, Proceedings, Vienna, 16-22 April 1966". STI/PUB/130, International Atomic Energy Agency, Vienna (Austria). 1966, 175p.

When *Drosophila* males are exposed to x-irradiation under anoxia, and the effects of post-treatment with N_2 are compared with those with O_2 , a reduction of the mutation- and translocation-frequencies is observed with N_2 in spermatozoa, but with O_2 in early spermatids. Since the same results have now been obtained with spermatozoa treated in inseminated females, and with spermatids from 24-h-old pupae, these post-radiation modifications cannot be from errors in the sampling of germ cells with different radiosensitivities. Experimental evidence suggests that in both types of cells, the post-radiation effects arise from enzymatic repair of potential lesions leading to mutation or chromosome breaks. For sperm it could be demonstrated that neither post-radiation interaction of radicals with O_2 , nor selective elimination of cells with genetic damage by post-treatment with N_2 can explain the observed effects. Radiosensitization after pre-treatment with sodium fluoride, iodoacetamide, ribonuclease or actinomycin-D suggests that in sperm both glycolytic enzymes and RNA or protein synthesis are involved in the repair process. In the early spermatids, on the other hand, oxygen is clearly required for repair to occur, and inhibition of RNA and/or protein synthesis by pre-treatment with actinomycin-D, ribonuclease or chloramphenicol leads to a reduction of the radiation-induced mutation frequency. Studies on the origin of stage-specific differences in radiosensitivity showed that early spermatids are characterized by a considerably higher O_2 -enhancement ratio than spermatozoa. Their greater response to radiation as compared with sperm thus arises from a greater intrinsic sensitivity to the induction of radiation damage in the presence of O_2 . O_2 -enhancement ratios for fully mature spermatozoa and late spermatids, however, do not differ significantly, but the higher radiosensitivity in the former than in the latter cells appears to originate from a greater degree of oxygenation, under normal conditions in air. (Auth.)

- 1236 Sobels, F.H., Michael, B., Mukherjee, R.N., Sankaranarayanan, K., Watson, W.A.F. REPAIR OF RADIOSENSITIVITY PHENOMENA IN *Drosophila* MALES. p.12 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, 26 Jun.-2 Jul, 1966, 263p." Abstr. 48. Also published in p.502-521 of "Radiation Research 1966", Amsterdam, The Netherlands, North-Holland Publishing Company, 1967.

When *Drosophila* males are exposed to x-irradiation in N_2 , and the effects of post-treatment with N_2 are compared to those of O_2 , a reduction of the mutation and translocation frequencies in sperm is observed with N_2 post-treatment, but in early spermatids with O_2 post-treatment. Evidence has now been obtained that these post-radiation modifications cannot be due to errors in the sampling of cells with different radiosensitivity. In spermatids oxygen-dependent repair is not observed after the application of a low dose rate. This "inverted" dose rate effect (will be) discussed. Current experiments are directed towards an elucidation of the possible mechanisms underlying post-radiation recovery by N_2 in mature sperm. Post-radiation interaction of radicals with O_2 seems unlikely. Radiosensitization by sodium fluoride suggests repair by glycolytic enzymes. Possible selective effects of chromosome breakage events will be discussed on the basis of dominant lethal and chromosome loss data. Studies on differences in radiosensitivity showed that early spermatids have greater intrinsic sensitivity to radiation damage in the presence of O_2 than mature sperm, but the higher sensitivity of mature sperm as compared to very late spermatids appears to originate from a greater degree of oxygenation in the former. (Abstr.)

- 1237 Sobels, F.H. RBE VALUES FOR GENETIC EFFECTS OF 15 MeV NEUTRONS IN RELATION TO STAGE SENSITIVITY IN *Drosophila*. *Int. J. Radiat. Biol.* **13**, 4 (1967) 378-379. Also presented at "Netherlands Radiobiological Society Meeting, Rijswijk (ZH), The Netherlands, 17 Nov. 1967".

The mutagenic effectiveness of 15 MeV neutrons was compared with that of x-irradiation in mature spermatozoa, sampled from the first ejaculate of 7-d-old males, and late spermatids, sampled from that of 2-3-h-old males. After x-irradiation in air, more mutations are produced in spermatozoa than in spermatids, but after exposure in either O₂ or N₂, roughly equal mutation frequencies are obtained in the two stages. Mature sperm thus appears to be better oxygenated than the late spermatids. In consequence, a greater relative biological effectiveness of neutron irradiation was expected in the relatively anoxic late spermatids. After irradiation with doses of 3000 rad of either x-rays or 15 MeV neutrons, the following frequencies of recessive lethals in a ring X-chromosome, and of II-III translocations were observed: (1) For lethals in sperm, 6.7% (67/1001) with neutrons and 9.7% (242/2488) with x-rays, and in spermatids, 7.8% (154/1985) with neutrons and 8.3% (162/2586) with x-rays, corresponding to RBE values of 0.69 and 1.24 for sperm and spermatids respectively. (2) For translocations in sperm, 7.6% (55/723) with neutrons and 7.3% (148/2028) with x-rays, and in spermatids, 6.8% (112/1685) for neutrons and 3.2% (72/2251) for x-rays. The ratio of effectiveness for neutrons versus x-rays can be calculated 1.05 in sperm and 2.14 in spermatids. The results show that in the cells which are by nature relatively anoxic, neutrons are more effective in producing genetic damage than x-rays. Since tumour cells are also relatively anoxic, i.e. compared with the surrounding normal tissues, the possible advantages of fast neutrons over x-rays for radiotherapeutic purposes seem well documented. The unusually low RBE value of 0.69 for lethals in mature sperm is ascribed to the use of 15 MeV neutrons, pure sperm samples, and a ring X-chromosome. Lethals associated with translocations are eliminated from the ring, and it is this class of damage that is characterized by relatively high RBE values. (Abstr.)

- 1238 Tazima, Y., Onimaru, K. MODIFICATION OF γ -RAY-INDUCED MUTATION FREQUENCIES IN THE SILKWORM BY POST-TREATMENT OF SPERMATIDS AND SPERMATOZOA WITH NITROGEN. *Rep. nat. Inst. Genet.*, Misima No.17 (1966) 92-94.

- 1239 Thobbi, V.V., Srihari, T. GROWTH RESPONSE OF *Prodenia litura* Fabr. IN RELATION TO THE CASTOR LEAVES OBTAINED FROM IRRADIATED PLANTS. *Ind. J. Ent.* **29**, 2 (1967) 154-156.

The food values of two types of castor leaves, *Ricinus communis* Linn., are compared, obtained from different sources of irradiation. The dwarf and the short along with the standard strain of H.C₆ were used, the dwarf mutant resulting from treatment with 10 000 R γ -rays and the short mutant from treatment with 2.5×10^{12} n/cm² of fast neutrons. The development of *P. litura* larvae was subsequently studied after feeding on these three types of castor leaves. Leaves obtained from H.C₆ proved more nutritive than those from dwarf and short mutants, the larvae reared on H.C₆ weighing significantly more on the 11th day of hatching than those fed on the other two sorts of leaves. The growth index value and the percentage of pupation were highest for H.C₆.

- 1240 Thomas, J.J., Jr., Baxter, R.C., Fenn, W.O. INTERACTIONS OF OXYGEN AT HIGH PRESSURE AND RADIATION IN *Drosophila*. p.36-37 in "Brief Description of Research Published or Accepted for Publication During 1966". Annual Report. Neumann, W.F., Rothstein, A., Eds, UR-49-784, Rochester Univ., N.Y. Atomic Energy Project. 1 Apr. 1967, 253p.

For abstract, see 1282.

- 1241 Thornley, M.J. METABOLIC CONDITIONS BEFORE AND AFTER IRRADIATION. p.170-192 of "Radiation Effects in Physics, Chemistry and Biology". Amsterdam, North-Holland Publishing Co. 1963.

Nine papers presented at the Second International Congress of Radiation Research are summarized. The papers deal with the importance of metabolic processes in both initial radiation damage and the process of repair. Specifically, studies on a variety of topics are reported, including the effects of various modifying agents on radiation-induced lethals in *Drosophila* males.

- 1242 Watson, W.A.F. POST-RADIATION RECOVERY IN EARLY SPERMATIDS AND SPERMATOCYTES SAMPLED FROM *Drosophila* PUPAE. p.234 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, Italy, 26 Jun.-2 Jul. 1966, 263p". Abstr.930.

Earlier work by Sobels showed that post-treatment with O_2 as compared to post-treatment with N_2 , favours repair of genetic damage induced by irradiation under anoxia in spermatids and spermatocytes sampled from adult flies. Attempts to show that this repair occurred when pupae were irradiated were unsuccessful when the same experimental procedure was followed. However, when 24 h-pupae are pre-treated with N_2 for 6 h, irradiated in N_2 with 2500 R x-rays, and post-treated with either O_2 or N_2 for 2 h, then in the 1st 1-d-brood there is a consistent decrease in mutation frequency (as measured by recessive lethals in a ring-X chromosome) after post-treatment with O_2 , as compared to that with N_2 . For five experiments, involving 6000 tested chromosome sets altogether, the average lethal frequency for N_2 was 6.5%, and that for O_2 4.7%. Statistical analysis using 2×2 contingency tables gives a probability of 0.004 (two-sided test). This result shows that the similar results obtained from earlier broods of adult flies did not originate from artefacts in the sampling technique, and support Sobels' conclusion that there is a repair system operating at this stage of development. Further data concerning the effect of higher doses and the induction of dominant lethals and translocations (will be) presented at the meeting. (Abstr.)

- 1243 Watson, W.A.F., Sankaranarayanan, K. POST-RADIATION RECOVERY IN SPERMATIDS SAMPLED FROM 24 HR OLD PUPAE OF *Drosophila melanogaster*. *Genetica* 38 (1967) 62-63.

Male pupae with a ring-X chromosome of the genetic constitution $X^{C^y} B/sc^N Y$ were subjected to 6 h pretreatment with N_2 , irradiated under anoxia with a high dose-rate of 46 R/sec at three different exposure levels (1250 R, 2500 R and 3750 R) and then posttreated for 2 h with either N_2 or O_2 . Following eclosion, the males were mated individually with six females for a 24-h-period and the progeny were utilised for sex-linked lethal and translocation tests. The results indicated a consistent and highly significant decrease in mutation and translocation frequencies following O_2 post-treatment and that the absolute reduction of the lethal frequencies was approx. the same at the three exposure levels. This was conceivably due to the fact that the repair system could cope with only a limited amount of damage and became saturated at high doses so that the repair was most effective when the dose was low. The results confirmed and provided additional evidence for the postulated oxygen-dependent repair system operating in spermatids. The effects of four dose rates (16.6 R/sec, 8.3 R/sec, 4.2 R/sec and 2.1 R/sec) at two exposure levels (2500 R and 1250 R) were investigated. The results indicated that the frequencies of sex-linked lethals at both the levels of radiation exposure were far from being significantly different between the N_2 and O_2 post-treated groups. A comparison of these results with those of high dose-rate studies revealed that after irradiation at low dose rates, the mutation frequencies following both N_2 and O_2 post-treatments were strikingly similar to those obtained at high dose-rate exposures with N_2 post-treatment indicating that at lower dose rates, O_2 post-treatment was no longer effective in bringing about repair. A possible explanation of these observations was that the repair process in spermatids proceeded in such a short time that after prolonged exposures to irradiation no repair was possible. (NSA 22; 1968, 521)

- 1244 Watson, W.A.F. POST-RADIATION RECOVERY IN EARLY SPERMATIDS SAMPLED FROM *Drosophila* PUPAE. *Mutation Res.* 4, 2 (1967) 169-176.

When 24- and 48-h-old *Drosophila* pupae were subjected to 6 h pre-treatment with N_2 , irradiated under anoxia, then post-treated for a further 2 h with either O_2 or N_2 , it was found that in the first one-day brood from the 24-h pupae there was a consistent and highly significant decrease in the mutation frequency following O_2 post-treatment, as compared to that with N_2 . This result confirms earlier findings of Sobels, and demonstrates the existence of an O_2 -dependent repair process operating in early spermatids of *Drosophila*. It was observed that more repair occurred at low than at high doses (i.e. the relative reduction in mutation frequency was greater), and the suggestion is put forward that the repair system can handle effectively only a limited amount of damage, but becomes saturated when this amount is exceeded at higher doses. The fact that translocation frequencies are also lowered by oxygen post-treatment is taken as an indication that potential breaks, rather than chromosome breaks, are involved in the repair process. Dominant lethal studies showed that it is most unlikely that the repair process could be due to an artefact caused by O_2 selectively eliminating cells carrying mutations. (Auth. summary)

- 1245 Wolff, S. MECHANISMS OF DOSE-RATE EFFECTS: INSIGHTS OBTAINED FROM INTENSITY AND FRACTIONATION. *Idengaku Zasshi* (Jap. J. Genet.) 40 Suppl. (1965) 38-48.

Contrary to early results in radiation genetics, results are now being obtained that indicate intra-cellular repair of one-hit genetic lesions. In some of these cases, however, other explanations have not been unequivocally ruled out. For instance, one must make sure that stage sensitivity coupled with mitotic delays and reversions and even cells selection do not obscure the results. There is more clarity in regard to two-hit intergenic mutations. These have long been known to undergo restitutional repair. By the use of dose fractionation techniques, it has been possible to separate effects on repair from effects on breakage and, by inhibiting various metabolic processes between two doses of radiation, some insight has been gained into the chemical processes involved in repair. Much of the experimental data has been obtained from studies on *Drosophila*.

- 1246 Yoon, J.S. GENETIC X-RADIATION DAMAGE AND ITS MODIFICATION BY SOME GASES AND A TIME FACTOR IN *Drosophila melanogaster*. *Diss. Abstr.* 27, 1 (1966) 337-B.

Oregon-R, Oak Ridge Strain males, 19 to 21 h old, were x-rayed with a total dose of 1000 R or 3000 R given in two equal fractions of 500 R or 1500 R at a dose rate of 500 R/min, except experiment # 1 in which they were given a single dose of 1000 R at $24 \pm 1^\circ\text{C}$ in several gas environments, with a time interval of 20 min or 40 min between the two doses. At each change of gases, the system was evacuated to remove all gases, then flushed with He for 1 min. Tests using CO were carried out in the dark and the others in the light, both at 1 atm of the gas or gas mixture. In order to study the genetic radiation damage and its modification in the presence of several gases and a time factor, the frequencies of dominant lethals and translocations induced in cells which were in different stages of spermatogenesis were scored using 7 sequential 2-d matings over a 3-week test period. The frequency of dominant lethals increased from sperm to spermatids and meiotic cells, then increased in spermatogonia. The spermatogonial cells were the least susceptible to x-rays. The cycle of damage for dominant lethals is similar to that for translocations, but does not coincide with it completely, and the peaks of damage for both are located in early post-meiotic stages. The cycle of frequencies of translocations coincides with that of percentages of sterility of F_1 . The coincidence of frequencies between translocations and the sterility demonstrates that the mechanisms of damage for both are related, at least in part. The NO (nitric oxide) effect on sperm and late spermatids is more drastic than the O_2 effect, but a major fraction of the effect is to cause the death of the sperm, or to slow down spermatogenesis. A duration of 4 min of gases in post-treatments appears to be too short to modify the damage. CO during radiation increases genetic damage above the other gases tested. No evidence of reduction in damage due to gas changes between radiation doses was demonstrated. There are few or no translocations recovered from pre-meiotic cells. The Y-chromosome was involved in 10.8% of total breaks, or about 1/4 as frequently as the two autosomes tested, and chromosomes II and III equally participated in an interchange. (From DA)

- 1247 Zakladnoi, G.A. RADIOSENSITIVITY OF THE GRANARY WEEVIL AS A FUNCTION OF TEMPERATURE. *Vest, sel'khoz. Nauki*, Mosk. No.3 (1967) 138-141. (In Russian, with French summary)

Varying the temperature between 10 and 30°C before and during irradiation (11000 rad γ -radiation from a ^{60}Co -source) had very little effect on mortality of the granary weevil, *Sitophilus granarius* L. A relationship was found to exist between post-irradiation temperature and mortality rate. An increase in temperature after irradiation drastically narrowed the mortality range.

- 1248 Zhukov-Verezhnikov, N.N., Volkov, M.N., Yazdovskii, V.I., Mayskii, I.N., Saksonov, P.P. et al. MODERN GENETICS AND PROBLEMS IN SPACE BIOLOGY. p.161-164 of "Aviation and Space Medicine". Parin, V.V., Ed. 1964, 464p. Translation of: "Aviatsionnaya Kosmicheskaya Meditsina". Moscow, Akad. Med. Nauk SSSR. 1963, N65-13683, National Aeronautics and Space Administration, Washington, D.C.

An overall view of future research to develop genetic safeguards for space travel is presented, on the basis of new information derived from a genetic analysis of the offspring of *Drosophila* and lysogenic bacteria that were carried on various Vostok space flights. The experiments with lysogenic bacteria imply that a combination of vibrations and γ -rays followed by vibrations almost doubled the genetic effects of the γ -rays. However, since effective levels of cosmic radiation

were lacking in the orbits, it is assumed that weightlessness may be a possible source of genetic effects. The selection of lysogenic bacteria is advocated for future research to develop substances to prevent genetic changes, to determine the effects of weightlessness, and to study blocking of the pathological information present in the DNA of these bacteria. (Scient. A. Techn. Aerospace Repts.)

See also:

- 27 Application of radioactive isotopes to the investigation of methods for the biological control of pests. V. The effects of γ -radiation on pupae of C. capitata previously labelled with ^{32}P . (Arroyo, M. et al., 1965)
- 944 Cytogenetic analysis of lethal mutations induced at various stages of spermatogenesis. (Hashim-Ahmed, M.S., 1965)
- 949 The relative mutagenic effectiveness of fast neutrons and x-rays in pre- and post-meiotic germ cells of Drosophila melanogaster. (Lamb, M.J. et al., 1967)
- 950 Molecular and radiation genetics. Annual Report 1965. (Leiden Rijksuniversiteit (Netherlands), 1966)
- 951 Can Drosophila spermatozoa be used in studies of recovery processes? (Lüning, K.G., 1961)
- 957 Annual report of the National Institute of Genetics, No.16, 1965. (National Inst. of Genetics, Mishima (Japan), 1966)
- 965 Dose-rate effect in the repair of radiation damage in spermatids of Drosophila melanogaster. (Sankaranarayanan, K., 1967)
- 970 Oxygen dependent differences in radiosensitivity between fully mature and almost mature spermatozoa. (Sobels, F.H., 1966)
- 976 Comparative study of the radiosensitivity at different stages of oogenesis. (Tikhomirova, M.M., 1967)
- 1001 The effects of x-rays on the chromosomes of locust embryos. II. Chromatid interchanges and the organization of the interphase nucleus. (Fox, D.P., 1966)
- 1002 The effects of x-rays on the chromosomes of locust embryos. III. The chromatid aberration types. (Fox, D.P., 1967)
- 1003 The effects of x-rays on the chromosomes of locust embryos. IV. Dose-response and variation in sensitivity of the cell cycle for the induction of chromatid aberrations. (Fox, D.P., 1967)
- 1016 Early chromosomal response to x-rays. (Leach, W.M. et al., 1966)
- 1017 Lack of x-ray induced chromosome "stickiness" in grasshopper neuroblasts. (Leach, W.M., 1967)
- 1025 Evidence for the two-hit nature of x-ray induced crossing-over in the centromeric region of Drosophila males. (Olivieri, G. et al., 1964)
- 1026 Interaction of x-ray and fast neutron-induced chromosome breaks in Drosophila. (Reddi, O.S., 1966)
- 1027 Identification of the proposal: x-ray induced changes in Drosophila germ cells. Progress Report, Sep.1, 1965 - Aug. 31, 1966. (Rinehart, R.R., 1966)
- 1038 Genetical after-effects of x-rays depending on the temperature regime. (Tikhomirova, M.M. et al., 1967)
- 1074 Comparison of frequency patterns between whole-body and fractional mutations induced by x-rays in Drosophila melanogaster. (Inagaki, E. et al., 1966)
- 1080 Mutagenic effect of 600-MeV proton irradiation. (Lamb, M.J. et al., 1966)
- 1081 The mutagenic effect of 600-MeV protons in Drosophila melanogaster. (Lamb, M.J. et al., 1967)
- 1087 Recent research on mutations induced by irradiation. (Meyer-Döring, H., 1960)
- 1089 Dose rate and time factor. (Mole, R.H., 1963)
- 1092 Mutagenic effects of massive acute x-irradiation in Drosophila melanogaster. (Nakao, Y. et al., 1965)
- 1095 Biological studies: genetics. (National Inst. of Radiological Sciences, Chiba (Japan), 1965)
- 1099 x-Ray induced changes in Drosophila germ cells. Three-year Comprehensive Report, Sept. 1, 1964 - Aug. 31, 1967. (Rinehart, R.R., 1967)
- 1126 Occurrence of dominant lethals in Drosophila under the influence of vibration, acceleration and γ -irradiation. (Darfenov, G.P., 1965)

- 1174 Effects of x-rays, tryptophan metabolites, and eye color mutants on the tumor-suppressor system in *Drosophila melanogaster*. (Brooks, G.T., 1967)
- 1250 Disproportionate amounts of genetic damage induced by ethylenimine and x-radiation treatments. (Alexander, M.L., 1966)
- 1263 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, H.B., 1966)
- 1271 Relative biological effectiveness of 14 MeV neutrons to gamma-rays for inducing mutations in mature sperm of the silkworm. (Murakami, A., 1966)
- 1272 Relative biological effectiveness of x-ray and gamma radiation. (Seeley, B.A. et al., 1966)
- 1277 Relative biological effectiveness, comparison of hard x-ray, soft x-ray, and beta radiation. (Stone, K.J., 1967)
- 1410 Modification of fitness in species and strains of flour beetles due to x-ray and DDT. (Erdman, H.E., 1966)
- 1418 The effect of x-rays and visible light upon the one day old meal worm, *Tenebrio molitor*, embryo. (Po-Chedley, D.S., 1966)
- 1425 Lifespan studies with strains of gamma-irradiated *Drosophila* adults. (Sonnenblick, B.P. et al., 1967)
- 1439 Radiation studies with the boll weevil: lethal effects on larvae, pupae, and adults; male sterility and dose fractionation. (Flint, H.M. et al., 1966)
- 1508 Genetics. (National Inst. of Radiological Sciences, Chiba (Japan), 1966)
- 1592 Control of fruit flies by gamma rays. (Huque, H. et al., 1966)

2.1.10. Comparative Studies

(Radiations. Mutagenic Chemicals. Physical Factors)

- 1249 Akov, S. RETENTION OF THE BLOOD-MEAL IN *Aedes aegypti* FOLLOWING STERILIZATION BY CHEMICALS AND IRRADIATION. *Ann. trop. Med. Parasit.* 60 (1966) 482-494.

Egg development in *A. aegypti* is inhibited by γ -irradiation and by chemosterilants. Whether chemosterilization and irradiation cause other physiological alterations, in addition to the more conspicuous effects on fertility, was examined. The effects of metepa (tris(2-methyl-1-aziridinyl) phosphine oxide), apholate (2,2,4,4,6,6-hexa(1-aziridinyl)2,4,6-triphospho-1,3,5-triazine), and tepa (tris(1-aziridinyl) phosphine oxide) on blood-digestion in *A. aegypti* females is described and compared with that of γ -irradiation. Elimination of the blood-meal was retarded in females previously treated with metepa, apholate, or tepa. A delay in blood-digestion was also observed in irradiated females, the retention of the blood-meal being most obvious 48 h after feeding. The midgut proteolytic enzyme activity in females treated with chemosterilants or irradiation was not lower than in the controls. The delay in blood-digestion was not due, therefore, to a lack of midgut proteases. Retention of the blood-meal was not due to an acute toxic effect, since it occurred also when the first blood-meal was given 8 d after treatment. No delay in the elimination of the blood-meal was observed following the second blood-meal. (NSA 22; 1968, 2546)

- 1250 Alexander, M.L. DISPROPORTIONATE AMOUNTS OF GENETIC DAMAGE INDUCED BY ETHYLENIMINE AND x-RADIATION TREATMENTS. p. 19 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, Italy. 26 Jun.-Jul. 1966, 263p". Abstr. 74.

Recessive lethal mutations were compared in the sex chromosome and second autosome of *Drosophila melanogaster* after ethylenimine treatment, x-ray treatment and combined treatments of both. When x-rays (1500 R) were given 1 d after treatment with 0.0004 ml of a 10^{-2} M solution of ethylenimine, the rate of sex-linked recessive lethals was equal to the sum of both types of treatment. However, with the combined treatment the rates for autosomal recessive lethals were not increased above that observed with x-ray treatment alone. When the time between the chemical treatment and x-rays was extended to 3 d, the combined treatments produced an additive or possibly synergistic effect for both sex-linked and autosomal recessive lethals. For sex-linked lethals, the ethylenimine, x-ray and combined treatments gave values of 4.0%, 2.5% and 6.4% when x-ray was given 1 d after chemical treatment. When x-ray treatment was given 3 d after the

chemical, the values were 5.2%, 4.2% and 11.3% for ethylenimine, x-ray and the combined treatments. For autosomal lethals, a rate of 20.0% was observed for the combined treatments when x-rays were given 1 d after the chemical. The rates were 14.4% and 24.9% for the x-ray and ethylenimine tests. With x-ray treatment 3 d after the chemical, 34.2% lethals were observed as compared to 12.8% for the chemical and 11.7% for x-rays. Ethylenimine as a mutagenic agent for autosomal lethals is not effective or is destroyed when x-rays are given 1 d after chemical treatment. If the chemical is allowed to act 3 d before x-ray treatment, an additive or possibly synergistic effect is observed for recessive lethals in both the X and autosomes. (Abstr.)

- 1251 Alexander, M.L. GENETIC DAMAGE INDUCED IN THE SEX CHROMOSOME AND AUTOSOMES, WITH x-RAY AND ETHYLENIMINE TREATMENTS. Radiat. Res. 31, 3 (1967) 614. Abstr. Eb-6, presented at "15th Annual Meeting of the Radiation Research Society. San Juan, Puerto Rico, 7-11 May 1967".

Spermatogenic germ cells of *Drosophila melanogaster* were treated with 1500 R of x-ray, injected with 0.004 ml of a 10^{-2} M solution of ethylenimine or treated with ethylenimine followed by x-radiation 1 or 3 d later. Sensitivity of sperm and spermatids are similar with the chemical treatment: spermatids do not show increased sensitivity as with x-ray and their sensitivity is not affected by combined treatments. Premeliotic germ cells show low sensitivity to both mutagenic agents. Genetic damage - recessive lethals induced in treated cells - observed in the X-chromosome with combined treatments approximately equals the sum for x-ray and ethylenimine. Mosaic lethals, induced the generation following chemical treatment, are not affected by x-ray treatment in the X-chromosome. The results with autosomes differ from the X-chromosome in several ways. The rate of mosaic lethals is lower in relation to complete lethals with chemical treatment. The rate of recessive lethals induced in the second chromosome by x-ray is not increased by ethylenimine if x-ray treatment is given 1 d after chemical treatment. In some cases, a rate equal to the sum of the x-ray and ethylenimine rate is observed if x-ray is not given until 3 d after chemical treatment. The induction of recessive and mosaic lethals in the X-chromosome with x-ray and ethylenimine appears to be completely unrelated. The autosomal results indicate that there is some interference or competition of the two agents in some phases of induction of recessive lethals. (Abstr.)

- 1252 Ascher, K.R.S. A REVIEW OF CHEMOSTERILANTS AND OVIPOSITION-INHIBITORS IN INSECTS. Wld Rev. Pest Control 3, 1 (1964) 7-27.

Work on chemosterilants and oviposition-inhibitors is reviewed. The advantages of chemosterilants over conventional killing methods are discussed, as are possibilities of combining them with insecticides. Chemical and radiation-induced sterilization are compared (p.12-13). The effects of chemosterilants on metabolism and behaviour, species specificity and problems connected with the application of chemosterilants are reviewed.

- 1253 Aubele, A.M. A COMPARISON BY MEANS OF x-IRRADIATION IN AIR AND IN OXYGEN OF THE SUPPRESSOR-ERUPT SYSTEMS IN SEVERAL STRAINS OF *Drosophila melanogaster*. Diss. Abstr. 27, 11 (1967) 4166-B.

A specific suppressor system, the suppressor-erupt -- erupt, was analysed in several strains of *D. melanogaster*. There is no significant difference between the frequencies of total erupt produced after x-irradiation in the suppressor-erupt strain used in this investigation and those found originally in earlier studies on this strain. A decrease in the expressivity of the suppressor-erupt system in the suppressor-erupt strain may be indicated by the lower frequency of extreme erupt out of the total erupt class which was obtained in the present study of this strain. Differences in penetrance and expressivity, particularly after x-irradiation in 100% C_2 , obtained in the $Su-er\ tu\ bw$; $er^+ su-tu^+$ strain and in the $al\ b\ Su-er^+ c\ tu^+ sp^2$; $er^+ su-tu^+$ strain after replacement of their respective second chromosomes by the second chromosome of the suppressor-erupt strain indicate some change between the original suppressor-erupt second chromosome and that now present in the $Su-er^+ tu\ bw$; $er^+ su-tu^+$ strain. Additional modifiers on the X-chromosome of the $Su-er\ tu\ bw$; $er^+ su-tu^+$ strain which act to enhance suppression of the erupt response are also suggested by results obtained with several substitution strains. Action of x-rays by direct enhancement of the effect of the erupt alleles is not supported from the results obtained in this investigation, since the penetrance and expressivity of the er^+ allele after x-irradiation differed among substitution strains having the same er^+ allele

together with different suppressor of erupt alleles in the second chromosome. The major action of x-rays in producing the erupt phenotype appears to be an interference with the action of the suppressor of erupt associated with any given *er* or *er*⁺ allele. The presence of O₂ during irradiation exerts a differentiating effect on the expression of erupt in the various strains tested. Combinations of second and third chromosomes with the same levels of extreme and total erupt after x-irradiation in air were found to differ from each other after x-irradiation in 100% O₂. (From DA)

- 1254 Baumiller, R. C. EFFECT OF SIGMA VIRUS ON DEVELOPMENTAL DELAY IN *Drosophila melanogaster*. CAUSED BY x-RAY INDUCED MUTANTS IN HETEROZYGOUS CONDITION. *Mutation Res.* 4, 6 (1967) 831-836.

Four strains of *D. melanogaster* were tested for their response to newly introduced heterozygous mutants both when infected with sigma virus and when cured. Each experiment involved the following procedure: Virgin females were obtained from an infected strain and its sibling or closely related uninfected substrain. Uninfected males aged for 3 d were or were not treated with 3000 R of x-rays. Radiated and control males were then mated to the two kinds of females providing four types of individuals for each strain: (1) uninfected control; (2) uninfected radiated; (3) infected control and (4) infected radiated. Two unstably virus infected strains show a significantly enhanced deleterious effect of such mutants when virus is present. Two stably virus infected strains show a significantly enhanced effect when virus is absent. These reactions are apparently not correlated with the mode of infection, stable or unstable, of a given viral strain. It is hypothesized that genetic differences between the flies, their virus, or both are responsible for the differences observed: stably infected flies being less stressed by heterozygous mutants when infected than when cured, unstably infected flies being more stressed by heterozygous mutants when infected than when cured.

- 1255 Botstein, C., Schulz, R. J. EXPERIENCE WITH HIGH ENERGY ELECTRON BEAM THERAPY. *Progr. Radiat. Therapy* 3 (1965) 27-49.

Some radiobiologic aspects of fast electron therapy are considered, particularly by comparison with properties and effects of other radiations, and some experimental and clinical studies with high-energy electrons are reported. A table shows the variation of RBE values (0.89 to 1.0) with 18- to 35-MeV electrons for various animal species. There are indications, based on both physical considerations and clinical observations, that electron beams are biologically more effective near the end of their path of penetration. The results of 4 studies designed to detect differences between RBE at surface and depth in unit density phantoms are examined. Three of the 4 experiments failed to show a change in RBE; however, the striking increase found in *Drosophila* studies indicates the need for further experimentation. Clinical experience suggests that the observable tissue reactions differ both qualitatively and quantitatively from those produced by conventional x-rays. Various aspects of dosimetry, and particularly the problem of output standardization of high-energy electron accelerators in terms of dose delivered at the dose max. in a phantom composed of tissue equivalent material, are discussed. Specific advantages of fast electron therapy are examined.

- 1256 Browning, L. S., Altenburg, E. A COMPARISON OF THE STERILIZING EFFECT OF x-RAYS, QUINACRINE MUSTARD AND AZASERINE ON *Drosophila* MALES. *Drosoph. Inf. Serv.* 40 (1965) 83.

Males of Muller's Maxy stock were treated with x-rays, quinacrine mustard and azaserine and individually mated (in vials) to Maxy females (2-3 per male). The males were transferred to new food vials with fresh virgins every third day for several such broodings. The dose of x-rays was 3000 R or 5000 R and that of the quinacrine sufficient to give a 2-3% lethal rate in mature sperm. The azaserine was weakly mutagenic (about 1% lethal inducing). In the present experiments, the x-rays produced a drastic drop in fertility in the third brood (8-10 d after treatment) from which there was a large measure of recovery in the fourth brood. In the case of chemical treatments, there was no such definite brood pattern. The effect of the three agents on the fertility of the Maxy males is tabulated. The results might indicate that the reduced fertility of the males after the chemical treatments is due to a toxic effect on their soma (reducing their life span and fitness to mate), rather than a sterilization of the germ cells at a sensitive stage (as in the case of x-rays), since the viability of the cultures undergoes considerable reduction from one brood to the next after the chemical treatments. With the x-rays, there is no such drastic drop in their viability. (From auth.)

- 1257 Campion, D. G. THE STERILISATION OF LEPIDOPTEROUS PESTS BY RADIATION AND CHEMO-STERILANTS. PANS 13, 4 (1967) 392-405.

- 1258 Carillo, J. L., Ortega, A., Rodriguez, J. EFECTO ESTERILIZANTE DE LAS RADIOCIONES GAMMA COMPUESTO "APHOLATE" SOBRE LA CONCHUELA DEL FRIJOL. (Sterilizing effect of γ -rays and apholate on the Mexican bean beetle, Epilachna varivestis Muls.) Agricultura t c. M x. 11, 4 (1963/1964) 168-175. (In Spanish)

The doses required for sterilization were low compared with other species. A ^{60}Co -source was used, and the effects of irradiation tested on eclosion and on reproduction. Doses up to 12 000 R were used. - The insects used were laboratory-bred. The effects of γ -rays were studied on the emergence and reproduction of adults irradiated at the egg stage. Doses of 150, 300, 600, and 1000 R were used, and the number of emerged adults noted (Table 1). At 150 R, egg development was unimpaired, the percentage of developed eggs was 27% (30% for unirradiated controls). At 1000 R, no eggs developed. Table 2 gives the number of eggs produced by pairing insects emerged from irradiated eggs. At 150 R, oviposition was not impaired; at 300 R, copulation and oviposition occurred but the eggs did not develop. Pupae were irradiated (1) to estimate the effect of various doses given to pupae of the same age on development and reproduction of adults, and (2) to estimate the effect of one single irradiation dose given to pupae of various ages on development and reproduction of adults. - The average lethal dose was also determined, using x-rays. Tabulated data (Table 3) show radiation effects on adult eclosion from pupae irradiated at different ages; the viability of eggs produced by pairing of irradiated and unirradiated insects (Table 4); and the effects of irradiation of pupae of various ages with 1500 R on adult emergence (Table 5). - Similar experiments were carried out using chemosterilants.

- 1259 Chandley, A. C. A COMPARISON BETWEEN THE EFFECTS OF x-RAYS AND HEAT TREATMENT ON RECOMBINATION IN THE X-CHROMOSOME OF Drosophila melanogaster. p. 51 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966". 263p. Abstr. 199.

Previous workers have shown that x-rays produce a marked inhibition of crossing-over at the distal end of the X-chromosome of D. melanogaster and an induction of crossing-over in the centromere region. It has also been known for many years that heat-treatment of females can produce an increase in crossing-over in the centromere region of the autosomes. We have now made a comparative study of the effects produced in the distal and centromere regions of the X-chromosome by the two agents. A similar comparison was made by Mavor and Svenson (1924) for Chromosome II but their study was confined to the proximal segments only. Females of the genotype $y^+ sc\ car, sc^{V1} ac^+ y^+/y^+ cv\ v\ f$ were used so that recombination could be measured along the full length of the chromosome, including the region spanning the centromere from $car-y^+$. Virgins were divided into three groups: irradiated with 3000 R x-rays, kept unmated for 24 h at 34°C, and controls. Apart from the period at 34°C, all flies were cultured at 25°C. The females were then mated singly in vials and transferred daily to fresh vials for 15 d. Recombination was scored for each region on each day. For the proximal region the results resemble those of Mavor and Svenson (1924) for Chromosome II. In the segment $car-y^+$ heat produced a two-fold increase in crossing-over on days 6, 7 and 8. On day 9, the level returned to the control value. x-rays produced an increase on every day up to day 15, but the biggest increase came on days 6, 7 and 8 when it equalled the increase found with heat treatment. In the middle of the chromosome ($v-f, f-car$), neither agent had any effect. In the distal segments ($sc-cv, cv-v$) heat and x-rays both gave greatly reduced crossing-over on days 6-9, but the heat-treated females again showed a return to the control level by day 10. x-rayed females showed only partial recovery, the decreased level of crossing-over persisting up to day 15. Thus, the effects of heat treatment over days 6-9 exactly parallel both the proximal increase and the distal decrease produced by x-rays, but whereas the x-ray effect persists indefinitely, the heat effect is confined to this 4-d period. In addition, x-rays induce crossing-over in late oocytes which have already finished natural meiotic crossing-over (days 1-5). (Abstr.)

- 1260 Fahmy, O. G., Fahmy, M. J. BIOLOGICAL ORGANIZATION IN RELATION TO DIFFERENTIAL GENE RESPONSE TO MUTAGENS. p. 14-25 of "Induction of Mutations and the Mutation Process". Velemínský, J., Gichner, T., Eds. Prague, Publishing House of the Czechoslovak Academy of Sciences, 1965.

Theories on chromosome structure and mutagenesis are reviewed. Results are reported from studies in *Drosophila* on the effects of x-radiation or the chemical mutagens, triethylenemelamine or a mustard derivative of phenylalanine, that demonstrated the relevance of each unit of biological structure to the process of mutagenesis, starting from the cell level through the chromosome and the gene to the subgenic elements that approach macromolecular dimensions. The degree of differential mutagenicity induced by x-radiation and the chemicals was assessed by determining the absolute mutation rate at 11 specific loci. The relative response of each locus to the different mutagens was compared and a complementation map was prepared of the rudimentary locus and the distribution of cistons damaged by the various mutagens. Studies on the mutagenic specificity of DNA showed that both homologous and heterologous DNA are effective in the induction of small chromosome deletions resulting in the autosomal dominants known as minutes, and to a lesser extent in the induction of point mutation visibles. It was also shown that a great many polymers of natural and synthetic origin possess the DNA type of mutagenicity. The specificity of action of DNA was studied on the 4th chromosome by comparing the distribution of minutes with that induced by x-radiation and recovered under the same conditions. The implications of the specific action of one mutagen on one locus and the possible genetic effects of synthetic macromolecules specific to particular loci are discussed. (NSA 20; 1966, 40706)

- 1261 Fahmy, O.G., Fahmy, M.I. THE NATURE AND DISTRIBUTION OF THE MUTATIONS INDUCED BY UNIRRADIATED AND IRRADIATED HETEROLOGOUS DEOXYRIBONUCLEIC ACID IN *Drosophila melanogaster*. *Genetics* 54, 5 (1966) 1123-38.

The only mutations appreciably induced by calf-thymus DNA (injected into adult males or fed to larvae) were small chromosome deletions: Minutes, and elimination of Bar from a marked Y-chromosome. Very weak activity also occurred as regards point mutations (recessive lethals and visibles) which was equivalent for the X- and 2nd-chromosome: these gave mutation frequencies in the proportion of their physical lengths (1: 2). The yield of point mutations was not increased by *irradiation (> 400 000 R) of DNA prior to its larval feeding. DNA was inactive as regards the induction of (a) X-chromosome breaks, leading to viable fragments of X0 males, and (b) non-disjunction, whether among the sex chromosomes, or the 4th autosomal pair. The proportion of 4th chromosome Minutes after the injection of calf-thymus DNA reached 26% of the total induced, which was considerably lower than that occurring with the other tested samples of the heterologous and homologous material (ranging from 85-45%). This variation seemed to be a function of the physicochemical state of the polymer, rather than its chemical constitution or biological source. The 2nd chromosome recessive lethals, recovered after the feeding of calf-thymus DNA, were mainly small deletions which were localized in segments rich in heterochromatin, especially around the centromere. Inter crosses between the independently induced mutations, however, did not yield any instances of allelism, indicating that the mutagenic selectivity of DNA did not extend to the genic level. (Auth. summary)

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- 1262 Friedman, L.D., Kiriazis, W.C. CHEMICALLY INDUCED VIABILITY MUTANTS IN *D. melanogaster*. *Drosoph. Inf. Serv.* 41 (1966) 87.

Studies are in progress on the relative frequency of chemically induced sex-linked lethals and detrimental mutations and their effect on the viability of *D. melanogaster*. Tests were made on 3925 X-chromosomes from Basc and Canton-S strains that were treated with the monofunctional alkylating agent ICR 100. The treated males were injected with 0.1% ICR 100 in 0.4% saline. Parents were discarded after 3 d so that the effects measured were on mature sperm. The experimental design and analysis is the same as used previously for similar studies with x-rays*. Estimates were made on the proportions of complete lethals and the genetic load of lethals and detrimentals induced. (1) The complete sex-linked lethal frequency induced by this compound in our experiments has been on the average of about 4.5%. There is no significant difference between the lethal rates induced in the + and Basc chromosomes. This differs from the results obtained with x-rays. (2) The ratio of the genetic load from non-lethal detrimental mutants to that from lethals was .390. The load is computed as the product of the frequency and the average effect on viability. It is a

* (See III/594).

much higher value than any effect of the same kind that has been established for x-ray. This indicates a much higher detrimental effect in relation to lethals that has been induced by the chemical mutagen in comparison to the effect caused by x-ray. Further studies are in progress including the determination of the induced mosaic lethal frequency. (Auth.)

- 1263 Glass, H.B. 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. NYO-1472-1, Johns Hopkins Univ., Baltimore, Md. 28 Feb. 1966, 35p.

The results of studies since 1953 on the comparative mutagenic effects of ionizing radiations on males and females are described, at comparable stages of the germ line. It is stressed that, when discussing mutation rates, it is essential to specify not only the sex and the stage of the germ cells at time of treatment (brood: or age of eggs, larvae, or pupae), but also the genetic strain. Translocations are very rarely induced in mature female gametes, inversions are somewhat more abundant after an identical dose of x-rays, and recessive lethals are about 2/3 as frequent in the female gametes as in the spermatozoa. The slopes of dosage curves for sex-linked recessive lethals in Oregon-R males and females diverge significantly ($2.8 \times 10^{-5}/R$ for the male, $1.6 \times 10^{-5}/R$ for the female). Sex-linked recessive lethals were induced in N, air, and O at 1000, 2000, 3000, and 4000 R; the frequencies of mutations in spermatozoa was uniformly 1/3 higher than obtained in mature oocytes. Good agreement was obtained in an autosome, chromosome 2, giving a mutation frequency in spermatozoa a little over 1.5 times the frequency in oocytes. Dominant Minute-bristle mutation studies are described, including studying the effect of a 5-R dose of x-rays. Work is also reported on the critical period for the effect of x-rays on the suppressor genes, and the occurrence of suppressor genes *su-er* and *su-tu* in wild-type strains. The effect of mating patterns on life span is also investigated.

- 1264 Hochmann, B. EMS AND ICR-100 INDUCED CHROMOSOME 4 LETHALS IN *D. melanogaster*. *Drosoph. Inf. Serv.* 42 (1967) 59.

Two chemical mutagens, ethyl methanesulfonate (EMS) and quinacrine mustard (ICR-100), when injected separately into Oregon-R males in the laboratory, have each induced 4th chromosome recessive lethal mutations at a frequency approximating 4%. This mutational response of the microchromosome is about four times that produced by x-ray doses of 3 or 4 R (see III/599). Details of the various experiments and their results are discussed.

- 1265 Jenkins, J.B. MUTAGENESIS AT A COMPLEX LOCUS IN *Drosophila* WITH THE MONOFUNCTIONAL ALKYLATING AGENT, ETHYL METHANESULFONATE. *Genetics* 57, 4 (1967) 783-793.

Ethyl methanesulfonate (*1*) is a potent mutagenic agent in *Drosophila*, inducing mutations at the dumpy locus with a frequency of $\geq 2\%$. Mutations were found in the progeny of males, both after feeding and after injection with *1*, and the induced mutation frequency was proportional to the concentration injected. *1* acted primarily on postmeiotic sperm cells, the premeiotic and meiotic cells remaining relatively immune to its effects. 98% of all the induced mutants detected in the F_1 were mosaic (containing mutant and non-mutant tissue). 35% of all the F_1 mutants contained mutant tissue in their gonads. The average amount of mutant tissue in a mosaic gonad was 56%, similar to values reported in studies with ICR-170 and nitrosomethylurea and in other studies with *1*. However, these values, all $\sim 50\%$, may be misleading because the variances are so large. With only 23% of transmitted mutations there was a disagreement in the classification of the phenotype found in F_2 compared to F_1 . In virtually every such instance of disagreement, the phenotype was less severe in F_1 than in F_2 . A comparison is made of the transmitting dumpy mutants induced with *1*, nitrosomethylurea, x-rays, and ICR-170, and a model of the dumpy region is constructed based on this comparison. (CA 68: 1968, 27781w)

- 1266 Khan, A.H. MUTAGENIC ACTIVITY OF IRRADIATED FOOD CONSTITUENTS. *Nucleus*, Lahore 3, 1/2 (1966) 30-31.

Experiments designed to detect a mutagenic effect of DNA towards *Drosophila* larvae after the DNA was exposed to a heavy dose of ionizing radiation prior to its addition to a chemically-defined and axenic *Drosophila* medium are described. Although non-irradiated DNA is found to be mutagenic

under these conditions, the prior irradiation of the DNA does not change the mutagenic effectiveness of the DNA compared with the non-irradiated DNA sample. (Auth.)

- 1267 Kitaoka, S. et al. EFFECTS OF GAMMA RADIATION AND CHEMOSTERILANTS ON THE CATTLE TICK, *Boophilus microplus*. Jap. J. sant. Zool. **18**, 273 (1967) 126-129.

Thiotepa proved the most potent sterlant followed by apholate and metepa, and finally hempa. Irradiation doses of 10 to >1000 kR inhibited oviposition.

- 1268 Klassen, W., Norland, J.F. STERILIZATION OF BOLL WEEVILS WITH COMBINATIONS OF CHEMOSTERILANTS AND RADIATION. Bull. ent. Soc. Am. **13**, 3 (1967) 203. Abstr. 358, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA, 27-30 Nov. 1967".

Dominant lethal mutations in post-meiotic germ cells are readily induced by apholate, busulfan, N,N,N',N'-tetramethyl-P-piperidino-phosphonic diamide and cyclic diester of 1 aziridinyl-phosphonic acid with pentaerythritol. Spermatogonial cells are destroyed by 3 kR of 200 kVp x-rays. Combinations of chemosterilant and x-rays induce permanent sterility. (Abstr.)

- 1269 Landa, Z., Ed. MECHANISM OF MUTATION AND INDUCING FACTORS. "Proceedings of a Symposium, Prague, Czechoslovakia, 9-11 Aug. 1965". Prague, Publishing House of the Czechoslovak Academy of Sciences, 1966, 524p. CONF-650814.

The induction of mutations in plants, *Drosophila*, mice, and rats by exposure to γ -, neutron, u.v., and x-radiations is discussed in 40 papers. Results are included from mutation studies on barley, maize, peas, sugar beets, tobacco, tomatoes, and wheat, *Drosophila*, mice, and rats. The relative efficiency of ethylenimine, dimethylsulfate, ethylmethanesulfonate, and hydroxylamine in inducing visible mutations in plants is compared and the induction of mutations in *Drosophila* by several chemical mutagens is reported. (From NSA 21: 1967, 8776)

- 1270 Mosse, I.B., Freimanis, Y.F. COMPARATIVE MUTAGENIC ACTIVITY OF SOME AROMATIC COMPOUNDS WITH OR WITHOUT γ IRRADIATION. Genetika No.4 (1965) 69-73.

The effects of nine aromatic compounds were tested in *Drosophila* for spontaneous and radioinduced mutations. Four preparations V-93, AV-69, F-4 and F-23 proved to be able to reduce the rate of recessive lethal mutations coupled with the sex induced by γ -exposure to 1500 R. Two of them AV-69 and F-23 also proved to be mutagens: AV-69 at the same concentration, F-23 at a greater concentration. The inefficiency of the F-25 and F-6 preparations may be ascribed to their insolubility in the nutrient media. Thus, a new class of genetically active compounds has been established. (Auth.)

- 1271 Murakami, A. RELATIVE BIOLOGICAL EFFECTIVENESS OF 14 MeV NEUTRONS TO GAMMA-RAYS FOR INDUCING MUTATIONS IN MATURE SPERM OF THE SILKWORM. Idengaku Zasshi (Jap. J. Genet.) **41** (1966) 17-26.

Mature sperm of the silkworm were exposed to fast neutrons or ^{137}Cs γ -radiation at late pupal stage. A series of ^{137}Cs γ -ray irradiation experiments were run in parallel with those 14 MeV neutrons. For the determination of mutation frequency visible recessive egg colour mutations were used as markers. Dose-frequency curves for recovered mutations increased linearly with the increasing dose for both radiations, which indicates that they are due to single-hit events. The frequency curves for mosaics, increased non-linearly, indicating that they are of multi-hit nature. Neutrons of 14 MeV energy were approx. six times as efficient as γ -rays in producing recessive visible mutations in mature sperm of the silkworm. Hence, RBE values of 14 MeV neutrons are larger in mature sperm than in spermatogonia. For the production of mosaics RBE of 14 MeV neutrons relative to ^{137}Cs γ -rays was about 5. (Auth.)

- 1272 Seeley, B.A., Peterson, J.B., Smoler, M.H. RELATIVE BIOLOGICAL EFFECTIVENESS OF X-RAY AND GAMMA RADIATION. Drosoph. Inf. Serv. **41** (1966) 178.

The RBE of 140 kVp x-rays and γ -rays from a ^{137}Cs -source was compared, by observing the frequency of induced sex-linked recessive lethals. Four series of tests were made with P, Canton S males using (1) 3200 R x-rays at 234 R/min, (2) an intense dose of 3200 R γ -rays at 466 R/min, (3) a dilute dose of 3200 R γ -rays at 6.9 R/min, and (4) controls. Results showed a very significant

difference in mutation induction between x-rays and both series of γ -rays, but no significant difference between the two γ -ray treated series. Earlier results (cf. 1/818) of ~ 1.6 for the RBE of a ^{60}Co -source and x-rays were confirmed.

- 1273 Slizyńska, H. CYTOLOGICAL ANALYSIS OF FORMALDEHYDE INDUCED CHROMOSOMAL CHANGES IN *Drosophila melanogaster*. Proc. R. Soc. Edinb. 66B (1957) 288-304.

Structural changes induced in male auxocytes after formaldehyde feeding were analysed cytologically. In comparison with the effects of x-rays (on mature sperm) there is: (1) a high proportion of mosaics; (2) an excess of repeats and deficiencies; (3) a shortage of translocations, and (4) fewer breaks in the heterochromatic regions. The very high frequency of mosaics and the low ratio of inter- to intrachromosomal changes may be explained by the delayed opening of potential breaks which tend to open simultaneously in the same chromosome but at different times in different chromosomes. The high number of "isochromatid" breaks (repeats) points to some connection with the reduplication cycle. The shortage of "eu-heterochromatic" changes in which "heterochromatic" breaks in salivary gland analysis are scored, can be similarly explained by a difference in the time of opening of potential breaks in the two types of chromatin. Initial non-random distribution of breaks as well as the conditions of rejoining in premeiotic cells may also play some role. (Auth.)

- 1274 Smith, R.H. DOMINANT AND RECESSIVE LETHAL MUTATIONS INDUCED BY MITOMYCIN C IN *Habrobracon* OOCYTES AND SPERM. Genetics 56, 3 Pt. 2 (1967) 591. Presented at "1967 Meetings of the Genetics Society of America. Stanford, Calif., USA. 31 Aug.-2 Sep. 1967".

Mitomycin C is a bifunctional alkylating agent that is a natural antibiotic derived from a species of Streptomyces. Metaphase I oocytes of *Habrobracon* are approx. 20 times as sensitive to mitomycin C as prophase I oocytes when dominant lethality is the criterion. This is comparable to the action on these two stages of x-radiation and other alkylating agents. When recessive lethality is the criterion, metaphase I and prophase I are essentially the same sensitivity, resembling ethyl methanesulfonate but not x-radiation or nitrogen mustard, where metaphase I has been shown to be more sensitive. Higher doses of mitomycin C than those used on females are required to obtain an effect on the gametes of males. Injected males were mated on three successive days. The dominant lethal frequency increases progressively from brood to brood, but the recessive lethal frequency remains essentially unchanged. Temperature sensitive recessive lethal mutations are induced by mitomycin in sperm. (Abstr.)

- 1275 Deleted.

- 1276 Sobels, F.H. STUDIES ON THE MUTAGENIC ACTION OF FORMALDEHYDE IN *Drosophila*. II. THE PRODUCTION OF MUTATIONS IN FEMALES AND THE INDUCTION OF CROSSING-OVER. Z. indukt. Abstamm.- u. Vererb. Lehre 87 (1956) 743-752.

Although not experimentally, comparisons are made between the effectiveness of x-rays and formaldehyde in inducing crossing-over, which is found to be about equal. Various people's x-ray data are considered (Whittinghill, Auerbach) in the discussion of the relative genetic effects. *Drosophila* females were exposed to cyanide gas prior to injection with different concentrations of formaldehyde. Compared to females which only received formaldehyde, the frequency of sex-linked lethals was increased by the cyanide pretreatment. Cyanide also enhances the mutagenic effects of formaldehyde on sperm stored in inseminated females.

- 1277 Stone, K.I. RELATIVE BIOLOGICAL EFFECTIVENESS, COMPARISON OF HARD x-RAY, SOFT x-RAY, AND BETA RADIATION. Bull. ent. Soc. Am. 13, 3 (1967) 192. Abstr. 108. Presented at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

The relative biological effectiveness of hard x-ray (80 kVp), soft x-ray (20 kVp) and β -radiation (^{90}Sr) was compared using lesser cornstalk borer eggs, *Elasmopalpus lignosellus*. (Abstr.)

- 1278 Strømnaes, Ø. STOCK DIFFERENCES IN x-RAY MUTATIONAL SENSITIVITY PATTERN OF *Drosophila melanogaster*. Hereditas 40 2,3 (1959) 221-229.

Stock dependency of radiation sensitivity was tested on Iso-Amherst and Oslo stocks. Males were irradiated and repeatedly paired with virgin females. The Oslo stock showed greater fertility. Sex-linked lethals were also induced at a lower rate in the Oslo stock.

- 1279 Sugai, E. EFFECT OF TEMPERATURE ON RADIATION INDUCED MALE STERILITY IN THE SILKWORM *Bombyx mori* L. Appeared as 1) NSJ-Tr-89, Japan Atomic Energy Research Inst. Tokyo, Dec. 1967, 9p, and 2) Translation of Jap. J. appl. Ent. Zool. 9, 4 (1966) 266-270.

For abstract, see III/726.

- 1280 Suzuki, D.T., Piternik, L.K., Hayashi, S., Tarasoff, M., Baillie, D., Erasmus, U. TEMPERATURE-SENSITIVE MUTATIONS IN *Drosophila melanogaster*. I. RELATIVE FREQUENCIES AMONG γ -RAY AND CHEMICALLY INDUCED SEX-LINKED RECESSIVE LETHALS AND SEMILETHALS. Proc. natn. Acad. Sci. U.S.A. 87, 4 (1967) 907-912.

Males were placed in gelatin capsules, irradiated with 4000 R of γ -rays delivered from a 6000 Ci ^{60}Co therapeutic source, at 200 R/min, and mated as outlined in the paper. Sex-linked recessive mutations that are lethals and semilethals at 29°C but survive at 17°C were recovered. Of the lethals and semilethals induced by γ -rays and mitomycin C, 3.2 and 3.5%, respectively, are temperature-sensitive (*ts*), whereas it is estimated that at least 10.7% of the lethals and semilethals induced by ethyl methanesulfonate are stable *ts* mutants. Such mutants provide a useful tool for a variety of genetic analyses.

- 1281 Taylor, K.B., Berryman, A.A., Blackwell, J.L. PROGRESS IN THE STERILIZATION OF THE EUROPEAN PINE SHOOT MOTH. Bull. ent. Soc. Am. 12 (1968) 286. Abstr. 98. Presented at "Portland Meeting, Portland, Oreg., USA. 28 Nov.-1 Dec. 1966".

Techniques for mating the European pine shoot moth were developed. Preliminary studies indicated that *tepa* was an effective sterilant. The potential use of this chemosterilant is compared with γ -irradiation. (Abstr.)

- 1282 Thomas, J.J., Jr., Baxter, R.C., Fenn, W.O. INTERACTIONS OF OXYGEN AT HIGH PRESSURE AND RADIATION IN *Drosophila*. J. gen. Physiol. 49 (1966) 537-549.

Oxygen at high pressure (OHP) and x-irradiation can interact in *D. melanogaster* to potentiate toxic actions characteristic of one agent alone. 1000 kVp x-irradiation in doses of 30, 60, and 75 kR accelerated the acute immobilization of young male *Drosophila* by O_2 at 7.8 atm, up to rates twice that observed with such O_2 -pressure alone. x-Irradiation alone, in these dosages, did not acutely immobilize *Drosophila*. x-Irradiation during exposure to 7.8 atm pO_2 was more effective and consistent in producing this potentiation than was x-irradiation that preceded exposure to OHP. Acute OHP toxicity in young female *Drosophila* was not potentiated by 75 kR. On the other hand, shortening of the life span of young males by the above doses of x-irradiation was augmented significantly by a concurrent 40 min exposure to OHP (which alone did not significantly decrease life span). This shows, for the first time, that O_2 can affect not only the acute effects of radiation, but also the residual irreversible effects indicated by life span shortening. (Auth.)

- 1283 Tokin, B.P. INSTITUT NATIONAL DE GENETIQUE DU JAPON. Genetika No.3 (1967) 190-195. (In Russian, with French summary)

The research programme at the National Institute of Genetics, Japan, is described. Work on the silkworm, *Drosophila* and other insects is discussed. The effects of irradiation by means of x- and γ -rays, and by neutrons were studied in terms of resultant cytogenetic modifications and mutations. Work is also described with radioisotopes (^{32}P and ^{131}I).

- 1284 Trams, A., Kuenkel, H.A., Henke, H. INVESTIGATIONS ON THE MUTAGENIC EFFECT OF NITROSO COMPOUNDS. p. 156-162 of "Biophysikalische Probleme der Strahlenwirkung". Muth, H., Ed. Stuttgart, Georg Thieme Verlag. 1966. (In German)

The mutagenic effect of N-nitroso-N-methyl-urethane, N-nitroso-morpholine, N-N-dinitroso-piperazine, N-nitroso-piperidine, and N-nitroso-N-methyl-acetamide was studied on *Escherichia coli* and *Drosophila melanogaster* and the results were compared with the mutagenic effects of x-radiation. The differences in the mutagenic effects of the urethane and acetamide were discussed at some length. (NSA 21; 1967, 22380)

- 1285 Whittinghill, M. BROOD DATA ON CROSSOVER RECOVERY FROM PRETESTED HEATED ADULT FEMALES. Drosoph. Inf. Serv. 39 (1964) 81.

Compared with inductions by x-rays (Whittinghill, Genetics 48: 1963, 915 and unpublished) the heat-induced* crossovers appeared at least 1 d earlier and possibly 2 or 3 d earlier than did viable x-ray induced crossovers. The partitioning of induction between gonial cells and early oocytes does not yet seem feasible. (From auth.)

* 33°C.

See also:

- 937 Mutagenic effect of neutrons and x-rays on Drosophila melanogaster oocytes and oögonia. (Dickerman, R.L., 1966)
- 1008 Estimation of the rejoining distance for chromosome exchanges induced in Drosophila sperm by combined doses of x-rays and neutrons. (Heddle, J.A. et al., 1966)
- 1010 Genetic and direct effects of gamma radiation on Drosophila. (Ives, P.T., 1966)
- 1019 Genetic crossing-over in both sexes of Megaselia scalaris. (Mainx, F. et al., 1967)
- 1026 Interaction of x-ray and fast neutron-induced chromosome breaks in Drosophila. (Reddi, O.S., 1966)
- 1038 Genetical after-effects of x-rays depending on the temperature regime. (Tikhomirova, M.M. et al., 1967)
- 1052 Preserving food by radiation; safe or unsafe. (Anonymous, 1967)
- 1055 An increased yield of gamma induced eye colour mutations from chronic versus acute exposures in Dahlbomimus. (Baldwin, W.F., 1967)
- 1122 Genetic effects of chronic γ -radiation on Habrobracon sperm. (Bonstel, R.C. von. et al., 1967)
- 1134 The induction of dominant lethal mutations in insects by ionizing radiation and chemicals - as related to the sterile-male technique of insect control. (LaChance, L.E., 1967)
- 1152 Mutation pattern in two wild-type stocks of Drosophila melanogaster. (Strömnaes, Ö., 1959)
- 1174 Effects of x-rays, tryptophan metabolites, and eye colour mutants on the tumor-suppressor system in Drosophila melanogaster. (Brooks, G.T., 1967)
- 1186 RBE of fast neutrons by the release of mutations in Drosophila melanogaster. (Dauch, F. et al., 1966)
- 1209 Effect of conjugate aromatic systems on heredity. I. Mutagenic and antimutagenic effect of certain indene compounds. (Mosse, I.B. et al., 1964)
- 1301 Modification in productivity and mortality of flour beetle species and strains due to x-ray and the insecticide, DDT. (Erdman, H.E., 1966)
- 1308 Some effects of gamma radiation and apholate on the fertility of Drosophila melanogaster. (Henneberry, T.J. et al., 1967)
- 1430 Modification of fitness in species and strains of flour beetles due to x-ray and DDT. (Erdman, H.E., 1966)
- 1489 Induced mutations in polygenic systems. (Aastveit, K., 1966)
- 1562 A. The IAEA laboratory at Vienna and Seibersdorf. Second Report. IV. Agriculture. 8. Insect eradication and pest control. 5. Co-ordinated programme on insect eradication and sterile-male technique. (International Atomic Energy Agency, Vienna, Austria, 1965)
- 1620 Codling moth control. (Madsen, H.F. et al., 1967)

2.2. DEVELOPMENTAL AND PHYSIOLOGICAL EFFECTS ON THE ORGANISM

2.2.1. General Articles. Surveys

- 1286 Hungate, F.P. RESPONSE OF INSECTS TO RADIATION. p. 2 of "Pacific Northwest Laboratory Monthly Activities Report, August 1966, on AEC Division of Biology and Medicine Programs". BNWL-322, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Sep. 1966, 18p.

Prior to chronic γ -radiation, flour beetle populations of single and mixed species were established at three temperatures and censused monthly for eight months as to larvae, pupae, and adults. From

the total number of bioforms observed it was clear that equilibrium was not attained during this period, possibly due to lack of homozygosity in the stocks. This was further suggested by a consistent difference in productivity in the several cultures which were presumed to be replicates.

- 1287 Lambrev, Z., Dushev, T. EFFECT OF IONIZING RADIATION x-RAYS ON THE SILKWORM (*Bombyx mori*). Nauchni Trud. vissh selskostop. Inst. Vasil Kolarov 14, 2 (1966) 179-182. (In Bulgarian, with German summary)

- 1288 Schlagbauer, A. RECHENPROGRAMME ZUR RATIONELLEN BESTIMMUNG DER EFFEKTIVEN UND BIOLOGISCHEN HALBWERTSZEIT BEI MESSUNGEN AN ÜBERLEBENDEN ORGANISMEN. (A method for computing the effective and biological half-life from measurements on surviving organisms.) G I T Fachztg Lab. No. 12 (1967) 1073-1080. Preprint. (In German)

The conditions are discussed which are necessary for an accurate determination of the effective half-life of living organisms. Reference is made to data obtained in tracer studies in entomology. The use of FORTRAN II calculating programmes for a rational and objective evaluation of experimental data is explained.

- 1289 Shipman, W.H., Cole, L.J. INCREASED RESISTANCE OF MICE TO x-IRRADIATION AFTER THE INJECTION OF BEE VENOM. Nature, Lond. 215 (1967) 311-312.

Subcutaneous injection of 5.6 µg bee, *Apis mellifera ligustica*, venom/g or intraperitoneal injection of a 1.1 µg/g dose into mice 24 h prior to x-irradiation (825 R) increased the survival from 0 - 80 and 20% respectively, by 30 d after the irradiation. Also, subcutaneous injection of 4.3 or 5 µg venom/g 1 d prior to exposure to x-irradiation (850 R) increased the 30-d survival from 0 - 70%, although these dosages were not effective in increasing survival when given 30 min prior to irradiation or injected immediately after the irradiation. The venom is placed in a different category from cysteine, AET, and related compounds which are effective when administered immediately prior to irradiation. At least three mechanisms may be invoked to account for the radioprotective effect of bee venom: (1) it has a stressor-like action, thereby eliciting an "adaptation syndrome," (2) it produces changes in the haemopoietic system, and (3) it has antibacterial properties. (CA 67: 1967, 61397q)

- 1290 Simón, F., García, B.G. EFECTOS DE LA RADIACIÓN GAMMA EN EL ARREBIATADO. (Effects of γ-radiation on the cotton stainer.) Boln Soc. ent. Agr. Perú 3 (1963) up.

The effects of γ-radiation on the Peruvian cotton stainer, *Dysdercus peruvianus*, were studied.

See also:

- 910 Biological Effects of Radiations. (Grosch, D.S., 1965)

2.2.2. Biochemistry. Physiology.

Pathogen, Parasite, and Pesticide Susceptibility. Reproductive Potential

- 1291 Abdul Matin, A.S.M., Bhuiya, A.D., Khan, Z.A. AN ATTEMPT TO OBTAIN STERILITY OF MALE RICE HISPA THROUGH GAMMA RADIATION. p. 155-156 of "Proceedings of the Agricultural Symposium. Dacca, Pakistan, 13-14 May 1966". 1966, 166p.

Adult males of *Dicladispa (Hispa) armigera* (Ol.) were irradiated at various doses of γ-radiation from a ⁶⁰Co source at a fixed dose rate of 34.8 kR/h and placed in cages with untreated females. Records were kept of egg production, hatch, etc. When untreated virgin females were mated with irradiated males, the percentage of viable eggs decreased with increase in dose. The average egg hatch in the untreated controls was 71.49%, whereas matings with male beetles exposed to 10000, 8000, 7000, 6000 and 5000 R resulted in averages of 1.4, 1.41, 9.3, 12.72 and 14.50% egg hatch, respectively. (RAE-A 56: 1968, ref. 875)

- 1292 Akov, S. RETENTION OF THE BLOOD-MEAL IN *Aedes aegypti* FOLLOWING STERILIZATION BY CHEMICALS AND IRRADIATION. Ann. trop. Med. Parasit. 60, 4 (1966) 482-494.

A ^{60}Co source, type Gammacell-200, emitting 7760 R/min was used on 4-d-old *A. aegypti*. Blood meals were given on rats at various intervals after chemosterilant or irradiation treatment, in some cases sheep blood after chemosterilant treatment. Two days after the blood meal females were dissected in 0.85% NaCl, and the size of the blood residue in the mid-gut and the stage of ovarian development were determined. Both the chemosterilant and irradiation treatment cause a delay in blood digestion, not due to a lack of mid-gut protease. The effect of metapa, apholate and tepa on egg development was studied. The elimination of the blood meal was retarded in all females thus treated. A delay in blood digestion in the irradiated females was most obvious 48 h after feeding on a rat. The mid-gut proteolytic activity in females treated with chemosterilants or irradiation was not lower than in the controls. The retention of the blood meal was not due to an acute toxic effect, since it occurred also when the 1st blood meal was given 8 d after treatment. No delay in elimination of the blood meal was observed following the 2nd blood meal. The relationship between the retention of the blood meal and ovarian development is discussed.

- 1293 Becker, G. HOLZBESTANDTEILE UND HAUSBOCKLARVEN-ENTWICKLUNG. (Wood components and the development of the larvae of *Hylotrupes bajulus*.) *Holz Roh-u. Werkstoff* 21 (1963) 285-289. (In German, with English summary)

The following is virtually the author's summary. Larvae of *H. bajulus* (L.) utilize only a relatively small portion of the carbohydrates that are abundant in their food (about $\frac{1}{3}$ of the cellulose and $\frac{1}{5}$ of the hexosans and pentosans, total about 22%). The utilization of carbohydrates is variable. Larvae causing a high loss of wood by catabolism consume comparatively less wood than larvae with poor carbohydrate digestion. The degree of utilization of wood is somewhat affected by temperature. Certain doses of γ -radiation make cellulose better digestible for the larvae. The growth rate of the larvae depends directly on the protein content of the wood, which decreases from the phloem towards the inner parts of the trunk. In wood stored for some years, the lower limit is about 0.2% protein based on the weight of the wood. In softwoods of German origin, the protein content does not fall below this threshold. The nutritive value of wood for the larvae decreases gradually, although the nitrogen content does not fall. The unfavourable transformation of amino acids and reduction of vitamin B content affect mostly the younger larvae. By γ -radiation, the ageing-process of proteins is accelerated. The gradual impairment of nutritive conditions for *Hylotrupes* larvae, resulting in slow growth and longer generation periods as well as in a higher death rate, is of practical importance. Essential oils and resins inhibit the development of *Hylotrupes* larvae, but the pine-heartwood constituents pinosylvin and pinosylvinmonomethylether, which have a toxic effect on termites and certain fungi, have little effect. Among the heartwood constituents of other conifers, taxifolin and norkatin showed no effect, but β -thujaplicin proved toxic. (RAE-A 54: 1966, 407)

- 1294 Biskhopf, R. DIE SPERMIOGENESE DER DROHNEN NACH BESTRAHLUNG DER JUNGLARVEN MIT VERSCHIEDENEN RÖNTGENDOSSEN. (Spermatogenesis in drones following irradiation of the young larvae with various doses of x-rays.) *Dt. ent. Z.* 13, 1/3 (1966) 237-262. (In German)

1-2 d old larvae of drones of *Apis mellifica mellifica* L. and *A. m. carnica* Pollm. were irradiated with 610, 1000 and 2000 R. The effect on spermiogenesis was studied. Apart from the first 24 h after irradiation when a relatively high percentage of larvae were thrown from their cells for unknown reasons, there was no atypical behaviour of the workers towards the irradiated brood. Only one isolated deviation in development was observed in the pupal stage of the 2000-R batch. The occurrence of position inversion at the pupal stage of 610-R and 1000-R larvae was of interest. A comparison of the radiation effects on spermiogenesis was made histologically. No anomalies occurred in 610-R larvae, partially damaged testes occurred in 1000-R larvae, and complete malformation of the testis in 2000-R larvae.

- 1295 Catalan, R. E., Muncio, A. M. IN VITRO EFFECT OF GAMMA-RADIATION ON DIFFERENT CHOLINESTERASE PREPARATIONS. *Nature*, Lond. 208 (1965) 1227.

Experiments were designed to investigate the in vitro effect of γ -rays on cholinesterase from various sources and of differing grades of purity. Irradiations were performed at 18°C in a thermostatically controlled cylindrical 2000 Ci ^{60}Co source. The dose-rate used was 2.5×10^5 R/h. Ten samples were simultaneously irradiated in sealed glass ampoules with a head space of 6 ml, containing air. Controls were handled in the same fashion, but they were not placed within the cobalt source. The preparations exposed to γ -radiation included bovine red blood cell cholinesterase preparations at

different stages of purification. These stages were: whole heads; homogenate; and a purified fraction. The enzymatic activities of the samples were controlled within 1 h of irradiation. Cholinesterase activity was measured potentiometrically using as substrate a solution of 0.5 M sodium chloride - 0.04 M magnesium chloride - 0.002 M acetylcholine bromide in 0.5 M phosphate buffer pH 7 and 38°C. The acetic acid liberated was automatically determined by titration with 0.005 N sodium hydroxide. Enzymatic activity was expressed as ml consumed alkali/min. The extent to which the pH of the samples was affected by the γ -irradiation was also determined. Experimental results were evaluated by plotting the percentage of the remaining enzymatic activity as a function of irradiation dose. Results indicate that the more purified the samples were, the more was the inactivating effect of the irradiation. In the cholinesterase preparations from common fly, the order of inactivation was: purified sample > homogenate > whole heads. Assays carried out with red blood cells and cholinesterase from the electric eel showed a high grade of inactivation. (NSA 20: 1966, 10586)

- 1296 Caralan, R. E., Municio, A. M. IN VITRO AND IN VIVO EFFECT OF γ -IRRADIATION OF COMMON FLY BRAIN CHOLINESTERASE. An. Fis. Quim. B 63, 12 (1967) 1145-1156.

The inactivation of cholinesterase by ^{60}Co radiation was dependent upon the purity and type of sample, with soluble enzyme being the most sensitive. Fly brain cholinesterase was the most radio-resistant. Enzyme inactivation was slightly increased in freeze-dried homogenates by storage after irradiation. The converse was noted with brain homogenates. Increased inactivation was noted at pH values other than 6.5. The Michaelis constant was unchanged in irradiated brains, but V_{max} was inversely proportional to exposure. N,N-Dimethylcarbamate and 3-ethyl-4-methylsulfonyl O, O'-diethyl phosphate exhibited a significant radioprotective action at exposures to 8×10^5 R. (CA 68: 1968, 36459z)

- 1297 Drummond, R. O., Medley, J. G., Graham, O. H. ENGORGEMENT AND REPRODUCTION OF LONE STAR TICKS (*Amblyomma americanum* (L.)) TREATED WITH GAMMA RADIATION. Int. J. Radiat. Biol. 10 (1966) 183-188.

Most unengorged nymphal lone-star ticks (*Amblyomma americanum* (L.)) exposed to 250-7500 R of γ -radiation from a ^{60}Co source engorged normally, and those irradiated with 1000 R or less moulted to adults; those irradiated with 2500 R or greater did not. Nymphs irradiated after completion of engorgement became increasingly tolerant to radiation during the moulting period. Those irradiated with 2500 R 1 d after engorgement did not moult, whereas those irradiated with 15000 R two weeks after engorgement moulted. Egg-laying and egg hatch were used as criteria to determine the effects of radiation on the reproduction of adults from irradiated nymphs or irradiated adults. Irradiation with 250 R had little or no effect on reproduction. With females, reproduction was reduced at a dose of 500 R and prevented at a dose of 1000 R. With males, reproduction was slightly reduced at a dose of 500 R, and at a dose of 1000 R, effects on reproduction varied according to the point in development at which the males were irradiated. With both sexes, irradiation with 2500 R or more prevented reproduction. (Auth.)

- 1298 Ducoff, H. S. x-RAY RESPONSE OF AN ENDOPARASITIC WASP. Radiat. Res. 27 (1966) 496. Abstr. BC-4. Presented at "14th Annual Meeting of the Radiation Research Society. Coronado, Calif., USA, 13-16 Feb. 1966".

Nemeritis canescens (Gravenhorst) is an ichneumonid parasite of larval microlepidoptera. Parasitised caterpillars show no early signs of injury, but continue to grow, and frequently pupate before death. Parasites hatch 3 d after oviposition (25°), proceed through 5 larval instars, and pupate about the 14th day. Adults emerge about 10 d afterwards, living about 10 d if fed, 3 d if starved. Only 1 parasite/host develops; any additional parasites are eliminated early in first instar, by fighting or by competition for O_2 . *Nemeritis*-parasitised *Anagasta* larvae were x-irradiated at various stages of parasite development. With adult emergence as criterion of survival, the LD 50 of *Nemeritis* was, for 1st instar, 3.8 kR; 5th instar, 5.5 kR; pupae, over 8 kR. Adults exposed to 36 kR survived as long as controls, whether fed or starved. Six kR to 1st-instar *Nemeritis* completely suppressed adult emergence; 12 kR caused only slight mortality in unparasitised *Anagasta* larvae. Accordingly, *Nemeritis* were exposed to 6 or 12 kR during 1st instar; hosts were sacrificed at intervals, and the developing *Nemeritis* examined. Parasites exposed to 12 kR never moulted, exhibited marked decreases in feeding and in intestinal motility, and died in about 25 d; 6 kR larvae exhibited slight,

temporary decreases in feeding and intestinal motility, and developed, after considerable delay, to 5th instar, dying in 25-30 d. (Abstr.)

- 1299 Erdman, H. E. FAST NEUTRON IRRADIATION EFFECTS ON REPRODUCTION AND THE INFLUENCE OF TEMPERATURE AND SEX-EXPOSED ONE DAY-OLD FLOUR BEETLES, Tribolium castaneum Herbst. Paper presented at the "Meeting of the Entomological Society of Canada, Vancouver, B. C., Canada, 19-21 Oct. 1964".

Reproductive onset and productivity (F_1 adults/female) were determined for virgin day-old flour beetles irradiated with 830 rad of fast neutrons, mated in male-exposed, female-exposed, both-exposed and neither-exposed pairs and maintained at 25, 29 and 32°C in 70% r.h. Earlier reproductive onset and greater productivity were associated with increasing temperatures. Irradiation delayed reproductive onset for exposed female combinations and reduced productivity. Biological interpretations are discussed. (From abstr.)

- 1300 Erdman, H. E. x-RADIATION AND TEMPERATURE MODIFICATION OF REPRODUCTIVE PERFORMANCE OF SINGLE-SPECIES AND MIXED-SPECIES CULTURES OF Tribolium confusum AND Tribolium castaneum. Physiol. Zool. 39, 2 (1966) 160-170.

Adult flour beetles sexed as pupae and maintained separately for three weeks after adult emergence, were given 0, 1575, or 2625 R of x-ray. Single- and mixed-species populations were established and incubated at 25, 29, or 32°C at 65%-70% r.h. Productivity was determined during ten weeks post-irradiation. Reproductive abilities increased with increased temperature and decreased with increased x-ray exposure for a given temperature. The reproductive fitness of T. castaneum was superior in all environments except at 0 R, 32°C. The frequencies of dominant lethals (which included lethality due to coexistence in mixed-species populations) increased with higher x-ray doses, but temperature and cohabitation influenced their expression within a species. Coexistence was responsible for a considerable reduction of productivity, which was also altered by temperature and x-ray. The rigours of coexistence were lessened at 2625 R exposures (undoubtedly due to reduced population density). Interpretations of dose-response curves on the bases of "single-hit" and "multi-hit" radiation phenomena were inferred from similar responses of diverse organisms. Most lethality occurred in the early (eggs to young larvae) part of the life cycle for both species. Species proportions in coexistent populations varied with temperature and x-ray but T. castaneum was consistently superior compared to T. confusum. The greater variability of T. castaneum probably makes it more fit in environments, featuring different temperatures and x-radiation exposures plus coexistence. Responses to radiation of single-species populations cannot be used to predict those of mixed-species populations. (Auth.)

- 1301 Erdman, H. E. MODIFICATION IN PRODUCTIVITY AND MORTALITY OF FLOUR BEETLE SPECIES AND STRAINS DUE TO x-RAY AND THE INSECTICIDE, DDT. p. 78 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy, 26 Jun. - 2 Jul. 1966, 263p". Abstr. 305.

Productivity modifications due to radiation plus insecticides have important applications in economic entomology, evolution and radiation ecology. Such changes are known in some cases to have a genetic basis. Studies were designed to determine the early effects of DDT and x-radiation, singly and in combination, on mortality and productivity of flour beetle species and strains (Tribolium confusum Duval "Chicago standard" and T. castaneum Herbst "Brazil ci" and "Sooty").

For further details, see 1410.

- 1302 George, J. A. EFFECTS OF GAMMA RADIATION ON FERTILITY, MATING, AND LONGEVITY OF MALES OF THE ORIENTAL FRUIT MOTH, Grapholitha molesta (LEPIDOPTERA: TORTRICIDAE). Can. Ent. 99, 8 (1967) 850-857.

Male G. molesta (Busck) treated with 40 krad of γ -radiation in the late pupal stage reduced egg-hatch by 93.6%, and in the young adult stage by 96.4%, in eggs from untreated virgin females with which they were mated; in addition, hatched larvae failed to complete development. Induced sterility was consistently greater in treated adults as compared with treated pupae. Females in the late pupal stage were sterilized with about 10 krad. Male longevity decreased in proportion to the radiation dosage above 30 krad when caged at a ratio of 3 ♂: 1 ♀. Longevity of untreated males decreased in proportion to the number of females available for mating. Radiation levels of 30 krad

or more decreased male mating, especially when applied to the pupal stage, in inverse proportion to dosage, as detected by caging males with three times as many females. The number of matings per untreated male increased with the number of females available up to an average of 3.8 while the number of matings per female averaged approx. 1.6 with from one to three males per female. (Auth.)

- 1303 Glover, S.I. THE EFFECT OF IRRADIATION UPON O_2 UPTAKE IN SOME INSECTS. Bull. ent. Soc. Am. 13, 3 (1967) 192. Abstr. 113. Presented at "New York Meeting of the Entomological Society of America. New York, N. Y., USA. 27-30 Nov. 1967".

The effect of irradiation upon O_2 uptake was investigated in the house fly, Musca domestica, and fall armyworm, Laphygma frugiperda. Pupae were irradiated at different levels, and emerging adults were tested at three ages. (Abstr.)

- 1304 Grosch, D.S. THE INFLUENCE OF ANTIBIOTICS ON THE FECUNDITY AND FERTILITY OF IRRADIATED Habrobracon FEMALES. Radiat. Res. 14, 4 (1961) 470-471. Abstr. 65. Presented at the "9th Annual Meeting of the Research Society. Washington, D. C., USA. 15-17 May 1961".

A concentric arrangement of ^{60}Co rods was used to deliver 4900 R to samples of virgin female braconid wasps. Some were given an acute dose delivered in 90 s, others received two 45-s fractions separated by 4 h of incubation. Both types of exposure resulted in a few days of infecundity after the eggs derived from preformed oocytes were deposited. Subsequently the difference in dose rate was reflected by striking differences in egg production. Refrigeration instead of incubation during the interfraction period allows no "recovery" or restoration. In order to identify important metabolic steps in the restoration process, chemical inhibitors have been employed. Chloromycetin and aureomycin, inhibitors of protein synthesis were detrimental to the recovery phase of Habrobracon egg production. They also lowered hatchability. Penicillin had no evident influence. This is consistent with Wolff's observations on the rejoining of radiation induced breaks in Vicia chromosomes. However the most potent agent, aureomycin, by itself decreased reproductive capacity. Furthermore, a shortened adult life span indicated a deleterious influence on non-dividing somatic tissue, presumably connected with interference with protein synthesis. In view of recent evidence that the insect ovary accepts protein from the blood rather than relying exclusively on the synthetic activity of its cells, interpretation of the primary effects of radiation at the cellular level may be obscured by alterations in somatic tissues involved in co-operative action with the insect ovary. (Abstr.)

- 1305 Grzelak, K., Lassota, Z. THE EFFECT OF γ -RAYS ON THE ACETYLCHOLINE LEVEL IN INSECTS. Bull. Acad. pol. Sci. Cl. II Ser. Sci. biol. 14 (1966) 391-395.

The diapausing pupae of Celerio euphorbiae were irradiated with a single 1000 kR dose of ^{60}Co γ -rays at a rate of about 200 kR/h. Within 2 h after irradiation the lethargic pupae as well as non-irradiated control ones of similar weight (1.9 ± 0.2 g) were bled, sectioned, and the fat body was discarded. The residual tissues were separated from the cuticula and immediately plunged into 10% trichloroacetic acid. The average wet weight of tissues to be analysed, prepared from 1 g of whole pupa was about 0.22 g. Tissues from three individuals were usually collected in 4 ml of 10% trichloroacetic acid and the mixed sample was homogenized in a glass homogenizer. The eggs of Bombyx mori were irradiated at diapause with a single dose of 20 kR of ^{60}Co γ -rays at a rate of about 200 R/min. At a given stage of embryogenesis 1 g of eggs was homogenized in 4 ml of 10% trichloroacetic acid. The quantities of acetylcholine in the homogenates were determined colorimetrically after separation on paper chromatograms. Irradiation caused an immediate increase in acetylcholine content of pupal tissues and a delayed increase of acetylcholine in irradiated eggs was correlated with the differentiation of the nervous system of the embryo. (NSA 20: 1966, 42874)

- 1306 Hart, W.G., Ingle, S. INFLUENCE OF RADIATION ON THE FECUNDITY OF THE BROWN SOFT SCALE. Bull. ent. Soc. Am. 12 (1966) 265. Abstr. 339. Presented at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

3rd-stage brown soft scale, Coccus hesperidum L., were subjected to dosages of 5000, 10 000, 20 000, and 40 000 R from a ^{60}Co -source. The scales were attached on Mexican squash, Cucurbita moschata, when exposed. No offspring were produced at the two higher dosages and reduced numbers at the lower dosages. (Abstr.)

- 1307 Hathaway, D.O. LABORATORY AND FIELD CAGE STUDIES OF THE EFFECTS OF GAMMA RADIATION ON CODLING MOTHS. J. econ. Ent. 59, 1 (1966) 35-37.

γ -radiation of the codling moth, Carpocapsa pomonella (L.), as an adult or fully mature pupa reduced the F_1 generation 98% when male moths treated with 40 kR were mated with untreated female moths. Treated female moths irradiated with 20 kR and mated with untreated males deposited no viable eggs. The population reduction in the F_1 generation was 84% when adult males treated with 40 kR were confined in field cages at a ratio of 20 treated males to one untreated male and one untreated female moth. The reduction of the F_1 generation was slightly lower, 76%, when both the adult females and males treated with 40 kR were released in field cages at a ratio of 20 treated males and 20 treated females to one untreated male and one untreated female moth. (Auth.)

- 1308 Henneberry, T.J., Mason, H.C., McGovern, W.L. SOME EFFECTS OF GAMMA RADIATION AND APHOLATE ON THE FERTILITY OF Drosophila melanogaster. J. econ. Ent. 60, 3 (1967) 853-857.

Untreated female D. melanogaster Meigen mated to irradiated or apholate-fed males produced about the same number of eggs as females of untreated pairs. Most of the eggs laid by females mated to irradiated or apholate-treated males were nonviable. None of the eggs laid by nine virgin females, three each mated 1-, 5-, or 10 d after treatment to a sterilized male, produced adult flies. Irradiated or apholate-fed females laid fewer eggs, most of which were not viable, than females of untreated pairs. The age of males or females when treated appeared to have little effect on results obtained after radiation exposure. Apholate appeared to induce a higher degree of sterility when males or females were older at the time of treatment. When females producing fertile eggs were mated to irradiated (16 kR) males, adult emergence was markedly reduced. Females mated first to irradiated (16 kR) males produced nonviable eggs. Subsequent mating with untreated males resulted in the production of fertile eggs. (Auth.)

- 1309 Jones, R.H. SOME IRRADIATION STUDIES AND RELATED BIOLOGICAL DATA FOR Culicoides variipennis (DIPTERA: CERATOPOGONIDAE). Ann. ent. Soc. Am. 60, 4 (1967) 836-846.

The following is virtually the author's abstract. In investigations in Texas, laboratory-reared examples of C. variipennis (Coq.) were treated with γ -radiation as larvae, pupae and newly emerged adults at doses of 5000, 10000 and 15000 R and as pupae at 20000 and 30000 R. The criterion for sterility of males was the reduction in the hatching of eggs deposited by untreated females with which they mated. With few exceptions, 95-100% of the males treated at doses above 5000 R were sterile in first matings, but males treated at all levels tended to recover fertility in later matings. Recovery decreased as the radiation dose increased, but even a dose of 30000 R failed to prevent recovery entirely. Treated females did not recover and rarely laid more than one egg batch, though those batches that were laid often had rather low percentages of sterility. With treated females, the number of eggs per batch decreased as the radiation dose increased, until at 30000 R no eggs were laid. Miscellaneous biological information on the laboratory colony, principally relating to reproductive performance, was obtained in testing the treated insects and the accompanying controls. (RAE-B 56; 1968, ref. 6)

- 1310 Kalmykov, F.G. CHANGE OF OXIDATIVE PROCESS IN INSECTS UNDER THE INFLUENCE OF γ -RAYS. Radiobiologiya 5, 4 (1965) 505-510.* (In Russian)

Respiratory activity was studied. The irradiation of winged flies (at the egg, larval and pupal stages), with 100 - 3000 R γ -rays lowered oxygen intake which remained at that level throughout metamorphosis and persisted in their progeny, regardless of the stage in the life cycle at which irradiation took place. When irradiation was combined with treatment with hydrogen cyanide, this modification in respiratory activity was not so marked. It would appear that γ -irradiation significantly affects the cytochrome oxidase.

* Also presented at the Fourth Conference on Endemic Diseases and Parasitological Problems of Khazakhstan and the Republics of Middle Asia, and at the Third Conference of Parasitologists of the Ukrainian Republic.

- 1311 Kang, Y. S., Cho, W. K., Kim, Y. J., Lee, C. C. ON THE RATE OF LAYING OF EGGS AND ADULTING IN D. melanogaster INDUCED BY x-RAYS. J. nucl. Sci., Korea 4 (1964) 64-68. (In Korean, with English summary)

The effects of radiation on the fecundity and the fertility of D. melanogaster were studied. The males were more susceptible to reduction in fertility than the females but the females recovered fertility sooner than the males in the 3000 R-irradiated mating groups. The results obtained are summarized in tabulated form, giving the mean numbers of eggs laid and percentages of eggs to become adult per female in 30 d.

Mating groups	Numbers of eggs laid	Percentages of eggs to become adult
Control	953 984	76.520
F ^T x M ^N	126 271	42.062
F ^N x M ^T	824 639	8.245
F ^T x M ^T	122 428	27.051

- 1312 Pulitzer, J. F. x-RAY-INDUCED MUTABILITY OF POLYGENES CONTROLLING HATCHING TIME IN Drosophila melanogaster. Mutation Res. 3 (1966) 158-166.

Hatching time is a suitable parameter for the study of polygenic x-ray induced mutations in D. melanogaster in the heterozygous state. Because eggs are relatively closed systems until the moment they hatch, many environmental complications are avoided. Moreover, by means of paired observations it is possible to measure minute changes in hatching time and thus to discern mutations with very small metrical effects. Eggs of nonirradiated females inseminated by irradiated males were studied. Analysis of the results by Bateman's method indicated that the min. incidence of mutations in sperm was about 26% at 1200 R and 49% at 2400 R. The mean metrical effect of each mutation was to retard hatching time by about 24 min. By this method it is not possible completely to exclude the possibility of some non-genetic physiological component of the changes observed. However, it seems rather unlikely that such a component will be significant to any great extent. (Auth.)

- 1313 Quraishi, M. A. H., Kershaw, W. E. THE EFFECT OF x-IRRADIATION ON THE SURVIVAL OF Liponyssus bacoti AND ON ITS SUSCEPTIBILITY TO INFECTION WITH Limnosooides carinii. Ann. trop. Med. Parasit. 60, 1 (1966) 57-62.

The following is based largely on the authors' summary. The results are given of experiments at Liverpool on the effect of x-irradiation on the survival of Ornithonyssus (Liponyssus) bacoti (Hirst) and on the development of L. carinii in it. Irradiation at 50 000-150 000 rad decreased survival of the mites in direct proportion to dosage. When batches of mites were irradiated at 90 000 rad 24 h before the infective feed, more infective larvae of L. carinii developed in the few mites that survived 15 d after irradiation than did in the much larger number of untreated mites that lived for 15 d. However, when the number of larvae developing was expressed in relation to the original numbers of mites used, the irradiation of the mites before they acquired their infection reduced the number of infective parasites developing to about half that in the unirradiated mites; irradiation 24 h after the infective meal effected a reduction to one-tenth. (RAE-B 55; 1967, ref. 441)

- 1314 Rockstein, M., Srivastava, P. N. TREHALOSE IN THE FLIGHT MUSCLE OF THE HOUSE FLY, Musca domestica L., IN RELATION TO AGE. Experientia 23, 8 (1967) 636-637.

At the end of the paper mention is made of some work in progress on the effects of x-irradiation at the early pupal stage on trehalose content and metabolism. No results are given.

- 1315 Sato, C., Sasaki, S., et al. EFFECTS ON x-RAYS ON RESPIRATION OF Sarcophaga PUPAE. Nippon Igaku Hoshasen Gakkai Zasshi (Nippon Acta radiol.) 26, 9 (1966) 1180-1183. (In Japanese)

The amount of O-consumption of pupal Sarcophaga which proved age-specific follows a U-shape curve of respiration; the ascending part was inhibited by x-rays during the latter half of the pupal stage. When measured on the 8th day of pupal life, inhibition of respiration varied with the dose and the age at it was given. Within 24 h of puparium formation, respiration appeared very sensitive

to inhibitory effects of radiation but quite insensitive when irradiated on the 4th day of pupal development. Components sensitive to respiration decreased and the mean effective dose of inhibition increased exponentially with age (0-4 d). During this period, the fraction of isolated myoblasts in muscle tissue also decreased with age. The inhibition of respiration of 1-d-old pupae was significantly related to the decrease in protein in the giant mitochondria of flight muscle. (Based on NSAJ 6: 1967, 43347)

- 1316 Shrivastava, S.C., Richards, A.G. AN AUTORADIOGRAPHIC STUDY OF THE RELATION BETWEEN HEMOCYTES AND CONNECTIVE TISSUE IN THE WAX MOTH, *Galleria mellonella* L. Biol. Bull. mar. biol. Lab., Woods Hole 128 (1965) 337-345.

The haemocyte count of *G. mellonella* during the prepupal and early pupal stages varies from 4000/mm³ to 15 000/mm³ as a function of age. The number of freely circulating cells can be approx. doubled within 6-24 h by bleeding the insect. Using ³H-thymidine and autoradiography it was found that there is a haemocyte differentiation sequence of prohaemocyte → plasmatocyte → adipohaemocyte. This differentiation requires about 3 d at 35°C, and the labelled cells have disappeared in another 3 d. The life expectancy of these cells, at least in prepupal and early pupal stages, is then less than 6 d. Transfusion of labelled haemocytes, followed by autoradiography of sections, confirmed the previous suggestion that adipohaemocytes have some role in the destruction of the larval neural lamella, but that no blood cells are involved in the formation of the connective tissue around the adult nervous system. (Auth. summary)

- 1317 Smith, J.C. STUDIES IN THE USE OF IONIZING RADIATION AS STIMULI. Progress Report, June 1, 1965-May 31, 1966. ORO-2903-28, Florida State Univ., Tallahassee, Dept. of Psychology. 30 May 1966, 10p.

Investigations of visibility curves of a variety of insects and preliminary studies on the sensitivity of the moth eye to β -particles and visible light are among the studies reported.

- 1318 Torossian, C., Causse, R. ETUDE EXPERIMENTALE DE LA LEVEE DE L'INHIBITION DE LA PONTE DES OUVRIERES DE LA FOURMI *Dolichoderus quadripunctatus* ELEVEES EN PRESENCE DE REINES AYANT SUBI UNE FORTE IRRADIATION γ . C.r. hebdom. Séanc. Acad. Sci., Paris 264 (1967) 2789.

Les reines, ayant subi une forte irradiation aux rayons γ (50 000, 75 000 et 100 000 rd en une seule exposition, respectivement, avec une précision de 2,5%, d'un irradiateur au ⁶⁰Co de 2000 Ci, au débit de dose de 1040 rd/min), ne peuvent plus maintenir l'inhibition totale de la ponte des ouvrières de leur colonie. Il semble que ce résultat soit imputable à la modification du rythme de ponte de la reine. C'est la première fois qu'on observe chez cette espèce, la ponte simultanée des ouvrières et de la reine.

- 1319 Vereecke, A., Pelereyts, C. THE INFLUENCE OF DOSE-RATE OF GAMMA-IRRADIATION ON THE REPRODUCING CAPACITY OF ADULT FEMALES OF *Tribolium confusum* Duval. Mede. Landb. Hoogeschool, Opzoekings Gent 32, 3/4 (1967) 890-903. (In English with Flemish, French and German summaries)

Adult females were exposed to γ -rays of high dose rate (234 krad/h) and of low dose rate (17.3 krad/h). The doses varied by 500 rad from 3500 - 5000 rad. Fecundity and fertility were controlled for a month. The fecundity was somewhat greater at the low dose rate whereas the fertility was not influenced by the dose rate. (Essentially auth. summary)

- 1320 Walker, J.R. REPRODUCTIVE POTENTIAL OF THE SWEETPOTATO WEEVIL AFTER EXPOSURE TO IONIZING RADIATION. J. econ. Ent. 59 (1966) 1206-8.

When male sweetpotato weevils, *Cylas formicarius elegantulus* (Summers) were exposed to 18 000 R of γ -rays and then mated with untreated virgin females, egg hatch was reduced to <1%. Irradiated males competed favourably with untreated males. Matings involving four sterile males, four untreated males, and four untreated virgin females had an average of 55% egg hatch. There was no subsequent reduction in the number of progeny produced when virgin females were first mated with untreated males and later with irradiated males. Radiosensitivity decreased as the age of the weevils increased. The average reproductive life span for the weevil is ~ 67 d for males, and 80 d for females, with an

average of 2 progeny/female/d. Irradiation shortened the life span but not to any disadvantage in this case since adult feeding causes serious damage. The utilization of a sterile-male approach is discussed. A water-filled ^{60}Co -pit was used as source, the material to be irradiated being placed in an air-tight diving bell and lowered into the pit.

- 1321 Yanders, A. F. THE RELATIONSHIP OF GENETIC DAMAGE TO INSEMINATION SUCCESS IN x-RAYED Drosophila SPERM. AED-Conf-226-4, Gmelin-Institut für Anorganische Chemie und Grenzgebiete, Frankfurt am Main (West Germany). 1966, 1p.

For abstract, see 1322.

- 1322 Yanders, A. F. THE RELATIONSHIP OF GENETIC DAMAGE TO INSEMINATION SUCCESS IN x-RAYED Drosophila SPERM. p. 238 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun. - 2 Jul. 1966, 263p". Abstr. 948.

The success of sperm in reaching and being retained in the storage organs of female D. melanogaster is measurably reduced if the males are irradiated prior to mating. This is possibly due to physiological damage resulting in a reduction of motility, and raises the question of whether radiation-induced physiological damage is correlated with genetic damage. To test this, males aged 1, 7, or 14 d, were irradiated with 4500 R of 250 kVp x-rays, and pair mated to two virgin females at 24 h intervals for eight mating periods. One of each pair of females was dissected and scored for insemination success; the second was permitted to produce progeny, which were counted, sexed, and examined for induced Minute mutations. Daily values were obtained for all parameters. A reduction in insemination success, noted in all treated groups, is related to the age of the male and the mating period. The reduction in progeny number/male/d follows the same trend as the reduction of insemination success, and no definite trend is seen in the recovery of Minutes. These data are consistent with the hypothesis that genetic and physiological damage are not correlated, but occur as independent events in sperm populations. (Abstr.)

See also:

- 102 Mutational response of the premeiotic germ-cell stages of adult Drosophila melanogaster males to x-irradiation. (Puro, J., 1966)
- 917 Note on the relative sensitivity to irradiation damage in homozygous and heterozygous Drosophila melanogaster with regard to their capacity of producing offspring. (Bonnier, G., 1959)
- 923 Nucleic acids in normal and γ -rays irradiated eggs of Bombyx mori. (Lassota, Z., 1967)
- 959 Fifth report from Norsk Hydro's Institute for Cancer Research for 1963-1964. (Norsk Hydro's Inst. for Cancer Research, Oslo, 1965)
- 963 Techniques for studying the effects of radiation on meiosis and related processes in mosquitoes with particular reference to Aedes aegypti. (Rai, K.S., 1968)
- 966 Cell and mitotic patterns of the regenerating germ core of Gryllus domesticus in controls and after irradiation. (Schwalm, F.E., 1965)
- 1078 x-Ray induced minutes in Drosophila melanogaster sperm ejaculated in consecutive matings. (Kvelland, I. et al., 1965)
- 1101 On the biological effect of high-energy protons. (Saksonov, P.P. et al., 1965)
- 1104 Genetic segregation in the unisexual wasp Devorgilla. (Speicher, B.R. et al., 1965)
- 1123 Effectiveness of sterilization of the mallow moth: irradiability at different stages of development, and certain features of mating and egg-laying. (Buginsky, V.I., 1963)
- 1124 Sterilization of the male alfalfa weevil (Hypera postica: Curculionidae) by x-radiation. (Burgess, E.E. et al., 1966)
- 1125 Sterilization of the female adult of Nauphoeta cinerea (Blattodea) by means of x-rays. (Caprotti, M. et al., 1963)
- 1127 Radiation sterilization studies on the tobacco budworm, Heliothis virescens Fab. (Flint, H.M., 1966)
- 1131 Sterilization of the coffee leaf miner. (Katiyar, K.P., 1967)
- 1132 Sterilization of parasites of the ash tree. (Khvatova, L., 1965)
- 1141 Laboratory studies to sterilize the boll weevil with radiation. (Mayer, M.S. et al., 1966)
- 1153 Some effects of gamma radiation on navel orange-worm, Paramyeloides transitella (Walker). (Subrahmanyam, U., 1967)

- 1166 The pathogenic effect of small and average doses of gamma-rays on future generations of irradiated insects. (Podolyan, V. Y., 1964)
- 1192 Effects of dimethyl sulfoxide (DMSO) on productivity of x-rayed flour beetles. (Erdman, H. E., 1965)
- 1256 A comparison of the sterilizing effect of x-rays, quinacrine mustard and azaserine on Drosophila males. (Browning, L. S. et al., 1965)
- 1278 Stock differences in x-ray mutational sensitivity pattern of Drosophila melanogaster. (Strømnaes, Ø., 1959)
- 1338 Observations on the behaviour of pupae of Hyphantria cunea irradiated with γ -radiation. (Boguleanu, G., 1965)
- 1341 A study of the life history and the effect of radiation on rice weevil Sitophilus oryzae L. (Chettachai Baditsing, 1966)
- 1342 Gross effects of gamma radiation on the Indian-meal moth and the Angoumois grain moth. (Cogburn, R. R. et al., 1966)
- 1354 Stérilisation de la mouche méditerranéenne des fruits, Ceratitis capitata Wied., par irradiation des pupes aux rayons gamma. (Féron, M., 1966)
- 1355 Gamma irradiation of pupae of the tobacco budworm. (Flint, H. M. et al., 1967)
- 1356 The effect of gamma irradiation on the Varo race of Bombyx mori L. II. Irradiation of eggs in the early and late embryonic stages. (Gubicza, A. et al., 1964)
- 1361 The susceptibility of the different stages of rice weevil, Sitophilus oryzae L. to gamma radiation. (Khan, Z. A. et al., 1967)
- 1363 The delayed death of 20 kR gamma rays irradiated embryo of Bombyx mori. (Lassota, Z., 1966)
- 1364 Effects of x-rays on the larva at the fourth stage of Anopheles maculipennis atroparvus. (Lecis, A., 1963)
- 1365 Cobalt-60 radiation studies with the European chafer. (Lippold, P. C. et al., 1966)
- 1366 Sterilization of onion maggots by irradiation with cesium-137. (McClanahan, R. J. et al., 1966)
- 1371 Determination of the dorsal mesothoracic disc in Drosophila. (Murphy, C. G., 1967)
- 1376 Effects of sub-lethal gamma radiation on the biology and behaviour of the Angoumois grain moth, Sitotroga cerealella Olivier. (Qureshi, Z. A., 1966)
- 1379 Gamma irradiation of European corn borer larvae. (Raun, E. S. et al., 1967)
- 1386 Biochemical and developmental response of grasshopper embryos and spermatogonia to x-irradiation. (Tahmisian, T. N., 1965)
- 1388 Récentes expériences de radiobiologie sur Bombyx mori. (Teulade, P., 1966)
- 1390 Effect of gamma radiation on Trogoderma glabrum and Attagenus piceus. (Tilton, E. W., et al., 1966)
- 1397 Effects of gamma radiation on development of Dermacentor occidentalis (Ixodidae). (Ziad Al-ahmadi, A., 1967)
- 1410 Modification of fitness in species and strains of flour beetles due to x-ray and DDT. (Erdman, H. E., 1966)
- 1412 Effect of ionizing radiation on the survival rate of Agrotis segetum Schiff, and its ability to breed. (Khakimova, R. K., 1964)
- 1431 Radiation sterilization of the black blow fly. (Bushland, R. C., 1966)
- 1439 Radiation studies with the boll weevil: lethal effects on larvae, pupae, and adults; male sterility and dose fractionation. (Flint, H. M. et al., 1968)
- 1455 Effects of dimethylsulfoxide on productivity of x-irradiated flour beetles. (Erdman, H. E., 1966)
- 1456 The combined effects of irradiation, vibration, and centrifugation on braconid fecundity, fertility and life span. (Grosch, D. S., 1966)
- 1457 Utilization of Habrobracon and Artemia as experimental materials in bioastronautic studies. Status Report, Jan.-June 1966. (Grosch, D. S., 1966)
- 1471 The effects of gamma radiation on mating competitiveness and fecundity of Hippelates pusio Loew. (Flint, H. M., 1968)
- 1477 Mating competition of gamma-irradiated and nonirradiated male Trogoderma glabrum Herbst. (Tilton, E. W. et al., 1966)
- 1668 Food irradiation research and pilot facilities in operation or planned in India. (Kumta, U. S. et al., 1966)
- 1689 Effects of gamma irradiation on the longevity and fertility of five species of stored-product insects. (Watters, F. L., 1966)

2.2.3. Tissue. Organ

- 1323 Baker, W.K. A CLONAL SYSTEM OF DIFFERENTIAL GENE ACTIVITY IN *Drosophila*. *Devl Biol.* 16, 1 (1967) 1-17.

The patterns of eye pigment variegation in 2 cases of position effect (one in *D. virilis* and the other in *D. melanogaster*) were laid down in the imaginal eye disk during the end of the 1st larval instar. The timing of this determinative event was made possible by comparing the variegation patterns with the size and shape of twin spots in the adult eye formed by the x-ray induction of somatic exchange at the end of the 1st instar. In *D. virilis*, the variegation patterns and the twin spots were compared in different flies; whereas, in *D. melanogaster*, a scheme was devised so that the comparison could be made in one and the same eye. The variegation pattern was clonal; therefore, the information contained in this determinative event was passed on to the daughter somatic cells for a number of cell generations until the differentiation of the eye was complete and pigment synthesis initiated. Although growth was markedly inhibited in larvae fed on a medium containing actinomycin D during the 1st instar, such treatment did not affect the pattern of position-effect variegation. (CA 67: 1967, 30174k)

- 1324 Broce, A.B., Goldman, L.J., Cromroy, H.L. RADIOSENSITIVITY OF COCKROACHES. *Bull. ent. Soc. Am.* 13, 3 (1967) 192. Abstr. 111. Presented at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Seven different species of cockroaches were tested for verification of the "Sparrow Hypothesis". The endothelial cell of the midgut was used as the radiosensitive indicator. Positive correlation with Sparrow's work on plants was obtained. (Auth.)

- 1325 International Atomic Energy Agency, Vienna (Austria). A CYTOLOGICAL STUDY OF THE EFFECTS OF RADIATION ON THE DEVELOPMENT OF THE REPRODUCTIVE ORGANS OF TWO SPECIES OF FRUIT FLIES, *Dacus oleae* AND *Ceratitis capitata*; PART OF A CO-ORDINATED PROGRAMME OF INSECT CONTROL USING RADIATION. Research contract 169. p. 79-81 of "IAEA Research Contracts, Seventh Annual Report". Technical Reports Series No.74. Vienna, International Atomic Energy Agency. 1967, 223 p. STV/DOC/10/74.

Research Institution: Laboratory of Agricultural Entomology, University of Florence, Florence, Italy.
Principal scientific investigator: B. Baccetti.
Period of contract: 20 Dec. 1962 - 19 Dec. 1965.

- 1326 Larsen, W. SURVIVAL OF IRRADIATED INSECT HEART FRAGMENTS FOLLOWING TREATMENT WITH PROPYL GALLATE. *Proc. Utah Acad. Sci.* 42, 1 (1965) 53-55.

The use of an organ culture to evaluate the action of ^{60}Co on survival time of insect tissues treated with propyl gallate was tested on heart fragments from embryos of the ovoviviparous roach, *Blaberus craniifer*. The developmental period for these embryos is ~3 months. 56 fragments (4 hearts/vial) were exposed to 82000 rad of γ -rays at room temperature, which served as controls, a 2nd group of 38 fragments to 44000 rad. Survival time at this level was ~16 d. Various concentrations of propyl gallate were tested. Propyl gallate proved to have radioprotective value. It extended survival time to 100% at the higher, and 66% at the lower level of irradiation. High concentrations of propyl gallate have a toxic effect on the tissues. In the 1st series, with a concentration of 0.0231 g/150 ml, only 70% of the fragments recovered and recovery time was slowed down. In the 2nd series, 100% recovered, with a lower concentration of propyl gallate. Propyl gallate is an antioxidant. Its protective action is discussed.

- 1327 Little, H.F. MIDGUT EPITHELIUM OF ADULT *Chelisoches morio* (DERMAPTERA: CHELISOCHIDAE) AND *Ceratitis capitata* (DIPTERA: TEPHRITIDAE) FOLLOWING IONIZING IRRADIATION. *Ann. ent. Soc. Am.* 60, 2 (1967) 412-414.

The midgut epithelium of a species of earwig, *Chelisoches morio* (F.), and of the Mediterranean fruit fly, *C. capitata* (Wiedemann), were found to be rather normal in appearance following exposure to 10 000 R (x-rays) and 10 000 rad (γ -rays) respectively. This phenomenon is in contrast to the severe damage to mammalian small intestine resulting from a dose only $\frac{1}{10}$ as great. Since there is good reason to believe that mitosis is important in maintenance of the midgut epithelium in both insect

species, the radioresistance of this epithelium implies considerable radioresistance on the part of the regenerative cells. (Auth.)

- 1328 Mortreuil-Langlois, M. EFFET DES RAYONS X SUR L'INTESTIN MOYEN DE Blabera fusca Br. C. r. Séanc. Soc. Biol. 154 (1960) 1769-1770.

The appearance of radiolesions of the mucous membrane of the middle intestine was studied in B. fusca (Orthoptera) irradiated with a dose of 25 000 R. The most radiosensitive cells are the regeneration cells at the moment of their differentiation in secretor elements. The irradiation does not suppress the secretion of epithelial cells. (Tr-auth., NSA 15: 1961, 17940)

- 1329 Mortreuil-Langlois, M. ETUDE HISTOPATHOLOGIQUE DE L'INTESTIN MOYEN DE Blabera fusca Br. (ORTHOPTERE) AU COURS D'UNE PERIODE PROLONGEE DE POST-IRRADIATION. (Histopathological study of the midgut of Blabera fusca Br. (Orthoptera) over an extended post-irradiation period.) Bull. Soc. zool. Fr. 98 (1963) 539-546. (With French summary only)

L'étude histopathologique du mésentéron chez l'Orthoptère Blabera fusca Br. irradié par les rayons X à la dose de 10.000 rads, a montré que: 1) les cellules épithéliales sont plus sensibles à l'action des radiations ionisantes que les fibres musculaires; 2) une augmentation de la résistance aux rayons X des cellules épithéliales apparaît au cours de leur différenciation cellulaire en éléments fonctionnels. A ce stade, les radiolesions morphologiquement décelables évoluent réversiblement; 3) des pycnoses apparaissent de plus en plus nombreuses dans les premiers jours de post-irradiation entraînant un dépeuplement des cryptes de régénération. La restauration se fait par division mitotique à partir du milieu de la deuxième semaine. (From auth.)

- 1330 Perez-Davila, Y., Baker, W.K. EFFECT OF ACTINOMYCIN D ON THE DEVELOPMENT OF THE EARLY IMAGINAL EYE DISKS OF Drosophila melanogaster. Devl Biol. 16, 1 (1967) 18-35.

The effect of actinomycin D (I), on the development of the imaginal eye disks was studied. I was placed in the food at 10 µg/ml during the 1st and 2nd instar. Histological studies indicated that the head anlagen of treated larvae (which weighed 30% as much as the control larvae) were somewhat smaller at the end of the 1st instar, although they contained the same number of cells. Cell division during the 1st instar was not affected by I. During the 2nd instar, all cell division ceased in the treated anlagen, while these cells in control larvae underwent three divisions. This was an abrupt change in sensitivity to I since anlagen of larvae on normal food during the 1st instar completely stopped cell division when placed on I-containing food at the end of this instar. The fate of the presumptive eye cells within the head anlage was determined by measuring the frequency and size of twin spots produced in the adult eye resulting from x-ray-induced somatic crossing-over. I-treated and control larvae were irradiated at the end of the 1st or at the end of the 2nd instar. No relevant difference was observed between the control and I series in the frequency of twin spots or in their size when the somatic crossing-over was induced at the end of the 2nd instar. The counts of cell numbers during the 2nd instar indicated no cell division in the I-treated anlagen, but three cell divisions in the control anlagen. I probably blocked cell division during the 2nd instar but allowed the chromosomes to replicate, and the chromosomes were subsequently distributed normally to the cells formed when cell division resumed upon removal of the larvae from the I-containing food. (CA 67: 1967, 51524f)

- 1331 Riemann, J.G., Flint, H.M. IRRADIATION EFFECTS ON MIDGUTS AND TESTES OF THE ADULT BOLL WEEVIL, Anthonomus grandis, DETERMINED BY HISTOLOGICAL AND SHIELDING STUDIES. Ann. ent. Soc. Am. 60, 2 (1967) 298-308.

Histological studies demonstrated that radiation doses considerably below those required for sterilisation killed most regenerative cells of boll weevils, A. grandis Boheman, which resulted in the loss of most or all of the secretory epithelium. Extensive damage to midgut was noted in one specimen that received 2000 R and in all those given 4000 R. Shielding experiments showed that when only the head and that part of the thorax anterior to the midgut were irradiated, mortality did not exceed that of the control. Irradiation over the abdomen and the posterior part of the thorax produced the same level of mortality as did whole-body irradiation. These findings indicate that damage to the midgut is the basic cause of the high mortality among weevils given sterilising doses of radiation. At 10 d after irradiation, no spermatogonia were found in any testes irradiated with 6000 R or more, and none were found in some testes that received only 2000 R. (Auth.)

- 1332 Shen, S. K., Berryman, A. A. THE MALE REPRODUCTIVE SYSTEM AND SPERMATOGENESIS OF THE EUROPEAN PINE SHOOT MOTH, *Rhyacionia buoliana* (LEPIDOPTERA: OLETHREUTIDAE), WITH OBSERVATIONS ON THE EFFECT OF GAMMA IRRADIATION. *Ann. ent. Soc. Am.* 60, 4 (1967) 767-774.

The morphology of the male reproductive system of *R. buoliana* (Schifferrmüller), the European pine shoot moth, and the process of spermatogenesis are described. Spermatozoa were first observed in 2-d pupae and the reproductive system was fully formed in 11-d pupae. The gonadal tissue of males irradiated with 36 000 and 54 000 rad as 11-d pupae and as adults was compared with that of untreated individuals. Irradiation caused increased tracheolation of the testicular epithelium, thickening of the walls of the seminal vesicles, dispersion of the spermatocytes from their peripheral location, degeneration of sperm bundles, and vacuolation of the testes. (Auth.)

See also:

- 927 A cytological study of radiation effects in testes of the screw-worm fly, *Cochliomyia hominivorax* (Diptera: Calliphoridae). (Riemann, J. G., 1967)
- 948 Effect of gamma rays on development of the sex cells in the beet fly. (Klimtaya, A. Y., 1965)
- 955 Analysis of genetic sensitivity to x-rays of ovaries of *Drosophila melanogaster*. (Morey, M., 1965)
- 972 Dose rate effect of radiation on spermatogonia of the silkworm. (Sugai, E. et al., 1967)
- 1305 The effect of γ -rays on the acetylcholine level in insects. (Grzelak, K. et al., 1966)
- 1318 An autoradiographic study of the relation between hemocytes and connective tissue in the wax moth, *Galleria mellonella* L. (Shrivastava, S. C. et al., 1965)
- 1335 A cytological study of the effects of radiation on the development of the reproductive organs of two species of fruit flies: *Dacus oleae* and *Ceratitis capitata*. Report No. 7 (Final), Dec. 20, 1962 - Dec. 19, 1965. (Baccetti, B., 1962/1965)
- 1388 Récentes expériences de radiobiologie sur *Bombyx mori*. (Teulade, P., 1966)
- 1401 Intestinal damage and water imbalance in gamma-irradiated larvae of *Bombyx mori*. (Lassota, Z., 1966)
- 1402 Reversal of heterochromatization and the activity of the paternal chromosome set in the male mealy bug. (Nur, U., 1967)

2.2.4. Developmental Stage Response. Delayed Development

- 1333 Asman, M., Rai, K. S. RADIOSENSITIVITY OF THE YELLOW-FEVER MOSQUITO, *Aedes aegypti*. *Proc. Indiana Acad. Sci.* 75 (1965) 109.
- 1334 Auerbach, S. I., Crossley, D. A., Jr., Shinn, A. F. POSTATTACK INSECT PROBLEMS. p. 137-142 of "Proceedings of the Symposium on Postattack Recovery from Nuclear War. Fort Monroe, Va., USA, 6-9 Nov. 1967".

These problems are essentially radiological or ecological. Radiological problems include β -dose response, life-cycle or radiation profile, and comparative radiosensitivity; ecological problems include population response, habitat, and secondary effect. Evidence has recently accumulated that the β -dose component of local fallout may be significantly greater for small organisms than the γ -dose component. Investigations are needed on β -dosimetry in insects representing characteristic body types, and on field response of insects subjected to acute or chronic β -exposures within their natural habitats. Radiation profiles were established for *Acheta domesticus* and *Tenebrio molitor*, which possess quite different early life-history stages (morphologically and physiologically, and in their ecological requirements). The 1st experiments involved exposure to γ -radiation from 1 kR to 100% increments. Younger stages again proved more sensitive than older ones. If mean survival times at 4 kR or 8 kR are compared with those of controls, the small larvae (*Tenebrio*) and small nymphs (*Acheta*) appear to be considerably more sensitive than older stages. Some general index of radiosensitivity is clearly required. Greater mortality appears to occur in irradiated *Acheta* in the field than in the laboratory (presumably due to predators and possible pathogens). - Individual lots of bees were tested for sensitivity to β -, γ - and neutron irradiation under laboratory conditions. 5000 rad of γ -radiation reduces the life span of worker bees by 29%. Irradiation of entire social units (colony) (5000 rad γ -rays at 85 rad/min) had catastrophic effects, causing pollination to drop

by 50% in 9 d, and to cease completely by 16 d. Within 8 d post-irradiation, ~99% of the bees had died.

- 1335 Baccetti, B. A CYTOLOGICAL STUDY OF THE EFFECTS OF RADIATION ON THE DEVELOPMENT OF THE REPRODUCTIVE ORGANS OF TWO SPECIES OF FRUIT FLIES: Dacus oleae AND Ceratitis capitata. Report No. 7 (Final), December 20, 1962 - December 19, 1965. NP-16176, Siena Univ. (Italy). Istituto di Zoologia e Biologia. IAEA-169-R2-RB, International Atomic Energy Agency, Vienna (Austria). 10p.

Progress is reported on a cytological study of the effects of 5000 to 8000 R γ - or x-radiation on the development of male and female reproductive organs of two species of fruit flies, D. oleae and C. capitata. Observations made on normal Drosophila melanogaster males are also reported. Applications of the findings in insect control using the sterile-male technique are discussed. Results showed that radiation damages spermatogones and first spermatocytes, but not spermatids. The action of radiation on male gonads appeared to be essentially mutagenic and not to involve structures that influence sperm mobility and penetration. The timing of spermatogenesis at different stages of development from larva to adult was studied in D. oleae by determining the type of germ cells present at each stage. Irradiation carried out during the pupal stage caused a decrease in the number of spermatozoa that reached maturity. It was concluded that the optimal time for males to be irradiated for population control is when meiotic or spermatidic sperm stages are most abundant in the gonad. Observations of radiation effects on female reproductive organs indicated that damage to ovarian structures irradiated at various doses at the pupal stage was qualitatively similar but variable in intensity. Radiation doses that caused an optimal mutagenic effect in males inhibited completely oviposition in females because of damage to the oögonia. (NSA 20: 1966, 42847)

- 1336 Baroughi-Bonab, H. IRE THESE. ETUDE DU DEVELOPPEMENT POST-EMBRYONNAIRE DE L'OVAIRE CHEZ Ephesia kühniella Z. (LEPIDOPTERA, PYRALIDAE). EFFETS DES RADIATIONS IONISANTES. Thesis, Paris Univ. (France). Faculté des Sciences. 1965, 65p.

The successive developmental stages of the ovary and oogenesis were investigated in the larva, pupa and adult of E. kühniella, and effects of various doses of γ -radiation administered to last-instar larvae was studied. The histological differentiation of ovaries and testes begins to become distinguishable in 4th- and 5th-instar larvae. In the last instar, the ovarioles are clearly distinguishable, and this ovarian "germarium" is described in detail. Each ovariole contains from 40-80 oocytes in different stages of development, corresponding to seven ovarian zones, A-G, which are described. Exposure of last-instar larvae to various doses of γ -radiation caused delays in metamorphosis: instead of the 7 d in controls it extended to 9 d after 2000 rad, 10 d after 4000 rad, 11 d after 6000 rad, 15 d after 8000 rad, 19 d after 10 000 rad, 22 d after 12 000 rad, and 31 d after 14 000 rad. Apart from that, a certain number of larvae die without undergoing metamorphosis which corresponds, on the other hand, to very long larval survival: from 23 d after 6000 rad up to 94 d after 15 000 rad. Larval mortality may reach 25% at 6000 rad, rising to 72% at 14 000 rad and to 100% at 15 000 rad. - The duration of pupation is affected less: from a duration of 8.29 d in controls it changes to 10.33 d in pupae (from larvae irradiated at 14 000 rad). Pupal mortality occurs above 8000 rad (50%), and rises to only 57% at 14 000 rad. It is independent of the delay in pupation. - Radiation effects on ovarian development and oogenesis show up after 2000 rad, administered to last-instar larvae. Subsequent adults are of reduced size but their ovarioles still have the usual oogenic stages in the vitellarium. Only 2/3 of each ovariole is, however, occupied by chorionated eggs of stages G and H, with G predominating. Adult ovaries are reduced still further by 4000 rad. Young oocytes are now rare or have disappeared, and the apical part of the ovariole appears "amputated". At 8000 rad, the moth is literally castrated. The ovarioles measure only 500 μ , dropping to 200 μ at 14 000 rad. The most sensitive oocytes are those at a stage of multiplication in the germarium. - Irradiation of pupae causes less significant changes. The fertility of incompletely sterilized females has not been checked. Already at 2000-4000 rad, however, cytoplasmic anomalies become noticeable, particularly a negative Feulgen reaction.

- 1337 Bluzat, M.R. MISE EN EVIDENCE DE LA RADIORESISTANCE DU DETERMINANT GERMINAL CHEZ Leptinotarsa decemlineata Say. C. r. hebdo. Séanc. Acad. Sci. 265, 25 D (1967) 2027-2029.

The posterior extremities of eggs of the insects were exposed to x-radiation before attaining the stage of 16 nuclei. Histological sections of larvae from irradiated eggs were prepared for examination of

the gonads. A 2nd group of irradiated eggs was reared to adults and the gonads were examined. Adults developing from eggs exposed to a dose of 10^6 R were fertile and reproduced normally; this demonstrates the extreme radioresistance of the germ cells. Larvae developing from eggs exposed to 10^7 R contained gonads without gametes. This result was not caused by selective destruction of the germinal primordia located in the posterior region of the egg. (NSA 22: 1968, 19433)

- 1338 Boguleanu, G. OBSERVAȚII ASUPRA COMPORTĂRII CRISALIDELOR DE *Hyphantria cunea* Drury IRADIATE CU RADIATII GAMMA. (Observations on the behaviour of pupae of *Hyphantria cunea* Drury irradiated with γ -radiation.) *Studii Cerc. Biol.*, Ser. Zool. 17 (1965) 387-391. (In Rumanian)

The following is based largely on the author's summary. In experiments in Rumania, the susceptibility of pupae of *H. cunea* (Drury) to γ -radiation varied greatly with age. Adults from pupae treated when 5-8 d old with 30 000 rem were almost normal in rate of emergence, life-span and mating ability, whereas those from pupae irradiated when 1-3 d old were adversely affected. Doses of 10 000-80 000 rem administered to pupae 3 d old greatly reduced adult emergence, adult life-span and oviposition and caused complete sterility of any eggs laid. The same doses applied to pupae 6 d old permitted almost normal adult behaviour; with doses of 40 000-60 000 rem, the eggs that were laid failed to hatch, and with 10 000-30 000 rem the eggs hatched but the larvae soon died. (RAE-A 55: 1967, ref. 26)

- 1339 Burkholder, W.E., Tilton, E.W., Cogburn, R.R. EFFECTS OF GAMMA RADIATION ON THE GRAIN MITE, *Acarus siro*. *J. econ. Ent.* 59, 4 (1966) 976-980.

The egg, larval, hypopial, and adult stages of the mite were treated with 13.2 ($\pm 10\%$), 17.5, 25, 45, and 100 krad of γ -radiation. Eggs hatched at 100 krad. Eggs and hypopi were able to transform to the adult stage at 45 krad, but larvae did not mature at dosages > 25 krad. Irradiated adults produced F_2 adults after dosages as high as 25 krad and irradiated hypopi and eggs at ≤ 17.5 krad, but larvae did not produce F_2 adults at dosages $> 13.2 \pm 10\%$ krad. (From auth.)

- 1340 Cavalloro, R., Cirio, U. RICERCHE CON RADIAZIONI IONIZZANTI SULLA STERILIZZAZIONE E RADIOSENSIBILITA DI *Chrysomela decemlineata* Say. (Study on the sterilization and radiosensitivity of *Chrysomela decemlineata* Say by means of radioisotopes.) *Redia* 50 (1966/1967) 365-377. (In Italian, with English summary)

The possible application of the sterile male technique to this pest of the Solanaceae family, particularly of the potato plant, was explored. Optimal conditions of day and night temperature, relative humidity, photo-period, light intensity and diet, were first determined in order to produce large numbers of insects in a controlled environment chamber. Irradiation with 200 kV x-rays showed that radioresistance increased with the development: doses resulting in 30% lethality thus increased in the ratio 1 to 80 to 240 of 1-d-old eggs, 1-week-old pupae, and 3-d-old adults, respectively. Radiation resulted in increased mortality of offspring, especially during moulting, and a lengthening of the various larval instars as well as a reduction of the life-span in adults irradiated as adults or emerging from irradiated pupae. The min. exposure dose for sterilization of both sexes proved to be 3000 R for pupae irradiated 3 d before the end of metamorphosis, and did not affect the sexual vigour of the insect. The sterile male technique could therefore be used in controlling this pest. (Based on auth.)

- 1341 Chettachai Baditsing. A STUDY ON THE LIFE HISTORY AND THE EFFECT OF RADIATION ON RICE WEEVIL (*Sitophilus oryzae* L.). p. 42-47 of "Insect Eradication by Irradiation, Bangkok, Thailand. 28-29 Jun. 1966". THAI, AEC-8, Office of Atomic Energy for Peace, Bangkok (Thailand).

The egg, larval, and pupal stages were found to last for 7-8, 13-17, and 7-11 d, respectively. The highest rate of oviposition was at 3-7 d. Different stages were exposed to radiation (from a ^{60}Co -source and the reactor, ^{235}U). Males were more radiosensitive. Sterility in adults was induced by 3500-4000 rad, no hatchability being observed at 4000 rad. The LD 50 for egg, larval, pupal, and adult stages were 15, 120, 1300, and 74 000 rad, respectively. In the laboratory, a dose of 25 000 rad killed 100% at the egg and the larval stage and 91.90% at the pupal stage, whilst all adults died within ~ 10 d of exposure.

- 1342 Cogburn, R.R., Tilton, E.W., Burkholder, W.E. GROSS EFFECTS OF GAMMA RADIATION ON THE INDIAN-MEAL MOTH AND THE ANGOUMOIS GRAIN MOTH. *J. econ. Ent.* 59 (1966) 682-685.

A study of the gross effects of γ -radiation on the Indian-meal moth, Plodia interpunctella (Hübner), and the Angoumois grain moth, Sitotroga cerealella (Olivier), was conducted. All metamorphic stages of the insects were treated with 13.2-10%, 17.5, 25, 45, or 100 krad of γ -radiation. Weekly observations were made to check mortality, ability of treated metamorphic stages to continue their development, and reproduction by treated individuals and their first-generation progeny. Eggs of both species and larvae of the Indian-meal moth were effectively controlled by all dosages. Larvae of the Angoumois grain moth were controlled by all dosages except 13.2-10% krad, which permitted some larvae to develop to the adult stage and reproduce. The life of insects treated as adults or as pupae was not greatly shortened by the treatments, but the incidence of sterility and a marked reduction in progeny produced per pair of moths varied directly with the dosage applied. Genetic damage, as evidenced by reduced reproduction, was transmitted to the F_1 generation. When treated directly, males of both species were less subject to genetic damage than were females; however, the progeny of treated males was more subject to genetic damage than was the progeny of treated females. A dosage of 17.5 krad should be sufficient to eliminate hidden infestations of eggs and young larvae of both species in packaging plants by preventing further development. (Essentially auth.)

- 1343 Craig, G.B., Jr. APPLICATIONS OF GENETIC TECHNOLOGY TO MOSQUITO REARING. Bull. Wild Hlth Org. 31 (1964) 469-473.

Experiments demonstrated useful levels of heterosis in Aedes aegypti. Characters improved by heterosis included resistance of eggs to radiation. The heterotic improvement was also evident in crosses between random-breeding strains. Crosses between the Rock and Red Eye strains of mosquitoes were made in connection with experiments on the effect of radiation on egg development. Considering the time required to complete pupation, the Rock parent required 28% and the Red Eye required 71% more time than did their F_1 progeny. It was noted that the hybrids were more resistant to radiation than the parental stocks. From eggs receiving a dose of 100 R of x-rays, no Red Eye pupated but 23% of Rock did pupate. However, 65% of the F_1 pupated. This radioresistance was probably due to heterosis rather than to a specific protective mechanism. From preliminary evidence, it appeared that the rate of mitosis in the hybrids was higher and therefore repair of radiation damage was more readily effected. (NSA 22: 1968, 2545)

- 1344 DeProost, M. BELGIUM CONTRIBUTIONS TO THE DATA ON IRRADIATION OF SUBSTANCES. CONF-650581-1, Centre d'Etude de l'Energie Nucléaire, Mol (Belgium), nd, 6p. "2nd International Symposium on Applications of Nuclear Science in Agronomy and Veterinary Medicine, Ghent, Belgium".

A brief review of the research projects in Belgium concerned, amongst others, with food irradiation and the effects of γ -radiation on metamorphic stages of the grain and rice weevils, Sitophilus granarius L. and S. oryzae L., the Mediterranean flour moth, Anagasta kuehniella, and the white bean infesting beetle, Acanthoscelides obtectus. Studies on the genetic risks involved in consumption of γ -irradiated foods are also briefly outlined. Descriptions of the ^{60}Co γ -irradiation facilities that were used in the projects are given.

- 1345 Ducoff, H.S., Bosma, G.C. INFLUENCE OF PUPAL AGE ON SENSITIVITY TO RADIATION. Biol. Bull. 130 (1966) 151-156.

Tribolium confusum exposed to germicidal u.v. at any time during the 5-d pupal period exhibits a high incidence of gross morphological deformities, particularly of the wings, in the emerging adult, although the greatest sensitivity to this effect occurs on the 1st day of pupation. Mortality within two weeks is by far the greatest, however, if u.v. irradiation is performed on the 3rd day of pupation. By contrast, sensitivity to both lethality and abnormality-induction after x-ray exposure is greatest on the 1st day of pupation and declines progressively thereafter, with the sharpest decline occurring late on the 2nd day. These differences are partially explained by the fact that energy absorbed from x-rays is distributed rather uniformly throughout the pupa, whereas most of the u.v. energy is absorbed in the outermost tissue layers. (Auth.)

- 1346 Ducoff, H.S. CHANGES WITH AGE IN THE RADIOSENSITIVITY OF ADULT FLOUR BEETLES. Radiat. Res. 31, 3 (1967) 612. Abstr. Eb-2. Presented at "15th Annual Meeting of the Radiation Research Society, San Juan, Puerto Rico, 7-11 May 1967".

Adults of the flour beetle, Tribolium confusum, exhibited a marked and progressive increase of radiosensitivity with age. Although there is no detectable difference in radiosensitivity between males and females in newly emerged beetles, the sensitivity of males increases with age more rapidly than that of females. Thus, for example, the LD 50/5 weeks at 30° is 12 kR for young adults of either sex, is 11 kR for 4-month-old females, and is just under 10 kR for 4-month-old males. Nine months after eclosion, the LD 50 (uncorrected for control mortality) is about 7 kR for females and 6 kR for males. The estimates for 9-month-old adults have a large error because of the small numbers and significant control mortality, but the sex-difference is all the more spectacular because the mortality rate of control females is greater than that of males. Beetles raised and maintained at 22° rather than 30°C also exhibit a progressive increase in radiosensitivity, but the change develops more slowly, as would be expected of a phenomenon dependent on metabolic processes. These results should be considered in the light of findings by previous investigators, and confirmed in our own studies, that beetles surviving low or midlethal radiation doses exhibit increased mean lifespan. (Abstr.)

- 1347 El-Miniawi, S.F., Leheta, M.F. ON THE EFFECT OF Co⁶⁰ GAMMA RADIATION ON THE DESERT LOCUST. Bull. Soc. ent. Egypte 48 (1964) 5-10.

1st, 3rd and 5th-instar hoppers and adults of Schistocerca gregaria Forsk. were exposed to doses ranging from 200 R - 30 000 R, at dose rates of 200 R/min and 680 R/min. Mortality data were obtained 3 and 5 d, and 1 and 2 weeks after exposure. Susceptibility decreases with increasing age, but increases with the dose received. Doses > 1000 R stopped feeding and produced sluggishness. Cannibalism among 5th-instar hoppers was frequent even after small doses. Females were less susceptible to radiation than males. A dose of 30 000 R produced LD 98.5/5d (high rate) and /7d (low rate) in 3rd-instar hoppers, with a corresponding LD 100 for 5th-instar hoppers.

- 1348 Erdman, H.E. METAMORPHIC AND ADULT LONGEVITY MODIFICATIONS DUE TO x-IRRADIATION OF PUPAL FLOUR BEETLES, Tribolium confusum (Jacquelin du Val). Bull. ent. Soc. Am. 12 (1966) 256. Abstr. 3. Presented at "Portland Meeting. Portland, Oreg., USA, 28 Nov. - 1 Dec. 1966".

Undelayed metamorphosis and reduced numbers of adults having decreased longevity were noted up to 70 kR x-radiation of pupae regardless of sex. Explanations of these radiation effects concern differential radiosensitivities of dividing and non-dividing cells, frequency and occurrence of cell divisions in specific tissues, and nuclear vs. cytoplasmic alterations. (Abstr.)

- 1349 Erdman, H.E. EFFECTS OF x-RAYS ON METAMORPHOSIS AND ADULT LIFE SPAN OF FLOUR BEETLES. Nature, Lond. 211 (1966) 1427-1428.

The investigation was undertaken to determine whether metamorphosis and length of life could be altered when flour beetle pupae were treated with x-rays. 25-26 d old pupae of Tribolium confusum duVal were sexed and given doses of 0, 1, 2.5, 5, 7.5, 10, 20, 30, 40, 50, 60, and 70 kR of x-rays. Each of 5 replicates at each dose contained 10 pupae of each sex. Deaths were noted twice weekly (culture at 29±1°C, r.h. 80-75%). The number of individuals unable to complete metamorphosis increased progressively from 5-70 kR, without delays in metamorphosis, against a 35% failure to metamorphose at 7.5-50 kR, and ~55% at 70 kR. Mortality increased progressively with increasing exposures. At 7.5 kR lethality approached 100% after 9 d, possibly due to adverse effects of radiation cell division(s). The lethality curve for 2.5 kR rose gradually, reaching a plateau by day 9 at 10-15%. The 5 kR curve had a gradual slope which levelled off by day 16 at ~60% lethality. Pupae (26-d-old) and 1-d-old adults were sterilized by 4 kR, indicating no change in meiotic activity between these developmental stages.

- 1350 Erdman, H.E. ONTOGENY AND x-RADIATION SENSITIVITY OF THE FLOUR BEETLE, Tribolium, p. 16-17 of "Pacific Northwest Laboratory Annual Report for 1966 to the USAEC Division of Biology and Medicine. Vol.1. Biological Sciences". BNWL-480, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Jul. 1967, 207p.

Early egg stages were most sensitive to irradiation. Mature larvae of T. castaneum were more sensitive than younger larvae or more advanced stages. Lethal doses for adults of two strains of this species were 14-15 kR and sterilizing doses were 5 kR. T. confusum was more sensitive with adult lethality at 8 kR and sterility at 4-5 kR.

- 1351 Erdman, H. E. EFFECTS ON FLOUR BEETLES IRRADIATED AS PUPAE. p. 17-18 of "Pacific Northwest Laboratory Annual Report for 1966 to the USAEC Division of Biology and Medicine. Vol. 1. Biological Sciences". BNWL-480, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Jul. 1967, 207p.
Incomplete metamorphosis and reduced adult life span were observed when pupae of the flour beetle Tribolium confusum were x-irradiated.
- 1352 Farkas, J. THE RADIATION RESISTANCE OF Tribolium confusum (Duval) AND Tyrophagus dimidiatus (Hermann). Közl. Kozponti Elmészertani Kutatóintézet 2 (1965) 10-15. (In Hungarian)
- 1353 Farkas, J. STUDY OF THE IRRADIATION TOLERANCE OF Tribolium confusum (Duval) AND Tyrophagus dimidiatus (Hermann). Acta biol. Hung. 16 (1967) (p?)
- 1354 Féron, M. STERILISATION DE LA MOUCHE MEDITERRANEEENNE DES FRUITS, Ceratitis capitata Wied., PAR IRRADIATION DES PUPES AUX RAYONS GAMMA. Annls Épiphyt. 17, 2 (1966) 229-239.
Experiments on the sterilisation of C. capitata (Wied.) by treating the pupae with γ -radiation were carried out in France. Pupae irradiated at 5-15 kR when 2-8 d old were killed or gave rise to adults that died soon after emergence; irradiation of older pupae did not affect emergence, but a dose of 15 kR caused rapid mortality. Female fecundity was reduced by treatment with 3 kR and decreased with increase of the dose; irradiation did not, however, prevent the females from making many oviposition punctures in the fruits provided and laying some non-viable eggs. Male pupae irradiated at 8 kR gave rise to sterile adults with unimpaired mating capacity. Studies with mixed populations of normal and treated adults showed that a ratio of at least 30 sterile flies to one normal one was necessary in order to obtain a reduction of over 90% in egg viability. (RAE A 55: 1967, ref. 613)
- 1355 Flint, H.M., Krassin, E.L. GAMMA IRRADIATION OF PUPAE OF THE TOBACCO BUDWORM. J. econ. Ent. 60, 6 (1967) 1655-1659.
Pupae of the tobacco budworm, Heliothis virescens (F.), were irradiated with ^{60}Co γ -rays before adult emergence. Male moths were 99% sterile after a dose of 35 krad. Female moths produced very few eggs when the dose was greater than 35 krad, though there was some egg hatch at this dose level. The emergence and lifespan of both sexes were reduced by sterilizing doses. The initiation and length of the oviposition periods for females mated with either treated males or untreated males were similar. However, females crossed with treated males produced significantly fewer eggs. Virgin females laid eggs, but their oviposition began later and was shorter than that of females crossed with males. The average life-time production of eggs for single pairs of control moths was about 800 eggs, though some females did produce more than 1600. When the sterility data from irradiated males were plotted, the resulting dose-response curve appeared to be sigmoidal. Cytological observations on spermatogenesis indicated that sperm were present in the testes of the pupae at the time of irradiation. (Auth.)
- 1356 Gubicza, A., Molnar, I. THE EFFECT OF GAMMA IRRADIATION ON THE VARO RACE OF Bombyx mori L. II. IRRADIATION OF EGGS IN THE EARLY AND LATE EMBRYONIC STAGES. Annls Inst. biol. Tihany 31 (1964) 3-13.
Results are summarized from a study of the effects of γ -radiation on the eggs of the silkworm, B. mori, exposed during various developmental stages, and on the morphology of larvae and on the health and fecundity of adult moths hatched from irradiated eggs. (NSA 20: 1966, 18345)
- 1357 Hershberger, H.C., Moore, B.S. SOME EFFECTS OF x-IRRADIATION ON LARVAE OF Galleria mellonella. J. invertebrate Path. 8, 2 (1966) 277-279.
2nd- and 3rd-instar larvae of G. mellonella (L.) irradiated with x-rays at 12000 R at the rate of 500 R/min showed numerous cellular abnormalities in the last instar, some of which are described. The larval period was increased by two months, and pupation was partially or completely inhibited. (RAE A 55: 1967, 81)
- 1358 Henneberry, T.J. SUSCEPTIBILITY OF VARIOUS STAGES OF Drosophila melanogaster TO GAMMA RADIATION. J. econ. Ent. 60, 4 (1967) 1041-1043.

All stages of *D. melanogaster* Meig. were exposed to γ -radiation from a ^{60}Co source. The sensitivity, in descending order, was: eggs, 1-d-old larvae, 1-d-old pupae, 3-d-old larvae, 3-d-old pupae, and adults. Exposure of eggs to ≥ 0.9 kR caused a high mortality rate in the egg and larval stages after exposure to 0.4 or 0.6 kR; death occurred in the pupal stage. Irradiation of larvae resulted in a high rate of pupal mortality. Adult females exposed to as much as 35 kR lived as long as untreated females. Adult males were shorter lived than untreated males after exposure to 21 kR or more. (Auth.)

- 1359 Kahan, R.S., Peleg, B.A., Eisenberg, E. RADIATION SUSCEPTIBILITY OF VARIOUS DEVELOPMENTAL STAGES OF THE MEDITERRANEAN FRUIT FLY (*Ceratitis capitata* Wied.) p. 282-283 of "Research Laboratories Annual Report, For the Period January-December 1965". 1A-1082, Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center, 363p.

An experiment is being carried out to determine the lethal dose of γ -radiation for laboratory-bred flies at various stages of the development cycle. The insects are dispersed in a suitable synthetic food medium and irradiated with the ^{60}Co plate source. This dose also rendered the adult fly sterile. Thus 10 krad may be sufficient for quarantine control of citrus and other fruits against this fly. Tests are now being carried out with lower doses and in vivo conditions, and eventually the wild type flies will be studied. (Abstr.)

- 1360 Kakhmanyuk, F.S., Petryna, M.F. EFFECT OF α AND γ RADIATION ON THE DEVELOPMENT OF UNMATCHED GYPSY MOTHS (*Ocnieria dispar* L., LYMANTRIDAE, LEPIDOPTERA). Vestí Akad. Navuk BSSR, Ser. Biol. No. 2 (1967) 98-104. (In Byelorussian)

The irradiation of caterpillars of unmatched gypsy moths with α - and γ -radiation at doses up to 500 R causes both a stimulating effect on the growth and development of the caterpillars as well as sterility (partial) of the developing males and females. The moths developing from irradiated caterpillars were quickly mated and as a result dark-coloured individuals appeared more often. Irradiation at doses of 500-5000 R did not cause externally any more deviations from the control caterpillars, but the sterilising effect appeared sooner. The irradiation of caterpillars at doses above 5000 R had a depressing effect on the growth and development and caused a significant increase of the sterilised individuals. A larger number of light-coloured individuals characterized by a low stability with respect to disease and changes in the abiotic factors occurs. α -radiation has a more depressing effect than γ -rays at all doses. (tr-auth.)

- 1361 Khan, Z.A., Matin, A.S.M.A. THE SUSCEPTIBILITY OF THE DIFFERENT STAGES OF RICE WEEVIL, *Sitophilus oryzae* L. TO GAMMA RADIATION. AECD/AG/22, Atomic Energy Centre, Dacca (Pakistan). May 1967, 15p.

A study was conducted on the effects of γ -radiation from a ^{60}Co -source on all developmental stages of rice weevil, *S. oryzae* L. Complete mortality of eggs was obtained by 2500 R, of larvae by 8000 R, of pupae by 10 000 R, and of adults by 12 000 R. Production of progeny was stopped at 9000 R in all the developmental stages. 12 000 R might be considered as minimum effective dose for the control of *S. oryzae* L. (Auth.)

- 1362 Kuzin, A.M., Yusifov, N.I. RADIOSENSITIVITY AT DIFFERENT DEVELOPMENTAL STAGES OF *Ephestia kuehniella* L. IN THE LIGHT OF EXPERIMENTS ON THE TRANSINDUCTION OF DNA. Radiobiologiya 7, 1 (1967) 3-6. (In Russian)

Different developmental stages were irradiated with γ -rays from a ^{137}Cs source, at 700 R/min. The results are interpreted in terms of interference with the transmission of information, referred to as DNA transinduction. 1-d and 4-d-old eggs, larvae 3-5 h after hatching from 28- and 34-d-old eggs, and pupae 1, 2, 4 and 9 d after pupating were used. The radiation effect was estimated in terms of the number of insects able to pass into the next developmental stage. The dose range studied was from 1-50 kR. After irradiation, the insects were kept in a thermostat at 30 °C and 50-60% r.h. The results represent average values from 3 series of experiments. The dose-effect curves were obtained for different radiation effects. The results indicate an extremely high radio-sensitivity of the DNA transinduction process, in connection with the transmission of new information and transition from one developmental stage to another. Thus, larvae continued to grow after irradiation but when it was time for a new piece of information to be transmitted to bring about

pupation, DNA transduction appeared to be totally suppressed, so that a larva continued as such for some 10 d without turning into a pupa.

- 1363 Lassota, Z. THE DELAYED DEATH OF 20 kR GAMMA RAYS IRRADIATED EMBRYO OF *Bombyx mori*, p. 137 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, Italy, 26 Jun. - 2 Jul. 1966, 263p." Abstr. 543.

Irradiation of diapausing eggs of *B. mori* with 20 kR of ^{60}Co γ -rays inhibits completely the hatching; the post-diapausal development however, albeit delayed, is not immediately arrested. The respiration is blocked at the level characteristic for normal gastrula (300 $\mu\text{l O}_2$ uptake/h/g of eggs). The synthesis of DNA continues till the amount of 1.2 mg/g of eggs is attained, corresponding to that found in normal eggs just ready to hatch. The synthesis of RNA is injured, the total amount being by 20% lower than in normally gastrulating eggs (4.5 mg and 5.5 mg per 1 g of irradiated and normal eggs respectively). The neurulation is abnormal as indicated by the low acetylcholine content found at the end of post-diapausal incubation (35 μg and 80 $\mu\text{g}/1\text{ g}$ of irradiated and normal eggs, respectively). The effects of investigated radiation dose are in many respects similar to those observed by Brachet et al. (Dev Biol 9: 1964, 398) in actinomycin D treated amphibian embryo. The damage of transcription process is suggested as the main mechanism of delayed injury of insect embryogenesis, due to ionizing radiation. (Abstr.)

- 1364 Lecis, A. EFFECTS OF x-RAYS ON THE LARVA AT THE FOURTH STAGE OF *Anopheles maculipennis atroparvus*, Atti Ass. genet. ital. 8 (1963) 236-241. (In Italian, with English summary) "Proceedings of the 8th Scientific Meeting of the Italian Genetic Association, Torino, Italy, 1-3 Oct. 1962".

Larvae of the species *A. m. atroparvus* in the four stages were irradiated, part of them 24 h after moulting and part 96 h after moulting. The adult hatched from these larvae were mated with normal ones. Mortality was higher in the larvae irradiated 24 h after moulting than in those irradiated 96 h after moulting. This difference is probably due to mitotic disturbances which take place more frequently in the stages of growth of the larvae mutated after only 24 h than in those mutated after 96 h, near to the nymphosis. From the crossing of adults hatched from irradiated larvae with normal females, with control of ovodeposition it was observed that percentage of hatched eggs and eggs having dead embryos was considerably different in the two types of experiment. As the number of hatched eggs was decisively higher, and the number of dead embryos lower in the larvae irradiated 24 h after moulting, it follows that a lower frequency of dominant lethal mutations must exist in the larvae irradiated 96 h after moulting. This would seem to signify that the greatest sensibility to x-ray effects is when the spermatogenic phenomena are completely or almost over. In the larvae mutated after 24 h only spermatogonial cells in the mitotic or intercinetic stages were observed, there were some leptotenic stages and rare cases of pachitonic; on the contrary in those mutated after 96 h there were abundant spermatids and prespermatid stages. (Auth.)

- 1365 Lippold, P.C., Gambrell, F.L. COBALT-60 RADIATION STUDIES WITH THE EUROPEAN CHAFER. Bull. ent. Soc. Am. 12 (1966) 286. Abstr. 97. Presented at "Portland Meeting, Portland, Oreg., USA, 28 Nov. - 1 Dec. 1966".

Dosages of 3000 rad on 3rd-instar larvae inhibited adult development. An LD 50 of 110 000 rad was obtained for adults 5 d after treatment. Crosses with 2500 rad-treated field-collected females resulted in infertile eggs. Mature check eggs were killed at 150 000 rad. (Abstr.)

- 1366 McClanahan, R.J., Simmons, H.S. STERILIZATION OF ONION MAGGOTS BY IRRADIATION WITH CESIUM-137. Can. Ent. 98, 9 (1966) 931-935.

Pupae of the onion maggot, *Hyalemya antiqua* (Meigen), did not complete their development when irradiated with 3.0 kR within 5 d of pupal formation. Older pupae were not adversely affected. Females from treated pupae were sterile and laid no eggs when caged with normal males. The males from treated pupae were sterilized to a high degree, yet normal females mated with them and laid normal complements of eggs. Less than 0.2% of 10 616 eggs laid by normal females caged with sterile males hatched. A 6:1 ratio of sterile to normal flies reduced egg hatch to 1.7%. (Auth.)

- 1367 Mueller, I., Pentz, S., Harte, C. DEPENDENCE OF THE SOMATIC MUTATION SPECTRUM OF Ephesia kuehniella ON THE DEVELOPMENT STAGE OF THE IRRADIATED ANIMAL. Z. Vererb. Lehre 97 (1966) 353-360. (In German)

Experiments were conducted to determine whether the developmental stage at irradiation affected the sensitivity pattern for mutant types in Ephesia. Dose effect curves were established for pupae of two age groups corresponding to the stages that were attained by preirradiation treatments at low and high temperatures. Moth pupae were exposed to 100, 200, 400, 600, 800, or 1000 R doses of x-rays. The exponent of the dose effect curves was the same for all mutant types and independent of the age at irradiation. Age groups differed in their mutational spectra. Results are discussed with regard to a possible difference in the specific radiosensitivity of epithelial cells and scale stem cells. (NSA 20: 1966, 42970)

- 1368 Murakami, A., Tazima, Y. STUDIES ON STRAIN DIFFERENCES IN RADIOSENSITIVITY IN THE SILKWORM. I. SCREENING OF SENSITIVE AND RESISTANT STRAINS TO EMBRYONIC RADIATION KILLING. Rep. natn. Inst. Genet., Misima No.17 (1966) 98-100.

- 1369 Murakami, A., Tazima, Y. STUDIES ON STRAIN DIFFERENCES IN RADIOSENSITIVITY IN THE SILKWORM. II. RELATION BETWEEN SENSITIVITY TO EMBRYONIC KILLING AND MUTABILITY. Rep. natn. Inst. Genet., Misima No.17 (1966) 100-101.

- 1370 Murakami, A. VARIATION IN RADIOSENSITIVITY DURING THE EARLY DEVELOPMENTAL STAGE OF THE SILKWORM EGG. Rep. natn. Inst. Genet., Japan 16 (1966) 107-109.

In order to elucidate differences in radiosensitivity at various phases of the DNA cycle of the cell, newly deposited eggs were used, taking hatchability as a criterion. Wild type C108 female silkworm were mated with males with the double recessive egg colour genes, *pe* and *re*. Three series of experiments were carried out, using either γ - or x-rays (I - eggs collected at 30 min intervals, subjected to 1000 R γ -rays at 100 R/min; II - collected at 15 min intervals, subjected to 1000 R 173 kVp x-rays, at 1000 R/min; III - collected at 10 min intervals, subjected to 1000 R x-rays). Cytological observations by the squash method showed that the time required for one division cycle was 45-50 min at 25°C, and 30 min at 30-31°C. The results were in good agreement with those obtained from hatchability data, indicating that the radiosensitivity pattern may well be correlated with a cyclic change in the cell division cycle. The cytological studies now in progress indicate that the peak of radiosensitivity appears around late prophase and metaphase.

- 1371 Murphy, C. G. DETERMINATION OF THE DORSAL MESOTHORACIC DISC IN Drosophila. Diss. Abstr. 27, 8 (1967) 2923-B.

The right and left dorsal mesothoracic imaginal discs of Drosophila larvae each give rise to one wing and one-half of the thoracic mesonotum with its characteristic pattern of bristles. Experiments involving extirpation and transplantation of whole discs, as well as cell lineage studies of genetically marked tissue indicated that the right and left dorsal mesothoracic discs were determined as separate anlagen early in development, probably in the embryonic stage. On the other hand, particular regions within each disc were later found to be individually capable of regulative reorganization under special conditions, such as x-ray treatment or provision of an extra period of growth before metamorphosis and concomitant differentiation. Thus, the discs were shown to be capable of intrinsic regulation, but free from regulative influences emanating from other anlagen. Similar results were obtained with the two eye discs, each of which normally gives rise to one eye and one-half of the dorsal surface of the head with its associated structures. The evidence presented indicates that these disc pairs, although participating in the formation of medium structures, do not exist as members of a bicentric regulative field. Instead it is concluded that determination of both eye and wing disc pairs into right and left entities is complete, both in mature larvae and in larvae in the middle of the third instar. (From DA)

- 1372 Nair, K. K., Bhaskaran, G., Sivasubramanian, P. EFFECT ON ADULT EMERGENCE OF WHOLE AND PARTIAL X-IRRADIATION OF PUPAE OF THE HOUSEFLY, Musca domestica nebulosa. Can. Ent. 99, 6 (1967) 597-598.

Irradiation of specific regions of 5- to 20-h-old housefly pupae with x-rays shows that exposure of anterior seven segments alone to 1200 R prevents adult emergence, whereas irradiation of posterior

region with doses up to 10 000 R has no effect on this phenomenon. It is evident that the target organ, damage to which results in the failure of adult emergence, lies in the anterior seven segments. It is suggested that failure to emerge is due to a direct effect of radiation on the differentiating myoblasts leading to dystrophy of the muscles. (Auth.)

- 1373 Nelson, T.E. THE EFFECTS OF GAMMA RADIATION UPON VARIOUS STAGES OF *Fannia canicularis* (L.). Bull. ent. Soc. Am. 12 (1966) 278. Abstr. 253. Presented at "Portland Meeting, Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

The lethal and sterilizing dosages of γ -radiation were determined for various developmental stages of the little housefly, *Fannia canicularis* (L.). The flies were exposed to γ -radiation in a 300 Ci ^{60}Co -irradiator with a mid-point flux of ~ 200 rad/min. (Abstr.)

- 1374 Planel, H., Soleilhavoup, J.P., Giess, M.C., Tixador, R. MISE EN EVIDENCE D'UN RETARD DE DEVELOPPEMENT DE *Drosophila melanogaster* PAR DIMINUTION DE LA RADIOACTIVITE NATURELLE AMBIANTE. C. r. hebd. Séanc. Acad. Sci. D 264, 6 (1967) 865-868.

Les méthodes de culture et de radioprotection ont été identiques à celles décrites précédemment. Les résultats démontrent que les diminutions de population des élevages effectués sous radioprotection ne sont pas provoquées par l'arrêt de développement de certains organismes embryonnaires ou larvaires, mais par un simple allongement du développement des pontes. Cette conclusion est démontrée d'une part par le retard des éclosions observé dans les cultures protégées, et d'autre part par l'identité numérique des populations adultes constatée après la fin des éclosions, du 14^e au 17^e jour.

- 1375 Planel, H., Soleilhavoup, J.P., Giess, M.C., Tixador, R. RECHERCHES SUR L'ACTION DES RADIATIONS IONISANTES NATURELLES CHEZ *Drosophila melanogaster*. (Studies on the action of ionizing radiations on *Drosophila melanogaster*.) C. r. Séanc. Soc. Biol. 161, 2 (1967) 467-470.

Previous studies have shown that natural ionizing radiations have a beneficial effect on unicellular animals by accelerating multiplication. Tests were made on *Drosophila* to determine if a similar effect could be observed on multicellular animals. The use of a radioprotective chamber caused a delay in the development of laying eggs. (NSA 22: 1968, 17045)

- 1376 Qureshi, Z. A. EFFECTS OF SUB-LETHAL GAMMA RADIATION ON THE BIOLOGY AND BEHAVIOR OF THE ANGOUMOIS GRAIN MOTH, *Sitotroga cerealella* Olivier. Diss. Abstr. 26 (1966) 7511-7512.

Data were obtained on hatching of eggs irradiated with 2-18 kR at different ages. A 10 Ci- ^{60}Co source was used. Development within kernels was observed by x-ray radiographs. Early and late 1st instar were irradiated at doses of from 2-20 kR; 3rd and last instars, and early and late pupae, from 5-25 kR; prepupae, from 3-24 kR. Fecundity and fertility were determined by mating irradiated females with normal males and vice versa. Effects of irradiation on females were evaluated by number and hatchability of eggs, as compared with normal females. Effects of irradiation on male fertility were appraised by mating males with normal females and noting fecundity and viability of eggs. Upon emergence, following irradiation, moths were weighed within 24 h and the adult life span recorded upon death. Results following irradiation of eggs of different ages showed that sensitivity declines with age. Larvae from eggs irradiated at age 24-48 and at 48-72 h, treated with 10, 14 and 18 kR did not develop; in dosages of 2 and 6 kR and check, larvae developed normally. Adult emergence after irradiation of early and late 1st instar, 3rd instar, and last instar, prepupae and early pupae revealed that irradiation delayed emergence and reduced the number emerged. Earlier stages were more sensitive than older ones. More males than females emerged when early larvae were irradiated, but the ratio was approximately unity with irradiated pupae. Structural deformities included twisted wings, fusion of tarsal segments, fusion of antennal segments, incomplete emergence and tumour formation in the abdominal region. They were largely found on adults irradiated while immature. Emergence of F_1 adults from irradiated 1-d-old adults showed that larvae developed under all radiation treatments but the number of emerged moths was less than in the controls. Fecundity and fertility studies indicate that 20 kR may cause complete sterility of both sexes when irradiated as 1st instar, 3rd instar, last instar and early pupae. Female adults following irradiation of prepupae when mated with normal virgin males and vice versa either failed to oviposit or laid infertile eggs after 10 kR. Generally, irradiated females were more sensitive to radiation than males. None of the doses prevented the hatching of eggs in crosses where treated males were

mated to untreated females and vice versa, following irradiation of late pupae. In crosses where treated females were mated to untreated males, and vice versa female fertility was reduced significantly from controls after doses of ≥ 10 kR. Fecundity and fertility of females in 1-d-old irradiated adults was significantly different from the controls under various crosses, but the crosses where treated males were mated to treated females showed a marked reduction in fecundity and fertility as compared to the crosses where treated males were mated to untreated females or treated females to untreated males. Adult longevity following irradiation of early and late 1st instar, 3rd instar and last instar, prepupae, early and late pupae and 1-d-old adults was not significantly different from the controls. Emerged adults irradiated as early and late 1st instar and last instar showed a significant reduction in body weight. (From DA)

- 1377 Qureshi, Z. A., Wilbur, D. A. EFFECT OF SUB-LETHAL GAMMA ON EGGS, EARLY, INTERMEDIATE, AND LAST INSTAR LARVAE OF THE ANGOUIMOIS GRAIN MOTH, *Sitotroga cerealella* Oliv. p. 112-124 of "Proceedings of the Agricultural Symposium, Dacca, Pakistan, 13-14 May, 1966". 1966, 166p.

Irradiation of eggs of different ages showed that sensitivity declined as the eggs became older. Hatched larvae from eggs irradiated at age group 24-48 and 48-72 h, treated with dosages of 10, 14, and 18 kR did not develop; in dosages of 2-6 kR the larvae developed normally. The adult emergence pattern after irradiation of the early and late 1st instar or the 3rd and last instar revealed that irradiation delayed emergence and reduced the number emerged. Earlier stages were more sensitive than older ones. Structural deformities included twisted wings, fusion of antennal segments, fusion of tarsal segments, incomplete emergence and tumour formation in the abdominal region. (Auth.)

- 1378 Deleted.

- 1379 Raun, E.S., Lewis, L.C., Picken, J.C., Jr., Hotchkiss, D.K. GAMMA IRRADIATION OF EUROPEAN CORN BORER LARVAE. *J. econ. Ent.* 60, 6 (1967) 1724-1730.

Actively growing non-diapausing 3rd-, 4th-, or 5th-instar laboratory-reared larvae of the European corn borer, *Ostrinia nubilalis* (Hübner), were irradiated with γ -rays from a ^{60}Co source. Diapausing larvae collected in the field were irradiated after either 3 or 5½ months of refrigeration. The non-diapausing larvae had too much somatic damage from the irradiation to make this a practical method of borer control. However, the diapausing larvae showed little evidence of somatic damage. Rates of pupation, moth emergence, and mating were nearly normal at levels of irradiation as high as 5000 rad. Numbers of eggs laid and egg hatch were most severely affected at 4000 and 5000 rad. There was an interaction between time to pupation and dose level when diapausing larvae were irradiated and then divided into three groups (A, B, and C) based on length of time to pupation. Egg hatch was significantly affected. All levels of radiation affected pupation period A (early) most strongly. Only 4000 and 5000 rad affected hatchability of eggs from pupation period B (middle). Only 5000 rad affected the egg hatch of pupation period C (late). Irradiation of diapausing larvae appeared to affect the motility or viability, or both, of sperm instead of inducing lethal gene mutations. (Auth.)

- 1380 Rockstein, M., Bhatnagar, P.L. x-IRRADIATION AND WING RETENTION IN THE COMMON HOUSE FLY, *Musca domestica* L. *Naturwissenschaften* 53, 24 (1966) 702-703. (In English)

Different x-ray doses varying from 10 000 to 30 000 rad were administered to batches of 2500 42-h-old pupae. The number of deaths and degree of wing retention were recorded daily for all successfully emerging adults, and wing loss data were tabulated. High doses of x-rays acted in a restorative fashion, with regard to the normal aging process of the adult, by increasing longevity and by delaying the otherwise characteristic loss of wings early in adult life. The degree of such enhancement increased with dose level, up to 30 000 rad. In the control group, only 7% of 1196 males died with 100% intact wings, while 73% showed complete wing loss. At 30 000 rad 96% of (only) 274 successfully emerged males showed complete wing retention, whereas all of the 208 emerged females showed complete wing retention at death.

- 1381 Rockstein, M., Dauer, M., Bhatnagar, P.L. FURTHER STUDIES ON THE EFFECT OF x-IRRADIATION ON THE HOUSE FLY, *Musca domestica* L. *Radiat. Res.* 31 (1967) 840-845.

Exposure of 36- to 48-h-old pupae of the common housefly, *M. domestica* L., to single doses of x-rays ranging from 2000-8000 rad had no appreciable effect on the percentage of emergence or on the normal appearance of the adult flies. All levels of radiation produced only a slight but significant decline in female life span. Such low levels of x-irradiation produced only a slight effect on male life span, with a decrease for 2000 rad, no effect at 4000 rad, and a slight increase at 6000 and 8000 rad. However, the effect of such x-irradiation on the otherwise normally high degree of wing loss in male houseflies was much more striking, the number of male houseflies retaining their wings at the time of death being trebled for all four dose levels studied. In the females, there was a smaller but nevertheless significant increase in such wing retention. (Auth.)

- 1382 Sasaki, S. EFFECTS OF x-IRRADIATION ON POSTEMBRYONIC DEVELOPMENT OF *Sarcophaga peregrina* Robineau-Desvoidy. Dobutsugaku Zasshi (Zoological Magazine) **75** (1966) 207-214. (In Japanese)

When larvae were x-irradiated with 0.5-50 kR, they were not killed and developed to prepupae. Irradiation of larval and prepupal stages caused death in the early pupal stage (early death); disturbance in exchange of the hypodermis was observed. When pupae were irradiated at 20 h of age or later, development continued but emergence did not occur because of general suppression of differentiation (late death). Radiosensitivity, when determined by the emergence rate, was scarcely altered during the period from 2nd-instar larva to 2nd-day pupa and thereafter it dropped off gradually. The most radiosensitive stage was 30 to 50-h-old pupae; fully grown 7th-day pupae were about 56 times as radioresistant as that of 1st-day pupa. The change in DNA synthesis rate was correlated with the change in radiosensitivity of the pupal stages except for the late pupal stage. Results of partial body irradiation of 1st-day pupa were also reported. Irradiation of the head and thorax had an equivalent effect to whole-body irradiation; irradiation of the head had the greatest effect. (NSA 21:1967, 22752)

- 1383 Schneider-Minder, A. CYTOLOGISCHE UNTERSUCHUNGEN ZUR DEUTUNG DER UNTERSCHIEDLICHEN STRAHLENEMPFLINDLICHKEIT VERSCHIEDEN ALTER *Drosophila*-EIER. (Cytological investigations to interpret the differential radiosensitivity observed in *Drosophila* eggs of different ages.) Arch. Julius Klaus-Stift. Vererb.-Forsch. **37** (1962) 38. (In German)

- 1384 Schneider-Minder, A. CYTOLOGISCHE UNTERSUCHUNG DER EMBRYONALENTWICKLUNG VON *Drosophila melanogaster* NACH RÖNTGENBESTRAHLUNG IN FRÜHEN ENTWICKLUNGSSTADIEN. (Cytological study of embryo development in *Drosophila melanogaster*, following x-irradiation at early developmental stages.) Int. J. Radiat. Biol. **11**, 1 (1966) 1-20. (In German, with English and French summaries)

Eggs of *D. melanogaster* were x-irradiated at two stages of different radiosensitivity of the 1st cleavage division (inter-/prophase and ana-/telophase) each stage receiving a different dose (1000 R or 650 R, respectively). This resulted, in spite of the differences in radiosensitivity, in approx. equal rates of embryonic mortality (about 85%). Regardless of the stage irradiated, approx. 80% of the eggs died in early stages of embryonic development, i.e. before blastoderm formation, and approx. 5% died in late stages of embryonic development. At different times after irradiation eggs were fixed and investigated cytologically. Regardless of the stage irradiated, the same lethal syndromes occurred. Those eggs, which die in early phases of embryonic development, exhibit one type of a rather uniform lethal syndrome only: first the multiplication of nuclei ceases, then that of chromosome division; finally the increase in number of protoplasmic islands comes to an end. Before disintegrating, these eggs usually contain eight nuclei, which seem to be mostly octoploid; the larger part of the eggs has 64 protoplasmic islands. The main cause of the lethality is probably an induced mitotic block, which itself could at least partly be caused by chromosomal bridges. Among the eggs, which die late in embryonic development, very different syndromes were recorded, which can manifest themselves at stages from the preblastoderm to very late embryonic development. These syndromes are probably brought about by different radiation-induced losses of either whole chromosomes or of chromosome parts; they may also be caused by alterations in the informational content of the genome. (Auth. summary)

- 1385 Shim, J. W., Hyun, J. S. SOME EFFECTS OF x-RAY IRRADIATION ON THE RICE STEM BORER. J. nucl. Sci. Korea **6** (1965) 193-199.

- 1386 Tahmisan, T. N. BIOCHEMICAL AND DEVELOPMENTAL RESPONSE OF GRASSHOPPER EMBRYOS AND SPERMATOGONIA TO x-IRRADIATION. Argonne nat. Lab. Rev. 2, 3 (1965) 52-53.

The effects of doses of x-radiation ranging from 25 to 200 kR, on respiration and development of grasshopper embryos were studied, with emphasis on the radiosensitivity of various organizational stages including induction, differentiation, cell division or multiplication, anabolism, and catabolism. Degrees of complexity at each organization level are discussed and the interdependence of all factors is considered. Results are included from an electron microscopic study of normal spermatogenesis in the grasshopper and the effects of x-radiation on spermatogenesis. (NSA 19: 1965, 38813)

- 1387 Teravskii, I. K. THE EFFECT OF IONIZING RADIATION ON ARGASID TICKS. Zool. Zh. 45 Pt. 3 (1966) 371-374. (In Russian, with English summary)

The following is substantially the English summary. In experiments in Leningrad, larvae, nymphs and adults of *Omithodoros tholozani* (Lab. & M'g'n.) (*papillipes* (Bir.)) infected with *Borrelia persica* (*sogdiana*) were exposed to γ -radiation from a ^{60}Co source. Doses of 2000 R were lethal to the larvae and inhibited metamorphosis of the nymphs. Doses of 5000-10000 R were not lethal to 3rd- and 4th-instar nymphs or adults, but they greatly reduced metamorphosis of the nymphs, and eggs laid by irradiated adults failed to develop. Metamorphosis of the offspring of irradiated ticks was delayed. Doses up to 10000 R were not lethal to the spirochaetes in the infected ticks. (RAE-B 56: 1968, ref. 58)

- 1388 Teulade, P. RECENTES EXPERIENCES DE RADIOBIOLOGIE SUR *Bombyx mori*. Atom. Energy Rev. 4, 2 (1966) 3-57.

Due to its physiological characteristics (embryonic diapause, synchronous gamete development) and its great genetic variability, *B. mori* constitutes excellent material for studying the effects of ionizing radiations. The use of numerous criteria (mortality, duration of embryonic development, and histological and biochemical analyses) has made it possible to follow the variations in radio-sensitivity as embryogenesis proceeds. It has likewise been possible to define the respective roles of diapause and of hibernation (particularly the effect of aging). Various studies of the embryo have further contributed valuable data on the effect of the mode of irradiation (dose fractionation and rate), and of LET, and have demonstrated the vital role of recovery. The effects of ionizing radiations on the progress of gametogenesis were tested by histological and genetic methods (particularly that of specific loci). The effect of the mode of irradiation and LET were studied on some particularly sensitive stages (e.g., advanced spermatogonia, type VI; spermatocytes at the end of meiotic prophase). The results obtained explain the processes involved in radio-induced mutagenesis and stress the significance of recovery. Radiobiological studies have also contributed to a better understanding of some physiological aspects of *B. mori*.

- 1389 Thompson, R. C. et al. RADIATION EFFECTS: GENERAL. p. 1-19 of "Pacific Northwest Laboratory Annual Report 1966 to the USAEC Division of Biology and Medicine. Vol. 1. Biological Sciences". BNWL-480, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Jul. 1967, 207p.

Data are presented on the mechanism and treatment of gastrointestinal radiation effects. Two papers discuss the effects of x-radiation on larval and pupal stages of flour beetles.

- 1390 Tilton, E. W., Burkholder, W. E., Cogburn, R. R. EFFECT OF GAMMA RADIATION ON *Trogodenna glabrum* AND *Attagenus piceus*. J. econ. Ent. 59, 4 (1966) 944-948.

A study to determine the gross effects of γ -radiation on *T. glabrum* (Herbst) and the black carpet beetle, *A. piceus* (Olivier), was conducted. All metamorphic stages of the insects were treated with $13.2 \pm 10\%$, 17.5, 25, 45, and 100 kRads or with $13.2 \text{ kRads} \pm 10\%$ repeated 5 times at hourly intervals for a total of 66 kRads $\pm 10\%$. Each week mortality, developmental progress, and reproduction by treated individuals were checked. Eggs and larvae of both species were controlled effectively by all dosages. However, no dosage used was enough to produce complete mortality immediately of any of the stages of either species. Reproduction in both species was limited in the F_1 generation to the insects where the P_1 generation received the lowest dosage. Indications are that males of both species when treated directly were less subject to genetic damage than the females. Genetic damage, as evidenced by reduced reproduction, was transmitted to the F_1 generation of *T. glabrum*. (Auth.)

- 1391 Tilton, E. W., Burkholder, W. E., Cogburn, R. R. EFFECTS OF GAMMA RADIATION ON *Rhyzopertha dominica*, *Sitophilus oryzae*, *Tribolium confusum*, AND *Lasioderma serricorne*. *J. econ. Ent.* 59, 6 (1966) 1363-1368.

Lesser grain borers, *R. dominica* (F.); confused flour beetles, *T. confusum* Jacquelin duVal; rice weevils, *S. oryzae* (L.); and cigarette beetles, *L. serricorne* (F.), were exposed to various levels of γ -radiation from a ^{60}Co source. All four metamorphic stages of each insect were used. Dosages were 13.2, 17.5, 25, 45, and 100 krad and, on all insects except the lesser grain borer, a fractionated dosage of 13.2 krad + 10% repeated five times at hourly intervals. The dose rate for all treatment levels was about 330 krad/h. In all species the adults were the most tolerant, followed by the pupae, then the larvae, and then the eggs. No dosage used was high enough to produce immediate complete mortality of all species. All four species were sterilized by γ -radiation in a single continuous dose of 25 krad or more. (Auth.)

- 1392 Vasilyan, V. V. THE EFFECT OF IONIZING RADIATION UPON THE DEVELOPMENT OF THE MALLOW MOTH. *Ent. Rev.* 39 (1961) 425-428. (In English) *Ent. obozr.* 39, 3 (1960) 599-604. (In Russian)

Effects of x-rays on the mallow moth *Pectinophora gossypiella*, the larva of which feeds on cotton plants and is an economic pest, was investigated. Irradiation of raw cotton being shipped to uninfested areas was considered as a means of preventing spread of this insect. Caterpillars were irradiated with 1000- to 15 000-R doses of 180-kV x-rays. A dose of 1000 R apparently had no effect on the development of the caterpillars, since the emerged moths were normal and had an almost identical egg production. Starting with a dose of 5000 R, x-rays had a deleterious action. Thus, of the 80 caterpillars irradiated with doses of 5000 R only one of the moths that emerged was apparently normal, while the rest were malformed. These malformed moths died 1-3 d after emergence and did not oviposit. Thus, when wintering caterpillars were irradiated in their cocoons at the beginning of May, doses of 5000 R and higher were lethal to the moths that emerged while doses of 10 000 R and higher killed the caterpillars before they could leave the cocoons. In contrast, last-stage caterpillars of the summer generation were found to be relatively resistant to x-rays. Doses of 5000 R and higher sharply decreased the fecundity of the moths or rendered them completely sterile. Doses of 10 000 R and higher were lethal for the caterpillars. In irradiation experiments with summer generation caterpillars feeding on cotton, up to 15% went into diapause. A dose of 1000 R had almost no effect on the development of the mallow moth. No difference was noted between the effects of irradiation of last-stage caterpillars and summer generation pupae. The doses used had no apparent effect on the longevity of the moths. (NSA 20: 1966, 9349)

- 1393 Vasilyan, V. V., Alaveryan, E. B., Edigaryan, S. E. STUDY OF THE EFFECT OF x-RAYS ON THE DEVELOPMENT OF THE MELON FLY. "Materialy Sessii Zakavkazskogo Soveta po Koordinatsii Nauchno-Issledovatel'skikh Rabot po Zashchite Rastenii. Erevan, Armenian SSR, 1967".

- 1394 Wixson, B. G., Clark, W. J. GAMMA RADIATION EFFECTS ON NYMPHS OF THE DAMSEL FLY *Argia translata*. *Ann. ent. Soc. Am.* 60, 2 (1967) 485-486.

Nymphs of *A. translata* Hagen in their final instar were collected from the river and irradiated in replicate sample groups of 10; radiation dosage was continuous, and administered at 710 rad/min. Median tolerance limit (TL_{50}) values were determined and plotted. TL_{50} calculated from these data were: 24 h - 15×10^3 rad; 48 h - 92×10^3 rad; 72 h - 52×10^3 rad. An unusual phenomenon of accelerated emergence was noted in the groups which received 750 and 7150 rad, respectively. Adult emergence was 1% in the control groups during the 72 h of the experiment, yet 9% of the 750 rad group completed normal emergence during this period. In the 7150 rad group, 12% attempted emergence but only half completed it successfully, the others being unable to straighten the wings or the abdomen into the normal adult position. There was no emergence in groups given > 71 000 rad.

- 1395 Würgler, F. E. UNTERSUCHUNGEN ÜBER DIE STRAHLENEMPFFINDLICHKEIT FRÜHER ENTWICKLUNGSTADIEN VON *Drosophila melanogaster*. (Studies on the radiosensitivity of early embryonic stages of *Drosophila melanogaster*.) Thesis, Zürich Univ. (Switzerland). Naturwissenschaftliche Fakultät. 1964, 151p. (In German)

Newly deposited fertilized eggs of different ages were tested for their radiosensitivity, for various doses of 50 kV x-rays. In series I, 10-20 min old eggs were collected at 10 min intervals and irradiated for 3 min. Dose-dependence. After irradiation in air at room temperature, embryonic and post-embryonic mortality rates and recessive lethal factors in the X-chromosome gave exponential dose-effect curves. These curves had previously been interpreted as one-hit curves, such that the radiation-induced point mutations as well as chromosome breaks and their results represent the basic cause of all effects registered. Genetic effects in the reproductive tract of surviving imagoes: 1000 R produced 13.3% viability-reducing mutations in the X-chromosome, amongst them 5.3% recessive lethals. The rate of reciprocal II/III-translocations, on the other hand, were extremely low (0.5%). Oxygen effect. Newly laid eggs are not damaged lethally when they are deprived of O for a max. of 7 min. The O content of the egg adapts to the gaseous environment within 15 sec. The dose-effect curves for embryonic and post-embryonic mortality and recessive lethal factors in the X-chromosome were flattened when irradiation took place in N instead of air. All curves were exponential. Cold treatment after irradiation, at temperatures between +10 and +3 °C for 30 min immediately after irradiation at room temperature, lowered embryonic mortality. In series II, eggs were collected at 3 min intervals of oviposition, and irradiated for 3 sec at various times after collection. Egg sensitivity, in terms of embryonic mortality after a particular dose, changed from minute to minute during early embryo development. Cytological analysis of non-irradiated eggs at various intervals after oviposition permitted the various radiosensitivities to be correlated with particular mitotic stages. The eggs were most sensitive during late ana- and early telophase, but relatively insensitive in interphase. Killed embryos could be recognized (a) at the early embryonic stage by their death prior to gastrulation, and (b) late embryonic, by dying after gastrulation, both lethal syndromes being recognizable visibly. Dose-effect curves were drawn for eggs of various ages, for early and late embryonic mortality. It could be shown that the exponential dose-effect curves for embryonic mortality of 10-20 min old eggs cannot be interpreted as one-hit curves. The exponential dose-dependence is the result of the superimposition of non-exponential curves (dose-effect curves for different lethalties of various mitotic stages present during irradiation). Radiation effects did not confirm the hypothesis of Lea and Ulrich according to which such effects are due to chromosomal aberrations. The radiation effects observed did not depend on the chromosomal constitution of the nucleus to that extent. It was concluded that non-chromosomal radiation effect may lead to death of the irradiated individual, a hypothesis supported by additional data. It appears probable from the results of cold-posttreatment and from the dose-effect curves for early and late embryonic lethality, that protein synthesis plays a significant role in the development of biologically identifiable radiation effects.

- 1396 Yüpare Permswarg. EFFECT OF GAMMA IRRADIATION ON THE DEVELOPMENT AND STERILITY OF ANGUMOIS GRAIN MOTH (*Sitotroga cerealella* Oliv.) p. 48-52 of "Insect Eradication by Irradiation, Bangkok, Thailand, 28-29 Jun. 1966". THAI. AEC-8, Office of Atomic Energy for Peace, Bangkok (Thailand).

A dose of 1000-4000 rad had little effect on rate of development. It was retarded by 8000 rad in 8-, 12-, 16-, 20- and 24-d-old cultures. The number of eggs per female decreased with increasing dosage and age. No eggs hatched from cultures aged 12, 16, and 20 d when exposed to 8000 rad. This suggests that sterility of both sexes should be obtained around 8000 rad. Further experiments are required to decide whether *Sitotroga* is suitable for control by the sterile male technique.

- 1397 Ziad Al-ahmadi, A. EFFECTS OF GAMMA RADIATION ON DEVELOPMENT OF *Dermacentor occidentalis* (IXODIDAE). Bull. ent. Soc. Am. 13, 3 (1967) 200. Abstr. 285, at "New York Meeting of the Entomological Society of America, New York, N. Y., USA. 27-30 Nov. 1967".

The effects of γ -radiation from ^{137}Cs source on development, fertility, and mutagenesis in two species of mites and ticks are being studied. Preliminary data on the development of embryos, larvae and nymphs of *D. occidentalis* irradiated at various dosages from 100-15 000 rad are discussed. (Abstr.)

See also:

- 26 The effect of thymidine- ^3H on the mortality of *Drosophila melanogaster* larvae. (Anil, Y.D., 1964)

- 532 Radiation profile of a herbivorous insect. (Reichle, D.E., 1966)
- 923 Nucleic acids in normal and γ -rays irradiated eggs of *Bombyx mori*. (Lassota, Z., 1967)
- 928 Cytological evaluation of dose-rate effects of radiation on mutation frequency of silkworm gonidia. I. Kinetics of proliferation and killing of spermatogonia during chronic irradiation. (Sado, T., 1966)
- 940 Radiomutability and heterogeneity of male germ cells of *Drosophila* before, during, and after meiosis. (Fritz-Niggli, H., 1966)
- 941 Biological effects of radiation. (Grosch, D.S., 1965)
- 953 The radiosensitivity of germ cells. (Mandi, A.M., 1964)
- 957 Annual Report of the National Institute of Genetics, No.18, 1965. (National Inst. of Genetics, Mishima, Japan, 1966)
- 963 Techniques for studying the effects of radiation on meiosis and related processes in mosquitoes with particular reference to *Aedes aegypti*. (Rai, K.S., 1968)
- 987 Etude de l'effet génétique des rayonnements ionisants chez le ver à soie. (Akhalaya, Y.G., 1967)
- 990 Cytogenetic and developmental effects of gamma-irradiation on *Aedes aegypti* L. (Asman, M., 1966)
- 1010 Genetic and direct effects of gamma radiation on *Drosophila*. (Ives, P.T., 1966)
- 1044 Effect of ionizing radiation and incidence of triplo-X females in offspring of attached-X *Drosophila melanogaster*. (U, R. et al., 1967)
- 1061 Effect of ionising radiation on the ontogenetical development and sex of the *Bombyx mori*. (Dinu, M. et al., 1966)
- 1062 Dependence of radiation induced mutation rate on maturity and dose for chrysalis of *Drosophila melanogaster* Meigen. (Ebeling, W., 1962)
- 1103 Mutant traits of the larval and pupal stadia of the wax moth. (Smith, T.L., 1967)
- 1123 Effectiveness of sterilization of the mallow moth; irradiability at different stages of development, and certain features of mating and egg-laying. (Buginsky, V.I., 1963)
- 1131 Sterilization of the coffee leaf miner. (Katiyar, K.P., 1967)
- 1132 Sterilization of parasites of the ash tree. (Khvatova, L., 1965)
- 1144 Biology and radiation sterilization of sugar cane leafhoppers. (Osborn, A.W. et al., 1966)
- 1149 Radiation sterilization of sugar-cane leafhoppers of the family Delphacidae. (Shipp, E. et al., 1966)
- 1158 Gamma-induced sterility in the sugarcane moth, [*Diatraea saccharalis* (Fab.) (Lepidoptera: Grammbidae)]. (Walker, D.W. et al., 1967)
- 1176 Influence of arginine of radiation damage of spermatids and spermatocytes in *Drosophila*. (Abeleva, E. A., 1965)
- 1218 Thymidine teratogenesis and mutagenesis in *Drosophila melanogaster*. (Parkash, O., 1967)
- 1233 Effect of aeration on gamma irradiation of house fly pupae. (Smittle, B.J., 1967)
- 1258 Sterilizing effect of γ -rays and apholate on the Mexican bean beetle, *Epilachna varivestis* Muls. (Carillo, J.L. et al., 1963/1964)
- 1294 Spermatogenesis in drones following irradiation of the young larvae with different amounts of x-rays. (Bischkopf, R., 1966)
- 1297 Engorgement and reproduction of lone star ticks (*Amblyomma americanum* (L.)) treated with gamma radiation. (Drummond, R.O. et al., 1966)
- 1302 Effects of gamma radiation on fertility, mating, and longevity of males of the oriental fruit moth, *Grapholitha molesta* (Lepidoptera: Tortricidae.) (George, J.A., 1967)
- 1307 Laboratory and field cage studies of the effects of gamma radiation on codling moths. (Hathaway, D.O., 1966)
- 1312 x-Ray-induced mutability of polygenes controlling hatching time in *Drosophila melanogaster*. (Pulitzer, J.F., 1966)
- 1325 A cytological study of the effects of radiation on the development of the reproductive organs of two species of fruit flies, *Dacus oleae* and *Ceratitidis capitata*; part of a co-ordinated programme of insect control using radiation. Research contract 169. (International Atomic Energy Agency, Vienna, Austria, 1967)
- 1332 The male reproductive system and spermatogenesis of the European pine shoot moth, *Rhyacionia buoliana* (Lepidoptera: Olethreutidae), with observations on the effect of gamma irradiation. (Shen, S.K. et al., 1967)
- 1398 Effect of radiation on the developing flour beetle, *Tribolium confusum*. (Buckhold, M. et al., 1967)

- 1399 Variations du spectre d'anomalies consécutives à une irradiation X chez l'embryon de Bombyx mori en fonction de l'hivernation préalable. (Coulon, M., 1966)
- 1415 The relationship between age at irradiation and life-shortening in adult Drosophila. (Lamb, M.J., 1966)
- 1421 Differential gerontomimetic effects of x-irradiation to pupae of male and female house flies. (Rockstein, M., 1966)
- 1422 Differential gerontomimetic effects of pupal x-irradiation of adult male and female house flies. (Rockstein, M. et al., 1966)
- 1428 The susceptibility of the red flour beetle, Tribolium castaneum (Hbst.) to gamma radiation. (Bhuiya, A.D. et al., 1967)
- 1434 Acute lethality after x-irradiation of Tribolium confusum adults. (Ducoff, H.S. et al., 1967)
- 1436 Study of the irradiation tolerance of some destructive storehouse insects and technical and economic aspects of insect destruction by irradiation. (Farkas, J., 1965)
- 1438 Lethal and mutation rates in newly laid x-irradiated Drosophila eggs at different oxygen concentrations. (Finsinger, F.X., 1964)
- 1441 Observation on the effects of γ -radiation on eggs of the desert locust, Schistocerca gregaria (Forsk.) (Hunter-Jones, P. et al., 1966)
- 1442 The effects of x-ray irradiation on the pupal mortality and hatchability of the rice stem borer. (Shim, J.W. et al., 1967)
- 1444 Studies on the use of gamma radiation in the control of pea weevil Callosobruchus chinensis L. (Srisan Ruangopas, 1966)
- 1446 The mortality effect of radiation on Drosophila melanogaster larvae of different ages. (Ucer, E., 1965)
- 1447 Preliminary study on the effect of gamma radiation in controlling oriental fruit fly (Dacus dorsalis Hendel) in banana. (Krithayakiem, V., 1966)
- 1450 Influence of incubation conditions on the radiobiological effects on eggs of Bombyx silkworms. (Akhalaya, Y.G., 1966)
- 1462 Influence of diapause on the radiosensitivity of khapra beetle larvae. (Rahalkar, G.W. et al., 1966)
- 1471 The effects of gamma radiation on mating competitiveness and fecundity of Hippelates pusio Loew. (Flint, H.M., 1966)
- 1484 Action des radiations ionisantes naturelles sur la reproduction des métazoaires: recherches chez Drosophila melanogaster. (Paniel, H. et al., 1967)
- 1514 An estimate of the effects of fallout beta radiation on insects and associated invertebrates. (Teresi, J.D. et al., 1966)
- 1583 Studies of the eradication of Anopheles pharoensis Theobald by the sterile-male technique using cobalt-60. I. Biological effects of gamma radiation on the different developmental stages. (Abdel-Malek, A.A. et al., 1966)
- 1584 Studies of the eradication of Anopheles pharoensis by the sterile-male technique using cobalt-60. III. Determination of the sterile dose and its biological effects on different characters related to "fitness" components. (Abdel-Malek, A.A. et al., 1967)
- 1593 Control of fruit flies Dacus zonatus Saunders by gamma-rays. (Huque, H. et al., 1967)
- 1608 Study of the biology, breeding and sterilisation of the cabbage fly, Phorbia brassicae Bouché, with special reference to its occurrence in radish cultures. (Riedel, M., 1967)
- 1622 Studies on the application of the sterility method in the tick Ornithodoros tholozani. (Galun, R. et al., 1967)
- 1662 Radiation disinfestation of grain and seeds. (Golumbic, C. et al., 1966)
- 1666 The Israel food irradiation programme and progress during 1964-1966. (Kahan, R.S. et al., 1966)
- 1668 Food irradiation research and pilot facilities in operation or planned in India. (Kurita, U.S. et al., 1966)
- 1670 Control of the Queensland fruit fly by gamma irradiation. (MacFarlane, J.J., 1966)
- 1677 "6th Annual AEC Food Irradiation Contractors Meeting, Washington, D.C., 3-4 Oct. 1966". (Mayer, E.L. et al., 1966)
- 1693 x-Ray irradiation effects on storehouse destructive insects. (Török, G. et al., 1959)

2.2.5. Malformations. Histopathological Changes

- 1398 Buckhold, M., Slater, J. V. EFFECT OF RADIATION ON THE DEVELOPING FLOUR BEETLE, Tribolium confusum. p. 43-51 of "Joint NASA-AEC Program in Space Radiation Biology. Progress Report, Fall 1967". UCRL-17751, California Univ., Berkeley. Lawrence Radiation Lab. Sep. 1967, 143p.

An interesting developmental abnormality has been studied. When irradiated with 2000 R of x- or γ -rays, young pupae develop into adults with a wing abnormality which consists of a median elytral split, elytral blistering, and protrusion of the underlying membranous wings. One or more of these effects are observed with varying degrees of severity as the dose is lowered. For 16-24 h old pupae, a dose response curve to 180-keV x-rays may be obtained which shows an extreme shoulder, a very sharp response at > 1200 R, and an ED-50 of 1430 R. Various physical and chemical parameters have been studied. Temperature had a synergistic effect. Sensitivity to x-rays (% of wing abnormality) varied with the age of the beetles. A delay in development (eclosion) has been found in 1-24 h old pupae. Eclosion delay appears to be a necessary but not sufficient condition for a wing abnormality. Various graphs are given. The effect of combining increased gravity and irradiation has not yielded any reliable results as yet.

- 1399 Coulon, M. VARIATIONS DU SPECTRE D'ANOMALIES CONSECUTIVES A UNE IRRADIATION CHEZ L'EMBRYON DE Bombyx mori EN FONCTION DE L'HIVERNATION PREALABLE. C. r. hebdo. Séanc. Acad. Sci., D 283, 16 (1966) 1153-1155.

Les irradiations par rayons X ont été effectuées dans les conditions suivantes: 80 kV, 10 mA, filtre 2 mm/Al, débit 50 R/min \pm 1. Les embryons sont irradiés à des stades un peu antérieurs à la blastocinèse aux doses suivantes 0 (témoins), 1000, 2000, 3000, 5000 R, et replacés dans les conditions normales d'incubation (22°C, 80% d'humidité); les embryons sont ensuite observés à des stades postérieurs à la blastocinèse où l'on détermine les anomalies qui les affectent. L'auteur distingue entre plusieurs types d'anomalies. Si le vieillissement est le seul facteur agissant, certaines anomalies (types III, VII et IV) n'apparaissent jamais. La fréquence de certaines anomalies (III, VI, I, XIII) augmente aussi bien sous l'action de l'irradiation que sous celle de l'hivernation préalable à l'irradiation. D'autres anomalies (II, VII, XIV) voient leur fréquence augmenter puis diminuer, selon la durée de l'hivernation préalable. Une anomalie (IV) très fréquente, après une irradiation et une courte hibernation, est de plus en plus rare au fur et à mesure que l'hivernation préalable s'allonge. Enfin le spectre des anomalies obtenues chez les témoins après 943 jours d'hivernation n'est pas significativement différent de celui obtenu dans les mêmes conditions chez les irradiés. L'examen des spectres obtenus en considérant les nombres d'anomalies rapportées au nombre total d'embryons étudiés confirme ces diverses conclusions.

- 1400 Coulon, M. ETUDE DU SPECTRE D'ANOMALIES CONSECUTIVES AU VIEILLISSEMENT ET A DES IRRADIATIONS X CHEZ L'EMBRYON DE Bombyx mori. Thesis, Lyon Univ. (France). Faculté des Sciences, 21 Jun. 1966, 97p.

A technique has been developed for mounting embryos of B. mori in toto, which allows the stages in embryogenesis to be determined at the moment when irradiation takes place. Various morphological anomalies of different organs (digestive tube, nervous system) have been noted and described. They are induced either by irradiation (x-ray doses from 1000-5000 R) or by being kept at 5°C, and aging beyond the time of diapause. The teratogenic effect seems to be proportional to the dose of radiation, at least for medium aging. Qualitatively, these anomalies do not vary as a function of the stage at which irradiation takes place (within the limits of stages D-F), nor of the dose. A spectrum of anomalies has been described as a function of the period of hibernation (which follows diapause and precedes irradiation). Several kinds of anomaly can be distinguished: those of the digestive system (tube) (types I-VI), those of the nervous system (VII-X) and "miscellaneous" (XI-XIII, which include effects on the labium, mandibles, and the silk gland). Various graphs are given, to illustrate the evolution of this anomaly spectrum as a function of hibernation. For certain anomalies irradiation is necessary, aging having a sensitizing action in some cases. Other anomalies occur as the result of extended conservation of the eggs in the cold, or following irradiation, regardless of the period of hibernation. Aging and x-rays can then have a comparable or a cumulative effect. Both irradiation and aging have a damaging effect on the physiology of the embryo. The mechanism of action is not understood.

- 1401 Lassota, Z. INTESTINAL DAMAGE AND WATER IMBALANCE IN GAMMA-IRRADIATION LARVAE OF *Bombyx mori*. Bull. Acad. pol. Sci. Cl. II Sér. Sci. biol. 14, 5 (1966) 293-296. (In English)

Larvae of the "warska" race of silkworm were irradiated 2-3 d after the 4th moult with single doses of 20, 65 or 200 kR of ^{60}Co γ -rays, and compared with controls. The only significant difference found in larval blood 1-2 d after irradiation was the abrupt decrease of the values estimated by the anthrone method observed in 200 kR irradiated larvae. The level of reducing substances determined by the Hagedorn-Jensen method remained unchanged in the blood of such larvae. The decrease in reducing substances found by both methods in 20 and 60 kR-treated larvae was noticeable only 5-6 d after irradiation, i.e. at a time when the body weight in both groups was substantially lower than in controls. The guts of such larvae were swollen and contained more liquid than normal ones. In the 200-kR-treated larvae examined 1-2 d after irradiation the gut tissue was very fragile. The radiosensitivity of insect gut may be explained in terms of mitotic death, since the degeneration and replacement of midgut cells is known to be very rapid. The inhibition of this renewal by irradiation would result in damage to the merocrine and holocrine secretion of digestive enzymes as well as in disturbance of peritrophic membrane formation, both processes depending upon the normally functioning midgut epithelium. The deteriorating digestion and resorption of food would be reflected in the blood composition and total weight of the animals, as observed in 25 and 65 kR-treated larvae. The acute effects of a 200 kR dose of γ -rays may be only partially due to the severe intestinal damage. The loss of water by evaporation from the body surface may contribute seriously to the rapid loss of body weight of the survivors. The inappetence following this dose restricted the amount of water taken up with mulberry leaves, and the severe damage to the intestine, as indicated by the fragility of gut tissues, prevented the digestion of food present in the gut.

- 1402 Nur, U. REVERSAL OF HETEROCHROMATIZATION AND THE ACTIVITY OF THE PATERNAL CHROMOSOME SET IN THE MALE MEALY BUG. Genetics 56, 3 Pt. 1 (1967) 375-389.

Planococcus citri (Risso), *Pseudococcus obscurus* Essig and *P. gahani* Green were used. In mealybugs (Coccoidea: Homoptera) with the lecanoid chromosome system, the haploid set of chromosomes which is contributed by the father becomes heterochromatic in male embryos. Cells in some of the male tissues lack the heterochromatic (H) set. This lack is shown to be the result of the reversal of heterochromatization, and the return of the H set to a euchromatic state. The types of cells in which this reversal takes place may vary from species to species, and the time of reversal of the H set may vary from tissue to tissue. The present study shows that the activities previously attributed to the H set can be explained by the activity of the paternal set following its return to a euchromatic state in some of the male tissues. Examination of several tissues of 3rd-instar males developing after 60 000 R paternal irradiation and hybrid males from the cross *P. obscurus* \times *P. gahani* indicated that developmental abnormalities occurred mostly in those tissues in which the H set had previously undergone reversal. The external morphology of males is determined by cells in which the paternal set is heterochromatic. The hybrid males resembled males of the maternal species in their external morphology, supplying additional evidence that the H set is genetically inactive.

See also:

- 1125 Sterilization of the female adult of *Nauphoeta cinerea*, (Blattoidea), by means of x-rays. (Caprotti, M. et al., 1963)
- 1130 Antennapedia (SS^{AnP}), an homeotic mutant of *Drosophila hydei* Sturtevant. (Gloor, H. et al., 1966)
- 1132 Sterilization of parasites of the ash tree. (Khvatova, L., 1965)
- 1294 Spermatogenesis in drones following irradiation of the young larvae with different amounts of x-rays. (Bischkopf, R., 1966)
- 1336 Ire Thèse. Etude du développement post-embryonnaire de l'ovaire chez *Ephestia kuehniella* Z. (Lepidoptera, Pyralidae). Effets des radiations ionisantes. (Baroughi-Bonab, H., 1965)
- 1357 Some effects of x-irradiation on larvae of *Galleria mellonella*. (Harshbarger, J. C. et al., 1966)
- 1377 Effect of sub-lethal gamma on eggs, early, intermediate, and last instar larvae of the Angoumois grain moth, *Sitotroga cerealella* Oliv. (Qureshi, Z. A. et al., 1966)

- 1388 Récentes expériences de radiobiologie sur Bombyx mori. (Teulade, P., 1966)
 1416 Observations on Drosophila given a high dose of protons. (Malich, C. W. et al., 1965)
 1451 Analysis of the combined effect of magnetic fields, temperature and radiation on development. (Amer, N. M. et al., 1965)
 1452 Results of biological experiments carried out under conditions of flight in ships vostok with participation of cosmonauts A. G. Nikolayev, P. R. Popovich, and V. F. Bykovsky. (Antipov, V. V. et al., 1964)

2.2.6. Senescence. Longevity. Fitness

- 1403 Abdul Matin, A. S. M. SUSCEPTIBILITY OF ADULT RICE WEEVIL, Sitophilus oryzae (L.) TO GAMMA RADIATION. p. 133-135 of "Proceedings of the Agricultural Symposium. Dacca, Pakistan, 13-14 May 1966". 1966, 166p.

An attempt was made to find the effects of γ -radiation from a ^{60}Co source on the adults of S. oryzae (L.). The weevils were exposed to doses of radiation of 5-100 kR. Doses of 10 kR or more caused 100% mortality within one month. (RAE-A 56:1968, ref. 871)

- 1404 Ayala, F. S. EVOLUTION OF FITNESS. I. IMPROVEMENT IN THE PRODUCTIVITY AND SIZE OF IRRADIATED POPULATIONS OF Drosophila serrata AND Drosophila birchii. Genetics 53 (1966) 883-895.

D. serrata and D. birchii flies were x-irradiated with 2000 R per generation for three generations. Two experimental populations of irradiated flies and one control population were started for each species at 25°C. After 51 d a sample of 300 flies was taken from each population to start 6 other populations at 19°C. The populations were maintained under conditions of intense competition, both among the larvae and among the adults. At 25°C, the irradiated populations of D. serrata decreased in size and in productivity during the first few weeks of the experiment. From the 6th to the 15th week they increased greatly in size and in productivity, and maintained their superiorities until the end of the experiment. The equilibrium levels were 50 or more % higher than that of the control. At 19°C the two irradiated populations of D. serrata were also superior to the control in productivity and in size from the 13th week until the end of the experiment. The two irradiated populations of D. birchii at 25°C increased in size steadily from the 5th week until the end of the experiment, exceeding the control population in productivity and in size by more than 50%. At 19°C there is no marked difference between the control and the irradiated population. - Regression analysis shows that there has been a continuous differential increase in the fitness of the irradiated populations of D. serrata at both temperatures, and in those of D. birchii at 25°C. It is concluded that an increase in genetic variability produced by high frequency radiation may, with natural selection, result in an increase in the rate of evolution of the population, and finally of the fitness of the population in new environments. (Auth. summary)

- 1405 Baxter, R. C., Blair, H. A. KINETICS OF AGING AS REVEALED BY x-RAY-DOSE-LETHALITY RELATIONS IN Drosophila. Radiat. Res. 30, 1 (1967) 48-70.

Median ages of death following sublethal doses and median lethal doses for acute lethality after 1 d were determined in relation to age of exposure, throughout normal life span, to 100-kV x-rays in D. melanogaster imagoes of both sexes. Both sets of data provide continuously decreasing functions of dose, D, with respect to age. Consequently D may be used as a single valued measure of age, and variations of functions of D with respect to age as rates of aging. Rates of aging as derived from either set of data are faster in the male than in the female and are inversely proportional to normal survival times, about 44 and 51 d, respectively, at the temperature used, 25°C. It is concluded that normal life span and rate of aging are fully determined on eclosion and are realized in the absence of unfavourable conditions. The injuries leading to acute and delayed death appear to affect different mechanisms, the former being wholly recoverable and not additive to the latter, which is irreparable at least in part. Doses below a certain level appear not to shorten life span, and extension of life span by exposure was not observed. (Auth.)

- 1406 Baxter, R. C., Blair, H. A. AGE OF DEATH IN *Drosophila* FOLLOWING SUBLETHAL EXPOSURE TO GAMMA RADIATION. Radiat. Res. **31**, 2 (1967) 287-303.
- Ages of death following exposure to ^{60}Co γ -radiation were studied for doses permitting survival of at least several days in wild-type *D. melanogaster* imagoes of both sexes. Lethal injury, represented by $D + 0.003D^2$, where D is the radiation dose, is a linear function of the reciprocal of the age of death. The equations for the two sexes differ only in the slope constants, which are proportional to the normal survival times, about 44 and 51 d, respectively, for male and female at 25°C. Average or median life shortening in the two sexes is not equal for a given dose but is the same fraction of normal survival time. Life shortening for various deciles with respect to time of death tends to be equal for the female, but for the male the lives of those dying early are shortened relatively less than the lives of those dying late. Thus the responses of male and female populations are different. In accord with prediction from higher doses, doses below a certain value appear not to affect life span. (Auth.)
- * (0 - 180 kR)
- 1407 Baxter, R. C., Blair, H. A. AGE OF DEATH IN *Drosophila* FOLLOWING SUBLETHAL EXPOSURES TO γ -RADIATION. p. 33-34 in "Brief Description of Research Published or Accepted for Publication During 1966". Annual Report UR-48-748, Rochester Univ., N. Y. Atomic Energy Project. Neuman, W. F., Rothstein, A., Eds. 1 Apr. 1967, 253p.
- See 1406.
- 1408 Clark, A. M., Cole, K. W. THE EFFECTS OF IONIZING RADIATION ON THE LONGEVITY OF PLOIDY TYPES IN THE WASP *Mormoniella vitripennis*. Expl Geront. **2** (1967) 89-95.
- The adult life span of *M. vitripennis* is influenced by the kinds of genes present rather than by the number of sets of chromosomes. Diploid males were more resistant than haploid males to ionizing irradiation. Diploid and triploid females were equal in radiation sensitivity. The data reported did not support the somatic mutation theory of aging and indicated further that the types of injury leading to natural aging were different from those leading to radioinduced decrease in life span. Although the data indicate that some type of nuclear injury is induced by ionizing radiation, the precise nature of the injury is still obscure. This is presumably because of the many physiological events that occur between initial radioinduced injury and death in a multicellular organism. (NSA 21:1967, 41509)
- 1409 Clark, A. M., Osmun, D. E. ADULT LIFE SPAN IN *Habrobracon serinopae* AFTER x-IRRADIATION DURING EARLY DEVELOPMENT. Nature, Lond. **214** (1967) 717-718.
- H. serinopae* females, homozygous for the recessive mutant veinless wings (vl), were mated to veined (+) males. From the fertilized eggs, diploid progeny (+/vl, male and female), and from the unfertilized eggs, haploid males (vl) were obtained. A comparison of development and adult life span for these three types was made after x-irradiation during cleavage. The dose rate was 300 R/min of 75 kVp x-rays. The wasps were reared at 30°C. There was a decrease in egg hatchability with increasing dose as shown by the larva/egg ratios. Those embryos that became larvae showed no further injurious effects as shown by the pupa/larva and adult/pupa ratios between the control and irradiated groups. Adults showed no structural abnormalities. There was no consistent decrease in adult life span with increasing dose. Injury from irradiation was manifested at cleavage or not at all and haploid types were more radio-resistant than diploids.
- 1410 Erdman, H. E. MODIFICATION OF FITNESS IN SPECIES AND STRAINS OF FLOUR BEETLES DUE TO x-RAY AND DDT. Ecology **47**, 6 (1966) 1066-1072.
- Studies were designed to determine the early effects of DDT and x-radiation, singly and in combination, on mortality and productivity of flour beetle species and strains (*Tribolium confusum* Duval "Chicago standard" and *T. castaneum* Herbst "Brazil cl" and "Sooty"). Five replicate populations each containing ten pairs of virgin beetles x-rayed with 0, 1, 2 or 4 kR of x-rays (250 kVp, 30 mA, 0.25 mm Cu + 1.0 mm Al filtration, 0.86 mm Cu HVL and 2.5 inches between target and subjects produced 1 kR/min) were cultured under standard conditions in food containing 0, 5, 10, 20 or 50 ppm DDT. Every two weeks for six weeks parental mortality was recorded and living adults were placed on fresh comparable food. The old food was reincubated and F_1 adult biomass and numbers were the

measures of productivity. Parental mortality was (1) unaffected by x-rays, (2) increased for "Brazil cl" at 50 ppm DDT, and (3) greater for females than males but unrelated to radiation or insecticide. Productivity measurements decreased with increasing x-ray or DDT. Productivity of T. confusum was, in general, more radiation-sensitive than that of T. castaneum strains, whereas both T. castaneum strains were more DDT-sensitive than was T. confusum. Radiation of 4 kR was almost sterilizing to T. confusum; of T. castaneum strain "Brazil cl" left no F₁ at 50 ppm DDT. Proportions of lethals due to x-ray or DDT were considered genetic dominants and used to quantify the relationship between radiation and insecticide in combination. Observed lethality simulated that expected for genetic dominant lethal effects when "Chicago standard" and "Brazil cl" were stressed with x-ray plus DDT. In "sooty", observed lethality was consistently lower than that predicted on the assumption of dominant lethal effects; i. e. productivity was less adversely affected when both stresses were applied than that expected by multiplying the effects of singly stressed populations. Within a species "sooty" populations showed more lethality due to x-rays than did "Brazil cl" populations; DDT had the opposite effect. (From abstr.)

- 1411 Hungate, F.P. RESPONSE OF INSECTS TO RADIATION. p. 2 of "Pacific Northwest Laboratory Monthly Activities Report, March 1966, on AEC Division of Biology and Medicine Programs". BNWL-247, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Apr. 1966, 17p.
In an earlier experiment with flour beetles, the black-body colour mutant, Sooty, appeared more DDT-resistant than the wild strain, Brazil cl, and was reproductively more fit when stressed with DDT and x-irradiation. To verify this observation and to determine whether the resistance was clearly associated with body colour, a series of new tests were initiated making use of specific crosses of the Sooty mutant with other strains. Data are not yet available.
- 1412 Khakimova, R.K. EFFECT OF IONIZING RADIATION ON THE SURVIVAL RATE OF Agrotis segetum Schiff, AND ITS ABILITY TO BREED. p. 255-257 of "Voprosy biologii i kraevoi meditsiny vol. 4 (Problems of Biology and Regional Medicine). Tashkent, Akad. NAUK Uz. SSR, 1963". Translation: Referat, Zh. Biol. (1964) 12E73.
Larvae and pupae of the cutworm, A. segetum were irradiated in a γ -unit, using ⁶⁰Co as the source with a dose rate of 115 R/sec. After irradiation with doses of 1000-15000 R, some of the larvae pupated, but the moths did not fly. After larvae had been irradiated with dosages less than 1000 R and pupae with 5000 - 7000 R, moths flew but did not lay eggs. Mating of normal females with irradiated males resulted in infertile egg masses because of the males' sterility. The author suggests that ionizing radiation be used to sterilise males and that these males then be released. (BA)
- 1413 Lamb, M.J., Maynard Smith, J. RADIATION AND AGEING IN INSECTS. Expl Geront. 1 (1964) 11-20.
- 1414 Lamb, M.J. THE EFFECTS OF x-IRRADIATION ON THE LONGEVITY OF TRIPLOID AND DIPLOID FEMALE Drosophila melanogaster. Expl Geront. 1 (1965) 181-187.
- 1415 Lamb, M.J. THE RELATIONSHIP BETWEEN AGE AT IRRADIATION AND LIFE-SHORTENING IN ADULT Drosophila. p. 163-174 of "Radiation & Ageing". Lindop, P.J., Sacher, G.A., Eds. London, England, Taylor & Francis, 1968.
All the work was done on adult flies given single doses of x-rays or ⁶⁰Co γ -rays. The results of experiments using young flies (2-6 d after emergence from the pupal stage) are outlined. With older flies it was found that the percentage reduction in the further expectation of life per unit dose was constant over part of the age and dose range, but there was some evidence that flies irradiated with high doses showed an increase in sensitivity with age. D. melanogaster and D. subobscura were used. The hypotheses that radiation accelerates the natural aging process or causes precocious aging are discussed and it is concluded that the data are more compatible with the accelerated aging hypothesis. It is suggested that the increase in sensitivity with increasing age at irradiation with high doses can be explained if irradiation causes two types of injury, one of which occurs immediately after irradiation and can be repaired, and one which is irreparable and has a delayed effect.
- 1416 Malich, C.W., Binnard, R. OBSERVATIONS ON Drosophila GIVEN A HIGH DOSE OF PROTONS. Drosoph. Inf. Serv. 40 (1965) 73.

The flies were very lethargic after the irradiation. It is extremely unlikely that the irradiation was so non-uniform that any of the flies escaped the high dose of 30 000 rad. The proton beam was scattered by 1/8" of carbon to produce a nearly constant flux over a circle of diameter 1 1/2", and only the central 1" disk was used. In addition, the beam was oscillated rapidly (several hundred cps) to smooth out any minute irregularities. The dose delivered corresponds to approx. 1260 protons per square micron, so that each chromosome should have received multiple hits. The median life of the flies after this dose of protons was shorter than normal, half dying in 18 d compared to the shortest period of 21 d observed for virgins under similar crowded conditions. The food was rather damp and since this dumpy strain gets stuck easily, the environmental conditions may have affected the lifetime more than the radiation. Consequently it is only concluded from this series that the sterilising effect was virtually complete. Degenerative effects associated with high radiation doses were evident in five flies sacrificed for histological studies. Two flies dissected 17 d after treatment had degenerate ovaries and their oögonia were vacuolated and necrotic. Live motile sperm were seen in the seminal receptacle of the fly taken from a vial with mates, while no sperm were found in one which had been without mates for a week. The three flies which lived 32 d were dissected, and showed more advanced degeneration of the ovaries and the oögonia than the younger pair. No sperm were seen in these flies, which had been without mates for 10 d. Further work with lower doses has suggested other non-reparable damage produced by protons, and some biochemical effects on the brain of adults are being investigated. (From DIS)

- 1417 Muller, H.J. MECHANISMS OF LIFE-SPAN SHORTENING. p. 235-245 of "Cellular Basis and Aetiology of Late Somatic Effects of Ionizing Radiation". London, 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 and inactivation, or segregation, even though it does involve the point-wise 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, radioinduced 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 radioinduced chromosome breaks. It is believed that the same basic mechanism accounts also for most of the acute damage that is produced by radiation. (Auth.)

- 1418 Po-Chedley, D.S. THE EFFECT OF x-RAYS AND VISIBLE LIGHT UPON THE ONE DAY OLD MEAL WORM, *Tenebrio molitor*. EMBRYO. p. 179 of "Third International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966, 263p". Abstr. 710. Also published as AED-Conf-226-121, Gmelin-Institut fuer Anorganische Chemie und Grenzgebiete, Frankfurt am Main (West Germany). 1966, 2p.

An attempt is made to examine the role of white light with respect to (a) the reported survival curve of x-irradiated meal worm; (b) a consideration of the possibility of white light as a photo-reactivating agent for the assumed resistance/recovery phenomena associated with the x-irradiated organisms; (c) obtaining greater detail of the embryological morphology and developmental characteristics. - The dose-effect results for the x-irradiated and visible light stimulated embryos are generally similar in that the survival curves are sigmoid. LD 50/8 for x-rays was 150 R, the visible light stimulus 1000 mW/cm². When, however, the x-irradiated embryos were counter-exposed to visible light an increase in survival time was noted for the embryos. (Work on the order of administering stimuli is being continued and their possible influence on the high-reserve titre of free amino acids.)

- 1419 Ratty, F.J. ESTIMATION OF SENSITIVITY OF *Drosophila melanogaster* TO RADIATION USING A THIRD-ORDER ROTABLE DESIGN. Three Year Comprehensive Report. SAN-529-3, San Diego State Coll., Calif. 1966, 24p.

Results are reported from a series of studies on the relation between survival of 1st-instar larvae of *D. melanogaster* and dose and time of x-radiation exposure. Radiosensitivity was estimated in 3 lines of inbred flies and the hybrids formed between them. Data are included on the correlation of

larvae survival to x-radiation with chromosome puffing pattern; the relation between age and non-disjunction in irradiated parents; mutation induction in *Drosophila* cultured on aged and non-aged medium supplemented with DNA irradiated with 150 kR; the mutability of loci in an X-chromosome duplication; and mutation induction in *Drosophila* cultured on a medium exposed to 150, 500, or 3000 kR γ -radiation. (NSA 20:1966, 31036)

- 1420 Ratty, F. J., Lovellette, E. J. CHROMOSOME SUBSTITUTION AND RADIOSENSITIVITY IN *Drosophila melanogaster*. *Radiat. Res.* 30 (1967) 825-831.

The survival of 1st-instar random-bred, inbred, and hybrid larvae formed by reciprocal crosses, after 1200 R of acute x-irradiation has been evaluated. The results show that survival of the irradiated lines is lower than that of the control larvae, while that of the inbred lines is lower in all irradiated and control groups. The lack of differences between the irradiated random and the irradiated hybrid lines is interpreted to mean that genetic variability is probably not important at this dose level and that detrimental genes in the hybrid genotypes are recessive. An interaction effect between radiation and inbreeding is noted, and it is suggested that a maternal effect could play only a minor role in the determination of radioresistance in these experiments. (Auth.)

- 1421 Rockstein, M. DIFFERENTIAL GERONTOMIMETIC EFFECTS OF x-IRRADIATION TO PUPAE OF MALE AND FEMALE HOUSE FLIES. p. 175-178 of "Radiation & Ageing". Lindop, P. J., Sacher, G. A., Eds. London, England, Taylor & Francis. 1966.

Irradiation of 36-48 h old pupae causes a significant change in emergence and longevity only at > 10 krad. Data were obtained for dosages of 10, 15, 20 and 30 krad, at 2 krad/min. The effects of x-irradiation on female fly longevity was one of progressive shift of the survival curve to the left. Accompanying this is a continuing diminution in mean lifespan over the entire dosage range, and a quite marked decrease in max. lifespan after 20 krad and 30 krad. The effect on longevity of the emerged male is much more complex: the average lifespan increases for 10 and 15 krad; is equal to the control at 20 krad; and declines significantly on exposing pupae to 30 krad. A rapid increase in male mortality rate occurred when wing loss was at a maximum. After irradiation of pupae with between 2 and 10 krad there appears to be no increase in wing retention at time of death, but at 20 and 30 krad there is a successively greater increase (a virtual doubling of wing retention per 10 krad) leading to virtually 100% retention at 30 krad. In females, wing retention is not markedly affected up to 10 krad but there is a gradual increase thereafter, with complete wing retention at 30 krad. This motor ability of flight represents an amelioration of a senescence phenomenon resulting from irradiation at the pupal stage.

- 1422 Rockstein, M., Bhatnagar, P. L., Dauer, M. DIFFERENTIAL GERONTOMIMETIC EFFECTS OF PUPAL x-IRRADIATION ON ADULT MALE AND FEMALE HOUSE FLIES. "Colloquium on Radiation and Ageing. Semmering, Austria, 23 - 24 Jun. 1966". AED-Conf-212-1, Gmelin-Institut fuer Anorganische Chemie und Grenzgebiete, Frankfurt am Main (West Germany). 1966, 2p.

Batches of 2500-3000 pupae of *Musca domestica* L. were exposed to single doses of x-rays from 2000 - 30000 rad, such as to give a dose rate of 2000 rad/min. Emergence was then studied under constant temperature, humidity and lighting conditions. Following irradiation up to 10000 rad, % emergence was only reduced slightly; at 15000 rad by 20%; at 30000 rad by 80%. The male: female ratio for emergence increased progressively from 1:1 to 1:33 at 20000 and 30000 rad. For doses of 10000 and 15000 rad the mean life span of males was increased by > 25%, while in females the mean life span decreased progressively with increasing x-ray dosage to a life span < 50% of the control, at 30000 rad. The sex differential normally favouring the female is minimized by x-irradiation, the mean life spans of both sexes being virtually identical at the dose levels used.

- 1423 Shilenko, B. V. GENETICS OF A HETEROZYGOUS POPULATION OF *Drosophila melanogaster*. I. VIABILITY AND POPULATION FITNESS OF HETEROZYGOUS CyLcn/cn110 CARRIER OF IRRADIATED CHROMOSOME cn110. *Genetika* No. 6 (1965) 104-109. (In Russian)

A new method of determining the heterozygous effect of radiation induced mutations is described. Normal IIrd chromosome of a male belonging to a balanced lethal population CyLcn/+^{cn}110 was marked with gene cn and then subjected to irradiation. Heterozygous individuals possessing normal chromosomes (marked cn 110) have been paired with individuals bearing non-marked chromosomes (+^{cn}110). Two crosses were carried out. The 1st cross CyLcn/cn110 x CyLcn/+^{cn}110 (chromosomes

cn110 being irradiated) represents the basis of the experimental population, while the 2nd cross $CyLcn/cn110 \times CyLcn/+^{cn110}$ (chromosomes cn10 being non-irradiated) represent the basis of the control population. It was shown that the proportion of the irradiated chromosomes of the experimental population is the same as that of the nonirradiated chromosome of the control population. Viability variation of the irradiated chromosome in F_1 individuals $CyLcn/cn110$ slightly exceeds that of nonirradiated cultures. The decreased rate of the proportion $CyLcn/cn110$ in generations of both the experimental and the control population is the same. Proportion of marked genotypes in crowded cultures exceeds that of uncrowded ones. (Auth.)

- 1424 Sonnenblick, B. P., Rockford, D. A POSITIVE RELATIONSHIP BETWEEN LONGEVITY AND RADIO-RESISTANCE IN *Drosophila melanogaster*. *Genetics* 50, 2 (1964) 287-288.

Materials used were a vigorous Canton-S strain and a strain $X^{C2} \gamma B$ and γf attached-X with ring-X males. 1- to 3-d imagoes were exposed to ^{60}Co , the dose rate 1500 R/h for 22 h/d. Doses were 0 R, 33 kR, 66 kR, 93 kR and 120 kR. Vials were maintained at 17°C, five pairs of flies per vial, with periodic changes of media and regular inspection of test organisms. In two experiments, the life spans of almost 1300 organisms were recorded. No larvae were ever noted in vials with irradiated imagoes. - Data permit the following comments: (a) mean life span of the untreated Canton-S strain is significantly lower than that of the mutant strain, in both sexes; (b) this relationship is repeated in the 33 kR samples and with females given 66 kR; (c) mutant males given 66 kR twice had a slightly higher average life span than did their + counterparts; (d) at the two highest doses employed, radio-resistance of both strains becomes essentially comparable; (e) excluding controls of both strains, male longevity in all exposed samples was lower than similarly treated females; (f) with care, appreciable numbers of control flies will live more than four months, a rare few over five months. - A radio-sensitive genetic complex in embryonic tissues may thus be radioresistant, to a certain degree of stress, in the nondividing tissues of the adult, with continuance of function and unexpected longevity. Radioresistance, utilizing life span as the parameter of choice, parallels longevity of untreated populations under our conditions and up to a 66 kR dose. Dose rate, repair of chromosomal breakage, and the comparative embryonal and imaginal tissue oxygen tensions are certainly other factors to be considered in evaluating results such as these. (Abstr.)

- 1425 Sonnenblick, B. P., Gartner, L. P. LIFESPAN STUDIES WITH STRAINS OF GAMMA-IRRADIATED *Drosophila* ADULTS. *Radiat. Res.* 31, 3 (1967) 612. Abstr. Eb-3. Presented at "15th Annual Meeting of the Radiation Research Society. San Juan, Puerto Rico, 7-11 May 1967".

The *Drosophila* adult soma is an essential non-reproducing system, except possibly for haemocytes and certain gut cells. We utilize a Canton wildtype strain and occasionally another strain with mutant phenotype containing ring-X-chromosome males and attached-X females, karyotypes reportedly radiosensitive during developmental stages with much mitotic activity. Some modifications of regular culture conditions at 19°C are used which, compared with our previous similar studies, result in marked increase in mean lifespan and in extension of range of individual longevity. Young adults have been exposed to ^{60}Co at 25 and 9000 R/min and to doses of 0, 33, 66, 93, and 120 kR. Germ cells are disastrously affected, with few eggs laid and no development noted. Some comments are: (a) there is evidence of a dose rate effect; (b) after 33 kR at the low but not high dose rate, there is no significant difference between lifespan averages of exposed and control samples, evidencing recuperation; (c) non-irradiated females usually but not invariably have a higher average longevity than male counterparts, but in all 24 irradiation tests with both strains the mean female lifespan always was greater; (d) after 120 kR at low dose rate in both strains, some 40% females survive when all males have died; (e) a male was the last day survivor in 8 of 10 control trials but after varied exposures a female lived longest 23 of 24 possible times; (f) a karyotype and genome considered radiosensitive in preadult stages, noted above, may show a surprising longevity with adult carriers. Assuming comparable nuclear radiosensitivity in fixed, nondividing cells and in cells capable of reproduction, questions arise as to the significance of chromosome breakage with and without rejoining in the continued functioning of the fixed cells, or the significance, if any, of the haploid X-chromosome condition and the male response to stress when there is a low or high diploid chromosome number, and extranuclear responses in nonreproducing cells with time, such as possible outer membrane permeability modification. (Abstr.)

See also:

- 507 Radiation ecology. (Auerbach, S.I., 1967)
- 1120 Application of radioactive isotopes to the investigation of methods for the biological control of pests. IV. The effects of γ -radiation on C. capitata when the dose of irradiation is fractionated. (Arroyo, M. et al., 1965)
- 1141 Laboratory studies to sterilize the boll weevil with radiation. (Mayer, M.S. et al., 1966)
- 1149 Radiation sterilization of sugar-cane leafhoppers of the family Delphacidae. (Shipp, E. et al., 1966)
- 1195 Studies on the experimental population of Drosophila melanogaster raised on irradiated banana diet. (Hossain, M.M. et al., 1966)
- 1196 ibid (1967)
- 1282 Interactions of oxygen at high pressure and radiation in Drosophila. (Thomas, J.J., Jr. et al., 1966)
- 1302 Effects of gamma radiation on fertility, mating, and longevity of males of the oriental fruit moth, Grapholitha molesta (Lepidoptera: Tortricidae). (George, J. A., 1967)
- 1313 The effects of x-irradiation on the survival of Liponyssus bacoti and on its susceptibility to infection with Litomosoides carinii. (Quraishi, M. A. H. et al., 1966)
- 1338 Observations on the behaviour of pupae of Hyphantria cunea Drury irradiated with γ -radiation. (Bogyleanu, G., 1965)
- 1340 Study on the sterilization and radiosensitivity of Chrysomela decemlineata Say by means of radioisotopes. (Cavalloro, R. et al., 1966/67)
- 1345 Influence of pupal age on sensitivity to radiation. (Ducoff, H. S. et al., 1966)
- 1346 Changes with age in the radiosensitivity of adult flour beetles. (Ducoff, H. S., 1967)
- 1347 On the effect of ^{60}Co gamma radiation on the desert locust. (El-Miniawi, S. F. et al., 1964)
- 1348 Metamorphic and adult longevity modifications due to x-irradiation of pupal flour beetles, Tribolium confusum (Jacquelin duVal). (Erdman, H. E., 1966)
- 1349 Effects of x-rays on metamorphosis and adult life span of flour beetles. (Erdman, H. E., 1966)
- 1351 Effects on flour beetles irradiated as pupae. (Erdman, H. E., 1967)
- 1356 The effect of gamma irradiation on the Varo race of Bombyx mori L. II. Irradiation of eggs in the early and late embryonic stages. (Gubicza, A. et al., 1964)
- 1358 Susceptibility of various stages of Drosophila melanogaster to gamma radiation. (Henneberry, T. J., 1967)
- 1380 x-Irradiation and wing retention in the common house fly, Musca domestica L. (Rockstein, M. et al., 1966)
- 1381 Further studies on the effect of x-irradiation on the house fly, Musca domestica L. (Rockstein, M. et al., 1967)
- 1388 Récentes expériences de radiobiologie sur Bombyx mori. (Teulade, P., 1966)
- 1436 Study of the irradiation tolerance of some destructive storehouse insects and technical and economic aspects of insect destruction by irradiation. (Farkas, J., 1965)
- 1454 Absence of "oxygen after-effects" in Calandra granaria during hibernation induced with low temperature. (Bychkovskaya, I. B. et al., 1965)
- 1456 The combined effects of irradiation, vibration, and centrifugation on braconid fecundity, fertility and life span. (Grosch, D. S., 1966)
- 1457 Utilization of Habrobracon and Artemia as experimental materials in bioastronautic studies. Status Report, Jan. - June 1965. (Grosch, D. S., 1965)
- 1459 Effect of exposure of irradiated pupae of the Mediterranean fruit fly, C. capitata, to high temperatures. (Katiyar, K. P. et al., 1967)
- 1461 Influence of post-treatment humidity on the irradiated rice weevil adult, Sitophilus zeamais Motschulsky (Coleoptera: Curculionidae). (Kumagai, M., 1967)
- 1479 The effects of gamma radiation on the biology and behaviour of adult Ips confusus (LeConte) (Coleoptera: Scolytidae). (Wood, D. L. et al., 1966)
- 1487 Changes in quantitative traits of Tribolium under irradiation and selection. (Bartlett, A. C. et al., 1966)
- 1499 Effects of radiation induced mutations on viability coefficients in Drosophila. (Falk, R., 1966)
- 1500 Fitness of heterozygotes for irradiated chromosomes in Drosophila. (Falk, R., 1967)
- 1514 An estimate of the effects of fallout beta radiation on insects and associated invertebrates. (Teresi, J. D. et al., 1966)

- 1520 Evolution of fitness. III. Improvement of fitness in irradiated populations of Drosophila serrata. (Ayala, F.J., 1967)
- 1583 Studies on the eradication of Anopheles pharoensis Theobald by the sterile-male technique using cobalt-60. I. Biological effects of gamma radiation on the different developmental stages. (Abdel-Malek, A.A. et al., 1966)
- 1584 Studies on the eradication of Anopheles pharoensis by the sterile-male technique using cobalt-60. III. Determination of the sterile dose and its biological effects on different characters related to "fitness" components. (Abdel-Malek, A.A. et al., 1967)
- 1593 Control of fruit flies Dacus zonatus Saunders by gamma-rays. (Huque, H. et al., 1967)
- 1608 Study of the biology, breeding and sterilisation of the cabbage fly, Phorbia brassicae Bouché, with special reference to its occurrence in radish cultures. (Riedel, M., 1967)
- 1618 Prospective use of radiation to control the hollyhock seed moth (Lepidoptera, Gelechiidae). (Azaryan, G.K. et al., 1965)
- 1620 Codling moth control. (Madsen, H.F. et al., 1967)
- 1657 Status of irradiation control of insects in grain. (Cornwell, P.B., 1966)
- 1662 Radiation disinfestation of grain and seeds. (Golumbic, C. et al., 1966)
- 1666 The Israel food irradiation programme and progress during 1964-1966. (Kahan, R.S. et al., 1966)
- 1668 Food irradiation research and pilot facilities in operation or planned in India. (Kumta, U.S. et al., 1966)
- 1699 Effects of gamma irradiation on the longevity and fertility of five species of stored-product insects. (Watters, F.L., 1966)

2.2.7. Lethal Effects

- 1426 Abdul Matin, A.S.M. SUSCEPTIBILITY OF ADULT RICE WEEVIL, Sitophilus oryzae (L.), TO GAMMA RADIATION. AECD/AG/15, Atomic Energy Centre, Dacca (Pakistan Agriculture Div.). Jan. 1966, 7p.

Weevils were exposed to dose from 5-100 kR. Within one week of irradiation, 100 kR and 80 kR produced mortalities of 100% and 95.2%, respectively, against only 4.8% for 5 kR. - LD₁₀₀/24 d was obtained with 10 kR and 15 kR. All doses > 5 kR produced 100% mortality within one month.

- 1427 Abdul Matin, A.S.M. SUSCEPTIBILITY OF ADULT RICE WEEVIL, Sitophilus oryzae (L.) TO GAMMA RADIATION. p. 133-135 of "Proceedings of the Agricultural Symposium. Dacca, Pakistan, 1966".

For abstract, see 1426.

- 1428 Bhuiya, A.D., Abdul Matin, A.S.M. THE SUSCEPTIBILITY OF THE RED FLOUR BEETLE, Tribolium castaneum (Hbst.) TO GAMMA RADIATION. AECD/AG/20, Atomic Energy Centre, Dacca (Pakistan). Mar. 1967, 11p.

The susceptibility of all developmental stages of T. castaneum was investigated. Almost complete kill was obtained as follows: for eggs with 9000 R, larvae 8000 R, pupae 20 000 R, and adults 25 000 R. A dose of 20 000 R may be considered the minimum effective dose for controlling T. castaneum, which still allows 8% survival of the sterilized adults.

- 1429 Bolukbasi, E.K. EFFECT OF TRITIATED THYMIDINE AND IRRADIATION ON THE MORTALITY OF ADULT Drosophila melanogaster LARVAE. CNAEM-32, Cekmece Nuclear Research Center, Istanbul (Turkey). 1965, 20p. (In English)

Several factors that might affect the increase in the mortality rate of adult D. melanogaster larvae when exposed to ionizing radiations have been studied. The application of tritiated thymidine and γ irradiation at different times to the same larvae caused a high but an additive mortality effect. The application of both irradiating agents to the larvae simultaneously caused a higher mortality rate which was even more than an additive one. An irradiated, tritiated thymidine-containing nutrient was found to be harmful for the larvae and seemed to be responsible for the increase in mortality level when both factors were applied to the larvae simultaneously. (CA 66: 1967, 73021e)

- 1430 Boontiam Disyam. RADIATION EFFECT ON RED FLOUR BEETLE (*Tribolium castaneum* Hbst.). p. 35-41 of "Insect Eradication by Irradiation, Bangkok, Thailand. 28-29 Jun. 1968". THAI. AEC-8, Office of Atomic Energy for Peace, Bangkok (Thailand).
- For eggs, LD 50 is ~1530 rad, LD 100/10 ~ 7500 rad; for larvae, ~2200 and 10 000 rad, respectively; for pupae, ~6200 and 30 000 rad, respectively. Dosages < 10 000 rad prolonged the pupal stage by 2 weeks. For adults, LD 50 ~62 000 rad, LD 100/10 80 000 rad. Sterility was induced in males and females by 6000 rad, but further study is required.
- 1431 Bushland, R. C. RADIATION STERILIZATION OF THE BLACK BLOW FLY. *Bull. ent. Soc. Am.* 12 (1966) 289. Abstr. 272. Presented at "Portland Meeting, Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".
- Pupae of *Phormia regina* (Meigen) were irradiated with x-rays and γ -rays to establish sterilizing and lethal doses of radiation. Normal females mated with sterile males would not mate a second time. In cage tests, sterile males competed for mates about equally with normal males. (Abstr.)
- 1432 Bychkovskaya, I. B. DYNAMICS OF LETHAL RADIATION EFFECTS IN VARIOUS BIOLOGICAL SPECIES. *Radiobiologiya* 6 (1966) 39-45. (In Russian)
- A literature survey was made on the dynamics of radio-induced death of animals, with emphasis on the principles of radiation injury leading to the death of man and monkeys. Data are also included on the life expectancy of rodents, insects, crustaceans, and infusoria after exposure to various doses of α , β , γ , or x-radiation.
- 1433 Bychkovskaya, I. B., Ochinskaya, G. K. ON THE SYSTEM OF THE RESPONSE OF BIOLOGICAL OBJECTS TO IRRADIATION (EXPERIMENTS ON GRANARY WEEVILS). *Zool. Zh.* 45, 1 (1966) 134-137. (In Russian)
- In tests in the Soviet Union in which adults of *Sitophilus* (*Calandra*) *granarius* (L.) were exposed to x-rays at doses of 0.84-126 kR, the curve for mortality in 50 d was S-shaped, with little mortality at up to 2.95 kR, 20% at 3.35 kR, 80% at 5 kR, 98% at 6.88 kR and 100% at 8.7 kR and higher. When time to 50% mortality was considered, there was a stepwise effect, the periods being about 20 d for 4.2-29.5 kR, 13 d at 34-57.5 kR, and 9 d at higher doses up to 82.5 kR and beyond. Different doses perhaps damage vital systems of different radiosensitivity. (RAE-A 56: 1968, ref. 243)
- 1434 Ducoff, H. S., Bosma, G. C. ACUTE LETHALITY AFTER x-IRRADIATION OF *Tribolium confusum* ADULTS. *Entomologia exp. appl.* 10, 2 (1967) 153-165.
- Recently emerged adults of *T. confusum*, maintained at 30°C in flour-yeast medium, were exposed to x-ray doses between 8 and 75 kR at dose rates of 225 or 1000 R/min. In all cases, there was no significant mortality for about 10 d, and all deaths attributable to the irradiation occurred during the next 10 - 15 d; after the lower doses, many insects survived this critical period and then lived on for many months. The relative dose-independence of the survival-time of decedents suggested that there is a specific mode of death, e.g., an as-yet-unrecognized acute lethal syndrome. Irradiated beetles incubated at 22°C exhibited about twice as great a delay in the onset of mortality, and a mortality period with about twice the duration, as those at 30°C, suggesting the necessity of a sequence of metabolic events in the development of lethality. Beetles on a cornstarch diet were at least as radioresistant as beetles on flour yeast; beetles at 22°C were distinctly more sensitive than those kept at 30°C. Older beetles, exposed 4 or 10 months after emergence, showed progressive increases in acute radiosensitivity. Implications of these findings for radiobiological investigations on adult insects are discussed. (Auth.)
- 1435 Farkas, J. INVESTIGATIONS INTO THE RADIATION RESISTANCE OF *Tribolium confusum* (Duval) AND *Tyrophagus dimidiatus* (Hermann). *Acta microbiol. hung.* 12 (1964) 15-28. (In Hungarian)
- The radiosensitivity of flour beetles was examined in the dose range of 3-50 krad. Survival times correlated with 25 and 50% mortality (LT 25 and LT 50) were established as a function of radiation doses. The lethal effect of irradiation abruptly increased between doses 6 and 12 krad, while doses over 12 krad accelerated beetle mortality only to a small degree. To sterilize adults and eggs, radiation doses of 3 - 8 krad were needed. Eggs were highly sensitive to x-rays, but larval resis-

tance was not higher than that of adults. Therefore, products can be completely disinfested by lethal doses established for adults. Also examined was whether the survival of flour beetles is affected by relative humidity during breeding subsequent to radiation applied in doses of 25 krad. Differences of LT 50 values corresponding to different levels of relative humidity were examined by variance analysis and the results thus obtained showed that the mean survival times observed under 30 and 90% relative humidity were significantly shorter than values at 70% relative humidity. Deviations in the mean survival time, however, are practically not important because differences in LT 50 values remained always below 25%. Radiation resistance of mites (*T. dimidiatus*) was investigated in the dose range of 25 - 300 rad and proved to be higher than that of the beetles, but with doses of 25 - 50 krad the reproduction of mites could also be prevented. (NSA 20: 1966, 24874)

- 1436 Farkas, J. NÉHÁNY RAKTÁRI KÁRTEVŐ ROVAR ÉS ATKA SUGÁRTÜRESÉNEK VIZSGÁLATA ÉS A BESUGÁRZÁSOS ROVARTALANÍTÁS TECHNIKAI - GAZDASÁGI VONATKOZÁSAI. (Study of the irradiation tolerance of some destructive storehouse insects and technical and economic aspects of insect destruction by irradiation). *Élelm. Ipar.* 19, 7 (1965) 221-225. (In Hungarian, with Russian, German and English summaries).

Doses between 3 and 300 krad of γ -radiation were used. The species tested included Coleoptera - *Alphitobius diaperinus* (Panzer) (lesser mealworm) (a, f); *Latridius* (*Enicmus*) *minutus* L. (a, p, f), the salami pest; *Gnathocerus cornutus* F. (broad-horned flour beetle) (a, f); *Tenebrio molitor* L. (yellow mealworm) (f); *Tribolium confusum* DuVal (a, f); Lepidoptera - *Ephestia kühniella* Zell. (Mediterranean flour moth) (f); and among Acarina, Acaridae - *Tyrophagus longior* (Gerv.) (*dimidiatus* Hermann) (heterogeneous population). - Death from irradiation occurred only after exposure to several hundred krad. Lowering of life span was observed with smaller doses. The lethal effects increase spectacularly between 6 and 12 krad, a dose corresponding to complete sterilisation. Larvae have less radioresistance than adults, and irradiation can inhibit pupation. *Enicmus minutus* proved the most susceptible species. Adults irradiated at 10 krad died between 10-12 d. - Tests have shown that the dose must be increased 8-10 times if a 50% destruction of insects is to be achieved in 6 instead of 12 d. Larger doses are required with mites (*Tyrophagus dimidiatus*); 50, 100 and 200 krad caused 50% reduction of the population after 27, 19 and 2½ d, respectively, and development of the mites was arrested by a dose of 50 krad even under favourable environmental conditions. The radiation sources used were either accelerators or radioisotopes with a long half-life. The advantages of irradiation as a method of disinfestation reside in the fact that complete destruction of the insect population can be achieved with the lethal doses, and eggs have proved very sensitive to radiation. No side effects in the food result from irradiation: no changes in the chemical composition have been observed, and no health risks are involved. In the USA, mobile radiation sources have proved very convenient for seasonal use. The method is very economical; the costs decrease from year to year. It is much cheaper than chemical methods of disinfestation.

- 1437 Farkas, J. INVESTIGATIONS INTO THE RADIATION RESISTANCE OF THE *Tribolium confusum* (DuVal) AND *Tyrophagus dimidiatus* (Hermann). *Acta biol.*, Szeged. 16 (1966) 207-215. (In Hungarian)

Radioresistance of flour beetles was examined in the dose range 3 - 50 krad. Survival times correlated with 25 and 50% mortality were established as a function of radiation doses. The lethal effect of irradiation increased between the doses 6 and 12 krad abruptly, while doses over 12 krad raised the speed of beetle mortality only to a small degree. To sterilise adults and eggs radiation doses of 3 - 6 krad were needed. Accordingly, insect eggs resistant to eradication by gas are highly sensitive to x-rays. Radiation resistance of larvae is not higher than that of adults either; therefore products can be perfectly disinfested by lethal doses established for adults. It was also examined, whether the survival of flour beetles was affected or not by relative humidity prevailing in after-breeding subsequent to radiation applied in doses of 25 krad. Differences of LT 50 values belonging to different levels of relative humidity were examined by variance analysis and the results thus obtained showed that the mean survival times observed under 30 and 90% relative humidity and corrected with the mortality rate of control populations were significantly shorter than values belonging to 70% relative humidity. Deviations in the mean survival time, however, are practically not important, because differences in LT 50 values remained always below 25%. Radiation resistance of mites was investigated in the dose range of 25 - 300 krad and proved to be higher than that of beetles, but with doses of 25 - 50 krad the reproduction of mites could also be inhibited. (Auth.)

- 1438 Finsinger, F. X. ABTÖTUNGS- UND MUTATIONS-RATEN NACH RÖNTGENBESTRAHLUNG FRISCH ABGELEGTER *Drosophila*-EIER IN VERSCHIEDENEN SAUERSTOFFKONZENTRATIONEN. (Lethal and mutation rates in newly laid x-irradiated *Drosophila* eggs at different oxygen concentrations.) *Vjschr. naturf. Ges. Zürich* 109 (1964) 175-195. (In German)
- Eggs of *D. melanogaster* that were 10 - 20 min old were irradiated in N/O mixtures with 1000 R of 50-keV x-rays. The N/O mixtures contained 0, 2, 4, 8, 10, 21, or 100% O₂. Embryonic mortality, postembryonic mortality, and the rate of recessive sex-linked lethal mutations were studied. The rates of all three effects increased in gas mixtures that contained from 0 - 10% O₂, but remained almost constant in atmospheres that contained from 10 - 100% O₂. The increased rates of embryonic mortality and lethal mutations observed in the O atmospheres, which reflected the ratio of the effect after irradiation in air to the effect after irradiation in N₂, amounted to 2.4. The analogous ratio for postembryonic mortality was lower. It was possible to show that various radiation effects that were induced within the same experiment, in spite of the same dose dependency, the same dependence on the O concentration, and the same ratio of increase due to the O concentration, were not caused by the same primary effects. (NSA 21; 1967, 22706)
- 1439 Flint, H. M., Bibow, W. R., Lahren, C. K. RADIATION STUDIES WITH THE BOLL WEEVIL: LETHAL EFFECTS ON LARVAE, PUPAE, AND ADULTS; MALE STERILITY AND DOSE FRACTIONATION. *J. econ. Ent.* 59, 5 (1966) 1249-55.
- Larvae, pupae, and adult weevils are very sensitive to x-rays, as measured by adult survival three weeks after irradiation. Adult survival of 50-70% three weeks after treatment was considered the minimum acceptable. Doses of x-rays that met this criterion were 1200 R for last-instar larvae, 2400 R for late-stage pupae, and about 3200 R for adults. In adult weevils, mortality occurred about 7-14 d after irradiation, and the death rate did not increase when doses were increased from about 3200 - 15 000 R. Male weevils were 90 and 99% sterilised by doses of about 7500 and 9000 R, respectively. No sterilised male lived more than three weeks, and no increase in fertility occurred. In a test with mixed populations of adults irradiated with doses of as much as 4800 R, a significant increase in fertility occurred during the three week test period, but 5 d after doses of 4000 or more roentgens, egg production was almost eliminated. No increased survival occurred when 8000 R were administered in four fractions of 2000 R each to adults at intervals between fractions of as much as 48 h. Both the lethal and sterilising effects of x-rays were reduced when weevils in the larval, pupal, and adult stages were sequentially irradiated with various fractionated doses. Dose fractionation is not promising as a means of producing a sterile and viable weevil. (Auth.)
- 1440 Hossain, M., Hossain, M. M., Rahman, R. LABORATORY REARING AND SUSCEPTIBILITY OF THE CONFUSED FLOUR BEETLE (ADULT) TO GAMMA RADIATION. AECD-RB-6, Atomic Energy Centre Dacca (Pakistan). Jan. 1967, 12p.
- In the course of studying adult susceptibility of *Tribolium confusum* Duv. the species was mass-reared and its life history studied. Milled flour at 28±2°C and 80±5% R.H. was fed. The duration of each stage in the life cycle was observed; dispersion in growth rate was found to be maximal in the embryonic stage and minimal in the larval stages. Adults of the same age were exposed to doses up to 25 kR to study mortality. 16-25 kR gave an LD 100/13 (d).
- 1441 Hunter-Jones, P., Haskell, P. T. OBSERVATION ON THE EFFECTS OF γ -RADIATION ON EGGS OF THE DESERT LOCUST, *Schistocerca gregaria* (Forsk.) *Bull. ent. Res.* 56, 4 (1966) 725-735.
- The following is virtually the authors' summary. It has been suggested that nuclear radiation might be used for locust control, but insufficient knowledge has hitherto been available to decide whether such a measure is feasible. The results of laboratory experiments on the effect of γ -radiation on eggs of *S. gregaria* (Forsk.) are described. After a single dose of γ -radiation, the resulting mortality among the eggs was correlated with the size of the dose received and the age of the egg at the time of irradiation. The dose required to kill the older eggs was 40 times that required to kill young eggs; thus, a dose of 144 rad caused almost complete inviability among eggs deposited 1-2 d before irradiation, but a dose in excess of 5600 rad was required to kill eggs deposited 11 d earlier. For comparison, the lethal dose of γ -radiation for humans is estimated to be 400-700 rad. When the irradiation dose was applied in three small fractions, with intervals between them, the percentage of eggs killed was less than when the same total dose was given in one exposure. This difference was presumably due to tissue recovery during the inter-radiation periods. The temperature to which the

eggs were exposed during such periods also affected survival, recovery being greater at higher temperatures. The possibility of using γ -radiation to effect control in the egg-fields, the cost of the equipment needed and the hazards involved are discussed. It is concluded that control by this method not only offers no advantage in terms of cost, effectiveness or convenience compared with conventional insecticide treatment but would be impracticable and dangerous to operators and the inhabitants, both humans and domestic animals, of the treated area. It is possible that other control techniques utilising radiation, such as sterile-male release or attractant traps treated with a sterilant, may be useful against certain species of locusts after further work on the development of chemical attractants has been carried out. (RAE-A 54: 1966, ref. 581)

- 1442 Shim, J. W., Hyun, J. S., Choi, S. Y. THE EFFECTS OF X-RAY IRRADIATION ON THE PUPAL MORTALITY AND HATCHABILITY OF THE RICE STEM BORER. J. nucl. Sci. Korea 7 (1967) 50-55.

- 1443 Smitnoff, W. A. EFFECT OF GAMMA RADIATION ON THE LARVAE AND THE NUCLEAR-POLYHEDROSIS VIRUS OF THE EASTERN TENT CATERPILLAR, Malacosoma americanum. J. Invertebrate Path. 9, 2 (1967) 264-266.

The effects of γ -radiation were studied on larvae with and without the virus, and on the lyophilized polyhedra. A ^{60}Co -source was used. It would appear that (1) irradiation with doses of $\approx 100\,000$ rad are lethal to 3rd- and 4th-instar larvae; (2) exposure to $2000\,000$ rad completely inactivates the polyhedra of the nuclear polyhedrosis of Malacosoma; (3) development of the virus seems to be accelerated in larvae exposed to low radiation doses. The need for further study of (3) is stressed.

- 1444 Srisan Ruangopas. STUDIES ON THE USE OF GAMMA RADIATION IN THE CONTROL OF PEA WEEVIL (Callosobruchus chinensis L.). p. 18-30 of "Insect Eradication by Irradiation, Bangkok, Thailand. 28-29 Jun. 1966". THAI. AEC-8, Office of Atomic Energy for Peace, Bangkok (Thailand).

Gamma radiation retarded development and had lethal and sterilising effects, depending on dose. 99.8% sterility in eggs was observed when both parents had been exposed as late pupae; 1400 rad caused 99.87% sterility in eggs, 2800 rad 100% when both parents had been exposed at the early-adult stage. Exposure at the late-larval, prepupal or pupal stages showed the female to be more susceptible. Lethal doses were as follows: for pupae, LD 100 - 32 000 rad, LD 50 - 6400 rad; prepupae and late larvae, LD 100 - 16 000 rad; 7-d-old eggs, LD 50 - 1240 rad, 5 $\frac{1}{2}$ (at 27.5°C) - 1202 rad, 4 d - 620 rad, 2 d - 380 rad, 1 d - 340 rad.

- 1446 Srisan Ruangopas. A PRELIMINARY STUDY ON THE USE OF GAMMA RADIATION IN THE CONTROL OF CIGARETTE BEETLE (Lasioderma serricorne F.). p. 31-34 of "Insect Eradication by Irradiation, Bangkok, Thailand. 28-29 Jun. 1966". THAI. AEC-8, Office of Atomic Energy for Peace, Bangkok (Thailand).

The radiosensitivity of eggs was studied. A dose of 800 rad caused 14%, 4000 rad 100% mortality in 1-d-old eggs. The life cycle of the beetle was found to be 37 d (approx. 8 d for the egg, 17 d for the larval, 10 d for the pupal, and $\sim 2-4$ d for the pre-emergence stage).

- 1446 Ucer, E. THE MORTALITY EFFECT OF RADIATION ON Drosophila melanogaster LARVAE OF DIFFERENT AGES. Istanbul Univ. Fen. Fak. Mecm., ser. B. 30 (1965) 171-175.

To investigate the response of Drosophila of different ages, experiments were performed on 3-, 72-, and 96-h-old larvae exposed to 1300 R of γ -irradiation ^{60}Co . The 96-h-old larvae (or prepupae) passed to the pupa stage apparently without being affected by irradiation and became adults. Larvae irradiated when they were 72 h old became pupae which did not show a statistically significant higher mortality rate than the controls. Larvae irradiated when they were 3 h old showed a considerably higher mortality rate until they reached the pupae and the adult stage. The 3-h-old larvae showed the highest mortality rate between 90 and 96 h after they were irradiated. In D. melanogaster larvae, in the post-embryonic stage, mitosis does not occur. The variable degree of sensitivity observed in the same cells of larvae belonging to different ages may be due to changes in the physiologic condition at the different ages. (NSA 22: 1968, 2549)

- 1447 Vichuda Krithayakiem. PRELIMINARY STUDY ON THE EFFECT OF GAMMA RADIATION IN CONTROLLING ORIENTAL FRUIT FLY (*Dacus dorsalis* Hendel) IN BANANA. p. 58-60 of "Insect Eradication by Irradiation, Bangkok, Thailand. 28-29 Jun. 1968". THAI. AEC-8, Office of Atomic Energy for Peace, Bangkok (Thailand).
- Oriental fruit fly when raised in ripe bananas at 90°F and natural humidity had an incubation period of 26-48 h, larval and pupal stages of 7-12 and 8-9 d, respectively, and an adult life span of 1-2½ months. Eggs (17-20 h old) were exposed to 3900, 12 000, 16 000 and 35 000 rad which resulted in 27%, 37%, 87% and 100% mortality. High doses killed larvae rapidly. Corresponding values for larvae were 44%, 93% and at 16 000 rad 95% in 10 d. Imperfections in the rearing technique caused excessive rises in mortality which must be eliminated in future experiments.
- 1448 Walker, D. W., Quintana-Muñiz, V. MORTALITY STAGING OF DOMINANT LETHALS INDUCED IN THE SUGARCANE BORER *Diatraea saccharalis* (F.) (CRAMBIDAE, LEPIDOPTERA). *Bull. ent. Soc. Am.* 12 (1966) 250. Abstr. 118. Presented at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".
- Embryonic development was followed in normal embryos, unfertilized eggs, and embryos from irradiated sperm (16.8 kR) or unfertilized eggs (12.0 kR). Embryonic deaths due to radiation occurred either early or late in development. Findings are discussed in relation to work with Hymenoptera and Diptera. (Abstr.)
- 1449 Zakladnoi, G. A. INFLUENCE OF THE GAMMA IRRADIATION DOSE RATE ON THE LIFETIME OF GRANARY WEEVILS. *Radiobiologiya* 6 (1966) 478-479. (In Russian)
- Increasing the dose rate accelerates the death of granary weevils. With increasing irradiation dose from 12 - 60 krad, the difference in the effect of the dose rate is levelled out at the level of 99.9% death of the weevils; however, the total effectiveness is negligibly reduced. (Auth.)
- See also:
- 26 The effect of thymidine-³H on the mortality of *Drosophila melanogaster* larvae. (Anil, Y. D., 1964)
 - 27 Application of radioactive isotopes to the investigation of methods for the biological control of pests. V. The effects of γ -radiation on pupae of *C. capitata* previously labelled with ³²P. (Arroyo, M. et al., 1965)
 - 532 Radiation profile of a herbivorous insect. (Reichle, D. E., 1966)
 - 979 The sensitivity of undifferentiated and differentiated nuclei following x-irradiation in the early stage of development of the egg of the termite *Kaloterms flavicollis* Fabr. (Truckenbrodt, W., 1965)
 - 1093 Comparisons of mutagenic and cell-killing effects of radiation in the silkworm. (Nakao, Y. et al., 1965)
 - 1095 Biological studies: genetics. (National Inst. of Radiological Sciences, Chiba (Japan). 1965)
 - 1131 Sterilization of the coffee leaf miner. (Katiyar, K. P., 1967)
 - 1158 Gamma-induced sterility in the sugarcane moth, *Diatraea saccharalis* (Fab.) (Lepidoptera: Crambidae). (Walker, D. W. et al., 1967)
 - 1247 Radiosensitivity of the granary weevil as a function of temperature. (Zakladnoi, G. A., 1967)
 - 1258 Sterilizing effect of γ -rays and apholate on the Mexican bean beetle, *Epilachna varivestis* Muls. (Carillo, J. L. et al., 1963/1964)
 - 1301 Modification in productivity and mortality of flour beetle species and strains due to x-rays and the insecticide, DDT. (Erdman, H. E., 1966)
 - 1341 A study on the life history and the effect of radiation on rice weevil (*Sitophilus oryzae* L.). (Chettachai Baditsing, 1966)
 - 1349 Effects of x-rays on metamorphosis and adult life span of flour beetles. (Erdman, H. E., 1966)
 - 1350 Ontogeny and x-radiation sensitivity of the flour beetle, *Tribolium*. (Erdman, H. E., 1967)
 - 1359 Radiation susceptibility of various developmental stages of the Mediterranean fruit fly (*Ceratitis capitata* Wied.). (Kahan, R. S. et al., 1965)
 - 1365 Cobalt-60 radiation studies with the European chafer. (Lippold, P. C. et al., 1966)
 - 1368 Studies on strain differences in radiosensitivity in the silkworm. I. Screening of sensitive and resistant strains to embryonic radiation killing. (Murakami, A. et al., 1966)

- 1369 Studies on strain differences in radiosensitivity in the silkworm. II. Relation between sensitivity to embryonic killing and mutability. (Murakami, A. et al., 1966)
- 1373 The effects of gamma radiation upon various stages of Fannia canicularis (L.). (Nelson, T.E., 1966)
- 1380 x-Irradiation and wing retention in the common house fly, Musca domestica L. (Rockstein, M. et al., 1966)
- 1381 Further studies on the effect of x-irradiation on the house fly, Musca domestica L. (Rockstein, M. et al., 1967)
- 1382 Effects of x-irradiation on postembryonic development of Sarcophaga peregrina Robineau-Desvoidy. (Sasaki, S., 1966)
- 1384 Cytological study of embryo development in Drosophila melanogaster, following x-irradiation at early developmental stages. (Schneider-Minder, A., 1966)
- 1390 Effect of gamma radiation on Trogoderma glabrum and Attageus piceus. (Tilton, E. W. et al., 1966)
- 1392 The effect of ionizing radiation upon the development of the mallow moth. (Vasilyan, V. V., 1961)
- 1395 Studies on the radiosensitivity of early embryonic stages of Drosophila melanogaster. (Würgler, F. E., 1964)
- 1405 Kinetics of aging as revealed by x-ray-dose-lethality relations in Drosophila. (Baxter, R. C. et al., 1967)
- 1408 Age of death in Drosophila following sublethal exposure to gamma radiation. (Baxter, R. C. et al., 1967)
- 1410 Modification of fitness in species and strains of flour beetles due to x-rays and DDT. (Erdman, H. E., 1966)
- 1458 Pyrimidines and the x-ray response of Tribolium confusum. (Hogan, G. R., 1966)
- 1460 Influence of post-treatment humidity on the irradiated rice weevil adult, Sitophilus zeamais Motschulsky (Coleoptera: Curculionidae). (Kumagai, M., 1967)
- 1610 Studies of eradication of Anopheles pharoensis by the sterile-male technique using cobalt-60. II. Induced dominant lethals in the immature stages. (Tantaway, A. O. et al., 1966)
- 1643 Disinsectization of African dried and smoked fish by means of irradiation. (Boisot, M. H. et al., 1966)
- 1650 Dosimetry, tolerance, and shelf life extension related to disinfection of fruits and vegetables by γ -irradiation. (Brewbaker, J. L., 1966)
- 1670 Control of the Queensland fruit fly by gamma irradiation. (MacFarlane, J. J., 1966)
- 1686 Gamma irradiation of grain and other reserves for sterilizing and exterminating pests. (Rukavishnikov, B. I., 1964)
- 1690 Food irradiation in Australia. (Scott, W. J., 1962)
- 1693 x-Ray irradiation effects on storehouse destructive insects. (Török, G. et al., 1959)
- 1696 Irradiation of mangoes for control of the mango seed weevil (Sternochetus mangiferae). (Upadhyay, M. D. et al., 1966)
- 1708 Killing silkworm pupae by irradiation. (Beard, R. L. et al., 1966)
- 1749 Application of an actographic recording method to the study of the effects of irradiation on Calandra granaria larvae. (Pesson, F. P. et al., 1965)

2.2.8. Modifying Factors

(Intensity. RBE. LET. Temperature. Synergists.

Chemicals including Protective Agents. Environment at Irradiation.

Medium. Pathogens. Physical Factors, e.g. Vibration, Acceleration, Etc.)

- 1450 Akhalaya, Y. G. INFLUENCE OF INCUBATION CONDITIONS ON THE RADIOBIOLOGICAL EFFECTS ON EGGS OF Bombyx SILKWORMS. Soobshch. Akad. Nauk. gruz. SSR 44 (1966) 727-734. (In Georgian)

x-irradiation to 1500 R produced a negative effect on embryonic development of Bombyx (sericaria mori) silk worm eggs. However, the damaging effects were eliminated by changing the incubation conditions which precluded winter laying. The influence of various incubation conditions on radiobiological effects on silk worm eggs is of practical importance. (NSA 21:1967, 20344)

- 1451 Amer, N.M., Tobias, C.A. ANALYSIS OF THE COMBINED EFFECT OF MAGNETIC FIELDS, TEMPERATURE AND RADIATION ON DEVELOPMENT. Radiat. Res. 25 (1965) 172-173. Abstr. 5. Paper presented at "13th Annual Meeting of the Radiation Research Society. Philadelphia, Pa., USA, 23-26 May 1965".

Since the effect of magnetic fields on radiation induced wing abnormalities in the adults of T. confusum was demonstrated, a systematic study was undertaken to explore the dependence of such effect on the intensity of the applied magnetic field and on temperature. We are finding that the percentage of abnormality decreases with increasing field intensity up to 8 kG, where the effect corresponds to a dose reduction factor of about 2 ($T = 38.5^\circ\text{C}$). At higher fields the magnetic post-irradiation protection decreases again. Moreover, the effect is much more marked at 38.5°C than at 30°C . Magnetic fields afford protection not only against x-rays but also against temperature induced abnormal development. The effects of magnetic fields also are being tested in various post-irradiation oxygen concentrations. At low oxygen partial pressure, the effect is predominantly protection; at high oxygen partial pressure the magnetic field enhances oxygen toxicity. We are finding that morphologically the effect of elevated temperatures and high oxygen tension on development is similar to that observed when the hormone ecdysone is present in reduced amounts; we are therefore testing the hypothesis that radiation, temperature, oxygen and magnetic fields may influence the hormonal regulatory processes. (Abstr.)

- 1452 Antipov, V.V., Delone, N.L., Parfyonov, G.P., Vystoky, V.G. RESULTS OF BIOLOGICAL EXPERIMENTS CARRIED OUT UNDER CONDITIONS OF FLIGHT IN SHIPS VOSTOK WITH PARTICIPATION OF COSMONAUTS A.G. NIKOLAYEV, P.R. POPOVICH, AND V.F. BYKOVSKY. "COSPAR Symposium. Florence, Italy, May 1964". N66-20043, Academy of Sciences (USSR). Moscow.

Reproduction processes in Drosophila melanogaster and the hereditary structures of Tradescantia paludosa were studied under conditions of cosmic radiation and weightlessness. The following results are reported along with descriptions of experimental procedures and conditions. The speed of laying eggs, and the viability of embryos and larvae were shown to be approximately the same under weightlessness and normal conditions. Several explanations are given for an excess of female issue: it is suggested that the most valid of these is a relative increase in the competitive capability of the female larvae under the experimental conditions. The following apparently non-hereditary anomalies were observed in the offspring: (1) an absence of 1/2 the thorax; (2) a one-sided absence of macrochetes; (3) a decrease and roughening of one eye; and (4) a shortening and incorrect nervation of one wing. It is noted that only 1/2 of the body is affected in each case. (From Sci. and Techn. Aerospace Repts.)

- 1453 Antipov, V.V., Delone, N.L., Parfyonov, G.P., Vystoky, V.G. RESULTS OF BIOLOGICAL EXPERIMENTS CARRIED OUT UNDER CONDITIONS OF "VOSTOK" FLIGHTS AND WITH THE PARTICIPATION OF COSMONAUTS A.G. NIKOLAYEV, P.R. POPOVICH, AND V.F. BYKOVSKY. Life Sci. Space Res. 3 (1965) 215-229. Also presented at "5th International Space Science Symposium. Florence, Italy, 12-16 May 1964". (See 1452)

The data are presented on a study of the effect of space flight factors, particularly of weightlessness and radiation, on the fertilization, growth and development of Drosophila melanogaster and on the mechanism of heredity in Tradescantia paludosa. Copulation, oviposition and development of Drosophila are shown to be possible under 4-d weightless conditions. A distortion in the sex ratio has been registered in the cultures of flies grown in flight. It is suggested that rearrangements of chromosomes are caused by the action of vibrations and accelerations while distortions in the mechanism of mitosis are mainly related to the weightlessness effect. (From auth.)

- 1454 Bychkovskaya, I.B., Ochinskaya, G.K. ABSENCE OF "OXYGEN AFTER-EFFECTS" IN Calandra granaria DURING HIBERNATION INDUCED WITH LOW TEMPERATURE. Radiobiologiya 5 (1965) 700-702. (In Russian).

The insects C. granaria were irradiated in special vacuum tubes at x-ray doses of 5, 6, 7, 8, 9, and 10 kR at a temperature of $1 - 5^\circ\text{C}$. The insects were held at a lowered temperature after irradiation for periods varying from 30 min to 12 d. The oxygen concentration was varied from 20 - 2% during and after irradiation. The survival at 60 d and the average lifetime of the irradiated insects were taken as criteria of radiation damage. On maintaining conditions of hypoxia during and after irra-

diation, a definite protective effect was observed. On creating conditions of hypoxia from the moment that the weevils had been warmed up to room temperature, no protective effect could be observed. Thus, no oxygen aftereffect could be detected by maintaining the weevils at low temperatures. (NSA 20: 1966, 5385)

- 1455 Erdman, H.E. EFFECTS OF DIMETHYLSULFOXIDE ON PRODUCTIVITY OF x-IRRADIATED FLOUR BEETLES. *Biol. Bull.* **130** (1968) 157-169. Also published as BNWL-SA-307, Battelle Memorial Inst., Richland, Wash.

Sexually mature virgin female flour beetles, *Tribolium castaneum* (Herbst), mutant: sooty, were treated with dimethylsulfoxide (DMSO) and x-rayed. Fecundity, fertility, and viability were measured. DMSO gave no radiation protection to female germ cells. Food containing 4.6% DMSO was unpalatable. Photomicrographs of ovarioles showed that sterility resulted because of osorption. DMSO might be economically important in protecting stored products from insects. (Auth.)

- 1456 Grosch, D.S. THE COMBINED EFFECTS OF IRRADIATION, VIBRATION, AND CENTRIFUGATION ON BRACONID FECUNDITY, FERTILITY AND LIFE SPAN. p. 99 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun. - 2 Jul. 1966. 263p." Abstr. 390.

Experiments with female *Habrobracon* show antagonistic rather than synergistic interaction of radiation and two kinds of factors postulated to increase stresses in cell structures. However, a preliminary series of experiments revealed that relatively low rates of centrifugation were necessary to avoid displacement of abdominal organs and provide consistent results. Three separate sets of experiments, two replicas each, featured 20 g for 24 h during which a total of 750 R of γ -rays was delivered from a ^{60}Co source. Egg production for the combined treatment was intermediate between that obtained from centrifugation or irradiation alone. In addition, hatchability was improved over that following radiation alone. Another combination providing egg production and hatchability records exceeding those of radiation alone involved 120 vibrations/sec delivered over a 4-h period subsequent to 2000 R of γ -rays from ^{137}Cs . Furthermore two 1000 R fractions separated by 4 h of vibration were not additive in effect. The vibration alone decreases reproductive performance only slightly. Greater efficiency in recovery mechanisms are suggested because improvement is noted particularly in units which were primitive oögonia at the time of treatment. Neither centrifugation alone or in combination with radiation decreased life span significantly. (Abstr.)

- 1457 Grosch, D.S. UTILIZATION OF *Habrobracon* AND *Artemia* AS EXPERIMENTAL MATERIALS IN BIOASTRONAUTIC STUDIES. Status Report, Jan. - Jun. 1965. N65-28538, North Carolina State Coll., Raleigh. Dept. of Genetics. 1965, 7p.

The combined effects of radiation and gravity forces in excess of 1 g were investigated using the wasp, *Habrobracon*. A motor designed for long continuous operation fitted with a head machined to hold capsules of wasps was used in this investigation. Centrifugation for a few minutes at a speed providing a force of 1000 g was found too severe for all stages of the braconid life cycle; however, the majority of adults survived 500 g for as long as 24 h. The radiation exposure was conducted with ^{60}Co at a dose rate of 30 R/h to give 720 R for a 24-h exposure. Experiments were made with centrifuged, irradiated, centrifuged and irradiated, and the control. Egg production and hatchability were decreased for the combination exposure of increased gravity and radiation below the records for either radiation or centrifugation alone. Experiments were also made to test the radiation and prototype packages under simulated space flight conditions. These conditions were: simulated flight profile, irradiation, combined effects of profile and radiation, and control. Wasp survival was good except in the 1000 R position where wasps were pulverized during the simulated reentry vibration testing. (Sci. and Techn. Aerospace Repts.)

- 1458 Hogan, G.R. PYRIMIDINES AND THE x-RAY RESPONSE OF *Tribolium confusum*. *Diss. Abstr.* **27**, 3 (1966) 947-B.

The radiosensitizing effects of incorporation into DNA of the halogenated pyrimidines, 5-bromouracil or 5-iodouracil, or their nucleosides (BUDR or IUDR) have been demonstrated in a variety of cell types. At relatively low concentrations in the medium, the halogenated antimetabolites exhibit toxicity within one week after hatching of larvae in analogue-containing medium. The toxicity of brominated analogues is less pronounced than that of the iodinated analogues and is slower to develop. Larval lethality attributable to toxicity and the lethality attributable to x-rays are not clearly

separable. The results obtained in this study indicate that the halogenated analogues tested influence lethality in x-irradiated adult Tribolium. Toxicity of the halogenated pyrimidines or halogenated nucleosides is demonstrable three to five weeks following isolation of pupae into analogue-supplemented medium. The brominated analogues are much more toxic to adults than 5-IU or IUdR. Analogue-treated adults exposed to 7 kR, which is sub-lethal for adults in normal medium, die much earlier than those treated with analogue alone or with supra-lethal doses of x-rays alone. Adults isolated as pupae into unsupplemented medium, transferred to analogue-containing ration after three weeks and irradiated immediately before transfer exhibit marked lethality within one week after irradiation. Transfer of adult beetles to normal medium after three weeks or less in the presence of halogenated analogue virtually eliminates lethality attributable to the analogue. x-irradiation at the time of transfer, however, leads to high mortality. The onset of mortality occurs between the 2nd and 3rd week post-irradiation and is similar to that of supra-lethally irradiated adults in normal medium. The effects of BUdR or IUdR on adult x-ray lethality persist one to two weeks after analogue exposure. Insects grown for 12 weeks in medium containing uracil or thymine exhibit the same survival as those reared in unsupplemented medium. Two weeks after 7 kR-irradiation a sharp decline in survival is seen in both uracil- and thymine-treated groups. No such response is observed in purine-treated Tribolium or adults treated with 5-aminouracil, 6-azathymine or 6-azauracil. (DA)

- 1459 Katiyar, K. P., Ferrer, F. EFECTO DE LA EXPOSICIÓN A ALTAS TEMPERATURAS SOBRE LAS PUPAS IRRADIADAS DE LA MOSCA DE MEDITERRÁNEO, Ceratitis capitata W. (Effect of exposure of irradiated pupae of the Mediterranean fruitfly, C. capitata, to high temperatures.) Turrialba 17, 1 (1967) 31-34. (In Spanish, with English summary)

The following is virtually the English abstract of this account of investigations to ascertain whether high temperatures during transport might have been responsible for the high mortality of adults from irradiated pupae of C. capitata (Wied.) liberated in Costa Rica. Pupae irradiated at 10 kR and normal pupae were kept for 2, 4, 6 and 8 h at temperatures of 25, 30, 40 and 45°C [77, 86, 104 and 113°F] and 60 to 85% r.h. Adult emergence was normal up to 40°C. Exposure to 45°C for 2 h was lethal to irradiated as well as normal pupae. A heat treatment of 40°C for 8 h immediately after irradiation had no latent adverse effect on the length of life of the adults. Irradiated females survived longer than normal females. (RAE-A 55: 1967, ref. 520)

- 1460 Kumagai, M. INFLUENCE OF POST-TREATMENT HUMIDITY ON THE IRRADIATED RICE WEEVIL ADULT, Sitophilus zeamais Motschulsky (COLEOPTERA: CURCULIONIDAE). Appl. Ent. Zool. 2, 1 (1967) 51-57.

The relative humidity was regulated by Zwölfer's method, using H₂O, NaCl and Ca(NO₃)₂ at four different temperatures ranging from 5°C to 35°C. Three different intensities of γ-irradiation from a ⁶⁰Co-source (100 000, 50 000, and 25 000 R) were used, and their effects examined at individual-level. The survival rate (SR) or the average number of days during which the insect remained alive, within a month of irradiation, were calculated. The number of days corresponding to SR 50 and SR 5 were compared. The data showed that the higher the relative humidity the less the influence of irradiation under any of the temperatures or dosages used; it is suggested that the effect of post-treatment humidity should not be ignored when irradiating the adult weevil.

- 1461 Deleted.

- 1462 Rabalkar, G. W., Nair, K. K. INFLUENCE OF DIAPAUSE ON THE RADIOSENSITIVITY OF KHAPRA BEETLE LARVAE. Proc. ent. Soc. Ont. 97 (1966) 126. Paper presented at "103rd Annual Meeting of the Entomological Society of Ontario, Toronto, Ont., Canada, 2-4 Nov. 1966".

Studies were conducted to determine the effects of varying periods of diapause on the radiosensitivity of the Khapra beetle larvae (Trogoderma granarium Everts). There was practically no mortality in the irradiated larvae during diapause but it manifested itself only after the diapause was broken at 38°C. Since the calculated LD 50's for 10, 20 and 30 d of post-irradiation diapause were not significantly different from one another it was also evident that increases in the length of diapause had no significant effect on post diapause survival time. On the other hand pupation seemed to be influenced by the duration of diapause in the irradiated larvae. This effect was best discernible at low doses. The significance of these findings is discussed. (Abstr.)

See also:

- 1300 x-Radiation and temperature modification of reproductive performance of single-species and mixed-species cultures of Tribolium confusum and Tribolium castaneum. (Erdman, H.E., 1966)
- 1304 The influence of antibiotics on the fecundity and fertility of irradiated Habrobracon females. (Grosch, D.S., 1961)
- 1310 Change of oxidative process in insects under the influence of γ -rays. (Kalmykov, P.C., 1965)
- 1326 Survival of irradiated insect heart fragments following treatment with propyl gallate. (Larsen, W., 1965)
- 1330 Effect of actinomycin D on the development of the early imaginal eye disks of Drosophila melanogaster. (Perez-Davila, Y. et al., 1967)
- 1372 Effect on adult emergency of whole and partial x-irradiation of pupae of the housefly, Musca domestica nebulosa. (Nair, K.K. et al., 1967)
- 1388 Récentes expériences de radiobiologie sur Bombyx mori. (Teulade, P., 1966)
- 1395 Studies on the radiosensitivity of early embryonic stages of Drosophila melanogaster. (Würzler, F.E., 1964)
- 1405 Kinetics of aging as revealed by x-ray-dose-lethality relations in Drosophila. (Baxter, R.C. et al., 1967)
- 1406 Age of death in Drosophila following sublethal exposure to gamma radiation. (Baxter, R.C., 1967)
- 1408 The effects of ionizing radiation on the longevity of ploidy types in the wasp Mormoniella vitripennia. (Clark, A.M. et al., 1967)

2.3. RADIATION EFFECTS ON INSECT POPULATIONS

2.3.1. Behaviour

- 1463 Bergeder, H.D., Böning, D. SOFORTWIRKUNGEN VON RÖNTGENSTRAHLEN BEI WIRBELLOSEN TIEREN UND FRÖSCHEN. (Immediate effects of x-rays on invertebrates and frogs.) Biophysik 2, 4 (1965) 239-246. (In German)

The study was aimed at clarifying the extent to which immediate reactions to ionizing radiation can be observed in the animal kingdom, and the existence of a possible correlation between individual radiosensitivity and the level of phylogenetic development. Results are tabulated in terms of orders, classes, and species investigated, group and/or individual reaction to irradiation, reaction period (including moment of first recognizable response), doses, reaction after irradiation, reaction after repeated irradiation, and reaction to partial irradiation. - Reaction ranged from antenna movement (as in Lepisma saccharina), general restiveness (as in Apis mellifica), trembling (as in Tenebrio molitor pupae), sudden twitching (as in Dytiscus marginalis), increase in peristaltic movement (as in Tenebrio molitor larvae and in Drosophila melanogaster), to avoiding action, from moving away (as in Aphidina ovipara), swimming away (Gyrinus nator), jumping away (as the grasshopper Tettigonia viridissima) to obvious escape (as in Formica rufa).

- 1464 Blaylock, B.G. THE EFFECTS OF IONIZING RADIATION ON INTERSPECIFIC COMPETITION. Paper presented at the "Genetics Society of America, Chicago, Ill., USA, 1-3 Sep. 1966". ORNL-DWG 67-4292.

The effect of acute and chronic radiation on competition was studied in laboratory populations of the sibling species Drosophila melanogaster and D. simulans which are similar both morphologically and genetically. D. simulans was the superior species for 30 weeks in the control populations, but was eliminated by D. melanogaster when the populations were exposed to a chronic dose of 4.3 rad/h. After an acute dose of 2000 rad, D. melanogaster was the superior species for approx. 12 weeks; however, the reverse was true when the populations were exposed to 10 000 rad. D. melanogaster was eliminated by D. simulans by the end of six weeks. The frequency of irradiated D. melanogaster or irradiated D. simulans (2000 rad) decreased rapidly when placed in competition with non-irradiated flies of the opposite species. Under these conditions, irradiated D. melanogaster recovered after six

weeks, but irradiated *D. simulans* never recovered and was eliminated in one population after 24 weeks. Population size was affected by the exposure to acute and chronic radiation, but most of the populations recovered after six weeks. The populations receiving 10 000 rad were the exceptions; they required 13 weeks to recover. This was attributed to the effects of radiation on the reproductive capabilities of these species. After nine weeks of competition the populations having the largest average size were the ones that received an acute dose of 2000 rad. (Auth.)

- 1465 Blaylock, B.G. EFFECTS OF IONIZING RADIATION ON INTERSPECIFIC COMPETITION. ORNL-P-3063, Oak Ridge National Lab., Tenn. 1967, 22p. Also presented at "2nd National Symposium on Radioecology, Ann Arbor, Mich., USA".

For abstract, see 1464.

- 1466 Brower, J.H. BEHAVIORAL CHANGES IN AN ANT COLONY EXPOSED TO CHRONIC GAMMA IRRADIATION. *Am. Midl. Nat.* 75 (1966) 530-534.

Changes in the behaviour of a colony of ants, *Formica integra*, were investigated in an area experimentally exposed to chronic γ -radiation at Brookhaven National Laboratory. The habits of the colony changed so that ants were no longer exposed to high radiation levels. The ants constructed a covered runway, 12.5 m long, extending away from the radiation source and used exclusively for travel to and from the nest. The ants also abandoned the habit of appearing on the exposed nest stub and banking it with litter. (Auth.)

- 1467 Brower, J.H. A POSSIBLE RADIATION AVOIDANCE RESPONSE EXHIBITED BY AN INSECT POPULATION IN NATURE. *Naturwissenschaften* 54, 2 (1967) 39-40.

The experimental forest was circular, with a 9500 Ci ^{137}Cs at its centre, delivering high intensity γ -radiation for 20 h each day. In 1961, observations were started on an active colony of *Formica integra* at the base of burned pine stump 18 m due east of the future site for the radiation source. The colony appeared normal and the characteristic behaviour of the species appeared well developed. In 1962, the colony was again observed to be active although now exposed to 10 R/h for 20 h/d. In the spring of 1963 the colony was again found to be active. The nest now had short sunken runways radiating in several directions. In 1964 the ant behaviour seemed unusual. A runway 12.5 m long had been constructed extending from the base of the stump outward at an angle away from the source. This runway was lost at 29 m from the radiation source. At 29 m the exposure level was only 3.3 R/h or $\sim 1/3$ of that at the nest. The runway was excavated below the surface of the soil and covered by ground litter for almost its entire length. Ants used this runway exclusively in travel to and from the nest. No ants were found elsewhere. The runway led not only away from the source of radiation but also toward a greater abundance of insect food (to counteract death of vegetation due to radiation). The behavioural change most likely to have been caused by a direct radiation avoidance response was the abandonment of the litter-collecting habit. The complex behavioural pattern of ants makes interpretation as to causal factors for the observed changes speculative.

- 1468 Brown, G.A. MALE COMPETITIVENESS IN IRRADIATED AND NON-IRRADIATED *Acarus siro* L. *Bull. ent. Soc. Am.* 13, 3 (1967) 194. Abstr. 155. Presented at "New York Meeting of the Entomological Society of America, New York, N.Y., USA. 27-30 Nov, 1967".

A study was established to determine if irradiated males of *A. siro* would compete favourably with non-irradiated males. Males were irradiated and placed in colonies with non-irradiated males in the following ratios: 1:0, 1:1, 1:5, 1:10. Each colony contained 10 non-irradiated females. (Abstr.)

- 1469 Darenkaya, N.G., Pravdina, G.M. SOME RESULTS OF THE INVESTIGATION OF ANIMAL BEHAVIOUR IN RADIATION FIELDS. p. 64 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, Italy, 26 Jun.-2 Jul. 1966, 263p." Abstr. 250.

The results of recent several years' studies of animal behaviour in radiation fields carried out with *Drosophila melanogaster*, fish, mice, rats, guinea pigs, dogs and monkeys are presented. In experiments with vertebrates γ -irradiation was used. In experiments with *D. melanogaster* the amount of eggs laid on food surfaces both exposed to and free from β -irradiation was determined. All the animals tested were shown to be capable of determining the position of the radiation source. A response to very low radiation doses (about 0.001-2 R) was obtained for the animals. Threshold dose rates causing

avoidance behaviour varied with the species. The discussion of the results is based on the assumption of radiation acting as an unconditioned stimulus. (From Abstr.)

- 1470 Dyer, K.F. FITNESS AND COMPETITIVE ABILITY IN IRRADIATED POPULATIONS OF Drosophila melanogaster. Mutation Res. 3, 4 (1966) 327-339.

Experiments are described in which a population of flies was given an acute dose of 1500 rad of x-rays every generation and then allowed to compete with a genetically similar but unirradiated population. The accumulation of 2nd chromosome recessive lethal mutations was measured to provide an estimate of the total genetic damage and it was found that >35% of the chromosomes carried these by generation 12. The rate of accumulation was found to agree fairly well with a straightforward theoretical prediction. The competitive ability of the irradiated population as measured by the number of flies emerging appeared to be well maintained and was, by generation 12, only slightly inferior to its unirradiated counterpart. The decline in the number emerging from generation 1 to 12 could largely be accounted for by the genetic deaths due to homozygous recessive lethals. Flies heterozygous for irradiated chromosomes, however, appeared to have a reduced competitive ability. The significance of these different responses to genetic damage in terms of the structure of the gene pool is discussed. (Auth. summary)

- 1471 Flint, H.M. THE EFFECTS OF GAMMA RADIATION ON MATING COMPETITIVENESS AND FECUNDITY OF Hippelates pusio Loew. J. econ. Ent. 59, 1 (1966) 96-99.

All gnats were treated either as adults 24-36 h after emergence or as pupae ~2 d prior to emergence. In mating tests males sterilised with 5000 R from a ^{60}Co -source were used. H. pusio Loew males which had been sterilised as adults with γ -radiation were found to be fully competitive with untreated males in fertilizing females in laboratory tests. When males were sterilised in the pupal stage, there was a significant reduction in their ability to compete with untreated males. Observations on the testes indicated a significant reduction in the size of testes of males treated in the pupal stage, while testes of males irradiated as adults were similar in size to untreated controls. When females were treated with a sterilising dose as adults, initial oviposition was 1.6- and 2.3-fold greater than untreated females during the 1st and 2nd days of oviposition, respectively. Thereafter the untreated females laid greater numbers of eggs to the end of the test period.

- 1472 George, J. A. EFFECT OF MATING SEQUENCE ON EGG-HATCH FROM FEMALE Aedes aegypti (L.) MATED WITH IRRADIATED AND NORMAL MALES. Mosquito News 27 (1967) 82-86.

Irradiated males appear to mate as effectively as non-irradiated males. An investigation into the relative competitiveness of spermatozoa from normal males and those from males sterilised by γ -irradiation in the pupal stage indicated no difference. It does appear, however, that though copulation may occur repeatedly, the only effective one is the first. In the experiments, male pupae due to emerge within ~8 h had been exposed to a dose of 8400 R of γ -radiation.

- 1473 Krebs, A., Benson, B. EFFECTS OF ^{60}Co -GAMMA RADIATION ON NATURAL DIGGING AND TUNNELING BEHAVIOUR OF THE ANT Pogonomyrmex californicus. Naturwissenschaften 53, 5 (1966) 131. (In English)

P. californicus (Buckley) shows regular and reproducible digging and tunneling behaviour. Ants were irradiated in groups of ten, in a commercial ^{60}Co γ cell at a dose rate of 1300 R/min (air). Total doses ranged from 39 000 R to 156 000 R. Immediately after irradiation the ants were transferred to special tunneling containers and observed for up to 12 d after exposure. The complexity of the tunnel systems and the amounts of sand moved decrease with increase in radiation dose, indicating damage to the ant's working ability and working skill. Daily shadow-graphs of the sand profiles allowed quantitative evaluation of the dose-effect relationship between dose and amounts of sand moved, and gave an idea of the delay in onset of digging activity for the different groups. Alterations in physiological processes in vital organs and systems by high energy radiation, damage to the central nervous system and/or interference with the chemical communication code among social insects, especially pheromone activities, may contribute to the radiation-induced behavioural changes.

- 1474 Nakagawa, S., Farias, G.J., Steiner, L.F. THE ATTRACTIVENESS OF MALE LURES TO SPERM-DEFICIENT FEMALE MEDITERRANEAN FRUIT FLIES. *Bull. ent. Soc. Am.* 12 (1966) 250. Abstr. 115. Presented at "Portland Meeting, Portland, Oreg., USA. 28 Nov.-1 Dec. 1966".

Releases of irradiated and normal females indicate that each responds strongly to trimedure or medure in daylight at 75°F or more in the absence or scarcity of males, but only after the virgin females become sexually mature or the older mated females appear deficient in sperm. (Abstr.)

- 1475 Picton, H.D. THE RESPONSES OF *Drosophila melanogaster* TO WEAK ELECTROMAGNETIC FIELDS. Thesis. Northwestern Univ., Evanston, Ill. 68p, 1964.

An investigation was made of the orientational responses of *D. melanogaster* to weak electromagnetic fields. Magnetic, electrostatic and γ -radiation fields with intensities similar to natural fields were used. The findings are based on an analysis of 109 285 individual fly observations accumulated during 2286 replicate runs. The magnetic fields were shown to influence the degree of turning, the variability of the data, the activity, the phototactic responses and the lunar rhythms of response of the flies. Similar findings were made for the electrostatic and γ -radiation fields. The γ -radiation gave the fewest number of significant responses. All of the fields appeared to have a phasing influence on some of the rhythmic lunar month responses. Combinations of fields tended to give responses more similar to those of the controls than did the single factor fields. The modification of the lunar patterns of response by the experimental conditions is discussed in relation to the biological clock problem. Results were compared with those of similar studies on other organisms. (NSA 20:1966, 18410)

- 1476 Smith, J.C. A STUDY OF THE USES OF IONIZING RADIATION AS STIMULI. Comprehensive Report, September 1961-May 1967. ORO-2803-33, Florida State Univ., Tallahassee. Dept. of Psychology. 31 May 1967, 18p.

Progress is reported on studies on the immediate response of pigeons and rats to x-ray stimulation. x-radiation was used as the conditioned stimulus in classical conditioning experiments. Preliminary results are included from studies on the effects of x-radiation on the behaviour of the Noctuidae moth. A list is included of 31 publications for the period covered by this report. (From NSA 21:1967, 28594)

- 1477 Tilton, E.W., Burkholder, W.E., Cogburn, R.R. MATING COMPETITION OF GAMMA-IRRADIATED AND NONIRRADIATED MALE *Trogoderma glabrum* Herbst. *J. econ. Ent.* 59, 1 (1966) 188-169.

A preliminary study was conducted to evaluate the mating competition offered by γ -irradiated male *T. glabrum* Herbst. Virgin males were irradiated with 25000 rad of γ -irradiation from a ^{60}Co source. When an irradiated male and a nonirradiated male were placed with a virgin female, 56% of the females produced viable eggs, as compared with 97% for the females with a nonirradiated male only. (Auth.)

- 1478 Weisbrot, D.R. COMPETITIVE INTERACTIONS AMONG IRRADIATED STRAINS OF *Drosophila melanogaster*. *Genetics* 56, 3 Pt.2 (1967) 596. Presented at the "1967 Meetings of the Genetics Society of America. Stanford, Calif., USA. 31 Aug.-2 Sep. 1967".

Experiments measuring the genetic effects of radiation in *Drosophila* usually involve comparisons of irradiated and unirradiated sibs, where both segregate in separate cultures containing a common genotype. For example, on *D. melanogaster*, the coisogenicity of second chromosomes is accomplished by crosses with the balanced lethal system, *Cy L/Pm*. In the process, the flies are irradiated and crossed to sibs to produce among other classes, the regenerated *Cy L/Pm* and wild-type flies homozygous for the 2nd chromosome except for some radiation induced heterozygosity. Comparisons are then made between these two classes in these and in unirradiated cultures. - To distinguish between the effects of the radiation and genotype interactions among the segregating genotypes, the following experiment was performed. Using the above procedure, six strains of *D. melanogaster* were established; three were coisogenic for 2nd chromosomes, and three were the *Cy L/Pm* strains used in each 2nd chromosome isolation. These six strains were then divided into a group whose males were irradiated, and an unirradiated control. Four generations after the treatment, the survival of larvae of each strain was tested in pure or homotypic cultures and in mixed cultures, containing the wild-type strain and its corresponding *Cy L/Pm* where both or neither had been irradiated. (See Weisbrot, Genetics 53:

1966, 427, for methods.) - The results indicate that while irradiation nonsignificantly reduced the viability of each strain in homotypic cultures, it improved the viability of the *Cy* *L/Pm* in mixed cultures. The genotypic interaction among the competitors modified the effects of the radiation. Furthermore, the apparent reduction in fitness of the irradiated wild-type larvae in mixed cultures would tend to lower the overall effects of the radiation on fitness. (Abstr.)

- 1479 Wood, D.L., Stark, R.W. THE EFFECTS OF GAMMA RADIATION ON THE BIOLOGY AND BEHAVIOR OF ADULT *Ips confusus* (LeConte) (COLEOPTERA: SCOLYTIDAE). *Can. Ent.* **98**, 1 (1966) 1-10.

Sterilisation of male and female *I. confusus* exposed to γ -radiation (^{60}Co) as newly emerged adults was almost complete at levels exceeding 7500 R and 10 000 R, respectively. Mating behaviour of males as expressed by sperm transfer was unaffected by dosages up to 60 000 R. The capacity of beetles of either sex to establish galleries was not affected significantly below this dosage, but female gallery pattern was altered above 15 000 R. Longevity was reduced at levels greater than 5000 R. LD 50 for males occurred at 11.5 d at 7500 R and 29 d in the controls. Mortality of progeny resulting from males irradiated at substerilisation levels was higher than in the controls. The dosage to achieve significant population reduction with minimum effect on longevity and other biological activity is estimated to lie between 6000 and 7500 R. These studies indicate that this sterilisation technique may have promise in the control of bark beetles. The necessity for rearing large numbers on artificial media could be circumvented by mass trapping utilizing their natural sex attractant and by mass rearing in cut host material in the laboratory. (Auth.)

See also :

- 1123 Effectiveness of sterilization of the mallow moth; irradiability at different stages of development, and certain features of mating and egg-laying. (Buginsky, V.I., 1963)
- 1127 Radiation sterilization studies on the tobacco budworm, *Heliothis virescens* Fab. (Flint, H.M., 1966)
- 1153 Some effects of gamma irradiation on the navel orange-worm, *Paramyelois transiteila* (Walker). (Subrahmanyam, U., 1967)
- 1156 Radiation-induced sterility for population control of the sugarcane borer (*Diatraea saccharalis*) in Puerto Rico. (Walker, D.W., 1966)
- 1294 Spermatogenesis in drones following irradiation of the young larvae with different amounts of x-rays. (Bischkopf, R., 1966)
- 1302 Effects of gamma radiation on fertility, mating and longevity of males of the oriental fruit moth, *Grapholitha molesta* (Lepidoptera: Tortricidae). (George, J.A., 1967)
- 1320 Reproductive potential of the sweetpotato weevil after exposure to ionizing radiations. (Walker, J.R., 1966)
- 1347 On the effect of Co^{60} gamma radiation on the desert locust. (El-Miniawi, S.F., 1964)
- 1354 Sterilisation de la mouche méditerranéenne des fruits, *Ceratitis capitata* Wied., par irradiation des pupes aux rayons gamma. (Féron, M., 1966)
- 1376 Effects of sub-lethal gamma radiation on the biology and behaviour of the Angoumois grain moth, *Sitotroga cerealella* Olivier. (Qureshi, Z.A., 1966)
- 1431 Radiation sterilization of the black blow fly. (Bushland, R.C., 1966)
- 1593 Control of fruit flies *Dacus zonatus* Saunders by gamma-rays. (Huque, H. et al., 1967)
- 1608 Study of the biology, breeding and sterilisation of the cabbage fly, *Phorbia brassicae* Bouché, with special reference to its occurrence in radish cultures. (Riedel, M., 1967)
- 1611 Studies on the eradication of *Anopheles pharoensis* by the sterile-male technique using cobalt-60. IV. Mating behavior and its frequency in the sterilized mosquitoes. (Tantawy, A.O. et al., 1967)
- 1612 Studies on the eradication of *Anopheles pharoensis* by the sterile-male technique using cobalt-60. V. Mating competitiveness in radiosterilized males. (Tantawy, A.O. et al., 1967)
- 1622 Studies on the application of the sterility in the tick *Ornithodoros tholozani*. (Galun, R. et al., 1967)
- 1749 Application of an actographic recording method to the study of the effects of irradiation on *Calandra granaria* larvae. (Pesson, F.P. et al., 1965)

2.3.2. Population Dynamics

- 1480 Bileva, D.S. THE EFFECTS OF α -IRRADIATION ON THE NUMBERS AND VIABILITY OF EXPERIMENTAL POPULATIONS OF Drosophila melanogaster. p. 177-187 of "Vliyanie ionizirovannykh izlucheni na Nasledstvennost". Dubinin, N.P., Ed. Moscow, Izdatel'stvo Nauka, 1966. (In Russian)

D. melanogaster was irradiated with 500, 1500, 3000, and 5000 R x-radiation and the population dynamics investigated. During the first 17 d, the decrease in numbers and viability varied directly with the dose. From the 27th-45th day, flies irradiated with 500 and 1500 R outdistanced the controls in numbers. At that stage, viability was equalized in the irradiated and unirradiated populations in the 2nd and 3rd generations. From the 55th - 144th day, numerical equilibrium was established in all populations; from the 170th - 385th day the populations again differed in numbers, evidently due to temperature variations. On the 434th day the experimental population did not differ from the control in viability. (NSA 22:1968, 21811)

- 1481 Carfagna, M., De Capoa, A. MAGGIORE AFFOLLAMENTO NUMERICO IN POPOLAZIONI DI Drosophila melanogaster PERIODICAMENTE IRRADIAE ED ALLEVATE IN CONDIZIONI DI FORTE PRESSIONE SELETTIVA. (Larger numerical overcrowding in populations of Drosophila melanogaster periodically irradiated and bred in conditions of strong selective pressure.) Atti Ass. genet. ital. 7 (1962) 232-238. (In Italian, with English summary). Also presented at "7th Scientific Meeting of the Italian Genetics Association. Parma, Italy, 9-10 Oct. 1961".

Investigations were carried out on 33 generations of D. melanogaster, a laboratory population of which were exposed to chronic x-irradiation (100 and 500 R per generation). The total number of flies were counted regularly at intervals of 14 d, with double testing of the hatchability and fertility at the 300th and 400th day for individual populations. (1) No significant differences were found between the numeric levels of the two populations exposed to the 100 R dose and those of the untreated controls, pooled means for the two series being 1443 ± 50 and 1354 ± 52.2 . (2) The increase in crowding of the two populations exposed to the 500-R dose, already noticeable in the 1st experimental series has become very clearcut, pooled means in the first treated series being 1598 ± 49 against 1354 ± 52 for the controls; a difference which is significant at the 0.001 level. (3) In spite of this obvious increase in the adaptivity of the irradiated populations to conditions of strong selective pressure, higher values resulted for the classical parameters of biological fitness in D. melanogaster (% of hatchability and fertility) for the controls. This apparent inconsistency is very probably due to the fact that there may exist physiological characteristics, other than those measured so far, which are of primary importance in determining fitness under the conditions described.

- 1482 Klimpinya, A.E. USE OF GAMMA RAYS TO REDUCE NUMBERS OF BEET FLIES. Latv. PSR Zināt. Akad. Vest. No. 11 (1966) n.p.

- 1483 Lewontin, R. C. A STUDY OF MATHEMATICAL MODELS OF MUTATION AND SELECTION IN MULTI-LOCUS SYSTEMS. Three Year Progress Report, December 1, 1964-November 30, 1967. COO-1487-3, Chicago Univ., Ill. Dept. of Zoology. 12p.

Progress is reported on: development of a multi-locus simulator (computer program) for determining gene frequencies; linkage disequilibrium at selected pairs of loci; phenotypic and genotypic means and variances of each kind of locus; synergistic effects of blocks of genes and effects of linkage on gene frequency; use of simulator for studies on multiple heterotic systems; effects of recombination on fitness of populations; development of a quadratic optimum model for determination of equilibrium of genes in quadratic optimum selection; segregation distortion resulting from abnormal gamete production; population dynamics of male-sterile alleles; effects of fluctuating selection in populations of a given size; selection in inbred populations using two-locus polymorphisms in the grasshopper, Moraba scura; estimation of fitnesses from genotypic frequencies in successive generations; rates of increase of populations of Drosophila; and interaction of genes in determining evolutionary changes in populations. (NSA 22:1968, 7938)

- 1484 Planel, H., Soleilhacoup, J.P., Giess, M.C., Tixador, R. ACTION DES RADIATIONS IONISANTES NATURELLES SUR LA REPRODUCTION DES METAZOAIRES: RECHERCHES CHEZ Drosophila melanogaster. C. r. heb. Séanc. Acad. Sci., D 264, 5 (1967) 755-758.

Les élevages ont été disposés à l'intérieur de deux enceintes de mêmes dimensions, en bois et polystyrène pour les élevages témoins, aux parois de plomb épaisses de 10 cm pour les élevages protégés. La protection de *D. melanogaster* vis-à-vis des radiations ionisantes naturelles provoque une inhibition ou un retard de développement, les populations adultes protégées étant, à la première génération, toujours numériquement inférieures à celle des cultures de contrôle. Cette constatation permet de penser que la notion d'une activité biologique des radiations ionisantes naturelles, déjà démontrée chez des Protozoaires, s'applique également à des organismes plus complexes, pluricellulaires.

- 1485 Sankaranarayanan, K. INFLUENCE OF SELECTION ON THE VIABILITY OF IRRADIATED EXPERIMENTAL POPULATIONS OF *Drosophila melanogaster*. *Genetics* 57, 3 (1967) 687-690.

The histories of four experimental populations, started in 1962, are reviewed. Three had received 120 000 R x-rays in 60, 30, and 20 generations, respectively, at rates of 2000, 4000 and 6000 R/per generation. Cage populations were developed from three populations with past radiation histories (See III - 926, 942, 944 and IV - 1510) and a control population, which were maintained under conditions designed to minimize larval crowding. The egg-to-adult viability remained at plateau levels of between 60 and 77% (far below that of the control) for periods ranging from 31-54 generations in the different parent populations. Under cage conditions, the viability in all the populations increased to > 90-95% of the control value in about two generations, and later on these were almost indistinguishable from the control level. It is suggested that the rapid rise in viability is a consequence of intense selection prevailing under cage conditions. Presumably mutants that were unfavorable in the new environment were eliminated rapidly and those that were favorable were retained and multiplied.

- 1486 Willard, W.K. LONG-TERM EFFECTS OF ACUTE LOW-LEVEL x-RAYS ON THE POPULATION DYNAMICS OF THE YELLOW FEVER MOSQUITO, *Aedes aegypti*. * *Hilth Phys.* 11, 12 (1965) 1577-1583.

Populations of four life-history stages (eggs, 1st-instar larvae, pupae and adults) of the yellow fever mosquito were subjected to acute low-level x-rays and followed through three generations. Fecundity, egg viability, larval growth rate and mean longevity were population parameters utilised in evaluating the long term effects. Effects were most strongly exerted in the 1st generation and gradually subsided in subsequent generations. Doses of 50-400 R were found to be stimulatory in some cases, while doses of 800 R and above were detrimental. The egg stage was found to be most sensitive followed by the larval, pupal and adult stages. Effects on egg viability were most drastic and persisted through three generations. (Auth.)

* See also ref. III/927, for thesis of the same title.

See also :

- 1300 x-Radiation and temperature modification of reproductive performance of single-species and mixed-species cultures of *Tribolium confusum* and *Tribolium castaneum*. (Erdman, H.E., 1966)
- 1490 Studies of the genetic processes in irradiated populations. Dynamics of enumeration of irradiated populations. (Bileva, D.S., 1965)
- 1491 A study of the genetic processes in irradiated populations of *Drosophila melanogaster*. III. The fecundity and the concentration of lethal mutations. (Bileva, D.S., 1967)
- 1496 Genetic variability induced by ionizing radiations in quantitative traits of *Habrobracon*. (Dalebroux, M.A., 1966)
- 1497 Progress report (on genetic studies), June 1, 1965 - June 1, 1966. (Dobzhansky, T., 1965/1966)
- 1522 Les hétéroptères de regan (Hemiptera, Heteroptera). (Dispons, P., 1964)
- 1530 An aphid population explosion induced by chronic gamma irradiation of a forest. (Woodwell, G.M. et al., 1967)
- 1579 Mating behavior and population dynamics of the boll weevil as related to the sterile-male-technique of insect control. (Gilliland, F.R. Jr., 1967)

2.3.3. Physiological Characteristics

- 1487 Bartlett, A.C., Bell, A.E., Anderson, V.L. CHANGES IN QUANTITATIVE TRAITS OF Tribolium UNDER IRRADIATION AND SELECTION. Genetics 54 (1966) 699-713.

The consequences of various combinations of selection (high and random) and levels of x-irradiation (0, 100, and 1000 R per generation) on pupal weight were investigated in two strains of T. castaneum for 11 generations. Reproductive fitness was measured each generation in terms of sterility, adult mortality and number of offspring. The Foundation Strain was an unselected panmictic population with an initial weight of 2.10 mg. The second strain, Large, had originated earlier from Foundation and had been selected for large pupal weight for 44 generations. At the beginning of the present study its average pupal weight was 5.66 mg. - High selection contributed to significant responses in pupal weight, but the degree of response was negatively correlated with the level of irradiation. Even though an increase in heritability and phenotypic variance was observed in some irradiated lines, a decline in reproductive fitness contributed to smaller selection differentials and in turn less selection response. - Several strain interactions were possibly related to the previous selection history of the genetic material. For example, reproductive fitness increased with high selection in Foundation and responded inversely in the Large Strain. Yet the latter was more resistant to the deleterious effects of irradiation than was the Foundation Strain. (Essentially auth. summary)

- 1488 Dalebroux, M.A., Kojima, K.I. AN ANALYSIS OF RADIATION-INDUCED VARIATION OF BODY-WEIGHT OF Habrobracon juglandis. Genetics 55, 2 (1967) 315-328.

A quantification of the genetic variability induced by γ -irradiation was carried out with quantitative characters of H. juglandis. Adult female (diploid) and male (haploid) body weights were studied in homozygous and heterozygous genetic backgrounds. The dose-response relationship was determined with respect to body weights of females that might be heterozygous for induced mutations. The responses to 0, 1.0, 1.5, 2.5 and 4.0 kR irradiations were measured using the F-ratio between the variances among family means in the irradiated material and in the control. The max. response was obtained at 1.5 kR. Induced genetic variability was studied in detail with 1.5 kR irradiation. (1) A striking increase of genetic variance was observed for induced-mutation-heterozygote females in either homozygous or heterozygous genetic background. (2) A great increase of genetic variance was also observed among males segregating for induced mutations in an otherwise homozygous line (i.e. males produced by mutation-heterozygote females with the homozygous genetic background). However, there was no significant increase of genetic variance among males produced by mutation-heterozygote females with the heterozygous genetic background. - These findings suggest that (a) induced mutations can increase or decrease body weight, (b) induced mutations affecting body weight are not necessarily recessive to their wild-type alleles, and (c) there are little or no nonallelic interactions between induced mutations and the rest of the genes affecting body weight. (Auth. summary)

See also:

- 1404 Evolution of fitness. I. Improvement in the productivity and size of irradiated populations of Drosophila serrata and Drosophila birchii. (Ayala, F.S., 1966)
- 1470 Fitness and competitive ability in irradiated populations of Drosophila melanogaster. (Dyer, K.F., 1966)
- 1496 Genetic variability induced by ionizing radiations in quantitative traits of Habrobracon. (Dalebroux, M.A., 1966)
- 1497 Progress report (on genetic studies), June 1, 1965 - June 1, 1966. (Dobzhansky, T., 1965/1966)
- 1511 Investigations on mutability of polygenes and on utilization of induced genetic variability. Summary of the results up to June 30, 1963. (Scostoli, R.E., 1963)
- 1520 Evolution of fitness. III. Improvement of fitness in irradiated populations of Drosophila serrata. (Ayala, F.J., 1967)

2.3.4. Genetic Changes

- 1489 Aastveit, K. INDUCED MUTATIONS IN POLYGENIC SYSTEMS. *Hereditas* 56, 1 (1966) 20-26.
A highly inbred line of *Drosophila melanogaster*, which showed no response to selection for high and low sternoplural chaetae number, was irradiated with 1500 R of x-rays or treated with repeated low doses of ethyl methane sulphonate (EMS). The induced genetic variation was measured by the response of the populations to 2-way selection. In the γ -ray experiment a clear response was obtained, in a negative as well as in a positive direction. In the EMS-treated lines no response to selection was obtained in the line selected for high number of sternoplurals. In the low line there was a clear and significant response. (Auth. summary)
- 1490 Bileva, D.S. STUDIES OF THE GENETIC PROCESSES IN IRRADIATED POPULATIONS. DYNAMICS OF ENUMERATION OF IRRADIATED POPULATIONS. *Dokl. Acad. Sci. U.S.S.R., Biol. Sci. sections* 164, 1-6 (1965) 597-599 (In English). Originally appeared in *Dokl. Akad. Nauk SSSR* 164, 1 (1965) 191. (In Russian). Cited as III/915.
The present article is the first in a series of studies of genetic processes which occur in irradiated populations, and is devoted to the analysis of the dynamics of population density following irradiation with different x-ray doses. Density is a convenient criterion for overall evaluation of radiation effects on populations and for establishing dose dependence. The original groups on *Drosophila melanogaster* consisted of 50 females and 50 males from an inbred line, established from wild flies. Doses of 500, 1500, 3000, and 5000 R were used, each of the five experimental series being repeated three times. During most of the experiment the population was kept at room temperature (24-26°C). During the first generation, density increase was depressed in irradiated populations approximately in accordance with radiation dose. Some population densities approached and some even surpassed the densities of controls between the 2nd and 3rd generations, after which statistically similar equilibrium conditions were established for all populations. The initial drop in density of the irradiated populations was evidently related to mutations induced by irradiation, which lowered the fertility and viability of the flies and were rapidly eliminated under conditions of intensive selection.
- 1491 Bileva, D.S. A STUDY OF THE GENETIC PROCESSES IN IRRADIATED POPULATIONS OF *Drosophila melanogaster*. III. THE FECUNDITY AND THE CONCENTRATION OF LETHAL MUTATIONS. *Genetika* No. 4 (1967) 66-73. (In Russian)
A study of the effect of irradiation and population density on the fecundity (egg production/female/d) of fruit flies (*D. melanogaster*) from the control and experimental populations was carried out. It was shown by this study that the effect of the density of population 30×30 and 50×50 reduces the fecundity not less considerably than the irradiation by dosages of 3000 R - 5000 R. The fecundity is determined virtually by that factor which limits it to a greater extent. At the population density 1×1 it is the irradiation. As the population density increases by 30-50 times, it is to a greater degree the shortage of food consumed per female. Consequently the difference in the fecundity between the control and irradiated flies decreases with the increase of the population density. In the 1st generation of the progeny of irradiated flies the normal fecundity is completely recovered. It was shown by the investigation of the concentration of lethal and semilethal mutations in the control population and in that irradiated once (at a dosage of 5000 R) before and after the establishment of the equilibrium of the numbers of individuals, that in the control population it was low (10.67%) because this population was derived from an inbred line. In F_2 following the irradiation the concentration of lethals and semilethals increased up to 30.4%. However, after the equilibrium of the population was restored, the concentration decreased again to the level of the control population. (NSA 21:1967, 28421)
- 1492 Blaylock, B.G. CHROMOSOMAL POLYMORPHISM IN IRRADIATED NATURAL POPULATIONS OF *Chironomus*. *Genetics* 53 (1966) 131-136. Also appeared in report form, as ORNL-P-1560, Oak Ridge National Lab., Tenn.
Chromosomal polymorphism in a natural population of *Chironomus tentans* inhabiting a stream contaminated by radioactive waste was compared with a nonirradiated population. Ten inversions and one deletion were found in the irradiated population but not in the control population. The frequencies of three endemic inversions which were found in both populations were not significantly

different in the irradiated and nonirradiated populations. It was concluded that in the irradiated population, where an increased frequency of new chromosome aberrations was detected, the frequencies of the endemic inversions were unchanged by the chronic radiation. (Auth)

- 1493 Blaylock, B.G. CYTOGENETIC STUDY OF A NATURAL POPULATION OF CHIRONOMIDAE INHABITING AN AREA CONTAMINATED BY RADIOACTIVE WASTE. p.835-846 of "Symposium for the Disposal of Radioactive Waste into Sea, Oceans, and Surface Water. Vienna, Austria. 17 May 1966". Vienna, International Atomic Energy Agency, Austria. 1966, 898p.

The aquatic larvae of *Chironomus tentans*, one of the midges, inhabit the radioactive bottom sediments of White Oak Lake and White Oak Creek in large numbers. This aquatic habitat has received varying quantities of radioactive waste released from the Oak Ridge National Laboratory since 1943. Dosimetric measurements and calculations based on radionuclide content of the bottom sediments indicate that these larvae were receiving 230 rad/yr. It is estimated that 130 generations have been exposed to this or greater dose rates for the past 22 years. During the past five years the incidence of chromosomal aberrations in the salivary gland chromosomes of larvae collected seasonally from the radioactive and control habitats was measured. Chromosomal polymorphism is prevalent in *C. tentans* in this locality and six endemic inversion heterozygotes were found in all populations. Three of these inversions occurred at relatively high frequencies (.09 to .22), but these frequencies did not fluctuate seasonally nor change significantly in the irradiated populations for five years. Also, the frequencies of endemic inversions in the irradiated populations were not significantly different from control populations. In addition to the six endemic inversions found in all populations, ten inversions and one deletion were observed only one time in 755 larvae from the radioactive habitat, while no additional aberrations were observed in 714 larvae from the control habitats. It is concluded that the ionizing radiation from the radioactive waste was increasing the frequency of new chromosomal aberrations in the White Oak Lake and White Oak Creek populations, but these new aberrations were eliminated by selection. Also this level of chronic radiation, which was capable of producing a detectable increase of new chromosomal aberrations, has not affected the fitness of the population by producing a change in the frequencies of the endemic inversions. (Auth.)

- 1494 Blaylock, B.G. POPULATION GENETICS AND RADIATION EFFECTS STUDIES. p.48-50 of "Health Physics Division Annual Progress Report for Period ending July 31, 1966". ORNL-4007, Oak Ridge National Lab., Tenn. Oct. 1966, 300p.

Study of the natural population of *Chironomus tentans* in White Oak Lake and White Oak Creek has continued since 1960. Annual samples were taken from this population, which has been exposed to an estimated dose of 230 rad/yr for > 120 generations; 12 different aberrations were found in the irradiated population (at a very low frequency). One aberration, a small inversion, was found in larvae of an irradiated population of *C. plumosus*. Ionizing radiation from the contaminated environment evidently increases the frequency of new chromosomal aberrations, which are, however, rapidly eliminated by natural selection. Laboratory populations of *Drosophila melanogaster*, *D. tropicalis*, and *D. simulans* were used to study the effects of γ -radiation in interspecific competition. Laboratory *D. melanogaster* established for chromosomal polymorphism studies were also used to study viability (egg to adult emergence) of the population after exposure to acute (2000 rad) and chronic (6 rad/h) γ -radiation. Viability was reduced by 80% but recovered rapidly after acute irradiation, whereas chronic irradiation resulted in a slow reduction, and was never as great.

- 1495 Buzzati-Traverso, A.A. VELOCITA' DI PROCESSI MICROEVOLUTIVI IN POPOLAZIONI IRRADIAE. (Velocity of microevolutionary processes in irradiated populations.) *Atti Ass. genet. ital.* 5 (1960) 183-184. (In Italian, with English summary). Also presented at "5th Scientific Meeting of the Italian Genetic Association and the 8th Annual Meeting of the Biometric Society. Naples, Italy, 22-24 Oct. 1958".

Previous experiments have shown that the rate of microevolutionary processes leading to higher fitness is higher in *Drosophila melanogaster* populations treated with x-rays than in non-irradiated control populations. Physiological traits, such as fecundity, as well as morphological traits controlled by polygenic systems were shown to undergo evolutionary change. Populations are currently under study in which the mutant spineless (ss) of the III chromosome is used as a marker in combination with other recessive mutants. In a relatively large number of such populations (2 out of 6 in

one set, and 7 out of 16 in another) individuals have appeared whose bristles are appreciably longer than those of the ss mutant. Since their 1st appearance in any one population the percentage of such non-spineless individuals has steadily increased, thus showing that they possess positive selective value. This trait is due to different sets of polygenes in each population. A comparison between irradiated and non-irradiated populations shows that the rate of occurrence of such polygenic mutants affecting the ss phenotype is markedly different in different populations. Indistinguishable phenotypic changes can thus show different selective values depending on the polygenic systems by which they are controlled. (Auth.)

- 1496 Dalebroux, M. A. GENETIC VARIABILITY INDUCED BY IONIZING RADIATIONS IN QUANTITATIVE TRAITS OF *Habrobracon*. Diss. Abstr. 26, 8 (1966) 4182.

The traits studied were adult female body weight, adult male body weight and fecundity. The experimental designs and mating schemes were set up to take max. advantage of the haploidy of the males in this organism. A group of females from an inbred line were irradiated and their parthenogenetic sons were mated individually to virgins from the same as well as from a different inbred line, in order to obtain families with homozygous and heterozygous genetic backgrounds, respectively. The analysis of the data on female body weight and fecundity was done on the basis of the means of the above families. The male body weight character was studied among individual grandsons within families and among family means. Doses 0.0-4.0 kR helped to determine an appropriate dose level at which a significant response in mutation yield could be expected in at least one of the traits under consideration. The dose of 1.5 kR was chosen on the basis of a preliminary investigation, (0.0-4.0 kR doses), and the effects of the radiations in later generations were studied in both homozygous and heterozygous genetic backgrounds. The radiation source used was ^{60}Co delivering γ -rays at the rate of approx. 250 kR/h. From an analysis of family means it appeared that (1) In both genetic backgrounds, a highly significant increase in genetic variation was detected for female body weight, (2) Insofar as fecundity is concerned, there was only a tendency towards increasing the genetic variability in the treated materials as compared to their respective controls. (3) There seemed to be no evidence of nonallelic interactions between induced mutations and their genetic backgrounds. When the analysis was carried out on individual male body weight, the increase in genetic variance induced by radiations was much larger under the homozygous genetic background than that found under the heterozygous background. The reliability of the dosage-response curve was discussed. An interpretation of the lack of any significant response for the fecundity trait was given, particularly on the basis of the dominance relationship between the induced mutant genes and their wild type alleles. Finally, in order to explain the apparent disagreement between the hypothesis of nonepistasis and the results obtained from individual male body weight, a possible explanation was proposed using a genetic model based on the absence of nonallelic interactions. (From DA)

- 1497 Dobzhansky, T. PROGRESS REPORT (ON GENETIC STUDIES), June 1, 1965 - June 1, 1966, NYO-3096-8, Rockefeller Univ., New York. 13p.

A review of current work and work completed is presented under the headings (1) Genetic loads in irradiated experimental populations, (2) Genetic loads in natural populations, (3) Chromosomal polymorphisms in natural and experimental populations, and (4) Genetic diversity and selection. [(1) is of immediate interest here.] The genetic consequences of exposure to x-radiation are described for experimental populations of *Drosophila melanogaster* maintained under conditions of relaxed selection. As expected, the egg-to-adult viability increased rapidly after relaxation; however, new and constant viability levels become established, all significantly lower than the control level (~70-75%). Thus, the egg-to-adult mortality in the populations with radiation histories continues, many generations after irradiation has been discontinued, to be 15-20% below the control level. (Competition had been deliberately minimized in the experimental populations.) - Experiments are also reported on irradiated and control populations of *D. serrata* and *D. birchii*. It appears that the increased genetic variance induced by the irradiation described may be exploited by natural selection to increase the fitness of the populations, at least under the highly artificial and stringently competitive conditions which had been deliberately created in the experiments.

- 1498 Dobzhansky, T. PROGRESS REPORT [ON GENETIC LOAD IN NATURAL POPULATION IN RELATION TO GENETIC BACKGROUND], June 1, 1966-June 1, 1967. NYO-3096-21, Rockefeller Univ., New York. 12p.

Radiation effects on the proportion of lethal 2nd chromosomes in Drosophila melanogaster were studied. Genetic loads in irradiated populations of Drosophila were studied. Three of the four populations had received accumulated doses of 120 000 R. Data obtained on continued irradiation would best be fitted by a hypothesis that the frequent lethals are maintained in the populations by heterotic advantages.

- 1499 Falk, R. EFFECTS OF RADIATION INDUCED MUTATIONS ON VIABILITY COEFFICIENTS IN Drosophila. p.80 of "3rd International Congress of Radiation Research, Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966, . 263p", Abstr. 315

Radiation induces a random array of mutations. Most of these mutations are deleterious in homozygotes. Yet, some investigators found the viability of heterozygotes for induced mutations to be higher in some cases than that of the unirradiated controls, especially when the control genotype was homozygous at most loci (Wallace) or was below an optimal heterozygosity level (Mukai). The hypotheses advanced to explain these increases in viability had to assume the existence of non-specific interactions of allele pairs. It was hoped that such hypotheses should explain the origin of variability in natural populations. The mean viability of D. melanogaster heterozygous for chromosomes irradiated in spermatogonia with 2000-3000 R was found to be somewhat less than that of the unirradiated controls. When the experiments were designed so as to eliminate factors that could bias the results, such as differences in competing ability that would compensate for differences in viability, the viability coefficient of heterozygotes for irradiated chromosomes was equal, or even higher than that of the unirradiated controls. In later experiments a significant increase in viability coefficients of flies heterozygous for chromosomes irradiated with 12 000 R in spermatogonia, was observed. Most chromosomes carried one or more mutations that affected the viability of the homozygotes severely. Similar high viability coefficients were observed in other series irradiated with 3000 R and 6000 R in spermatogonia. Since the unirradiated controls were highly heterozygous, irradiation was expected to reduce the viability coefficients, even according to the "optimal heterozygosity" hypothesis of Mukai. Another method of estimating viability yielded lower viability estimates for heterozygotes for irradiated chromosomes than for the unirradiated controls. (Abstr.)

- 1500 Falk, R. FITNESS OF HETEROZYGOTES FOR IRRADIATED CHROMOSOMES IN Drosophila. Mutation Res. 4, 6 (1967) 805-819.

Artificial populations of D. melanogaster were established in small plastic containers. Each population was started with equal numbers of flies heterozygous for a curly-chromosome and a given irradiated chromosome and flies heterozygous for the same curly-chromosome and an unirradiated chromosome. Since the homozygotes were either lethal or sterile, only fitness of the heterozygotes for the irradiated chromosome and of the heterozygotes for the unirradiated chromosome determined the fate of the populations. - In one experiment more than 240 populations were started with chromosomes which had been exposed in spermatogonia to 2000 R. Most populations were maintained for 3-4 months. In the second experiment more than 200 populations were started with chromosomes which had been exposed in spermatogonia to 4 doses of 3000 R each. Most populations were maintained for 7 months, and those not heterozygous for lethals were maintained for another 5 months. A third, control experiment, included only non-irradiated chromosomes. In both radiation experiments the fitness of heterozygotes for irradiated chromosomes was below unity fitness. It did not deviate from unity in the control experiment. The mean fitness of heterozygotes for lethals was reduced by about 7%/generation. Subvitals were defined so that they overlapped the normal range, yet their fitness in heterozygotes was reduced by about 2%/generation. Normal chromosomes in the irradiated samples did not deviate from unity fitness. On the average the fitness of the heterozygotes for a sample of newly induced mutations is correlated to the viability of the homozygotes. This is also demonstrated by the improvement in the viability of the homozygotes for chromosomes, which were originally subvital, after these were exposed for nearly 1 yr to selection as heterozygotes. (From auth. summary)

- 1501 Hoyer, R. F. SOME NEW MUTANTS OF THE HOUSE FLY, *Musca domestica*, WITH NOTATIONS OF RELATED PHENOMENA. *J. econ. Ent.* 59, 1 (1966) 133-137.
- Two subcolonies, one from the Orlando Regular and the other from the Tropical "P" strain, had been routinely exposed to γ -radiation (~600 R) as pupae in each generation for more than 50 generations. Several mutants of the housefly, *M. domestica* L., were isolated from normal and γ -irradiated strains reared in the laboratory. The identity and maintenance of mutant strains, along with notations of related phenomena, are presented. Most of the aberrant forms that were isolated involved wing form, wing positioning, or the pattern of wing venation. Four established mutant strains, classic wing, stubby wing, dot vein, and white, have proved useful in the genetic analysis of insecticide resistance.
- 1502 Jones, L. P. EFFECTS OF X-RAYS ON RESPONSE TO SELECTION FOR A QUANTITATIVE CHARACTER OF *Drosophila melanogaster*. *Genet. Res.* 9, 2 (1967) 221-231.
- Lines with ten pairs of parents and selected at an intensity of 20% were exposed to 1000 R of x-rays for 0, 2, 10 or 30 generations. Lines which received some irradiation generally gave greater response than the unirradiated controls. The phenotypic variance in the irradiated lines was much higher than in the controls. There was little difference in behaviour between lines receiving ten generations of irradiation and those irradiated every generation. Lines receiving only two generations of irradiation had lower variances than the other irradiated lines, but in one of three replicates the response was greater than the corresponding continuously irradiated line. Lethal frequencies were much higher in irradiated than unirradiated lines. Particular chromosome II and III lethals were at high frequencies in most of the irradiated lines but in only two out of five controls. On relaxation, the mean of the irradiated lines generally declined considerably, but in the unirradiated lines there was only a very small regression. It appears that most of the extra response and increased variance in the irradiated lines were caused by a few genes with large effect on bristle number. (Auth. summary)
- 1503 Kitagawa, O. THE EFFECTS OF X-RAY IRRADIATION ON SELECTION RESPONSE IN *Drosophila melanogaster*. *Idengaku Zasshi* (Jap. J. Genet.) 42 (1967) 121-137.
- Experiments were conducted with *D. melanogaster* for the purpose of investigating the mechanism by which new genetic variability available for artificial selection is induced by x-rays and to estimate the increase in polygenic variability in abdominal bristle numbers. Genetic variability, probably originating from mutation and recombination in polygenic systems, was induced by x-irradiation (1500 R) and contributed to the effectiveness of artificial selection. Selection response based on analysis of variance was greatest when both sexes were treated and in groups where males only were treated. Rates of radioinduced mutations, in terms of increments of variance, were 28.1×10^{-5} for both sexes treated, 10.7×10^{-5} for only females treated, and 20.3×10^{-5} for only males treated. (NSA 21: 1967, 26397)
- 1504 LaChance, L. E., Hopkins, D. E. EFFECT OF SELECTION ON WHAXY: AN AUTOSOMAL DOMINANT MUTATION IN THE SCREW WORM FLY WITH RECESSIVE LETHAL EFFECTS. *Am. Nat.* 99 (1965) 47-57.
- The mutant Whaxy was originally described as one of several mutants in the screw worm fly, *Cochliomyia hominivorax*, induced by ^{60}Co γ -radiation. Irradiation of a large number of flies was carried out in connection with a programme of radioinduced sterilisation of males for eradication of this fly. The mutation has now been under selection for more than 30 generations. The mutant flies are viable and their flight or other activity is not affected. In general, the data support the hypothesis that the Whaxy factor is dominant and lethal in the homozygous condition. However, after 22 generations of selection the number of Whaxy progeny in each generation increased significantly and has remained at a higher-than-expected level, assuming that the homozygous state continued to be lethal. Tests were conducted to investigate the possible reasons for the increase in Whaxy progeny. Data are presented on the hatchability of eggs, pupal emergence, and segregation of progeny from different crosses involving Whaxy flies. In the earlier generations crosses of Whaxy flies produced the expected 3 Whaxy : 1 normal progeny, and out-crosses produced the expected 50% Whaxy progeny. To explain the fact that after 22 generations of selection the number of Whaxy progeny in each generation increased significantly above 66% and remained at a level higher than expected, the possibility that selection resulted in a higher viability of the hetero-

zygotes, survival of the homozygotes, or lower viability of the wild type is considered. Data from several experiments supporting one or the other alternatives are presented. The phenotype is due to a dominant autosomal mutation with recessive lethal effects. (NSA 21: 1967, 6476)

- 1505 Marques, E.K. GENETIC EFFECTS OF GAMMA RADIATION ON Drosophila POPULATIONS UNDER INTERSPECIFIC COMPETITION. p. 149 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966, 263p." Abstr. 580.

The average fitness of Drosophila populations can be measured by the competition between different species. The changes induced in their genetic pool by radiation will be represented by selective advantage or disadvantage measured by the proportional number of offspring of one species compared with the number of another in successive generations. The interspecific competition between D. nebulosa and D. willistoni started with 50% of each species without overlapping generations always results in the elimination of D. willistoni. The speed of elimination in 16 population cages at 25°C (588 032 flies) was modified by the ^{60}Co γ -radiation. After a decrease of the average fitness dependent of the doses accumulated in the D. nebulosa populations (500 R, 1000 R or 2000 R per generation) we obtained an increase in the fitness of the 1st and 2nd group of these irradiated populations. In the control populations between the 8th to the 12th generations D. nebulosa eliminated the other species. At that generation we obtained in the irradiated populations 85.88% (500R/generation), 57.64% (1000R/g) and 1.70% (2000R/g) of D. nebulosa. We started 24 new populations with 50% of D. nebulosa of the 13th generation of the populations above mentioned in competition with D. willistoni from a non-selected stock. The D. nebulosa showed an increase in the competitive ability but maintaining the decrease in the average fitness dependent of the accumulation of doses: \bar{w} : Control > 500R/g > 1000R/g. Replications of these same populations when irradiated with 1000R per generation showed a different fitness measured by the speed of elimination of the D. willistoni: \bar{w} : 500R/g > 1000R/g > Control. Tests of egg mortality (120 383 eggs) and egg-adult viability showed this same relation, clearly suggesting the appearance of radioresistance. (Abstr.)

- 1506 Matsudaira, Y. ON THE INTERACTION BETWEEN THE CHROMOSOMES CARRYING THE DETRIMENTAL GENES OR GENE BLOCKS IN VIABILITY. J. Radiat. Res., Chiba 4, 2-4 (1965) 111-119. (In English)

This investigation was carried out to clarify whether or not the induced detrimental genes or gene blocks interact with each other, by means of using Drosophila as the material. It was ascertained that an interaction between genes or gene blocks for the viability in the 2nd and 3rd chromosome exists. It was also demonstrated that the spectra of viability, this is, the distribution of frequencies in viability, formed bimodal curves for irradiated 2nd chromosomes, for irradiated 3rd chromosomes, and for both irradiated 2nd and 3rd chromosomes. The spectrum of viability in the isogenic lines is discussed with inference to these results. Further, the genetic load of an organism having two interacting loci is calculated, based on the theoretical model and based on the obtained results. (Auth.)

- 1507 Mukai, T., Yoshikawa, I., Sano, K. THE GENETIC STRUCTURE OF NATURAL POPULATIONS OF Drosophila melanogaster. IV. HETEROZYGOUS EFFECTS OF RADIATION-INDUCED MUTATIONS OF VIABILITY IN VARIOUS GENETIC BACKGROUNDS. Genetics 53 (1966) 513-527.

Heterozygous effects on viability of induced 2nd chromosome mutations were tested in both homozygous and heterozygous genetic backgrounds (with respect to the 2nd chromosome), in experiments involving approximately 2.8 million flies. The mutations, mainly polygenic, were induced by 500 R x-irradiation administered at a dose rate of approx. 100 R/min. Induced mutations are heterozygously slightly beneficial in an otherwise homozygous genetic background which was directly extracted from an equilibrium natural population, while they are, in heterozygous condition, neutral or at least not heterotic in an otherwise homozygous genetic background which was synthesized using 64 unrelated wild-type stocks. When these induced mutations were placed as heterozygotes in either intra- or inter-population crosses, they seemed to be slightly detrimental. The radiation-induced mutation rate of polygenes controlling viability was estimated to be approx. 0.79 per 2nd chromosome per 500 R. The role of overdominance in the maintenance of genetic variation in random mating equilibrium populations is discussed. (Auth.)

- 1508 National Inst. of Radiological Sciences, Chiba (Japan). GENETICS. p. 47-55 of Annual Report [on Radiological Sciences]. NIRS-5. Dec. 1966, 84p.

Progress is reported on numerous studies including one on the effects of x-rays on genetic load in a Drosophila population; heterozygous effects of newly arising spontaneous lethal genes on viability in D. melanogaster; effects of toymycin on x-ray induced recessive lethal mutation rates in D. melanogaster; the effect of chronic radiation on sex-linked lethal mutation frequencies in D. melanogaster.

- 1509 Salceda, V.M. RECESSIVE LETHALS IN SECOND CHROMOSOMES OF Drosophila melanogaster WITH RADIATION HISTORIES. Genetics 57, 3 (1967) 691-699.

Experimental populations with radiation histories, and a control population, were kept in laboratory population cages under conditions of extreme crowding and intense larval competition. The frequencies of 2nd chromosomes which were lethal or semilethal when homozygous remained at levels appreciably higher than in the control, while the egg-to-adult viability declined below the control level in the populations with radiation histories. The rates of allelism of the lethals in experimental populations are fairly high, owing to some lethal loci being present in many chromosomes. These lethals are maintained in the populations by natural selection because of their heterotic effects in heterozygous individuals. (Auth. summary)

See also 1485.

- 1510 Sankaranarayanan, K. SOME COMPONENTS OF THE GENETIC LOADS IN IRRADIATED EXPERIMENTAL POPULATIONS OF Drosophila melanogaster. Genetics 54, 1 Pt. 1 (1966) 121-30.

Three experimental populations, kept under conditions designed to minimize the larval competition and crowding, received each 120 000 R of x-rays during 20, 30 and 60 generations, respectively. The egg-to-adult viability decreased sharply, but, after the radiation was discontinued, the egg-to-adult viability recovered rapidly for several generations and then reached a plateau. This plateau is, however, 15-20% below that in the control, unirradiated, population. - The frequencies of the 2nd chromosomes which were lethal or semilethal when homozygous declined after the cessation of the radiation, without however in any case reaching the control level. The frequency of alleles among the lethals has increased. Some particular lethal chromosomes have become more frequent, probably owing to heterotic effects under the conditions obtained in these experiments. (Auth. summary)

- 1511 Scossiroli, R.E. INVESTIGATIONS ON MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY. Summary of the Results up to June 30, 1963. TID-19432, Pavia Univ. (Italy). Istituto di Genetica. 1 Jul. 1963, 34p.

Results are reported from studies of radioinduced mutations in maize, wheats, tomatoes, and alfalfa. Observations on induced genetic variability for quantitative traits are presented. Data are also included from a genetic analysis of long- and short-winged lines of Habrobracon juglandis after 15 generations of inbreeding. (NSA 17:1963, 38748)

- 1512 Scossiroli, R.E. INVESTIGATIONS ON MUTABILITY OF POLYGENES. Final Report. NYO-10620, Pavia Univ. (Italy). Istituto di Genetica. 31 Dec. 1963, 13p.

Progress is reported in studies on the effect of spontaneous and induced mutations in the induction of quantitative genetic traits in plants. x-radiation was used as the mutagenic agent when applied to seed or gametes. Data are included from a study on the persistence of genetic variability under prolonged inbreeding in populations of the parasitic wasp, Habrobracon juglandis. A list is included of publications resulting from investigations carried out under this contract.

- 1513 Sperlich, D. POPULATION GENETICS. PART I. Drosophila. Fortschr. Zool. 18 (1967) 223-278, (In German)

Genetic burdens in certain irradiated Drosophila populations are reviewed. Effects on populations of D. ananassae irradiated by atomic bomb tests were inconclusive. After single irradiation of 70 000 D. willistoni with a high dose and subsequent isolation the lethal factor frequency decreased to normal after five generations, but the allele rate remained high, indicating that single heterotic lethal factors reached an increased frequency. In other studies with this species and with D. subobscura and D. pseudoobscura it was found that the inversion density decreased after irradiation; the adaptive inversion system was disturbed, and the lethal factor frequency returned to normal after

1½ yr. The frequency of irradiated chromosomal types decreased initially and then became normal after irradiation of *D. pseudoobscura* that had AR and CH chromosomal structural types. In populations of *D. melanogaster* irradiated once or chronically, the fitness components of egg hatch rate and egg-imago survival rate reached 70-75% of normal after a few generations. At this time the populations contained 60-90% lethal II chromosomes. This lethality was eliminated slowly and incompletely. The egg hatch rate of irradiated *D. willistoni* did not reach normal value 15 generations after irradiation. After 2½ yr of irradiation with 65 000 R the number of individuals of two populations of *D. melanogaster* reached the starting value after an initial decrease. Decreased growth capacity was demonstrated in irradiated *D. pseudoobscura* populations. Radio-induced chromosomal inversions were observed in *Chironomus tentans* populations. About 25% of irradiated *D. melanogaster* populations showed chromosomal structural changes, and many translocations were observed after neutron irradiation. It was concluded that general conclusions about the increased mutation rates observed in irradiated populations could not be made. (NSA 22:1968, 8509)

- 1514 Teresi, J.D., Newcombe, C.L. AN ESTIMATE OF THE EFFECTS OF FALLOUT BETA RADIATION ON INSECTS AND ASSOCIATED INVERTEBRATES. (1) USNRDL-TR-982, Naval Radiological Defense Lab., San Francisco, Calif, 28 Feb. 1966, 86p. (2) AD-633024. 1966, 93p.

Three practical considerations were found to merit attention in the evaluation of the impact of fallout radiation on terrestrial insects and associated invertebrates. First, the relatively low dose levels that will affect developmental stages as compared to adult stages; second, the lower doses required to produce late mortality as compared to those required for early deaths; and third, the relatively low doses that will cause sterility. The calculated potential β -doses indicated that the dose level expected to sterilise a large majority of the organisms considered would be found in areas bounded approx. by the 50 R/h at 1 h γ -contour (4600 R-rad accumulated in about 5 d) for a 1 MT burst, by the 100 R/h at 1 h γ -contour (5200 R-rad in about 5 d) for a 10 MT burst and by the 100 R/h at 1 h contour (5200 R-rad in about 14 d) for a 100 MT burst. (Auth.)

- 1515 Tobari, I., Nei, M. GENETIC EFFECTS OF X-RAYS ON QUANTITATIVE CHARACTERS IN A HETEROGENOUS POPULATION OF *Drosophila melanogaster*. II. FURTHER INVESTIGATION. p.66-67 of "Annual Report 1964". NIRS-4, National Inst. of Radiological Sciences, Chiba (Japan). Dec. 1965, 94p.

1000 flies of each sex taken at random from a heterogeneous population were exposed to 1000 R of x-rays at 100 R/min. Three generations after x-irradiation the means and variances of abdominal and sternopleural bristles were examined, and the total phenotypic variance was partitioned into its components by a sib analysis. The tabulated data from two sets of experiments indicate that the genetic component was increased throughout by x-rays whereas the environmental component showed no significant change. This suggests that the increase of phenotypic variance by x-rays is mainly due to the increase of genetic component, as is expected theoretically. The amount of variance increase/R is computed as 10.1×10^{-4} and 5.0×10^{-4} for abdominal and sternopleural bristles, respectively. The increases in genetic variance would appear to be brought about by the mutations of fixed loci rather than of loci with intermediate gene frequencies.

- 1516 Valencia, R.M., Lindsay, D.L., Valencia, J.L., Muñoz, E. TOTAL RADIATION-INDUCED GENETIC DAMAGE TO ENTIRE GENOMES OF *Drosophila melanogaster*. p.227 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966, 263p.". Abstr. 904.

A study is underway in which all the different kinds of genetic damage (lethals, sterility factors, morphological alterations and detrimental factors) and cytological damage (translocations, inversions and deletions), which have heretofore been measured more or less separately, are being measured in entire irradiated genomes of *D. melanogaster*. In the present experiment, males were x-irradiated with either 2000 R or 4000 R and mature sperm sampled. The males were mated to females of a balancer stock in which all the chromosomes bear phenotypic markers and/or crossover suppressors, and daughters bearing one irradiated genome and one balancer genome were collected. These were mated individually to balancer stock males, and the progeny of each female were mated among themselves in such a manner as to balance or make homozygous each chromosome of the genome. Genetic effects not detected already during this process were tested

for by appropriate crosses. Salivary gland preparations of all chromosomes of each genome were examined. The results obtained thus far (with 248 X-bearing and 138 Y-bearing genomes) demonstrate the feasibility of studying total genome damage. (These results were presented in detail and the work planned and/or in progress was discussed.) (From abstr.)

- 1517 Valencia, R. M. THE FREQUENCY OF GENETIC DAMAGE IN ENTIRE IRRADIATED GENOMES. Radiat. Res. 31, 3 (1967) 813. Abstr. Eb-5. Presented at "15th Annual Meeting of the Radiation Research Society, San Juan, Puerto Rico, 7-11 May 1967".

By means of markers and/or crossover suppressors in all four chromosomes of Drosophila melanogaster, entire X- or Y-bearing irradiated genomes were collected and analysed for recessive lethals and sterility factors, dominant or recessive visibles and chromosome rearrangements of all kinds. 40 X-bearing genomes which received 2000 R of x-rays and 310 genomes (181 X-bearing and 129 Y-bearing) which received 4000 R delivered to mature spermatozoa have been completely analysed to date. Considering each point mutation (whatever its phenotype) and each chromosome break as a genetically altered "site", the results from the 4000 R group are as follows: 196 (63.2%) of the genomes surviving the irradiation and producing sufficient progeny to allow the collection and analysis of the entire genome were found to be genetically damaged to some extent. Of these, 97 had 1 damaged site, 63 had 2, 26 had 3, five had 4, three had 5 and two had 6 damaged sites. The total number of damaged sites in the 310 genomes was 348, or an average of 1.12 per genome. The average number of altered sites per chromosome was .188 for the X-chromosome, .194 for the Y-chromosome, .432 for chromosome II, .471 for chromosome III and .029 for chromosome IV, showing essentially a direct relationship between chromosome length and amount of inherited damage. Phenotypic effects (morphological changes, lethality, detrimentality and sterility) (will be) discussed in relation to one another and to the cytological nature of the alteration. (Abstr.)

- 1518 Vann, E. THE FATE OF x-RAY INDUCED CHROMOSOMAL REARRANGEMENTS INTRODUCED INTO LABORATORY POPULATIONS OF Drosophila melanogaster. Am. Nat. 100 (1966) 425-449.

Several lines of D. melanogaster of various geographic origins were subjected to intensive inbreeding for > 60 generations. Small samples of adult males were then taken from some of the inbred lines and irradiated (6000 R). Various types of structural rearrangements were induced in the sperm chromosomes; 30 chromosomal rearrangements were subsequently recovered and identified cytologically. Members of each culture that contained a newly-induced rearrangement (one of either 15 paracentric, or 9 pericentric inversions or 6 translocations) were mated to nonirradiated members of each of the other inbred lines to initiate a series of populations that at the start contained known frequencies of a specific rearrangement and that also possessed varying degrees of genic dissimilarity between the chromosomes of each pair of founding lines. After eight or nine generations, samples of larval salivary gland chromosome taken from each population were examined in order to determine the frequency of structural heterozygotes within the populations after having been subjected to the effects of "natural" selection. Paracentric inversions were found to be considerably more able to maintain structurally polymorphic populations than either the pericentric inversions or translocations. It could be shown that (a) individuals structurally heterozygous for a 2-break paracentric inversion suffer from an average selective disadvantage of 0.35, relative to non-inversion homozygotes, due to chromosome breakage (this was counteracted to varying degrees by the amount of genic heterozygosity included within the inverted segment); (b) a curvilinear relationship exists between the length of the inverted segment and structural heterozygote fitness, which again varies with the amount of genic heterozygosity included within the inverted segment; (c) individuals structurally heterozygous for chromosomes of unrelated origins maintain almost 50% more genic hybridity/small chromosome segment than do those whose chromosomes came from the same mass culture; and (d) from the relative success of the paracentric inversions in maintaining structurally polymorphic populations it was concluded that the genes contributing to fitness heterosis are well-scattered among the chromosome arms of this species. (Based on auth. summary)

- 1519 Vann, E. G. A GENETIC ANALYSIS OF INDUCED CHROMOSOMAL REARRANGEMENTS IN LABORATORY POPULATIONS OF Drosophila melanogaster. Diss. Abstr. 26 (1966) 6983.

This experiment was designed to gain information on the genetic basis of hybrid vigour through observations on the fate of newly-induced chromosomal rearrangements - especially paracentric inversions - in laboratory populations of D. melanogaster. The initial parental flies of the

different populations were hybrids obtained by matings between different inbred lines. After a min. of 62 generations of inbreeding, small numbers of males from each of eight inbred California lines were irradiated with 5000 R of x-rays and were mated to their unirradiated sisters. The F_1 progeny were used to set up some 200 single pair F_2 matings. Twelve F_2 progeny from each culture were sacrificed for cytological examination of salivary gland chromosomes. In this way, F_2 cultures in which flies carried newly-induced aberrations were identified. Each newly-induced rearrangement (15 paracentric inversions, 9 pericentric inversions and 6 translocations) was subjected to test within a series of twelve populations formed by crossing the rearrangement-bearing flies (1) to their own sibs, (2) to flies from their own inbred line, and (3-12) flies from ten other inbred lines. The resultant populations were kept in half-pint bottles by mass transfer of adults each generation; after a number of generations (generally eight or nine) the frequency of structural heterozygotes was determined in a sample of some 30 larvae. As expected, translocations and pericentric inversions were almost completely eliminated from the populations containing them. These aberrations in the form of paracentric inversions (with one exception) were retained in most populations. They were retained in high frequencies in populations whose parents were hybrids between distantly related strains. Longer paracentric inversions were retained in greater frequencies than shorter ones. It was estimated from the data that the average newly-induced aberration imposes a selective disadvantage of 35% on its heterozygous carriers; this disadvantage is the result of chromosomal breakage and, probably, associated genetic damage. Aside from this "inherent" disadvantage, the average selective advantages associated with the paracentric inversions were 0.40 in "Intrastrain" populations, 0.53 in "Interstrain" populations and 0.63 in "Unrelated" populations. The selective advantage increased with inversion length; this increase was as high as 0.60% per 1/120th of a chromosome arm in the case of the "Unrelated" populations. It was concluded that the genes responsible for heterosis are numerous and are scattered throughout the chromosome complement. Because of the pronounced relation between heterosis and inversion length, it seems unlikely that position effect contributed greatly to the observed hybrid vigour. (From DA)

See also :

- 1031 Equilibria for inversions induced by x-rays in isogenic strains of Drosophila pseudoobscura. (Sperlich, D., 1966)
- 1064 Viability of heterozygotes for induced mutations in Drosophila melanogaster. III. Mutations in spermatogonia. (Falk, R., 1967)
- 1065 Viability coefficients and preferential recovery. (Falk, R., 1967)
- 1095 Biological studies: genetics. (National Inst. of Radiological Sciences, Chiba (Japan), 1965)
- 1111 Genetic variability in Aedes aegypti (Diptera: Culicidae). II. Mutations causing structural modifications. (VandeHey, R.C. et al., 1962)
- 1342 Gross effects of gamma radiation on the Indian-meal moth and the Angoumois grain moth. (Cogburn, R.R. et al., 1966)
- 1423 Genetics of a heterozygous population of Drosophila melanogaster. I. Viability and population fitness of heterozygous CyLcn/cn10 carrier of irradiated chromosome cn10. (Shilenko, B.V., 1965)
- 1470 Fitness and competitive ability in irradiated populations of Drosophila melanogaster. (Dyer, K.F., 1966)
- 1488 An analysis of radiation-induced variation on body-weight of Habrobracon juglandis. (Dalebroux, M.A. et al., 1967)
- 1520 Evolution of fitness. III. Improvement of fitness in irradiated populations of Drosophila serrata. (Ayala, F.J., 1967)
- 1522 Male sphaerophthalmine mutillid wasps of the Nevada test site. (Ferguson, W.E., 1967)

2.3.5. Ecological Aspects

- 1520 Ayala, F.J. EVOLUTION OF FITNESS. III. IMPROVEMENT OF FITNESS IN IRRADIATED POPULATIONS OF Drosophila serrata. Proc. natn. Acad. Sci. U.S.A. 58, 5 (1967) 1919-1923.

The experiment was designed to allow for the incorporation by recombination of the newly induced mutants in the gene pool before strong natural selection was applied. In one experiment 2000 males

were irradiated with 2000 R x-rays, and mated. Males of the progeny were again irradiated with 2000 R, and mated; samples of males from the subsequent progeny were withdrawn, and again irradiated and mated. The genome of the males in the experimental populations received on the average 4000 R. The females received various amounts of radiation, averaging 2000 R. (Further experimental details are given.) - Genetic variability induced by x-irradiation augmented, after selection, the adaptedness of two populations of *D. serrata* to a new environment.

- 1521 Ayres, R. U. SPECIAL ASPECTS OF ENVIRONMENT RESULTING FROM VARIOUS KINDS OF NUCLEAR WARS. PART II, ANNEX IV. EFFECTS OF THERMONUCLEAR WAR ON WEATHER AND CLIMATE. HI-303-RR/A-IV, Hudson Inst., Inc., Croton-on-Hudson, N.Y. 8 Jan. 1964, 29p.
- An admittedly superficial view of some possible consequences of a thermonuclear war for weather and climate suggests the possibility of a sequence of meteorological and climatic events roughly as follows, following an attack of 10 000 MTs (ground-burst): initial widespread dirty (contaminated with fallout) rains and/or snow lasting several weeks; fairly heavy haze in the stratosphere, gradually disappearing over a period of several (i.e., 3-4) years; many forests on lower slopes killed or weakened by radiation, followed by insect outbreaks (2nd, 3rd, and subsequent years); enhanced wind and water erosion where plant cover is depleted; loss of forest cover on watersheds resulting in higher soil temperatures; and ultimately, higher ground temperatures, fewer forests, some marginal lands turned into desert, and many river valleys damaged by floods. (Auth.)
- 1522 Dispons, P. LES HETEROPTERES DE REGAN (HEMIPTERA, HETEROPTERA). Rev. Serv. biol. vétér. Armées, Fr. 17, 4 (1964) 139-142.
- Conséquences biologiques des effets nucléaires sur les Arthropodes. Aspects biogéographiques et composition de la faune entomologique saharienne. (Bull. sign. biophysique-biochimie)
- 1523 Ferguson, W. E. MALE SPHAEROPHTHALMINE MUTILLID WASPS OF THE NEVADA TEST SITE. Brigham Young Univ. Sci. Bull., Biol. Ser. 3, 4 (1967) 1-20.
- An ecological and taxonomical study of the sphaerophthalmine Mutillidae of the Nevada Proving Grounds Area was made. Important contributions to the data on distribution and taxonomy of the nocturnal Mutillidae are also included: new species of male mutillids are described. It was shown that former ground zeros of nuclear detonations were reoccupied by the mutillids within a few years after a blast or series of blasts. A careful search for anatomical changes among the Mutillidae collected at the test site revealed that the nuclear testing did not produce any genetic abnormalities. (NSA 21: 1967, 39502)
- 1524 Goates, M. A. MITES ON KANGAROO RATS AT THE NEVADA TEST SITE. Brigham Young Univ. Sci. Bull., Biol. Ser. 3, 4 (1963) 1-12.
- A systematic study of parasitic mites on kangaroo rats of two species at the Nevada Test Site was conducted from Aug. 1959 - Dec. 1961. The intent was to determine the kinds, numbers, seasonal occurrences, and ecological relations of mites in nuclear disturbed and contiguous undisturbed areas. A total of 1256 rats from nine plant communities was examined. Data are summarized. (NSA 18: 1964, 13)
- 1525 Payne, J. A., Crossley, D. A., Jr. ANIMAL SPECIES ASSOCIATED WITH PIG CARRION. ORNL-TM-1432, Oak Ridge National Lab., Tenn. Apr. 1966, 67p.
- Following a nuclear attack, carrion remains of domestic animals could pose difficulties for human survival because of public health and sanitation problems associated with carrion. Insects influence the course and rate of decomposition, and radiation effects on insect populations could alter the normal decomposition pattern. A study was made of the animal community in pig carrion, preliminary to experimental research on the influence of radiation and other factors on succession in carrion. A total of 522 animal species representing 3 phyla, 9 classes, 31 orders, 151 families, and 359 genera were found associated with various decomposition stages. A systematic list of all species, their abundance, microhabitat, and food relationships is given. (Auth.)
- 1526 Southwood, T. R. E. "Ecological Methods with Particular Reference to the Study of Insect Populations". London, Methuen & Co. Ltd., 1966, 391p.

Radioisotopes, their use and the results obtained and obtainable are discussed in connection with marking insects (p. 58, 83-71, 80), the labelling of predators via labelled prey (p. 251-253), the measurement of feeding rates and assimilation (p. 361-363), and respiration studies (p. 367). The application of radiographic techniques to the detection of insect infestation in grain, other seeds, in moist plant tissues (wood-borers, stem borers, and bollworms), etc. (p. 121), are described.

- 1527 Sperlich, D., Karlik, A., Pohl, E. MUTAGENIC ACTIVITY OF RADON-222 IN Drosophila melanogaster. Strahlentherapie 132, 1 (1967) 105-112. (In German)

Male Drosophila were kept in a Rn-containing atmosphere and the percentage of the lethal mutations induced in the sex chromosome was determined. The spontaneous mutation rate was 0.17%, it was $0.37 \pm 0.18\%$ when the flies were kept for 24 h in an atmosphere containing $2.8 \mu\text{Ci Rn/l}$, $2.42 \pm 0.57\%$ when they were kept for 24 h in $78.6 \mu\text{Ci Rn/l}$, and $0.35 \pm 0.17\%$ after a 21-d stay in the natural Rn atmosphere of the mine in Badgastein/Boeckstein (with $0.0035 \mu\text{Ci/l}$). The effect of the 24-h exposure to $78.6 \mu\text{Ci/l}$ was calculated to correspond to 576 R x-rays. (CA 66: 1967, 73028k)

- 1528 Woodwell, G.M. EFFECTS OF IONIZING RADIATION ON NATURAL ECOSYSTEMS. BNL-7200, Brookhaven National Lab., Upton, N.Y. nd., 11p.

The characteristic patterns of natural ecosystems are outlined, and types of changes produced in these patterns by ionizing radiation are discussed. Potential levels of radiation exposure produced by nuclear war are estimated. Data are summarized from studies of radiation effects on natural ecosystems. It is concluded that total radiation exposures in the range of 5 000-10 000 R in a six-month period would kill more than 90% of the trees of most deciduous forests, and exposures in the range of 1000-3000 R would damage coniferous forests similarly, while grasslands, weed fields, and tundra would be substantially more resistant. Coincident with the radiation damage to plants in such systems there would be fluctuations in insect and animal populations. Radiation exposures in the range of 1000-10 000 R are well within the range of exposures from fallout that could be expected from a nuclear attack. (NSA 18: 1964, 35306)

See also III/1417.

- 1529 Woodwell, G.M., Ed. p.20-38 of "Ecological Effects of Nuclear War". BNL-917 (C-43), Brookhaven National Lab., Upton, N.Y., 1965, 72p.

The kinds of effects discussed are not individually unique to nuclear catastrophe. Most can and do result from a variety of non-nuclear forces. Unique features would be (1) the interaction of several severe limiting factors, with total effect not simply the sum of component effects, and (2) the great size of the stressed area, which probably influences the rate of recovery more than the severity of the acute forces themselves. As regards insect populations, the principal changes after irradiation have been found to follow changes in the abundance of food. There might be temporary upsurges (e.g. in the case of defoliators) of certain species.

- 1530 Woodwell, G.M., Brower, J.H. AN APHID POPULATION EXPLOSION INDUCED BY CHRONIC GAMMA IRRADIATION OF A FOREST. Ecology 48, 4 (1967) 680-683.

A population explosion of the aphid, Myzocallis discolor Morell, occurred on white oaks (Quercus alba) damaged by chronic γ -irradiation. Oaks exposed to 9.5 R/d during 18 months supported max. aphid populations of 25 winged adults per leaf (350 000/m² of forest). The aphid was not found in the undamaged forest. The irruption was correlated with changes in predator populations and with small changes in the sugar, total N and lipid content of white oak leaves. The relative importance of these two sets of factors could not be determined. (Auth.)

See also:

- 1492 Chromosomal polymorphism in irradiated natural populations of Chironomus. (Blaylock, B.G., 1966)
1493 Cytogenetic study of a natural population of Chironomidae inhabiting an area contaminated by radioactive waste. (Blaylock, B.G., 1966)
1494 Population genetics and radiation effects studies. (Blaylock, B.G., 1966)
1557 Computer simulation of the sterile male theory. (Berryman, A.A., 1966)

2.4. APPLICATIONS

2.4.1. General Articles. Recommendations. Surveys

- 1531 Anonymous. THE POTENTIAL ROLE OF THE STERILITY METHOD FOR INSECT POPULATION CONTROL WITH SPECIAL REFERENCE TO COMBINING THIS METHOD WITH CONVENTIONAL METHODS. ARS-33-98. 1964. 54p. Agricultural Research Service, United States.
- 1532 Beard, R.L. RADIATION, INSECTS AND FOOD PRESERVATION. p. 23-25 of "Papers on Certain Aspects of Food Preservation". THAI-AEC-9, Office of Atomic Energy for Peace, Bangkok (Thailand). 6 Sep. 1966. 34p.
Very general introductory article.
- 1533 Cavalloro, R. L'IMPIEGO DELLE RADIAZIONI IONIZZANTI E DEGLI ISOTOPI RADIOATTIVI IN ENTOMOLOGIA AGRARIA. (The application of ionizing radiations and radioisotopes to agrarian entomology.) Paper presented at the "Convegno sulle Applicazioni dell'Energia Nucleare in Agricoltura. Novara, Italia. 5-7 maggio, 1961". (In Italian, with English and French summaries)
Survey.
- 1534 Descamps, M., Wintrebert, D. POSSIBILITES D'UTILISATION DES FACTEURS BIOECOLOGIQUES DE LIMITATION DES ACRIDIENS MIGRATEURS. Entomophaga 11, Pt. 2 (1966) 217-229.
Several bioecological factors liable to reduce the number and the nocivity of locusts are reviewed and discussed, among them genetic factors (very briefly), involving the sterilisation of males, and irradiation with genotypic purpose. Tropic and trophic factors, biotic factors and eco-climatic factors are also discussed, in more detail.
- 1535 Fowler, E.E. NEW DEVELOPMENTS AND TRENDS IN THE ISOTOPE INDUSTRY. Isotopes Radiat. Technol. 3 (1966) 185-192.
Uses of isotopes and radiations are discussed. The dimensions of the growth of industrial uses in the United States are illustrated. Tracer methodology and applications, radioisotope gauging, radiography, process radiation development, radiation preservation of food, and isotopic power are considered. (NSA 20; 1966, 37142)
- 1536* Huque, H. ROLE OF ATOMIC ENERGY IN INSECT STUDY AND CONTROL. Agriculture Pakist. 13 (1962) 77-80.
Uses of radioisotopes and ionizing radiations in entomological research, and particularly in radio-sterilisation eradication programmes are reviewed. Programmes whereby sterilisation of insect pests and their complete eradication were achieved by radioisotopes are exemplified by screw-worm fly. Consideration is given to use of the sterilised-male method on fruit flies and to the use of ionizing radiation to kill other insects, particularly pests in clothing, packaged foodstuff, and wood products. A device for the control of stored grain pests and the pink boll worm is described. The effect of γ -radiation on silkworm cocoons, with reference to technological properties of raw silk, is also discussed. (NSA 21; 1967, 34846)
* Originally listed as III/1067, without abstract.
- 1537 International Atomic Energy Agency, Vienna (Austria) and Food and Agricultural Organization of the United Nations, Rome (Italy). JOINT RECOMMENDATIONS OF THE COORDINATING MEETING ON RESEARCH ON MUTATIONS IN RICE BREEDING AND THE PANEL MEETING ON CONTROL OF RICE INSECTS USING RADIATION. Int. Rice Comm. News. 15, 3 (1966) 34-37. Also presented at "2nd Meeting on the FAO/IAEA Coordinated Programme of Research on the Use of Induced Mutations in Rice Breeding 1965/1966. Manila, Philippines. 21-25 Feb. 1966".
It was recommended that the training and knowledge of plant breeders be utilized by entomologists in evaluating radiation effects on insects; that irradiation dosages at various developmental stages be determined (lethal and sterilising doses, and doses inducing dominant lethality) for the stem

borer; also, the competitiveness of adult males, and the vigour of emerged adults in relation to dosage and stage of irradiation. The need for ecological studies of field populations was stressed. In addition to the rice stem borer, Chilo suppressalis, the rice gall midge, Pachydiplax oryzae, and the leafhoppers Sogota, Nilaparvata and Nephotettix are considered to be serious in some parts of Southeast Asia, India and Pakistan. The need for more detailed studies on their field ecology and the field population outside the paddy field or in off-season of rice growing was stressed.

- 1538 Jafri, R. H. PROSPECTS OF INTEGRATED MICROBIAL AND RADIATION CONTROL OF HARMFUL INSECTS. J. invertebrate Path. 9, 3 (1967) 293-297.

This paper is a "theoretical insect pathology" consideration of the prospects of integrated microbial and radiation control of harmful insects. While considering this topic our attention is directed first to the possible applications of the radiation sterilising method of population suppression. The exploratory investigations of this subject have shown that ionizing radiation will induce sterility but there is considerable variation in the amounts needed. The research also suggests that radiation damage may in some cases prevent application of the method to some insects. In nature some insects appear to be so abundant that the use of the sterile-male technique may not be feasible without first processing the geographically isolated and non-isolated infested area with other control measures to bring wild populations "within reach". Such a situation can be approached from two angles. The population may be controlled by means of well-tried microbial pathogens. Also, the release of sterile male insects carrying parasites or pathogens has control possibilities. In such a situation an intensified search has to be made for those pathogens that are non-virulent when present in or on the adult, but are highly virulent to the larvae. Coelomomyces and Theiohania are probably of this category. - The increased susceptibility of irradiated insects to pathogens is opening a new field of investigation. The life span of Tribolium castaneum and T. confusum beetles was shortened considerably when the test insects received Bacillus thuringiensis immediately and after an interval of 24 and 144 h following exposure to x-rays. The life span of the irradiated beetles was somewhat shortened by the presence of Farinocystis tribolii, Nosema whitei, and Adelina tribolii, protozoan parasites in the fat body of the test insects. - There are promising prospects of evolving, through irradiation, new strains of pathogens of high virulence. Already, strains of increased virulence of Beauveria bassiana and Aspergillus flavus have been evolved by means of ionizing radiation. There is economic feasibility in using γ -radiation from ^{60}Co in the control of diseases of the honey bee, and in the sterilisation of honey. The use of radiation as an insect repellent and the behavioural aspects of radiation on insects is a fascinating field of future investigation. Examples of this phenomenon are cited. (Auth.)

- 1539 Kioft, W. INSEKTEN VERNICHTEN SICH SELBST. (Insects annihilate themselves.) Naturw. u. Medizin 3, 13 (1966) 29-37. (In German)

Review of the principle and the commercial successes to date of the sterile-male technique. Achievements based on radiosterilisation, and the usefulness of chemosterilants are discussed.

- 1540 Lagoni, H. L. RADIOAKTIVE STRAHLEN IN DER LAND- UND ERNÄHRUNGSWIRTSCHAFT. (Radioactive irradiation in agriculture and food production.) Verbraucherdienst 6 (1961) 210-211. (In German)

The application of α -, β -, and γ -radiation for combating insects, the sterilisation of food products, mutation breeding of crop plants and in animal husbandry, are discussed. Radioisotopes have already been applied successfully (with examples) in agricultural research and practice, and their application is on the increase.

- 1541 Laven, H. GENETICS AGAINST PESTS. Bild. Wiss. 6 (1966) 447-453. (In German)

General article stressing the need for new genetic methods of insect control, in view of the rapid general increase in the resistance developed by insects against chemical agents. In 1945 this was noted with Danish houseflies for the first time. By 1950 the resistance of 11 different types of disease-carrying insects had been established. There were 81 types by 1962, by now there probably are 100 types. At first it was believed that this resistance was due to acquired tolerance but it was later found to be based on genetic biochemical differences. The principles of the sterile-male technique are discussed, with examples drawn from experience to date. The general problems inherent in the method are considered.

- 1542 Lourie, I.M., Shea, T.E. PROTECTION AGAINST IONIZING RADIATIONS. OUTLINES, DESCRIPTION, AND CONSIDERATIONS OF THE ESTABLISHMENT OF PROGRAMS OF THIS TYPE IN THE AMERICAS. Boln. Of. sanit. pan-am. 51 (1961) 113-118.

A programme is being developed under the auspices of the World Health Organization for protection from radiation and proper utilization of nuclear energy in the Americas. A programme of aid has been developed by the Oficina Sanitaria Panamericana (OSP) consisting of four major points, one of them the promotion of the use of radioisotopes for diagnostic, therapeutic, and research purposes, and the promotion in Latin America of research projects related to radiation and its effects. Possibilities are suggested for application of the sterile-male technique, with the object of exterminating certain diseases in Latin America. The help of OSP is promised with the provision of consultants for all four points of the programme, as well as scholarships for the training of all types of personnel.

- 1543 Manowitz, B. GAMMA RAYS FOR FUN AND PROFIT. BNL-50084, Brookhaven National Lab., Upton, N.Y. 20 Apr. 1966, 13p.

The history of programmes to find uses for fission products is reviewed briefly. The γ -emitting radioisotopes, ^{60}Co and ^{137}Cs , are described in detail as to characteristics, availability, and the design of irradiators using these sources. The results of specific applications of γ -radiation to insect control, food preservation, and polymerization studies are presented. (NSA 22: 1968, 12534)

- 1544 Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo (Egypt). ANNUAL REPORT, JANUARY 1, 1965-DECEMBER 31, 1965. NP-16547. Jan. 1966, 38p.

Activities in the training of specialists in the application of radioisotopes in science, industry, agriculture, and medicine and in research using radioisotope techniques are reported. Progress on eradication of *Anopheles pharoensis* and *Ceratitis capitata* by radiosterilization techniques is reported. A list of 29 references to papers published on work performed at the centre is included.

- 1545 Moh, C.C. THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE. Triennial Report, July 1, 1963 - June 30, 1966. NYO-2043-130, Inter-American Inst. of Agricultural Sciences, Turrialba (Costa Rica). 171p.

Applications of atomic energy in the development of improved strains of agricultural plants, better control of plant diseases and insect pests, and the proper management and use of soils are discussed for countries in the American tropics. The use of γ -radiation for the control of Mediterranean fruit fly, *Ceratitis capitata*, the tropical warble fly, *Dermatobia hominis*, the parasitic larvae of which cause cutaneous myiasis in cattle, and the coffee leaf miner, *Leucoptera coffeella*, was investigated. Results are reported from extensive studies on the biology of these species. A list is included of publications during the period covered by this report.

- 1546 Nagy, B., Pozsár, B., Szalay-Marzsó, L. SUGÁRZÁSOK ALKALMAZÁSA ÁLLATI KÁRTEVŐK ELLENI VÉDEKEZÉSÉBEN. (The use of ionizing radiations for the control of harmful animals.) Kiad. Orsz. Atomenerg. Bizottság Izotóp Int. 15 (5+) III, III, 83p., multigraph. Budapest 1965. (In Hungarian)

This is a review of the world literature compiled for use in Hungary, and it contains sections on the general effects of radiation on animals and animal tissues, the use of radiation for the control of insect pests, whether directly, as in the radiation of infested foodstuffs, or indirectly, as in the sterilisation of males for subsequent field release, and the possible value of such techniques in Hungary. (RAE-A 54, 12: 1966, 633)

- 1547 Nelson, S.O. TOWARDS BETTER INSECT CONTROL. Crops Soils 18, 1 (1965) 8-9.

Use of ionizing and non-ionizing radiations to control insect pests is reviewed, including the sterile-male technique. Doses of radiation that kill insects do not damage wheat for milling and baking or affect nutritional qualities to any noticeable degree. The U.S. Food and Drug Administration has approved wheat irradiation by γ -ray sources for insect control. Electron irradiation of wheat and γ -irradiation of citrus are also under consideration by the FDA. Current estimates of costs for treating grain with radiation are somewhat higher than costs for chemical insecticide treatment. As the nuclear and electronic industries develop further, however, costs for ionizing radiation are

expected to decline substantially. The eventual application of radiation for control of stored-product insects can be expected.

- 1548 Nelson, S.O. ELECTROMAGNETIC ENERGY, p. 89-145 of "Pest Control. Biological, Physical, and Selected Chemical Methods". Kilgore, W., Douth, R.L., Eds. New York, Academic Press, 1967, 477p.

Various forms of electromagnetic energy have long been recognized as offering possible means for insect control. The electromagnetic spectrum is discussed, and the particular energy ranges (radio-frequencies, infra-red, visible, and u.v.) are considered in some detail. The use of ionizing radiations (x- and γ -rays) are dealt with on p. 129-137, the illustrations used being amply documented as part of the bibliography on p. 139-145.

- 1549 Sigurbjornsson, B. INTERNATIONAL COOPERATION IN MUTATION BREEDING RESEARCH. Qualitas Pl. Mater. veg. 13 (1966) 389-394.

Cooperative studies being carried out under unified control by various nations for using ionizing radiations, neutrons, and other mutational agents for crop improvement are briefly discussed. The Joint FAO/IAEA Division of Atomic Energy in Agriculture is conducting several internationally coordinated programmes of research in the fields of mutation research, insect eradication, fertilizer efficiency studies, and food preservation. Participating scientists in each of these programmes work on the same general problems and coordinate their approach to solving them. This is done in some cases by having all participants run identical field experiments, in other cases by the distribution of specific tasks or by combined efforts to solve certain problems as appropriate. Once a year the participants in these programmes meet to report on their research activities and to coordinate their research programmes for the ensuing year.

- 1550 Zeeuw, D. de. FOOD IRRADIATION - AN IMPROVEMENT TO HUMAN DIET. Euratom Bull. 3, 3 (1964) 15-17.

Research carried out in the past 20 years to evaluate irradiation as a tool for food preservation is summarized. Attention is given to studies of: sprout inhibition in potatoes and onions, extension of shelf life of fresh fruit and vegetables, insect control in cereals and flour products, and improvement of dairy products. (NSA 18; 1964, 39762)

- 1551 Zeeuw, D. de. RESEARCH ACTIVITIES OF THE ASSOCIATION EURATOM-ITAL. Atompraxis 12 (1966) 231-236.

Research activities of the Association Euratom-ITAL (Instituut voor Toepassing van Atoomenergie in de Landbouw Wageningen) are directed towards the practical application of radiation and radioactive elements and compounds in the field of agriculture, particularly in the spheres of food technology, growth and development of plant and animal, pest and disease control, and breeding. Results achieved thus far and new perspectives for the use of nuclear techniques in the field of agriculture are outlined. Pilot plant applications of ionizing radiations are in an advanced stage in various countries, in particular the USA, Turkey, Argentina, for the control of insects in their products (fruit, grains, cereal products). There is a growing interest in the disinfestation of tropical fruit, such as papayas, mangoes and pine-apples. Emphasis is to be placed on the application of the sterile-male technique to Ceratitis capitata, Dacus oleae, and the onion fly.

See also:

- 42 The use of radionuclides and their radiation in (the) plant pest control. (Haisch, A. et al., 1966)
 910 Biological Effects of Radiations. (Grosch, D.S., 1965)
 1629 Control and sterilization of pests of grain storages by gamma rays. (Dockal, J. et al., 1965)
 1666 The Israel food irradiation programme and progress during 1964-1966. (Kahan, R.S. et al., 1966)
 1688 Food irradiation research and pilot facilities in operation or planned in India. (Kurta, U.S. et al., 1966)
 1876 Recent advances in food irradiation research in Japan. (Matsuyama, A., 1966)

- 1769 Ionizing radiations in applied entomology. (Cadahia, D., 1965)
 1770 *ibid* (1966)
 1790 International experience in the use of radioisotopes. (Zeleny, V., 1963)

2.4.2. Population Control

- 1552 Smith, C.N. NEW APPROACHES TO THE CONTROL OF PEST ORGANISMS. p. 145-150 of "Pesticides and Their Effects on Soils and Water, ASA Special Publication No. 8". Madison, Wis., USA, Soil Science Society of America, Inc. 1966, 150p. Paper was also presented at the "Annual Meeting of the Soil Science Society of America, Columbus, Ohio, USA. Nov. 1965".

An introductory article, dealing with induced sexual sterility and its usefulness for eradicating certain species of insects. - The importance of research on attractants is stressed.

- 1553 Knipling, E.F. SOME BASIC PRINCIPLES IN INSECT POPULATION SUPPRESSION. Bull. ent. Soc. Am. 12, 1 (1966) 7-15.

Information gained from the screw-worm population control programmes is discussed. The author considers characteristic trends of insect populations subjected to different systems of control. The system of insect control by the use of conventional insecticides is concluded to be highly efficient in terms of numbers of insects destroyed when the insect population density is high but highly inefficient when the population is low. The contrary is true of the system of sterile insect release. However, the latter, when used in conjunction with the insecticide system of insect control provides a means of reversing the law of diminishing returns in dealing with the elimination of insect populations. The application of the basic principles of integrating chemical treatments and sterile insect releases for the control of a specific insect is discussed, theoretical models being used. The problem of the boll weevil is considered, and the projects under way for dealing with the pest. - The integration of predator (or parasite) releases and sterile insect releases, which independently affect different stages of the host insect provides a more efficient system of insect population control than either system employed alone. The integration of cultural control and release of sterile insects for tobacco hornworm (*Manduca sexta* (Johannson)) control is considered. - The author deliberately omitted any discussion here of the basic principles involved in the use of insect attractants and chemosterilants.

2.4.2.1. Sterile Male Technique

- 1554 Ailam, G., Galun, R. OPTIMUM SEX RATIO FOR THE CONTROL OF INSECTS BY THE STERILITY METHOD. Ann. ent. Soc. Am. 60, 1 (1967) 41-43.

Formulae are derived for the expected number of fertile eggs laid by a population containing fertile and sterile individuals. It is concluded that introduction of sterile individuals of the two sexes, for control of population, is never inferior, and sometimes even superior, to the introduction of one sex alone. (Auth.)

- 1555 Anonymous. IRRADIATION. A BIOLOGICAL CONTROL WEAPON AGAINST OMNIVOROUS LEAF ROLLER AND CODLING MOTH. Agric. Res., Wash. 14, 5 (1965) 7.

- 1556 Arroyo Varela, M., Jimenez, A., Mellado, L., Caballero, F. APPLICATION OF RADIOACTIVE ISOTOPES TO THE INVESTIGATION OF METHODS OF BIOLOGICAL CONTROL OF INSECT PESTS. I-V. TESTS WITH P-32 AND GAMMA-RAYS ON *Ceratitis capitata*. Boln Patol. veg. Ent. 28 (1965) 233-298. (In Spanish)

- 1557 Berryman, A.A. COMPUTER SIMULATION OF THE STERILE MALE THEORY. Bull. ent. Soc. Am. 12 (1966) 263. Abstr. 335, presented at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

A computer programme based on the mathematic description of the sterile male theory facilitated the determination of release strategies and prediction of the effects following release. The theory

may also be applied to ecological research, particularly in determining population survival parameters. (Abstr.)

- 1559 Collins, P. GENETIC WEAPONS, POPULATION REPLACEMENT, INDUCED STERILITY, OR THE INTRODUCTION OF DELETERIOUS GENES - ARE ALL PROMISING BIOLOGICAL METHODS OF FIGHTING DISEASE-CARRYING INSECTS. New Scient. 21 (1964) 351.

Survey article on autocidal control measures, pin-pointing Craig's (WHO) review article on how one might attack the problem of certain insect vectors of (human) diseases. These measures are discussed. Sterility may be induced by irradiation or chemically. The principle of meiotic drive is described.

- 1559 Cutkomp, L. K. PROGRESS IN INSECT CONTROL BY IRRADIATION INDUCED STERILITY. PANS 13, 1 (1967) 61-70.

Requirements, advantages and disadvantages of the sterile-male release technique are discussed. The more important insects studied in relation to the possibility of employing the sterile male technique are summarized in a table. Those starred have research support by the IAEA. Except where stated, host damage is attributable to the immature or larval stage.

A. Progress good to excellent

<u>Pest</u>	<u>Hosts</u>
Screw-worm (<i>Cochliomyia hominivorax</i>)	cattle, livestock
*Mediterranean fruit fly (<i>Ceratitis capitata</i>)	citrus and other fruits
*Melon fly (<i>Dacus cucurbitae</i>)	cucurbits
Mexican fruit fly (<i>Anastrepha ludens</i>)	citrus, mangoes
Oriental fruit fly (<i>Dacus dorsalis</i>)	most fruits

B. Considerable progress, but application of technique either small scale or requiring further study

<u>Pest</u>	<u>Hosts</u>
*Olive fly (<i>Dacus oleae</i>)	olives
*Codling moth (<i>Carpocapsa pomonella</i>)	apples, pears
Pink bollworm (<i>Pectinophora gossypiella</i>)	cotton
Gypsy moth (<i>Porthetria dispar</i>)	forest and shade trees
Cockchafers (<i>Melolontha vulgaris</i>) - Larvae	grasses
- Adults	deciduous trees
Boll weevil (<i>Anthonomus grandis</i>) - Larvae and adults	cotton
*Tsetse flies (<i>Glossina</i> sp.)	cattle, livestock

C. Application may be feasible, but much more research needed

- **Dacus zonatus*
- **Dacus ciliatus*
- Corn earworm (*Heliothis zea*)
- Tobacco budworm (*Heliothis virescens*)
- Tobacco hornworm (*Manduca sexta*)
- *Torsalo or Tropical Ox Warble (*Dermatobia hominis*)
- Sugarcane borer (*Diatraea saccharalis*)
- European corn borer (*Ostrinia nubilalis*)
- Oriental fruit moth (*Grapholitha molesta*)
- Rice stem borers: **Chilo suppressalis*
- Tryporyza incertulas*

- 1560 Hathaway, D. O., Butt, B. A. THE STERILITY APPROACH TO INSECT-CONTROL. p. 28-34 of the "72nd Annual Meeting. Transactions of the State Horticultural Society. 1966". (PDB 3:1967, 16133)

- 1561 Hurpin, B. RESULTATS ET PERSPECTIVES DE LA LUTTE BIOLOGIQUE CONTRE LES *Oryctes*. *Olfaginaires* 21, 2 (1966) 77-82.

Various methods of combating the insect (particularly *Oryctes rhinoceros*) are discussed. Before even the possibility of eventually applying the sterile-male technique could be considered certain basic research would be required and is indicated briefly (p. 80).

- 1562 International Atomic Energy Agency, Vienna (Austria). A. THE IAEA LABORATORY AT VIENNA AND SEIBERSDORF. Second Report. IV. AGRICULTURE. B. INSECT ERADICATION AND PEST CONTROL. 5. CO-ORDINATED PROGRAMME ON INSECT ERADICATION AND STERILE-MALE TECHNIQUE. p. 24 of "Technical Reports Series No.41". Vienna, International Atomic Energy Agency. 1965, 106p. STI/DOC/10/41.

Two insect rearing rooms with controlled light, temperature and humidity were installed for the rearing of Mediterranean fruit flies and olive flies. Radiation research is being conducted to compare the dosages of neutrons and γ -radiation required to sterilise *Ceratitis capitata*. Results to date indicate that there is little difference in either the amount of γ -radiation or neutron radiation necessary for sterilisation.

- 1563 Kattiyar, K.P. CONTROL DE UNA POBLACION DE INSECTOS, UTILIZANDO EL METODO DE MACHOS ESTERILES. (Control of an insect population by means of the sterile male technique.) (1) Presented at the Symposium on "Moscas de los Frutos. Asunción, Paraguay, 21-26 Aug. 1967. Organized by CIPA (Comité Interamericano de Protección Agrícola". n.p. (In Spanish) Also published as report (2) NYO-2043-151. n.d.

Essentially a survey.

- 1564 Kloft, W. ATOMENERGIE ZUR SCHADINSEKTEN-AUSROTTUNG. BERICHT ÜBER NEUARTIGE BEKÄMPFUNGSMETHODEN MITTELS FREILASSUNG STRAHLENSTERILISierter INSEKTEN IN USA. (Atomic energy for the eradication of insect pests. Account of novel methods of pest control by the release of radiation-sterilized insects in the USA.) Sonderbeitrag über die Arbeit der Universität Würzburg. M. P. 12.2.1964. (In German)

- 1565 Knippling, E.F. THE STERILITY METHOD OF PEST POPULATION CONTROL. p. 233-249 of "Research in Pesticides. Proceedings of the Conference on Research Needs and Approaches to the Use of Agricultural Chemicals from a Public Viewpoint. Davis, Calif., USA, 1-3 Oct. 1964". Chichester, C.O., Ed. New York, Academic Press. 1965, 380p.

Review of the principles involved, and the basic knowledge required of the biology and ecology of the pest before control measures can even be considered by the sterility method. The current status is discussed. Examples of ways in which sterile insect releases might be employed to regulate populations of certain pests are given. A table illustrates a hypothetical model showing trends of boll weevil populations on 1000 acres of cotton when subjected to various treatment systems. The theoretical trend of a low-density tsetse fly population, averaging 200 flies/mile², is shown when subjected to sterile male releases at rates and for periods indicated in the table (II). A third table illustrates the estimated trend of the tobacco hornworm population east of the Mississippi river subjected to sterile moth releases in a 2-yr programme. - Some consideration is also given to vertebrate pests.

- 1566 Knippling, E.F. FURTHER CONSIDERATION OF THE THEORETICAL ROLE OF PREDATION IN STERILE INSECT RELEASE PROGRAMS. *Bull. ent. Soc. Am.* 12, 4 (1966) 361-364.

An attempt is made to predict population suppression due to parasites and predators. The effect of releasing into the natural population large numbers of sterile males and sterile egg-laying females in terms of increasing egg parasitism and/or predation, and the various assumptions made and the additional information required are discussed.

- 1567 Knippling, E.F. KNIPLING ON PEST CONTROL. *Agric. Chem.* 21, 4 (1966) 34-36. Also presented at the Symposium on "Scientific Aspects of Pest Control. Washington, D.C., USA, 1-3 Feb. 1966". Survey.

- 1568 Knippling, E.F. STERILE TECHNIQUE - PRINCIPLES INVOLVED, CURRENT APPLICATION, LIMITATIONS, AND FUTURE APPLICATION. p. 587-618 of "Genetics of Insect Vectors of Disease". Wright, J.W., Pal, R., Eds. Amsterdam, Elsevier Publishing Company. 1967, 794p.

The author discusses the general principles involved in the control of insect populations by release of sterile insects and briefly reviews the current situation in regard to research in this field and the practical application of the method, by reference to the screw-worm fly [*Callitroga hominivorax* (Coquerel)], fruit flies and *Glossina* spp., with a short note on the development of chemosterilants for insect control. (RAE-B 56; 1968, ref. 562)

- 1569 LaChance, L.E., Schmidt, C.H., Bushland, R.C. RADIATION-INDUCED STERILIZATION. p. 147-196 of "Pest Control. Biological, Physical, and Selected Chemical Methods". Kilgore, W., Doult, R.L., Eds. New York, Academic Press. 1967, 477p.

Comprehensive review article. The article first considers the development of the sterile-male theory, the components of sterility, the physiological and cytogenetic basis for various kinds of sterility (infecundity, inability to mate, sperm inactivation, dominant lethal mutations, aspermia), types of sterility induced in various male insects, and the type of sterility desired for insect control programmes. The section on applications deals with the screw-worm eradication programmes, and with field trials for control, broken down into work on Diptera [fruit flies, *Lucilia sericata* Meig., *Musca domestica*, and mosquitoes], Lepidoptera [*Carpocapsa pomonella* (L.), *Paramyeloides transiella* (Walker)], and Coleoptera [*Melolontha vulgaris* (F.)]. An entire section (p. 182-193) is devoted to research needs: the comparative radiosensitivity of various species is discussed [illustrated by a table (p. 184-187)]; also, factors relevant to the success of future field trials, which include satisfactory and economical rearing methods, quantitative data on natural populations, a practical method of inducing sterility, and a knowledge of the components of sterility.

- 1570 Landa, V., Režábová, B. PROBLÉMY STERILISACE HMYZU. (Problems in insect sterilization.) *Agrochémia*, Bratislava 5 (1966) 150-152. (In Czech)

Review article. Recent progress in inducing sexual sterility in insects by chemosterilants and the results of trials carried out on *Lasioderma serricorne* and *Cochliomyia hominivorax* are discussed. The chemosterilants are classified, and the conditions under which the technique can be applied are given. The comparison between radiation- and chemical sterilization of *Musca domestica* L., and future work in this field to be done at the Institute of Entomology in Prague are briefly outlined.

- 1571 Lawson, F.R. INTEGRATING CONTROL OF PEST POPULATIONS IN LARGE AREAS. p. 27-45 of "Proceedings of the FAO Symposium on Integrated Pest Control, Pt.3, Rome, Italy. 11-15 Oct. 1965". Rome, Food and Agriculture Organization of the United Nations. 1966, 129p.

In the review of experimental data the sterile male releases as used in the eradication of the melon fly, *Dacus cucurbitae* Coq., from Guam are discussed. The bulk of the article is not concerned with radiosterilization but views the problem of pest control as one requiring a co-ordination of various techniques.

- 1572 Lawson, F.R. THEORY OF CONTROL OF INSECT POPULATIONS BY SEXUALLY STERILE MALES. *Ann. ent. Soc. Am.* 60, 4 (1967) 713-722. (Errata Note: *ibid.* 60, 5 (1967) 1076).

The theory of control of insect populations by the release of sexually sterile populations or by treating field populations is examined by establishing basic premises and deriving algebraic equations. The effect of multiple mating is shown to depend on the fertility of females mated to both sterile and fertile males. The effect of release of males alone will be the same as release of both males and females when the released females are sterile; the effect of release of females alone will depend on the number of times males can mate. If a population is seasonally cyclic, the timing of initial releases will have no effect on the number of sterile adults or the time required for extermination, but the initial reduction will be greater and the population before extinction will be lowered if releases are started when the increment of increase is least. The increment of increase of a population and the factors determining the increment are important in determining plant capacity and cost of control. When the cost of the rearing plant, the cost of operation, and the number of generations required to reach extinction are considered, we appear to have an optimum size of

plant and rate of release; higher rates of release are costly and save little time. Sterilisation of the males in a natural population is a more effective method than the release of sterile populations if both males and females are killed or sterilised. The relative efficiency of different treatments of the two sexes in the field depends on the mating ability of the males, the proportion of the two sexes that survive treatment, and the fertility of the survivors. (Auth.)

- 1573 Maksymov, J. K. NEUE WEGE IN DER INSEKTENBEKÄMPFUNG. (New perspectives in insect control.) Schweiz. Z. Forstwes. 116, 3 (1965) 235-242. (In German, with French summary)

This paper describes the practical and experimental methods being used to fight annoying insects. Classic methods, such as biological control by *Bacillus thuringiensis* and the use of DDT (dichlorodiphenyltrichloroethane) insecticides, are reviewed. Emphasis is placed on the newer methods of chemosterilization and sexual attraction by synthetic hormones. Sterilisation by γ -rays from ^{60}Co is discussed. (From auth. summ. transl.)

- 1574 Mehrotra, K.N., Sethi, G.R. ADVANCES IN INSECT POPULATION CONTROL BY THE STERILE-MALE TECHNIQUE. J. scient. Ind. Res. 25 (1966) 539-543.

The history and basic principles of the sterile-male technique for the eradication of insect pests are described. A critical evaluation of various methods for induction of sterility in insects and the aspects of nutrition concerned with mass rearing of insects are discussed. A brief account of research being performed in different parts of the world on various aspects of the technique is given and future lines of work are indicated. (NSA 21; 1967, 22720)

- 1575 Shipp, E., Osborn, A.W. THE THEORETICAL ROLE OF PREDATORS IN STERILE-INSECT RELEASE PROGRAMS. Bull. ent. Soc. Am. 12, 2 (1966) 115-118.

The benefits derived from predators will be related to their effectiveness at different prey densities, the size and duration of natural population fluctuations, as well as the relative length of the life cycles of predator and prey species. Advantages gained through the efficient use of parasite or predator populations in eradication programmes based on releases of sterile insects may be summarized as follows: (1) the cost of some programmes may be reduced by the combination of these two factors and by elimination of sexing and handling procedures; (2) there may be an increase in the range of pests for which sterile-male release programmes are feasible. The decline of a naturally fluctuating population may be hastened, thus increasing the duration of the low-density period; (3) there is an additional safeguard in the availability of predator pressure when sterile releases cease. — The use of predators in sterile-male eradication programmes is being investigated in a study of sugarcane leafhoppers of the genus *Perkinsiella*. Increasing the effectiveness of Knippling's sterile-male eradication technique by the possible supplementation of both "flushing" and increased predator effectiveness is considered.

- 1576 Van Hoeck, F. NUCLEAR ENERGY IN AGRICULTURE AND THE FOOD INDUSTRY. Ass. Belge dev. pacif. energie atom. Bull. Inf. 8, 45/46 (1963) 58-63.

General survey. Some mention is made of insect sterilisation by irradiation.

See also:

- 467 Some applications of radioactive isotopes in ecological research. (Noordink, J. P. W., 1965)
905 Atomic energy in the control of insects. (Baccetti, B., 1962)
906 Studies on the inheritable variability of radiation of insects and the biological control of (?) sterilized insects. (Chiang, J. J. H., 1965)
1118 Radiation sterilization in controlled insect pests. (Andreev, S. V. et al., 1967)
1134 The induction of dominant lethal mutations in insects by ionizing radiation and chemicals — as related to the sterile-male technique of insect control. (LaChance, L. E., 1967)
1135 Radiation-induced sterilization. (LaChance, L. E. et al., 1967)
1335 A cytological study of the effects of radiation on the development of the reproductive organs of two species of fruit flies: *Dacus oleae* and *Ceratitis capitata*. Report No. 7 (Final), December 20, 1962 — December 18, 1965. (Baccetti, B., 1962/1965)
1547 Towards better insect control. (Nelson, S. O., 1965)

- 1633 Can nuclear energy be used for the protection of cereal stores against insects? (Persson, P., 1965)
- 1740 Waxed-paper laboratory cage for sterilization studies with the oriental fruit moth, Grapholitha molesta (Busck) (Lepidoptera: Tortricidae). (George, J. A. et al., 1964)
- 1758 Bibliographie concernant la lutte biologique. (Franz, J.M. et al., 1967)
- 1760 Information circular on Radiation Techniques and their Application to Insect Pests, No. 7. (International Atomic Energy Agency, Vienna (Austria), 1966)
- 1770 Ionizing radiation in applied entomology. (Cadahia, D., 1966)
- 1789 Physical methods of insect control. (Wattens, F.L., 1965)
- 1791 "Proceedings of FAO/IAEA Training Course on Use of Radioisotopes in Entomology, Gainesville, Fla., 4 Oct. - 26 Nov. 1965". (International Atomic Energy Agency, Vienna (Austria) et al., 1965)

2.4.2.1.1. Coleoptera

- 1577 Andreev, S.V., Martens, B.K., Molchanova, V.A., Saldan, L.N. RADIOSTERILIZATION IN THE FIGHT AGAINST INSECT PESTS. Vest. sel', -khoz. Nauk No.1 (1967) 48-52. (In Russian)

The sterile-male technique, utilizing radiation, was tried on the bean weevil, Bruchus obtectus, the Colorado potato beetle, Leptinotarsa decemlineata, and the corn earworm, Heliothis armiger. Bean weevils and corn earworms were irradiated, using a ⁶⁰Co-source: 6000 or 8000 R, respectively, proved sterilizing doses. An x-ray unit was used on Leptinotarsa: 8000-10 000 R resulted in the complete sterilization of males. An investigation into the effect of different ratios of sterilized to non-sterile insects upon population density gave a population decrease down to 34% after introducing 20% of sterile males, compared with the control, and only 9% after 60% of sterile males. The optimal sterilizing doses ranged from 6000 to 10 000 R for the above-mentioned insects. A detailed analysis of the whole complex of conditions necessary for the successful application of the sterile-male technique shows that costs are lowest when it is applied to control insects whose complete life cycle takes place under field and barn conditions (e.g. for the pea and bean weevils). It is possible to achieve the total liquidation of such insects as early as in the third generation. The research report is preceded by a brief analysis of work on some of the main problems connected with this technique, e.g. the effect of γ -radiation on the reproductive organs, the determination of optimal sterilizing doses subject to the developmental stage considered, and the selection of economically important insects whose biological characteristics make the technique particularly appropriate.

- 1578 Chung, S.L., Lippold, P.C. COBALT-60 STERILIZATION STUDIES WITH THE EUROPEAN CHAFER. II. Bull. ent. Soc. Am. 13, 3 (1967) 192. Abstr. 109, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Sterilisation doses for field and laboratory-reared beetles were determined. Sub-sterilising doses resulted in enhanced egg production with some crosses. Egg production was dependent on female-male ratios. Improved techniques for rearing and holding stages after treatment were developed. (Abstr.)

- 1579 Gilliland, F.R., Jr. MATING BEHAVIOR AND POPULATION DYNAMICS OF THE BOLL WEEVIL AS RELATED TO THE STERILE-MALE-TECHNIQUE OF INSECT CONTROL. Diss. Abstr. 28, 3 (1967) 1269-B - 1270-B.

These studies were conducted to investigate whether certain aspects of the mating behaviour and population dynamics of the boll weevil, Anthonomus grandis Boheman, would affect effective application of the sterile-male technique for the control and/or eradication of this pest. It appears that the female is primarily responsible for controlling mating frequency under normal field conditions. However, as population density increases, the influence of males in controlling mating frequency also increases. Results of alternate mating studies showed that when an equal number of matings with sterile and normal males occurred, both equally influenced overall egg-hatch. The initial mating in the sequence had little effect on overall egg-hatch, while the last mating prior to oviposition was most influential on subsequent egg viability. Only slight differences were noted between egg fertility from single and double matings, an indication that little additional sperm is transferred in the 2nd mating if it occurs within a few hours. The developmental diet of the males