

- 396 Hall, W. E., Sun, Y.-P. MECHANISM OF DETOXICATION AND SYNERGISM OF BIDRIN INSECTICIDE IN HOUSE FLIES AND SOIL. J. econ. Ent. 58, 5 (1965) 845-9.
- With ^{14}C -labelled Bidrin[®] insecticide (3-hydroxy-N,N-dimethyl-cis-croton-amide dimethyl phosphate), some studies have been made on its detoxication by house flies, Musca domestica L., and its stability in soil. House flies were treated topically with tagged Bidrin with and without the synergist sesamex. Two hours after treatment, the following effects were observed with synergist: increase in knockdown from 10-15% to nearly 100%; no significant effect on absorption; considerable reduction in the excretion of radioactive compounds; lower degree of metabolism of Bidrin; the absence of one route of metabolism. One of the metabolites found in a significant quantity in the absence of synergist, but very little when synergist was present, was identified as the highly toxic compound 3-hydroxy-N-methylcrotonamide dimethyl phosphate (SD 9129). Bidrin was quickly detoxified in soil. However, considerable stabilization of Bidrin in soil was observed when treated with 500 ppm of sesamex, chloropicrin, Nemagon[®] soil fumigant (1,2-dibromo-3-chloropropane), chloromycetin, acti-dione, Shell 345 Soil Fungicide[®] (diacetoxy propene) or O,O,O-trimethyl phosphorothioate (SD 4741). Detoxication of Bidrin was also greatly reduced in sterilized or "air dry" soil. (Auth.)
- 397 Lindquist, D. A., Bull, D. L., Ridgway, R. L. SYSTEMIC ACTIVITY OF BIDRIN IN THE COTTON PLANT. J. econ. Ent. 58, 2 (1965) 200-3.
- Radioassay with ^{32}P -labelled Bidrin[®] (3-hydroxy-N,N-dimethyl-cis-croton-amide dimethyl phosphate) and bioassay with cotton aphids, Aphis gossypii Glover, were used to study the systemic activity of the insecticide in cotton plants. Direct application of Bidrin to the stems of cotton plants was a more efficient method of applying the toxicant than soil injection, seed treatment, or foliar sprays. (Auth.)
- 398 Menzer, R. E., Casida, J. E. NATURE OF TOXIC METABOLITES FORMED IN MAMMALS, INSECTS, AND PLANTS FROM 3-(DIMETHOXYPHOSPHINYLOXY)-N,N-DIMETHYL-CIS-CROTONAMIDE AND ITS N-METHYL ANALOG. J. agric. Fd Chem. 13, 2 (1965) 102-12.
- Bidrin, 3-(dimethoxyphosphinyloxy)-N,N-dimethyl-cis-crotonamide, is metabolized to yield trace amounts of 3-(dimethoxyphosphinyloxy)-N-methyl-N-hydroxymethyl-cis-croton-amide and larger amounts of 3-(dimethoxyphosphinyloxy)-N-methyl-cis-crotonamide (SD 9129). SD 9129 is further metabolized to yield 3-(dimethoxyphosphinyloxy)-N-hydroxy-methyl-cis-crotonamide and 3-(dimethoxyphosphinyloxy)-cis-crotonamide. The toxicity to both insects and mammals increased upon successive N-demethylation. Balance studies on the fate of the ^{32}P and ^{14}C from Bidrin- ^{32}P , Bidrin-N-methyl- ^{14}C , SD 9129- ^{32}P , and SD 9129-N-methyl- ^{14}C are considered. Studies on milk residues, urinalysis, and metabolism in house flies (Musca domestica L.) and bean plants, and toxicity to adult American cockroach (Periplaneta americana (L.)) are reported. An unusual pattern of synergism of the toxicity of the Bidrin metabolites in house flies by sesamex [2-(2-ethoxyethoxy)ethyl-3,4-(methylenedioxy)phenyl acetal of acetaldehyde] was noted.

Demeton

- 399 Dedek, W. ZUR KENNTNIS DER HYDROSE- UND ISOMERISIERUNGREAKTIONEN EINIGER SYSTOXHOMOLOGEN. (Hydrolysis and isomerization reactions of some Systox compounds). Atompraxis 10, 4 (1964) 164-7. (In German)
- The rate constants of the hydrolysis and isomerization reactions of four insecticidal thiophosphoric acid esters of the Systox type were determined by means of ^{32}P -labelled substances. The course of the reaction is in line with existing hypotheses. The following radioactive substances were synthesized: ^{32}P -thiophosphoryl bromide, $\text{P}(\text{SBr})_3$; ^{32}P -dialkylthiophosphoric acid bromide, $(\text{RO})_2^{32}\text{P}(\text{S})\text{Br}$; and ^{32}P -(O,O-dialkyl-O-(8-alkylmercaptoethyl)-thionophosphate, $(\text{RO})_2^{32}\text{P}(\text{S})\text{OCH}_2\text{CH}_2\text{SR}$.

Phorate

- 400 Jaccquinot, L., STUDY BY MEANS OF ^{35}S ON THE RESIDUES OF AN INSECTICIDE ON MILLET. Agron. trop., Nogent 19, 12 (1964) 1081-8. (In French)

Millet seed with 2.75% of $(\text{EtO})_2\text{P}(\text{S})\text{SCH}_2\text{SEt}$, tagged with ^{35}S , was sowed. Extracts of leaves were analysed by paper chromatography with $\text{Me}_2\text{CO-EtOH-H}_2\text{O}$ (30:30:40). R_f value of the major radioactive component was 0.77, 0.90, and 0.96 for all 4-cm plants germinated within 15, between 15 and 20, and between 20 and 25 d from date of sowing, respectively. The R_f of the control was 0.50. (CA 63:1965, 1145g)

Di-Syston

- 401 Bull, D.L. METABOLISM OF DI-SYSTON BY INSECTS, ISOLATED COTTON LEAVES, AND RATS. J. econ. Ent. 58, 2 (1965) 249-54.

Di-Syston® (O,O -diethyl S-[2-(ethylthio)ethyl]phosphorodithioate) was absorbed, metabolized, and excreted rapidly by 5th-instar bollworms, *Heliothis zea* (Boddie), and adult boll weevils, *Anthonomus grandis* Boheman. Insects excreted the toxic oxidative derivatives as well as the hydrolytic products of Di-Syston metabolism, but rats slowly excreted only hydrolytic products. As many as four oxidative and nine hydrolytic metabolites of Di-Syston were detected in the biological systems used. The oxidative products included the sulfoxide and sulphone derivatives of Di-Syston of the oxygen analogue of Di-Syston. In animals and plants, the initial oxidative reaction with the Di-Syston molecule occurred at the mercapto sulphur atom. In plants, Di-Syston was converted almost quantitatively to its sulfoxide derivative during the first few minutes after treatment. The chief hydrolytic products of Di-Syston metabolism were diethyl phosphate and O,O -diethyl phosphorothioate. In addition, small concentrations of ethyl phosphate, phosphoric acid, and five unidentified products were detected in certain samples. O,O -diethyl phosphorodithioate was not formed in insects or plants but trace amounts of the metabolite were detected in the urine of treated rats. Similar products were formed in the different biological systems but the rates of metabolism varied considerably. Two batches of pure (> 98%) ^{32}P -labelled Di-Syston with initial specific activities of 2.5 mCi/g^2 and 10.6 mCi/g^2 , respectively, were used.

- 402 Bull, D.L. METABOLISM OF DI-SYSTON IN INSECTS AND RATS. Bull. ent. Soc. Am. 10, 3 (1964) 165. Abstr. 96.

Both oxidative and hydrolytic conversion of ^{32}P -labelled Di-Syston occurred in 5th-instar bollworms, *Heliothis zea* (Boddie), and male white rats. The nature and relative concentrations of different metabolites were determined by standard radiometric procedures.

- 403 Ridgway, R.L., Lindquist, D.A., Bull, D.L. EFFECT OF METHOD OF APPLICATION ON UPTAKE OF DI-SYSTON BY THE COTTON PLANT. J. econ. Ent. 58, 2 (1965) 349-52.

^{32}P -labelled Di-Syston® (O,O -diethyl S-[2-(ethylthio)ethyl] phosphorodithioate) was applied to the soil with and without irrigation and at a variety of locations in relation to the cotton plant. Results indicated that irrigation, deep placement, and sidedressing on both sides instead of on one side of the drill row increased uptake. Radioassay of different parts of the cotton plant indicated that after applications were made to soil greater quantities of radioactivity accumulated in the leaves than elsewhere. After application to the stem, Di-Syston did not translocate to other parts of the plant to the extent reported for some other systemic insecticides (Auth.)

Malathion

- 404 Giles, R.H., Jr. THE ECOLOGY OF A SMALL FORESTED WATERSHED TREATED WITH THE INSECTICIDE MALATHION- ^{35}S . Diss. Abstr. 25, 2 (1964) 731.

The faunal ecology of two 20-acre forested watersheds near Dover, Ohio, was studied for 1 year before aerially spraying one watershed with 2 lb/acre of malathion- ^{35}S . Effects were studied for one year after treatment. Many different sampling devices and methods were used to measure

the effects of the insecticide on populations of soil microfauna, arthropods, mollusks, reptiles, amphibians, birds, and mammals. Barium sulphate precipitates were prepared of samples of animals, plants, soil, and water. The radioactivity of the ^{35}S in these samples was measured. Amounts of malathion, its metabolites, or components within the samples were determined. Malathion was followed from the airplane, within the air, over the canopy, through the three-layered deciduous forest, within soil, and within animals and plants. The insecticide had limited effects on mammals and birds; no effect on reptiles, amphibians, and mollusks; some effect on microarthropods; and variable effects on fish and on hundreds of arthropod families. The insecticide apparently reduced mammalian population size; caused the cessation of bird singing for 2 d post-spray; had no effect on reptile, amphibian, and mollusk populations; had a short-term effect on soil microarthropod populations; had no effect on soil bacterial and fungal populations; and had no apparent effect on some insect populations, though greatly reducing others. There was no evidence of population resurgence following disruption of predator-prey balances. (DA)

- 405 Kotivistoinen, P., Vanhanen, L., Koskinen, E.H. DISAPPEARANCE OF MALATHION RESIDUES FROM GOOSEBERRIES AT DIFFERENT RESIDUE LEVELS. J. agric. Fd Chem. 13, 4 (1965) 344-6.

Post-harvest applications of ^{32}P -labelled malathion at different initial deposit levels were made on gooseberries which were then subsequently stored at 22-25°C. The berries were analysed after 3 and 7 d of storage, and the distribution patterns of malathion- ^{32}P into chloroform-soluble, water-soluble, and inextractable fractions as well as the loss from the berries were determined. In the 7-d pattern, which was, except the lowest residue level, essentially the same as the 3rd pattern, the proportion of the ^{32}P -activity in the chloroform fraction was 31% at the initial deposit level of 2.2 ppm, 44% at the 130 ppm level, 85% at the 330 ppm level, and 95% at the 1802 ppm level. The amounts of malathion- ^{32}P found in the water fractions varied from 59% at the lowest to 3% at the highest residue level. The actual figures in malathion equivalents for the four application levels were 1.1, 51, 38, and 98 ppm, indicating the presence of a malathion-degrading enzyme system in gooseberries with a limited capacity. The amounts of radioactivity not extractable from the berry solids to either the chloroform or water fractions varied from 10% at the lowest to 2% at the highest level. Of the initial loads of radioactivity, 14-23% or 0.3-324 ppm in malathion equivalents was not recovered. This study indicates that the disappearance behaviour of residues of malathion may depend on the amount of the initial deposit. (Auth.)

- 406 Kotivistoinen, P., Karinpää, A., Kõnönen, M., Vanhanen, L. EXTRACTION OF MALATHION RESIDUES FROM FRUITS. J. agric. Fd Chem. 13, 4 (1965) 347-9.

Stripping unmacerated crops with benzene as an extraction method for malathion post-harvest residues on fruits was compared with three other methods: blending the crop in water with subsequent tumbling with benzene, blending in ethanol with subsequent tumbling with benzene, and drastic blending in chloroform followed by additional extractions with a methanol-acetone mixture. One extraction method was used both on small crop samples (~20 g) containing ^{32}P -labelled malathion residues and on larger samples (250 g) having inactive residues. To study the efficiency of this method, ^{32}P -labelled malathion was applied to gooseberries after harvest by dipping in a malathion emulsion. The fruit was then stored at ~20°C. The chloroform-soluble, water-soluble, and inextractable radioactivity levels were assayed just after application and twice during the first week of storage (see Tables 3 and 4). - In all cases stripping the unmacerated crops gave the highest values of initial deposits and in most cases also the highest residue recoveries during the first few days after malathion application; later, slightly higher recoveries were obtained from blended macerated materials.

- 407(2) Giles, R.H., Jr., Peterle, T.J. NEW TRACER TECHNIQUES FOR EVALUATING THE EFFECTS OF AN INSECTICIDE (MALATHION) ON THE ECOLOGY OF A FOREST FAUNA. Washington. Fishery Bull. Fish Wildl. Serv. US 187 (1981/62) 100.

See II/677: TID-13650, Ohio State Univ. Research Foundation, Columbus, 31 Aug. 1961. 22p.

- 408 Mansingh, A. THE EFFECT OF MALATHION ON THE CATABOLISM OF LABELLED GLUCOSE IN Blattella germanica (L.). Indian J. Ent. 26, 4 (1964) 423-33.

A malathion-susceptible (S) and a resistant (R) strain of *B. germanica* were used in a study of the metabolic interrelationship between carbohydrates, proteins, amino acids, and lipids of malathion-intoxicated roaches. Glucose-U-¹⁴C was catabolized mainly into ¹⁴CO₂, carbohydrates, organic acids and sugar phosphates, free amino acids and protein. Trehalose and glycogen were found to be the major storage forms of sugars. The existence of an efficient mechanism of carbohydrate-amino acid interconversion is indicated. Free glutamate, aspartate, glutamin-asparagine, serine, glycine, alanine and proline incorporated ¹⁴C from the administered glucose-U-¹⁴C. Malathion-intoxication of S-roaches increased the ¹⁴CO₂-output by ~84%, lowering the concentrations of glucose, trehalose, glycogen, and some of the free amino acids, whilst also slightly lowering ¹⁴C-incorporation into body proteins. No evidence of any effective inhibition of glycolysis of Krebs' TCA cycle was found. Poisoned R-roaches catabolized the administered glucose similarly to the S-roaches, except for slightly increased sugar utilization. The presence of a protective mechanism which indirectly prevents the depletion of carbohydrates by malathion action is indicated. The effect of malathion on the carbohydrate metabolism in insects appears to be secondary to some primary lesion which involves endergonic reactions.

- 409 Matsumura, F., Hogendijk, C. J. THE ENZYMATIC DEGRADATION OF MALATHION IN ORGANOPHOSPHATE RESISTANT AND SUSCEPTIBLE STRAINS OF *Musca domestica*. Ent. expl appl. 7 (1964) 179-193.

³²P-malathion was synthesized from ³²P-phosphoric acid and purified by column chromatography. ³²P-malaoxon was prepared by peracetic acid oxidation of ³²P malathion and separated from it by an alumina absorption column. ¹⁴C-malathion, labelled in the two and three positions of the succinyl moiety was also used. The metabolic fate of labelled malathion in both strains of flies was studied in vivo and in vitro. The main interstrain difference was the superior ability of the two malathion-resistant strains to degrade malathion to its monocarboxylic acid derivative. Attempts were made to characterize the carboxyesterases responsible for this difference with respect to heat stability, pH dependency and organophosphate inhibition, and to estimate their importance in causing resistance by means of cross-resistance and synergism experiments. The relation to, and possible identity of the carboxyesterases with, the malaoxon degrading enzymes previously found in the malathion-resistant strains is discussed.

- 410 Matsumura, F., Voss, G. MECHANISM OF MALATHION AND PARATHION RESISTANCE IN THE TWO-SPOTTED SPIDER MITE, *Tetranychus urticae*. J. econ Ent. 57, 6 (1964) 911-17.

¹⁴C-malathion (¹⁴C-succinyl labelled) and ³H-parathion (³H-ethyl labelled) were used. Comparative studies on the breakdown activities in organophosphate-resistant and -susceptible spider mite, (*T. urticae* Koch) strains, against radioactive malathion and parathion and non-radioactive malaoxon and para-oxon revealed that the resistant Blauvelt strain had a superior ability to detoxify malathion, parathion, and malaoxon as compared with the susceptible Niagara strain. In the case of malathion breakdown, the highest interstrain difference was found in the amount of carboxyesterase products, but a substantial difference in the phosphatase activity was also observed. These results were in accordance with the experiments in vivo with radioactive malathion and parathion. A second OF-resistant spider mite strain, characterized by another protection mechanism, also showed a high rate of malathion and parathion breakdown. The total uptake of malathion by the Blauvelt strain did not significantly differ from that by the Niagara strain. The rate of ChE inhibition in vivo in Niagara mites was much higher than in Blauvelt mites. Furthermore, homogenates of the Blauvelt strain were found to hydrolyse β -naphthyl benzoate at a higher rate than Niagara homogenates. The unique features of the malathion-resistance in the Blauvelt strain were compared with data already published on malathion-resistance in mosquitoes and house flies (*Musca domestica* L.).

- 411 Matsumura, F., Voss, G. PROPERTIES OF PARTIALLY PURIFIED MALATHION CARBOXYESTERASE OF THE TWO-SPOTTED SPIDER MITE. J. Insect Physiol. 11, 2 (1965) 147-60.

Niagara normal and Blauvelt resistant strains of *Tetranychus urticae* Koch were used. The toxic phosphorus compounds employed were ¹⁴C-malathion (2,3-succinyl carbon labelled), ³H-parathion (ethyl hydrogen labelled), non-radioactive malaoxon, and di-isopropyl phosphorofluoridate (DFP). The malathion carboxyesterase found in a multiple organophosphate-resistant strain of the spider mite was purified about 80-fold and characterized. It was shown to have hydrolytic activities against malathion (carboxyesteratic as well as phosphoroesteratic), malaoxon,

parathion (phosphoroesteratic), and a number of naphthyl and nitrophenyl esters. By comparing it with its counterpart in susceptible mites and using differential inhibition techniques, it was concluded that (1) malathion carboxyesterase and an aliesterase which hydrolysed 8-naphthyl benzoate were inseparable, and that (2) malathion- and parathion-phosphatase belonged to a different enzyme group from that of the carboxyesterase of malathion. The additional carboxyesterase of the resistant strain had 20 times as high an affinity to the substrate as that of the susceptible strain, if the Km measures affinity. This enzyme differs from that of susceptible mites in being very sensitive to dilution and dialysis at low concentrations and by being eluted at a different salt concentration from a DEAE-cellulose column.

- 412 Peterle, T. J., Giles, R. H., Jr. NEW TRACER TECHNIQUES FOR EVALUATING THE EFFECTS OF AN INSECTICIDE ON THE ECOLOGY OF A FOREST FAUNA. Final Report, December 1, 1960 - November 30, 1963. TID-20355, Ohio State Univ. Research Foundation, Columbus, Jan. 1964, 444p.

The faunal ecology of two deciduous-forested, 20-acre water-sheds near Dover, Ohio, was studied intensively for 1 year. The second year, one of the watersheds was aerially sprayed with 2 lb/acre of malathion labelled with ^{35}S . Effects of the insecticide were studied by sampling all faunal segments from the microbiota of the soil to raccoons. The insecticide and its metabolites were followed from the airplane through the air, the forest vegetation, and in soil and water. Results indicate that malathion is an effective insecticide that, although harmful to some forms, is of short residue and permits rapid recovery of decimated or altered populations. (NSA 18:1964, 17362)

Dimethoate

- 413 Lindquist, D. A., Hacskeylo, J., Davich, T. B. EFFECT OF LIGHT AND HUMIDITY ON THE ABSORPTION AND TRANSLOCATION OF DIMETHOATE IN THE COTTON PLANT. J. econ. Ent. 58, 3 (1965) 415-8.

^{32}P -dimethoate was used. In studies of absorption and translocation of dimethoate by cotton plants, as affected by different light and humidity conditions, similar amounts of dimethoate were absorbed by the roots of plants whether maintained in the light or the dark. Cotyledons also accumulated similar amounts of dimethoate during an 8-h exposure. Leaves on the same cotton plant, but under different conditions of light and humidity accumulated different amounts of dimethoate. Both humidity and darkness resulted in greatly reduced dimethoate accumulation in the leaves.

- 414 Pietro-Tonelli, P. de PENETRATION AND TRANSLOCATION OF ROGOR APPLIED TO PLANTS. Adv. Pest Control Res. 6 (1965) 31-84.

After dealing with the physico-chemical and toxicological properties of Rogor, the author concentrates on the systemic effects of the insecticide. In the subsequent sections on the systemic effect of Rogor intensive use had been made of ^{32}P . The subject is considered in terms of the systemic effect after foliar application (penetration into the leaf, migration from one half of the leaf blade to the other, migration through the veins, translocation from leaf to leaf, outward translocation from leaves to fruits, translocation from leaves to fruits, and translocation from leaves to roots); the systemic effect after fruit application (penetration into the fruit, migration from one half of the fruit to the other, and translocation from fruits to leaves); the systemic effect after twig application (penetration and migration in, and translocation from the twigs); the systemic effect after stem application (translocation from stem to leaves, and from the trunk to aerial and ipogeeal organs of the plant); and the systemic effect after complete and partial spray application to aerial part of the plant.

- 415 Sanderson, D. M., Edson, E. F. TOXICOLOGICAL PROPERTIES OF THE ORGANOPHOSPHORUS INSECTICIDE DIMETHOATE. Br. J. Ind. Med. 21, 1 (1964) 52-64.

$(\text{MeO})_2\text{P(S)SCH CONHMe}$ (dimethoate) was studied as the pure compound (recrystallized from absolute ether, odourless) (I); as the laboratory grade material (all physical constants as I, but possessing thiol odour) (II); as technical grade (containing about 7% $(\text{MeO})_2\text{P(S)SMe}$) (III); as liquid formulation (32-40% III in $\text{MeO}(\text{CH}_2)_2\text{OH}$ or in cyclohexanone) (IV); or as a wettable powder (20% III in china clay) (V). Single oral LD50 of I in rats, hamsters, guinea pigs, and rabbits was 500-680,

in mice 60, and in birds 15-50 mg/kg. I changes into II on standing, with substantial increase in toxicity for most species. III, IV, and V had toxicities as high or higher than II; IV showed lower LD50 in MeO(CH₂)₂OH than in cyclohexanone due to exchange of alcoholic radicals during storage, the isolated reaction product having LD50 of 1 mg/kg. Intraperitoneal, intravenous, and subcutaneous single LD50's were similar to the oral values. Signs of poisoning are typical for a cholinesterase (VI) inhibitor, and are delayed 0.5-2 h after dosing, dependent on the purity of the material. Death followed after 3-30 h, or recovery took place in 2-4 d. Survivors showed no permanent ill-effects. In rats dosed with 190-300 mg II/kg, erythrocyte and plasma-VI fell to 15% of pre-exposure level in 3 and 20 h, respectively, but both values recovered to 85-100% in 14d; brain-VI fell to 37% in 7 d and recovered to 60% only. Dermal LD50 on 24-h contact in rats was 700-1150, the lowest VI-inhibiting dose was 30-50 mg/kg. In humans, ³²P-labelled IV applied to skin was largely unabsorbed after 5.5 h. Upon daily intraperitoneal administration of II to rats, the highest non-lethal dose was 40, the highest non-toxic dose 3, and the highest non-VI-inhibiting dose 0.7 mg/kg/d. There were no toxic effects in humans ingesting 0.04 mg II/kg daily, or 0.25 mg/kg as a single dose; during prolonged dietary administration of II or IV to rats animals receiving 0.4-0.8 mg/kg/d (5-10 ppm) were indistinguishable from controls by any criterion including VI activity. The concentration causing 50% inhibition of rat brain VI is 8.5×10^{-3} M for I, and 1×10^{-3} M for II. Toxicity of I is due to in vivo oxidation to its P:O analogue and three other metabolites (separated by CHCl₃ extraction). Plant metabolites are identical to those formed in the liver; sprayed vegetation presents no extra hazard. Work of other authors is reviewed. (CA 61:1964,4895b)

- 416 Uchida, T., Dauterman, W. C., O'Brien, R. D. THE METABOLISM OF DIMETHOATE BY VERTEBRATE TISSUES. J. agric. Fd Chem. 12, 1 (1964) 48-52.

The ability of vertebrate tissues to degrade dimethoate in vitro was investigated. ³²P-labelled dimethoate was synthesized and purified essentially as described in J. agric. Fd Chem. 7:1959,188; the steps by which ³²P-labelled dimethoate acid was synthesized biochemically are described. Dimethoate was degraded rapidly in rat liver but very little in other (rat) tissues. The degrading activity of the livers of other species was, in descending order: rabbit, sheep, dog, rat, cattle, hen, guinea pig, mouse, and pig. The activities were related to the toxicity of dimethoate. Dimethoate acid was the only product from sheep liver; O,O-dimethyl phosphorodithioate was the only product from guinea pig liver. Rat and mouse livers gave both products. In sheep liver, degradation was by a microsomal amidase, some of its properties being described.

- 417 Uchida, T., Rahmati, H. S., O'Brien, R. D. THE PENETRATION AND METABOLISM OF H³-DIMETHOATE IN INSECTS. J. econ. Ent. 58, 5 (1965) 831-5.

The toxicity, penetration, and metabolism of dimethoate were studied in Musca domestica L., the American cockroach, Periplaneta americana (L.), the Colorado potato beetle Leptinotarsa decemlineata (Say), the large milkweed bug Oncopeltus fasciatus (Dallas), and the house cricket Acheta domestica (L.). Aqueous ³H-dimethoate (1 µl) was injected into the abdomen. There were marked variations in toxicity, penetration, and metabolism, including a 5-fold variation in net production of oxygen analogue and a 100-fold difference in cholinesterase sensitivity. Differences in penetration were seen during the initial 30 min, but thereafter the speed was almost the same for all species. The highly sensitive house fly showed particularly rapid penetration, extensive production of oxygen analogue, and sensitive cholinesterase. However, variations in these factors could not explain all the variations in toxicity to the five species.

- 418 Wang, W.-Y., Wu, C.-L. THE TOXICITY OF ROGOR A NEW INSECTICIDE. Igiena 13, 3 (1964) 201-6.

The toxicity of Rogor (I) was investigated in mice after oral administration. The LD0, LD5, LD50 and LD100 values were 60, 80, 126, and 240 mg/kg, respectively. The minimum dose of I affecting the activity of blood cholinesterase was 10 mg/kg. Injections of 5 mg atropine/kg or 45 mg PAM/kg 0.5-1 h prior to the administration of I, increased the LD50 2-fold. I reduced the rate of ¹³¹I uptake and ¹³¹I release by the thyroid in mice. (CA 62:1965,3344b)

Phosphorus Phenyl (Carbocyclic) Derivatives

- 419 Metcalf, R. L., Reynolds, H. T., Fukuto, T. R., Collins, C. FACTORS INFLUENCING THE SYSTEMIC INSECTICIDAL ACTION OF SUBSTITUTED PHENYL DIMETHYL PHOSPHATES. *J. econ. Ent.* 57, 4 (1964) 531-6.

³²P-radiotracers of 2,4,5-trichlorophenyl dimethyl phosphate (A), 4-methylthiophenyl dimethyl phosphate (B), and 4-nitrophenyl dimethyl phosphate (C) were used to study the systemic insecticidal activity of these compounds in cotton plants following application to the stem or as a 5% granule to the soil about the roots. Although all three compounds are effective contact insecticides, neither A nor C was appreciably active as a systemic insecticide and only traces of the intact insecticides could be found in the leaves up to 32 d after treatment. However, B is an active systemic insecticide and this observation was in agreement with the findings of the radiotracer investigations which showed relatively large amounts of B or its toxic oxidation products in leaves and squares. It was concluded that B was more soluble in the lipid cuticle of the cotton plant and that its oxidation in the plant environment to the more toxic sulphoxide and sulphone derivatives provided the necessary "delay factor" so that it was translocated in lethal amounts. (Auth.)

Methyl Parathion

- 420 Lybeck, H., Leppaluoto, J., Aimo, H. THE EFFECT OF AN ORGANOPHOSPHORUS CHOLINESTERASE INHIBITOR, METHYL PARATHION, UPON THE ACCUMULATION OF IODIDE BY THE THYROID GLAND. *Ann. Acad. Sci. Fennicae*, Ser. A V (Suomal. Tiedekat. Toim., Sarja A V) 108, 17 (1964) 8p. (In English)

Methylparathion (150 γ) (I) or 1 mg propylparathion (II) was given to female rats, followed by intraperitoneal injection of 20 μ Ci ¹³¹I. The percent uptake was less than in controls, with max blocking effects of I and II seen after 8 h, and decreasing thereafter. The effect of I was greater than II in applied dosages. (CA 61:1964, 15282h)

Parathion

- 421 Cavalcaselle, B., Bellis, E. de, Liani, A. PRELIMINARY INVESTIGATIONS ON THE ABSORPTION OF PARATHION-³²P BY POPLAR STEMS. *Ente Naz. Cell. Carta. Cent. Sper. Agr. Forest. P.* 7 (1964) 89-97.
- 422 Iyatomi, K., Saito, T. METABOLISM OF PARATHION IN RESISTANT AND SUSCEPTIBLE RICE STEM BORER. p. 500-1 of "Proceedings of the 12th International Congress of Entomology, London, 8-16 Jul. 1964". Freeman, P., Ed. London, Royal Entomological Society of London, 1965.

The metabolic fate of topically applied ³²P-parathion was studied in larvae. Chloroform extracts of homogenized larvae contained parathion, paraoxon, and their still active metabolites, and degraded substances in the water extract. Detoxication of ³²P-parathion and paraoxon by the tissues of the resistant and susceptible borer in vitro was examined. Results showed that blood has the most important role in detoxication of parathion and paraoxon in the resistant strains. Although differences have been found between the resistant and susceptible strains of borer with regard to the zymograms of esterases separated and revealed by means of the thin layer agar gel electrophoresis, there is no conclusive evidence that such differences may account for resistance to parathion. Parathion-resistant borers showed no cross-resistance to methyl parathion and EPN. There was no significant difference in the rate of destruction of ³²P-methyl parathion between resistant and susceptible strains. Thus, parathion resistance does not exhibit a group resistance pattern as does chlorinated hydrocarbon resistance, and the mechanism of resistance seems to be related to slight structural changes in the organophosphorus insecticides. Resistance to parathion is relatively unstable, and on removal of selection pressure, resistant borers decrease their detoxication ability and become susceptible again in six generations.

- 423 Matsumura, F., Hogendijk, C.J. THE ENZYMATIC DEGRADATION OF PARATHION IN ORGANOPHOSPHATE-SUSCEPTIBLE AND -RESISTANT HOUSEFLIES. J. agric. Ed Chem. **12**, 5 (1964) 447-53.
- The metabolic fate of parathion and diazinon, in one organophosphate-susceptible and two resistant strains, was studied by chromatography and radioisotope techniques. ^{32}P -parathion and diazinon were synthesized from ^{32}P -phosphoric acid. Paraaxon was obtained from ^{32}P -parathion by means of peracetic acid oxidation at 35°C for 12 h, or synthesized from $^{32}\text{POCl}_3$ obtained from $\text{H}_2^{32}\text{PO}_4$. The main interstrain difference resulted from the superior ability of the resistant strains to degrade parathion to diethyl phosphorothionate. The enzyme involved in the degradation process in the strains S and Ka was purified about 30 times by acetone powder formation, DEAE-fractionation, and ethanol precipitation. The partially purified enzyme preparations obtained from all three strains hydrolysed parathion and diazinon to diethyl phosphorothionate, but their activity in hydrolysing paraaxon was relatively low. The importance of these interstrain differences in relation to organophosphate resistance is discussed.
- 424 Mengle, D.C., Lewallen, L.L. METABOLISM OF P^{32} LABELED PARATHION IN SUSCEPTIBLE AND PHOSPHATE-RESISTANT STRAINS OF THE MOSQUITO Aedes nigromaculis (Ludlow). Bull. ent. Soc. Am. **10**, 3 (1964) 165. Abstr.
- Radioactive parathion, synthesized in the laboratory, was applied to A. nigromaculis (Ludlow) larvae collected from various locations in the San Joaquin Valley. Bioassay indicated as high as 1000-fold resistance between populations. Results indicate greater insecticide hydrolysis in resistant larvae, resistance more closely correlated with breakdown of paraaxon than parathion.
- 425 Hilton, B.D., O'Brien, R.D. SYNTHESIS OF H^3 -ETHYL PARATHION. J. econ. Ent. **58**, 5 (1965) 1025-6.
- The synthesis of ^3H -parathion (2.5 mM) is described, the ^3H -alcohol being introduced in the final step. The synthesis of p-nitrophenyl phosphorodichloridodithionate (PDT) is included since it is not available commercially. The isotopic yield of parathion was 45%, of 97% purity. The method is equally suitable for ^{14}C -ethyl parathion. The authors point out that the principle of ^3H -alkylating in the terminal synthetic step should be applicable to many other organophosphates, and have so far succeeded in preparing the appropriate intermediate for ronnel and its P-(O) analogue.
- 426 Nakatsugawa, T., Dahm, P.A. PARATHION METABOLISM BY LIVER MICROSOMES. Bull. ent. Soc. Am. **11**, 3 (1965) 157. Abstr. 57. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. -2 Dec. 1965".
- ^{35}S -parathion activation by liver microsomes showed binding of ^{35}S onto microsomes nearly equivalent to the paraaxon formed. A more abundant, ^{35}S -metabolite was water soluble and extractable from a acidic media with chloroform or ethyl acetate. The microsomal system split parathion at the arylphosphate bond. All reactions required NADPH_2 and oxygen. (Abstr.)
- 427 Potter, J.L., O'Brien, R.D. PARATHION ACTIVATION BY LIVERS OF AQUATIC AND TERRESTRIAL VERTEBRATES. Science, N.Y. **144** (1964) 55-57.
- ^3H -parathion was synthesized by reacting ^3H -ethanol with P_2S_5 , chlorinating the mixture with SO_2Cl_2 , and reacting the resultant diethyl phosphorochloridodithionate with sodium p-nitrophenate (with a yield of 2.5%, and a specific activity of 7.58 mCi/mM). Liver slices from seven terrestrial and six aquatic animals were studied for their ability to activate parathion, and to convert it to paraaxon, a potent anticholinesterase. Although there are similarities between the liver systems which activate parathion and which degrade drugs such as aminopyrine and phenacetin, liver slices of aquatic vertebrates can activate parathion but cannot degrade such drugs.
- 428 Saito, T. TOXICOLOGICAL ASPECTS OF INSECTICIDE RESISTANCE. Jap. J. Med. Sci. Biol. **17**, 1 (1964) 44-6.
- Larvae of Chilo suppressalis were treated topically with 0.6 γ parathion- ^{32}P (II). After 1 d at 25°C the larvae were homogenized with H_2O and extracted with CHCl_3 and 2N HCO_2H in 80% EtOH . Analysis of the extracts showed that more II had been detoxified by the resistant strains. The

metabolites of II in the susceptible strain were about equal parts of diethyl parathion (III), diethyl thiophosphoric acid, diethyl phosphoric acid, H_2PO_4 , and thiophosphoric acid. The resistant strains showed more II in the metabolites. The mechanism of resistance was suggested as involving a dealkylation of paraoxon. (CA 61:1964, 8835b)

- 429 Zschintzsch, J., O'Brien, R.D., Smith, E.H. THE RELATION BETWEEN UPTAKE AND TOXICITY OF ORGANOPHOSPHATES FOR EGGS OF THE LARGE MILKWEED BUG. J. econ. Ent. 58, 4 (1965) 614-21.

Eggs of the large milkweed bug, *Oncopeplus fasciatus* (Dallas), are totally insensitive to parathion vapour, but freshly emerged larvae are sensitive. Work with 3H -parathion showed that large quantities are taken up by the eggs, but very little reaches the embryo. However, on emergence from poisoned eggs, larvae rapidly take up parathion from the egg and die soon thereafter. Ten other organophosphates and two carbamates are, like parathion, without ovicidal action on this species; but dichlorvos and trichlorfon are lethal to the late stages of developing eggs. Studies with ^{14}C -dichlorvos showed that extremely large quantities are taken up by the eggs, and a large fraction of it reaches the embryo. It is concluded that the non-toxicity of parathion is a penetration phenomenon, involving either a barrier or very poor partitioning from external lipid into the egg interior; but the ineffectiveness of dichlorvos to early stages may be due to their intrinsic insensitivity. (Auth.)

Paraoxon

- 430 Fredriksson, T. THE PERCUTANEOUS ABSORPTION OF PARATHION AND PARAOXON. VI. IN VIVO DECOMPOSITION OF PARAOXON DURING THE EPIDERMAL PASSAGE. J. invest. Derm. 42 (1964) 37-40.

In the cat the rate of percutaneous absorption of paraoxon following topical application of 50 μ l ^{32}P -labelled material measured 6×10^{-9} mole/min/cm 2 . The radioactivity of the blood after 3 h corresponded to 0.05 γ /ml paraoxon. Inhibition of plasma cholinesterase activity was the same as with non-labelled paraoxon, indicating that the radiation of a high-energy β -ray emitter does not injure the absorption barrier. Almost 90% of the topically applied paraoxon was detoxified by enzymes in the skin before it was absorbed by the capillaries. (CA 60:1964, 13772d)

Colep

- 430-a Marco, G.J., Jaworski, E.G. METABOLISM OF O-PHENYL O'-(4-NITROPHENYL) METHYLPHOSPHONOTHIONATE (COLEP) IN PLANTS AND ANIMALS. J. agric. Ed Chem. 12, 4 (1964) 305-10.

O-phenyl- ^{14}C -O'-(4-nitrophenyl) methylphosphonothionate (Colep- ^{14}C) was synthesized with uniformly labelled phenol to a specific radioactivity of 0.97 mCi/mM. A solution of the compound in ethanol (5.2 mg/ml) was applied by microsyringe to the individual leaves. The time course metabolism of Colep was followed for 28 d in apple and cotton seedlings. Thin layer chromatography in several solvent systems of the benzene, chloroform, and water extracts of the apple and cotton leaves showed a variety of radioactive compounds other than Colep. Because acid hydrolysis converts most of the radioactivity in all extracts to phenol, the variety of radioactive compounds separated by chromatography represent phenolic-containing materials. Within 24 h, most of the radioactivity from an oral dose of Colep is excreted in the urine of rats. No activity is found in the respired CO_2 or fat tissue. Little activity is found in the intestines, liver, kidneys, or faeces. Thin layer chromatographic and ion exchange analyses of the urine indicate the presence of a mixture of polar phenolic conjugates.

Sumithion

- 431 Miyamoto, J. THE MODE OF ACTION OF ORGANOPHOSPHORUS COMPOUNDS. III. ACTIVATION AND DEGRADATION OF SUMITHION AND METHYL PARATHION IN MAMMALS IN VIVO. Agric. bioL. Chem., Tokyo 28, 7 (1964) 411-21.

The fate of sumithion (I) and methyl parathion (II) in guinea pigs and rats was studied. I and II, labelled with ^{32}P , were given to the animals intravenously. The tissue was homogenized, de-proteinized, and extracted with CHCl_3 . Radioactive materials in both water and CHCl_3 were determined by paper chromatography. Both I, II and their oxons were detected in all the tissues a few minutes after the administration. Non-toxic CHCl_3 -insoluble demethyl compounds were richly present in liver and kidney. (CA 62:1965,1027c)

- 432 Reynolds, H. T., Fukuto, T. R., Metcalf, R. L. SYSTEMIC ACTIVITY OF p-METHYLTHIO-PHENYL ALKOXY ALKYLPHOSPHONOTHIOATES IN COTTON PLANTS. Bull. ent. Soc. Am. 10, 3 (1964) 164. Abstr.

Systemic phosphonate and phosphate insecticides with p-methylthiophenyl moiety were screened against cotton pests following topical and soil treatments. The most effective, O-p-methylthiophenyl O-methylmethylphosphonothioate, and several oxidative derivatives were then field-evaluated. Radiotracer studies of absorption, translocation and metabolism were made under controlled laboratory conditions.

Ronnel

- 433 Millar, K. R. RESIDUES IN TISSUES OF SHEEP FOLLOWING ORAL DOSING AND TIP SPRAYING WITH ^{32}P -LABELLED RONNEL. N.Z. J. agric. Res. 8, 2 (1965) 302-12.

Following oral dosing of sheep at a rate of 100 mg/kg live weight Ronnel (O,O-dimethyl O-(2,4,5-trichlorophenyl) phosphorothioate) (I) appeared rapidly in the blood of sheep. The highest concentrations found were attained 4 h after treatment. After 21 d, 70% of the administered dose had been detected in the urine, and 7% in the faeces, largely as O-methyl, O-(2,4,5-trichlorophenyl) phosphorothioate, and dimethylphosphorothioic and -phosphoric acids. No appreciable amounts of I were found stored in the fat. Residues in subcutaneous fat taken from sheep sprayed with 800 ml of 0.2 and 0.4% solutions of I were negligible, the maximum concentration found being 0.35 γ/g 1 week after treatment. No I could be detected in the fat 3 weeks after spraying and presumably the animals could then be used for food. The metabolism of I in sheep appears to follow very closely that of the cow and rat. Results indicated satisfactory agreement between radiochemical and cholinesterase inhibition methods of estimating unchanged I. (CA 63:1965,3536f)

Famphur

- 434 O'Brien, R. D., Kimmel, E. C., Sfera, P. R. TOXICITY AND METABOLISM OF FAMPHUR IN INSECTS AND MICE. J. agric. Ed Chem. 13, 4 (1965) 366-9.

Famphur [p-(dimethylsulphamoyl)phenyl dimethyl phosphorothionate] was essentially equitoxic by injection into mice, female and male cockroaches, and milkweed bugs, but was degraded at greatly differing rates in these organisms, decreasing in the above order. The level of the oxygen analogue (famoxon) was examined in the whole organisms and roughly paralleled the famphur level. In the insects only, N-demethylation occurred. The slow degradation rate in the milkweed bug appeared to be compensated by a relative insensitivity of its cholinesterase to famoxon. The variations in degradation rate among mice and two sexes of cockroach were relatively small (1.9-fold) and were deemed not to require postulation of important differences in innate sensitivity of insects and mammals. Radioactive famphur, ring-labelled with ^3H to give a specific activity of 78.5 mCi/mM, its unlabelled and labelled P(O) analogue, famoxon, its unlabelled mono-N-demethylated derivative and ring-labelled N-dimethyl-p-sulphamoylphenol were used.

- 435 O'Brien, R. D., Dannelley, C. E. PENETRATION OF INSECTICIDES THROUGH RAT SKIN. J. agric. Ed Chem. 13, 3 (1965) 245-47.

^3H -carbaryl (1-naphthyl N-methylcarbamate) (ring-labelled, with a specific activity of 3.7 mCi/M), ^3H -famphur (dimethyl p-N-dimethylsulphamoylphenyl phosphorothionate) (ring-labelled, with a specific activity of 78.4 mCi/mM), ^{14}C -DDT (labelled in the alkane carbons, at 4.93 mCi/mM), ^{14}C -ethane-labelled malathion (at 3.9 mCi/mM, and ^{14}C -ring-labelled dieldrin (at 20.5 mCi/mM)

were used. The penetration through rat skin of DDT, famphur, carbaryl, malathion, and dieldrin was examined using radioactive compounds. The penetration rates varied markedly, increasing in the above order, and the rate was not related to the olive oil-water partition coefficient. Compounds also varied in the proportion which could be recovered from skin by acetone washing. The vehicle in which the compounds were applied also influenced penetration rate, which increased in the order oil, benzene, acetone.

Cidial

- 436 Bazzi, B., Fabrini, R. METODO DI DETERMINAZIONE DEI RESIDUI DELL'ESTERE ETILICO DELL'ACIDO *O,O*-DIMETILDITIOFOSFORIFENILACETICO (CIDIAL®) NELL'OLIO DI OLIVA IN BASE AL DOSAGGIO SPETTROFOTOMETRICO DEL FOSFORO. SEPARAZIONE DAL ROGOR E DAL SUO ANALOGO OSSIGENATO. (Method for determining residues of the ethyl ester of *O,O*-dimethyldithiophosphoryl phenyl acetic acid in olive oil, based on spectrophotometric determination of the phosphorus. Separation of Rogor and its oxygen analogue). "Estratto da "Atti" del III Convegno sulla Qualità, Perugia, 25-27 May 1964". (In Italian)
- ³²P-labelled Rogor was used.
- 437 Bazzi, B., Fabrini, R., Canale, G. METHODE DE DETERMINATION DES RESIDUS DE L'INSECTICIDE CIDIAL DANS LES OLIVES. "Extrait du Volume de Conférences et Communications du VIème Congrès de l'Association Internationale d'Expertise Chimique, Athènes, 7-12 Sep. 1964". (In French)

On décrit une méthode de microdétermination chimique du Cidial employé contre le *Coccus oleae* dans les olives. Le procédé est basé sur l'extraction du Cidial des fruits, sur la séparation successive de l'huile par le système biphasé n-hexane-acétonitrile, sur la séparation du Cidial des insecticides hydrosolubles (par exemple Rogor) éventuellement employés avec le Cidial pour contrôler des autres insectes, sur la purification de la substance active par chromatographie et sur la micro-distillation successive, dans les conditions bien déterminées, des composés phosphorés gênants, et enfin sur le dosage colorimétrique se basant sur le phosphore. On a largement utilisé le composé marqué au ³²P en vue d'analyser les rendements d'extraction, l'efficacité des diverses séparations et les rendements réalisables à l'aide des différentes techniques de purification. La chromatographie sur couches minces a procuré un moyen de contrôle très valable. La sensibilité de la méthode est telle qu'on peut déterminer 0.2 ppm de Cidial.

Ciodrin = Shell SD 4294

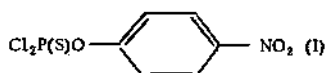
- 438 Chamberlain, W.F. THE METABOLISM OF P³²-LABELED SHELL SD-4294 IN A LACTATING EWE. *J. econ. Ent.* 57, 1 (1964) 119-21.
- A study was made of the absorption, elimination, and metabolism of orally administered ³²P-labelled Shell SD-4294 (Ciodrin®), α -methylbenzyl 3-hydroxycrotonate dimethyl phosphate, in a lactating ewe. The peak radioactivity in both the blood and urine occurred at 8 h, which indicated a moderate rate of absorption but rather rapid elimination. Some 61-90% of the radioactivity in the urine was dimethyl phosphoric acid; the other metabolites occurred only in small quantities. The ratio of α to β isomer in the blood was similar to that in the original sample of SD-4294, whereas the very small residues in the milk consisted of β isomer only. (Auth.)
- 439 Chamberlain, W.F. THE METABOLISM OF P³²-LABELED CIODRIN IN A LACTATING GOAT. *J. econ. Ent.* 57, 3 (1964) 329-31.
- A study was made of the metabolism of ³²P-labelled Ciodrin®, α -methylbenzyl 3-hydroxycrotonate dimethyl phosphate, by a dermally treated milk goat. Eleven percent of the applied dose was eliminated in the urine. Only minute quantities of radioactive material appeared in the faeces and milk. Dimethyl phosphoric acid accounted for 78.7-91.2% of the radioactive material in the urine. No radioactive material could be extracted from the blood, and the maximum true residue in the milk was only 0.20 ppb. (Auth.)

- 440 Potter, J. C., Burton, W. B. SYNTHESIS OF ALPHA-METHYLBENZYL 3-(DIMETHOXYPHOSPHINYLOXY)-CROTONATE LABELED WITH PHOSPHORUS-32 AND CARBON-14. *J. agric. Ed Chem.* **12**, 5 (1964) 439-42.

The *cis* and *trans* isomers of α -methylbenzyl 3-(dimethoxyphosphinyloxy)-crotonate labelled with ^{32}P and ^{14}C have been prepared. The ^{14}C preparation was made by the exchange of methanol- ^{14}C with the methoxy groups in trimethyl phosphite. The trimethyl- ^{14}C phosphite was then reacted with α -methylbenzyl 2-chloroacetoacetate to form α -methylbenzyl 3-(dimeth- ^{14}C -oxyphosphinyloxy)-crotonate. The ^{32}P preparation was made by the reaction of ^{32}P trichloride and methanol. The resulting trimethylphosphite- ^{32}P was reacted to form α -methylbenzyl 4-(dimethoxyphosphinyloxy)-crotonate. The mixtures of *cis* and *trans* crotonates so prepared were separated from each other by columnar chromatography. The purity of the *cis* isomer was estimated to be 98-99%. The yield of the purified *cis* isomer was 32% in the ^{14}C preparation and 41% in the ^{32}P preparation. These compounds serve as insecticides (Essentially auth.)

- 441 T'u, T'ung-Yuan, Yao, Tu-Ch'ing, Ting, Hui-Chen. SYNTHESIS OF ISOTOPICALLY LABELED COMPOUNDS. III. SYNTHESIS OF THE ISOTOPICALLY LABELED INSECTICIDES 1605- ^{14}C AND LURGO- ^{32}P . *Yuan. Tzu Neng* **1** (1965) 56-59. (In Chinese)

Insecticide 1605- ^{14}C , the synthesis of which has not yet been published, was produced experimentally from **I** and $\text{Me}^{14}\text{CH}_2\text{OH}$. **I** was prepared from S , PCl_3 and 1,4- $\text{HO}(\text{O}_2\text{N})\text{C}_6\text{H}_4$ and treated with $\text{Me}^{14}\text{CH}_2\text{OH}$ (prepared from $\text{Ba}^{14}\text{CO}_3$) to produce 1605- ^{14}C in 67% yield and with a recovery of 80% of the radioactivity. Another insecticide, Lurgo- ^{32}P , was prepared by a modified Daubeman method. The process involved the reaction of $\text{Na}_2\text{H}^{32}\text{PO}_4$ with **P** and **S** for the production of $^{32}\text{P}_2\text{S}_3$, which was then treated with MeOH and NH_3 to yield $(\text{CH}_3\text{O})_2\text{P}(\text{S})\text{SNH}_2$; the latter was mixed with $\text{ClCH}_2\text{CONHMe}$



to produce the insecticide $(\text{CH}_3\text{O})_2\text{P}(\text{S})\text{SCH}_2\text{CONHMe}$. The yield was 75-7% and the radioactivity recovered calculated on the basis of $\text{Na}_2\text{H}^{32}\text{PO}_4$ was 26.4%. The results of paper chromatography and autoradiography indicated that the experimental products were identical with the commercial insecticides. (CA 64:1966,4977c)

Phosphorus Heterocyclic Derivatives

Imidan

- 442 Chamberlain, W. F. A STUDY OF THE DERMAL TREATMENT OF A STEER WITH C^{14} -LABELED IMIDAN. *J. econ. Ent.* **58**, 1 (1965) 51-5.

Absorption, excretion, and metabolism of ^{14}C -Imidan[®] (O , O -dimethyl *S*-phthalimidomethyl phosphorodithioate) were studied in a steer after dermal application. Imidan was moderately absorbed by the skin of the steer, since 9.6% of the applied dose was recovered in the excreta within 7 d. The compound was rapidly broken down in the blood system, as indicated by the small percentage of radioactivity which could be extracted with chloroform (less than 2%). The principal route of elimination of absorbed material was through the urine, in which nearly 8% of the applied dose was found within 7 d. Paper chromatography and electrophoresis of urine samples indicated that the primary degradation of Imidan in the steer occurred at the nitrogen atom, resulting in the almost exclusive production of phthalic and phthalamic acids. The presence of benzoic acid as a metabolite was not conclusively proved. The systemic action against common cattle grubs, *Hypoderma lineatum* (de Villers), is evidently the result of very low concentrations of Imidan or the oxygen analogue. (Auth.)

- 443 McBain, J. B., Menn, J. J. FATE OF ^{14}C [N-(MERCAPTOMETHYLPHTHALIMIDE S-(O,O-DIMETHYLPHOSPHORODITHIOATE)] (IMIDAN) IN RATS AND INSECTS. Bull. ent. Soc. Am. 11, 3 (1965) 157. Abstr. 48. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. -2 Dec. 1965".

The insecticide Imidan is readily biodegraded in rats and insects via hydrolysis. These studies were carried out with Imidan labelled with ^{14}C in one of the carbonyl groups of the phthalimide moiety. Radiochromatography and other supporting analyses indicated that phthalamic and phthalic acids were the major detoxication products. (Abstr.)

- 444 Menn, J. J., McBain, J. B. METABOLISM OF PHTHALIMIDIMETHYL O,O-DIMETHYL PHOSPHORODITHIOATE (IMIDAN) IN COTTON PLANTS. J. agric. Fd Chem. 12, 2 (1964) 162-6.

Imidan- ^{14}C was readily absorbed by treated leaves but not translocated in the plant. The major acetone-extractable non-phosphate metabolites of Imidan consisted of phthalic and/or phthalamic acid, benzoic acid, and possibly one or more benzoic acid derivatives. These were determined by radiochromatography and autoradiography. Evolution of $^{14}\text{CO}_2$ and evidence for ^{14}C incorporation into plant constituents further indicated ready decarboxylation and metabolism of the phthalimide moiety of Imidan in the plant. The thiol analogue of Imidan was not discovered in cotton plant tissues; furthermore, the presence of a posthydrolysis phosphorothionate derivative on paper chromatograms indicated that hydrolysis of Imidan in vivo predominated over oxidation. (From auth.)

- 445 Menn, J. J., McBain, J. B., Ford, I. M. METABOLISM OF PHTHALIMIDOMETHYL-O,O-DIMETHYLPHOSPHORODITHIOATE (IMIDAN) IN WATER, INSECTS AND THE RAT. p. 486 of "Proceedings of the 12th International Congress of Entomology, London, 8-16 Jul. 1964". Freeman, P., Ed. London, Royal Entomological Society of London, 1965.

The fate of ^{14}C -Imidan is described in aqueous media, Blattella germanica, and a male albino rat. Radioscans of chromatograms of internal acetone cockroach extracts indicated the presence of Imidoxon (phthalimidomethyl-O,O-dimethylphosphorothioate) 2 h after topical application of ^{14}C -Imidan. An increasing build-up of non-acetone-extractable radioactivity accumulating in tissues with time was observed. The bound activity in tissues appears to exist in the form of a phthalic (PA) or phthalamic (PAA) acid derivative. A portion of the ^{14}C -activity from Imidan was presumably incorporated into carbohydrates and/or tryptophan and tyrosine. In both cockroach and rat the end products of Imidan metabolism apparently consist of phthalic acid (PA) or phthalamic acid (PAA) and derivatives, while in plants they are PA and benzoic or its derivative(s). PAA (alkaline pH) and PA (acid pH) are the aqueous hydrolysis end products. The nature of the derivatives is not yet established.

Dursban

- 446 Kenaga, E. E., Whitney, W. K., Hardy, J. L., Doty, A. E. LABORATORY TESTS WITH DURSBAN INSECTICIDE. J. econ. Ent. 58, 6 (1965) 1043-50.

Dursban is the Dow trademark for O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphorothioate. It has a wide spectrum of insecticidal activity as shown by laboratory tests. Dursban is moderately residual on plant surfaces and is quite residual on inert surfaces such as wood, as judged by insecticidal properties. It is volatile enough to form insecticidal residues on surfaces of nearby untreated objects and is stable except under fairly rigorous conditions of alkalinity and acidity. Dursban has potentialities for the control of premise insects such as flies and cockroaches; stored-product insects; plant-damaging pests such as aphids, mites, and lepidopterous larvae; insect pests of sod and soil; mosquito larvae; and many other arthropods. In some vapour tests radioactive Dursban, ^{35}Cl -labelled at the 3 and 5 positions and analysed by liquid scintillation, was used.

Diazinon

- 447 Farnham, A. W., Lord, K. A., Sawicki, R. M. STUDY OF SOME OF THE MECHANISMS CONNECTED WITH RESISTANCE TO DIAZINON AND DIAZOXON IN A DIAZINON-RESISTANT STRAIN OF HOUSEFLIES. J. Insect Physiol. **11**, 1 (1965) 1475-88.

The toxicities of diazinon and diazoxon to two strains of *Musca domestica* (normal and resistant) were measured by injection and topical application. Both compounds were more toxic by injection. The difference in susceptibility by the two ways of poisoning was greater with the resistant than the susceptible flies because insecticide penetrates less readily into the resistant flies, as indicated by measurement of loss from the surface using radioactive diazinon (O,O-diethyl O-(2-iso-propyl-4-methyl-6-pyrimidyl phosphorothioate) labelled in the ethyl groups with ^{14}C). Resistance of both strains increased with age; ^{14}C -diazinon penetrated the cuticle of younger flies more rapidly than of older flies. Even when injected, more diazinon or diazoxon was needed to kill resistant flies than the susceptible, indicating that penetration was not the only reason for resistance. ^{14}C -diazinon was decomposed more efficiently by resistant than by susceptible flies.

- 448 Gerzín, L. W. THE RECOVERY OF C^{14} -DIAZINON AND ITS C^{14} -LABELED METABOLITES FROM SOIL. Bull. ent. Soc. Am. **10**, 3 (1964) 176. Abstr.

Methods were developed for recovery of ^{14}C -metabolites from soils. Radioactive chloroform-soluble components, water-soluble components, volatilized diazinon and carbon dioxide were detected. Residual life of diazinon varied from 16 weeks to over 32 weeks. A major part of the ^{14}C was eventually evolved as carbon dioxide.

See also:

- 84 The effect of malathion on the metabolism of amino acids in the German cockroach *Blattella germanica*. (Mansingh, A., 1965)
- 336 Studies on the rate of penetration of diazinon, dieldrin and malathion in resistant and susceptible *M. domestica*. (Crothers, W. C., Forgash, A. J., 1964)
- 363 Absorption and distribution of DDT in the boll weevil and the influence of synergists on toxicity. (Land, J. D., 1963/64)
- 460 Metabolism of carbamate and organophosphate insecticides by cattle and poultry and associated residues in livestock products. (Buttram, J. R., 1964)

5. Carbamates

Zectran

- 449⁽²⁾ Williams, E., Melkle, R. W., Redemann, C. T. THE IDENTIFICATION OF METABOLITES OF ZECTRAN® INSECTICIDE IN DOG URINE. AED-Conf. 133-38, 1963, 12p. Presented at the "145th National Meeting of the American Chemical Society, New York, 8-13 Sep. 1963".

Five-months-old beagles were used, preconditioned by feeding inactive Zectran in their rations, which was interrupted by a total of 14 feedings of tagged Zectran. The study was carried out subsequent to a study on Zectran metabolites in broccoli (ref. 465) in order to determine whether there are metabolites in the plant which are not present in the animal. No unhydrolysed 4-dimethylamino-3,5-xylyl methylcarbamate was detected. 4-dimethylamino-3,5-xylenol was found, and 4-dimethylamino-3,5-xylenol and 2,6-dimethylhydroquinone occurred as water-soluble conjugates.

- 450 Williams, E., Melkle, R. W., Redemann, C. T. IDENTIFICATION OF METABOLITES OF ZECTRAN INSECTICIDE IN DOG URINE. J. agric. Fd Chem. **12**, 5 (1964) 457-61.

A metabolic study is described. Radioactive Zectran, 4-dimethylamino-3,5-xylyl- α , 3- $^{14}\text{C}_2$ -methylcarbamate (specific activity 0.031 mCi/mM) was used. Free 4-dimethylamino-3,5-xylenol

and water-soluble conjugates of 4-dimethylamino-3,5-xyleneol and 2,6-dimethyl-hydroquinone are identified as metabolites.

- 451 Williams, E., Meikle, R. W., Redemann, C. T. RADIOSYNTHESIS OF CARBON-14-LABELED 4-DIMETHYLAMINO-3,5-XYLYL METHYLCARBAMATE. *J. agric. Fd Chem.* 13, 3 (1965) 211-13.

4-dimethylamino-3,5-xylyl methylcarbamate was labelled with ^{14}C at three locations. The carbonyl group was labelled in 46% yield based on radioactivity by the conversion of acetic anhydride-1,1- ^{14}C to methyl isocyanate and reaction of this with 4-dimethylamino-3,5-xyleneol. The 1-position in the ring was labelled in 3% yield by the addition of carbon dioxide- ^{14}C to the di-Grignard reagent of 1,5-dibromo-2,4-dimethylpentane and catalytic conversion to 3,5-xyleneol. This was followed by nitrosation, hydrogenation, methylation, and reaction with methyl isocyanate. The di-Grignard reagent was prepared by a seven-step synthesis starting with diethyl malonate. Both the 3-position in the ring and the 3-methyl group were labelled in 10% yield by the reaction of acetaldehyde-1,2- ^{14}C with ethylacetoacetate and conversion to 3,5-xyleneol. (Auth.)

- 452⁽²⁾ Williams, E., Meikle, R. W., Redemann, C. T. THE IDENTIFICATION OF METABOLITES OF ZECTRAN[®] INSECTICIDE IN BROCCOLI. AED-Conf. 133-39, 1963, 12p. Presented at the "145th National Meeting of the American Chemical Society, New York, 8-13 Sep. 1963".

The following metabolites were identified: 4-dimethylamino [3, α - ^{14}C]3,5-xylyl methylcarbamate, 4-dimethylamino-3,5-xyleneol, 2,6-dimethylhydroquinone, 2,6-dimethyl-p-benzoquinone, 4-dimethylamino-3,5-dimethyl-o-benzoquinone. No conjugated 4-dimethylamino-3,5-dimethylpyrocatechol was found but 4-dimethylamino-3,5-xyleneol and 2,6-dimethylhydroquinone were found as water-soluble conjugates. It was shown that metabolites of this pesticide had been incorporated into lignin.

- 453 Williams, E., Meikle, R. W., Redemann, C. T. IDENTIFICATION OF METABOLITES OF ZECTRAN INSECTICIDE IN BROCCOLI. *J. agric. Fd Chem.* 12, 5 (1964) 453-7.

At the appearance of the first flowers, Zectran was applied to broccoli by dissolving 4 mg of 4-dimethylamino-3,5-xylyl- α - ^{14}C -methylcarbamate in 50 μl of corn oil and streaking the stem immediately below a flower cluster. Broccoli was harvested 10 d later. Counting, chromatographic, and fractionation procedures used in studying the metabolism of Zectran are described in detail. In addition to a small amount of Zectran, the following metabolites were found to be present in the broccoli flower: 4-dimethylamino-3,5-xyleneol, 2,6-dimethylhydroquinone, 2,6-dimethyl-p-benzoquinone, and 4-dimethylamino-3,5-dimethyl-o-benzoquinone. The xyleneol was found in both free and conjugated form, but the hydroquinone derivative was detected only as a water-soluble conjugate. Evidence is presented which suggests that metabolites of this pesticide have been incorporated into lignin.

Carbaryl

- 454 Dorrough, H. W., Casida, J. E. NATURE OF CERTAIN CARBAMATE METABOLITES OF THE INSECTICIDE SEVIN. *J. agric. Fd Chem.* 12, 4 (1964) 294-304.

The chemical nature of Sevin metabolites formed by rat liver microsomes fortified with reduced nicotinamide-adenine dinucleotide phosphate and by cockroaches and house flies was examined. Metabolites tentatively identified were 1-naphthyl N-hydroxymethylcarbamate, 4-hydroxy-1-naphthyl N-methylcarbamate, and 5-hydroxy-1-naphthyl N-methylcarbamate. At least two unidentified metabolites had the $\text{C}-\text{O}-\text{C}(\text{O})-\text{N}-\text{C}$ structure intact. Hydrolysis yielded 1-naphthol and at least two unidentified metabolites lacking the carbamyl group. These eight metabolites, five of which were carbamates, were formed by the liver microsomes and insects. Certain of these metabolites appeared in the milk of a goat treated orally with Sevin-carbonyl- ^{14}C . Most of these metabolites were absent in plants injected with Sevin- ^{14}C where carbonyl- ^{14}C , methyl- ^{14}C , or naphthyl- ^{14}C samples of Sevin yielded water-soluble persisting metabolite(s). Similar, but more limited studies, are considered with Bayer 39007 (o-isopropoxyphenyl N-methylcarbamate), Bayer 39007-carbonyl- ^{14}C and three labelled samples of Sevin were tested on *Musca domestica* L. and *Periplaneta americana* (L.). Bioassays on metabolites of Bayer 39007 indicated reduced biological activity compared with the original insecticides.

- 455 Knaak, J.B., Tallant, M.J., Bartley, W.J., Sullivan, L.J. THE METABOLISM OF CARBARYL IN THE RAT, GUINEA PIG, AND MAN. J. agric. Fd Chem. 13, 6 (1965) 537-43.

The metabolic fate of methyl- ^{14}C , carbonyl- ^{14}C , and naphthyl- ^{14}C -labelled carbaryl in the rat and guinea pig was investigated. The overall recovery of the naphthyl, carbonyl, and methyl label was, respectively, 95, 99, and 91% of dose. Tissue residues (2-3% of dose) were found only in the case of methyl-labelled carbaryl. The metabolites identified were 4-(methycarbamoyloxy)-1-naphthyl glucuronide, 1-naphthyl glucuronide, 4-(methycarbamoyloxy)-1-naphthyl sulphate, and 1-naphthyl sulphate. Evidence is presented for the possible direct conjugation of carbaryl with glucuronic acid to form 1-naphthyl methylcarbamate N-glucuronide and 1-naphthyl methylimidocarbonate O-glucuronide. The assay of carbaryl, carbaryl derivatives, and metabolites in water by fluorimetry was investigated in conjunction with ^{14}C chromatographic studies and the method applied to the analysis of urines from men exposed to carbaryl dust. The only detectable metabolites present were 1-naphthyl glucuronide and sulphate. (Auth.)

- 456 Williams, M.W., Batjer, L.P. SITE AND MODE OF ACTION OF 1-NAPHTHYL N-METHYL-CARBAMATE (Sevin) IN THINNING APPLES. Proc. Am. Soc. hort. Sci. 85 (1964) 1-10.

When 1-naphthyl N-methylcarbamate (Sevin) was applied to Red Delicious spur leaves only, a slight thinning response resulted, and when applied to fruit only, heavy thinning occurred. By applying both ring- and side-chain-labelled ^{14}C -Sevin to spur leaves, it was found that movement of Sevin in the vascular tissue was slow, and after extended periods of time little activity was detected in the seeds. With either leaf or fruit applications, radioactivity was present mainly in the vascular tissues of the fruit. When a fruit was dipped in ^{14}C -Sevin, activity appeared in the vascular tissue in a short time. The vascular tissue of the fruit is considered to be the site of action of Sevin. Extraction and analysis of fruit and leaf tissues treated with ^{14}C -Sevin showed that most of the recovered ^{14}C was in the methylene chloride fraction and a small amount was present in the ethanol-water fraction. Paper chromatography of the methylene chloride fraction showed only the presence of 1-naphthyl N-methylcarbamate. The main component of the ethanol-water fraction, though unidentified, contained both the naphthol ring and the carbonyl carbon of the original Sevin molecule. It is proposed that Sevin interferes with the movement of vital growth factors in the vascular tissues of the fruit. Such interference prevents the growth of weak fruits, and abscission, either with or without seed abortion, results. (Auth.)

Dimetilan

- 457 Zubairi, M.Y. METABOLISM OF THE CARBAMATE INSECTICIDE DIMETILAN- C^{14} 1-DIMETHYL-CARBAMOYL-5-METHYL-3-PYRAZOLYL DIMETHYLCARBAMATE-(CARBOXYL- C^{14}). Bull. ent. Soc. Am. 10, 3 (1964) 163. Abstr. 47

Dimetilan was rapidly metabolized by house flies and American and German cockroaches. Five of the metabolites from the American cockroach were purified by column and thin layer chromatography and the major one appeared to be the N-methyl, N-hydroxymethylcarbamate of dimetilan. The nature of the other carbamate metabolites will be discussed.

- 458 Zubairi, M.Y., Casida, J.E. DETOXICATION OF DIMETILAN IN COCKROACHES AND HOUSE FLIES. J. econ. Ent. 58, 3 (1965) 403-9.

Dimetilan- ^{14}C (2-dimethylcarbamoyl-3-methyl-5-pyrazolyl dimethylcarbamate-carbonyl- ^{14}C) is rapidly metabolized in *Blattella germanica* (L.) to yield nine ^{14}C -labelled metabolites. Six of these metabolites are formed also in *Periplaneta americana* (L.) and four in *Musca domestica* L. Metabolites tentatively identified include 2-dimethylcarbamoyl-3-methyl-5-pyrazolyl N-hydroxymethyl, N-methylcarbamate and 2-methylcarbamoyl-3-methyl-5-pyrazolyl dimethylcarbamate. Three other metabolites are unidentified N-hydroxymethyl derivatives. None of these metabolites was more toxic to house flies than dimetilan, but one formaldehyde-yielding metabolite was almost as toxic as the parent material. Many metabolites were synergized in their toxicity by resamex as was the case also with dimetilan and certain of its analogues. N-methyl hydroxylation appears to be a major factor in the detoxication of dimetilan in insects. (Auth.)

Various Methylcarbamates

- 459 Abdel-Wahab, A. M. DEGRADATION AND PERSISTENCE OF EIGHT SUBSTITUTED PHENYL METHYLCARBAMATE-CARBONYL- C^{14} INSECTICIDES ON BEAN FOLIAGE. Bull. ent. Soc. Am. 11, 3 (1965) 156. Abstr. 39. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".
- Matacil and Zectran were each decomposed on exposure to sunlight to more than ten carbamates: 4-dimethylamino, 4-methylformamido, 4-amino, and 4-formamido analogues were identified as the major degradation products. Mesurol was oxidized to its sulphoxide and sulphone derivatives. Carbaryl was the most persistent compound and Baygon and UC 10854 the least while Banol and HRS-1422 were of intermediate stability. (Abstr.)
- 460 Buttram, J. R. METABOLISM OF CARBAMATE AND ORGANOPHOSPHATE INSECTICIDES BY CATTLE AND POULTRY AND ASSOCIATED RESIDUES IN LIVESTOCK PRODUCTS. Dis. Abstr. 24, 10 (1964) 4319.
- ^{32}P -labelled Bayer 22408 (O,O-diethyl O-naphthalimido phosphorothioate) was applied dermally as a 0.5% emulsion to two Holstein dairy cows. Detectable quantities of the intact insecticide were isolated from milk for the first 6 d after treatment. Bayer 22408 equivalents in the milk were about 10 times higher than the actual Bayer 22408. The oxygen analogue of the parent compound was not present in milk, but it was the predominant non-hydrolyzed product in the faeces. The faecal metabolites were toxic to stable fly (*Stomoxys calcitrans* (L.)) larvae, but not to house fly (*Musca domestica* L.) larvae. Sevin® (1-naphthyl N-methylcarbamate) was applied dermally to cows (head) under different conditions and milk tested for residues at given intervals. - Six steers were treated intramuscularly (hip or neck) with ^{32}P -labelled Co-Ral® (O,O-diethyl O-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl phosphorothioate). The Co-Ral did not diffuse from the point of injection to surrounding tissues in an even pattern but moved along bundles of muscle fibre. For example, analysis of biopsy samples revealed that certain portions of the muscle contained 500 times more Co-Ral than an adjoining section; 3 d after treatment, 85% or more of the injected dose had moved from the site of injection. There was a small amount of the oxygen analogue of Co-Ral present in the 3 and 7 d biopsy samples. The cumulative percentage of administered radioactivity that appeared in the faeces of steers by 14 d post-treatment ranged from 0.7 - 7.6%. Some Co-Ral escaped degradation and appeared in the faeces as non-hydrolysed materials. There were no gross histopathological effects due to treatment. The anthelmintic activity of Co-Ral administered intramuscularly was not encouraging. Recoveries of Sevin, Co-Ral, Bayer 22408, Kepone® (decachlorooctahydro-1,3,4-metheno-2H-cyclobuta [cd] pentalen-2-one), Bayer 29493 (O,O-dimethyl O-[4-(methylthio)-m-tolyl] phosphorothioate), and Ruelene® (O-4-tertbutyl-2-chlorophenyl O-methyl methylphosphoramidate), from milk ranged from 87 to 97%. Ruelene, Bayer 22408, and Bayer 29493 were stable under in vitro conditions in raw milk for periods up to 14 d after incubation, but by 3 d after incubation, some Co-Ral remained in the milk residue following acetonitrile extraction. Ruelene was rapidly metabolized by laying hens receiving the compound in the diet for 7 d at 100 ppm. The in vivo degradation of Ruelene proved complex, involving enzymatic attack at the two ester groupings and the amide bond of the molecule.
- 461 Casida, J. E., El-Wahab, A. A., Gillett, J., Krishna, J.-G., Kuhr, R., Oonithan, E., Shrivastava, S., Miskus, R. PROGRESS REPORT ON THE COMPARATIVE FATE OF EIGHT SUBSTITUTED-PHENYL N-METHYLCARBAMATE- C^{14} INSECTICIDES. PARTS I and II. Bull. ent. Soc. Am. 10, 3 (1964) 163. Abstr. 48, 49.
- Eight N-methylcarbamates of interest as potential commercial insecticides were radio-labelled and their fate examined on and in bean plants, in rats and house flies, and in a rat liver microsome hydroxylation enzyme system. Oxidation, hydroxylation, hydrolysis and conjugation resulted in the appearance of a great variety of products with each carbamate.
- 462 El-Sebay, A. H., Metcalf, R. L., Fukuto, T. R. CARBAMATE INSECTICIDES: SYNERGISM BY ORGANOETHIOCYANATES. J. econ. Ent. 57, 4 (1964) 478-82.
- Isobornyl thiocyanacetate and related thiocyanates were shown to be highly synergistic when used in combination with several insecticidal carbamates against the house fly, *Musca domestica* L.

Synergism comparable to that obtained with commercially available methylenedioxyphenyl synergists was demonstrated against susceptible and carbamate-resistant flies. Experiments with ^{14}C -labelled carbamates showed that the synergism involved inhibition of the biochemical detoxication of the carbamate within the body of the fly. ^{14}C -ring-labelled phenyl *N*-methylcarbamate (specific activity 1.5 mCi/mM) was prepared by adding ring-labelled phenol to an excess of methyl isocyanate in a capillary tube. It was shown to be >99% pure by paper chromatography. ^{14}C -labelled (ring and 3,5-methyl groups) Zectran was obtained commercially, shown to be ~90% pure by paper chromatography.

- 463 Georgioun, G.P. EFFECTS OF CARBAMATES ON HOUSE FLY FECUNDITY, LONGEVITY, AND FOOD INTAKE. J. econ. Ent. **58**, 1 (1965) 58-62.

Topical application of sublethal but knockdown-inducing doses of Isolan® (1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate) to house flies, *Musca domestica* L., resulted in substantial reduction of egg laying but did not affect mating, longevity, or egg fertility. Significant reductions in fecundity were obtained whether the insecticide was applied before or after mating and whether the insects had prior access to milk or not. Increasing the doses above the sublethal level had a greater repressing effect on fecundity but did not cause complete sterility. Thus, a sublethal dose of 0.3 µg per fly reduced total egg production by 35.8%, while doses of 0.6 and 1.0 µg, representing LD10 and LD30 levels, respectively, reduced egg production by 43.1% and 77.2%, respectively. The effect of the treatments was long lasting; the daily egg production in flies treated with 0.6 µg did not equal that of the control until the 19th d after treatment; by the use of ^{32}P milk it was found that treated flies consumed as much as 51.8% less milk than the untreated flies even 8 d after treatment. Tests with other carbamates indicated that while physostigmine and Pyrolan® (3-methyl-1-phenyl-5-pyrazolyl dimethylcarbamate) had no effect on fecundity, dimethilan, carbaryl, Bayer 39007 (*O*-isopropoxyphenyl methylcarbamate) and Hercules 5727 (*m*-isopropylphenyl methylcarbamate) caused significant reduction in egg production. Although the precise nature of the interaction between the insecticide and the physiological processes that are significant in reproduction remains unresolved, the available evidence indicates that cholinesterase inhibition is not directly responsible for the suppression of egg production.

- 464 Gheorgioun, G.P. STUDIES ON RESISTANCE TO CARBAMATES IN MOSQUITOES. Bull. ent. Soc. Am. **10**, 3 (1964) 174. Abstr.

Selection of *Culex pipiens quinquefasciatus* and *Anopheles albimanus* with *O*-isopropoxyphenyl and *M*-isopropylphenyl *N*-methylcarbamates resulted in low levels of resistance to selective agents and to related carbamates. Tests with ^{14}C -labelled *O*-isopropoxyphenyl *N*-methylcarbamate indicated resistance is due to enhanced detoxication mechanisms. Appropriate crosses showed this resistance to be of polygenic nature.

- 465 Metcalf, R.L., Fukuto, T.R. EFFECTS OF CHEMICAL STRUCTURE ON INTOXICATION AND DETOXICATION OF PHENYL *N*-METHYLCARBAMATES IN INSECTS. J. agric. Fd Chem. **13**, 3 (1965) 220-31.

A review paper, dealing primarily with 15 years of research by the authors on the chemistry and mode of activation of substituted phenyl *N*-methylcarbamate insecticides. The biological activities of some 130 compounds are described. Detailed consideration is given to the interaction of these carbamates with the active site of insect cholinesterase. Detoxication mechanisms are described in relation to synergism and insect resistance. Some unpublished work in which ^{14}C -labelled carbamates were used confirmed that detoxication by resistant flies is the primary factor conferring resistance. In the experiments, ^{14}C (ring and 3,5-methyl-labelled) 4-dimethylamino-3,5-xylene *N*-methylcarbamate was injected into the abdomens of flies; after appropriate intervals, the labelled metabolites were extracted and separated by paper chromatography. The results are tabulated and show the pronounced effect of a 1½-h pretreatment with piperonyl butoxide in reducing the detoxication of the carbamate within the fly. Other cited studies also employed radioisotopes.

- 466 O'Brien, R.D. REACTION OF CARBAMATES WITH CHOLINESTERASE. Bull. ent. Soc. Am. **10**, 3 (1964) 163. Abstr. 46.

Evidence obtained by kinetic analysis of recovery from inhibition, and from the products following reaction of a ring-labelled carbamate with purified cholinesterase, supports a carbamoylation mechanism for inhibition. (Abstr.)

- 467 Oonithan, E. S. METABOLISM OF METHYLCARBAMATE INSECTICIDE CHEMICALS BY RAT LIVER ENZYME SYSTEMS. Bull. ent. Soc. Am. 11, 3 (1965) 158. Abstr. 66. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".

Metabolism of eight ^{14}C -labelled *N*-methyl- and two ^{14}C -labelled *N,N*-dimethylcarbamate insecticides by a microsome + NADPH_2 system proceeds at a rate dependent on the nature of the aryl of heterocyclic ring substituents. Certain of the carbamate metabolites formed were more potent cholinesterase inhibitors than the parent compound. (Abstr.)

See also:

- 363 Absorption and distribution of DDT in the boll weevil and the influence of synergists on toxicity. (Land, J. D., 1963/64)
435 Penetration of insecticides through rat skin. (O'Brien, R. D., Dannelley, C. E., 1965)

6. Pyrethroids

Pyrethrins and Cinerins

- 468 Chang, Shen Chin, Kearns, C. W. METABOLISM IN VIVO OF ^{14}C -LABELLED PYRETHRIN I AND CINERIN I BY HOUSE FLIES WITH SPECIAL REFERENCE TO THE SYNERGISTIC MECHANISM. J. econ. Ent. 57, 3 (1964) 397-404.

Randomly labelled ^{14}C -pyrethrin I (PI^*) and ^{14}C -cinerin I (CI^*) were used alone and in combination with sesamex in the study of their metabolism by house flies, *Musca domestica* L., in vivo. The metabolisms of PI^* and of CI^* follow a similar pattern and the difference is quantitative rather than qualitative. The difference in potency of PI^* and CI^* was due to the rate of detoxification. There is no difference in the absorption rate. More than 96% of the absorbed dose of CI^* or PI^* was detoxified 4 h after topical application. The mechanism of synergism was explained by the fact that the synergist prevents the detoxification of the absorbed pyrethroids although the absorption of pyrethroids is less in the presence of sesamex than in its absence. Five metabolites plus chrysanthemic acid each from PI^* and CI^* have been isolated and partially characterized. The amount of free chrysanthemic acid never exceeds 2.8% of the applied dose. The direct hydrolysis of the ester linkage in either molecule is not a major detoxification mechanism. Of five metabolites, three showed intact chrysanthemic acid moiety and ester linkage. The detoxification process is apparently initiated on the keto-alcohol moiety while the acid moiety and the ester linkage are still intact. Further breakdown of the altered molecule into more polar compounds is indicated. (Auth.)

Chrysanthemumic Acid

- 469 Nishizawa, Y., Casida, J. E. SYNTHESIS OF *d-trans*-CHRYSANTHEMUMIC ACID-1- ^{14}C AND ITS ANTIPODE ON A SEMIMICRO SCALE. J. agric. Fd Chem. 13, 6 (1965) 525-7.

dl-trans-Chrysanthemumic acid-1- ^{14}C was prepared in 45% yield from 4 mM of ethyl glycinate-1- ^{14}C . Yield of the *trans*-acid was increased by isomerization of methyl *cis*-chrysanthemumate-1- ^{14}C with sodium *tert*-amylate. Geometrical isomers of the acid were separated by column chromatography, and optical isomers of the *trans*-acid were resolved as a quinine salt for the *l*-isomer and an *l*- α -methylbenzylamine salt for the *d*-isomer. Over-all yields of *trans*-chrysanthemumic acids-1- ^{14}C , based on radioactivity from ethyl glycinate-1- ^{14}C (2.7 mCi/mM), were: 22.8% of impure *d*-isomer, 10.4% of pure *l*-isomer, and 7.0% of pure *d*-isomer with specific activities of 1.3 - 2.7 mCi/mM. (Auth.)

7. Nicotine Alkaloids (including Anabasine and Related Compounds)

- 470 Alworth, W.L., DeSelms, R.C., Rapoport, H. THE BIOSYNTHESIS OF NICOTINE IN *Nicotiana glutinosa* FROM CARBON-14 DIOXIDE. J. Am. Chem. Soc. **86** (1964) 1608-16.

Plants of *N. glutinosa* were grown in an atmosphere containing $^{14}\text{CO}_2$ for periods varying from 2 h, the shortest time at which incorporation of radioactivity into nicotine could be detected, to 12 h. The nicotine, isolated separately from the root and aerial portions, was degraded, and the activity in the pyridine ring, the N-methyl group, and carbon-2' of the pyrrolidine ring was determined. These data were correlated in terms of (1) the rate of incorporation of CO_2 into nicotine, (2) the site of nicotine syntheses, (3) the relative rate of N-methyl syntheses, and (4) the relative rate of syntheses of the pyridine and pyrrolidine rings. The conclusions thus reached compared with those in the literature derived from grafting experiments and from feeding precursors other than CO_2 . Evidence is presented for independent nicotine synthesis in both root and aerial portions, and some questions are raised concerning the glutamate-symmetrical intermediate hypothesis for pyrrolidine ring biosynthesis. (Auth.)

- 471 Alworth, W.L., Liebman, A.A., Rapoport, H. THE BIOSYNTHESIS OF NICOTINE IN *Nicotiana glutinosa* FROM CARBON-14 DIOXIDE. FORMATION OF THE PYRROLIDINE RING. J. Am. chem. Soc. **86** (1964) 3375-81.

Radioactive nicotine, isolated from the root and aerial portions of *N. glutinosa* after a 6 h exposure to $^{14}\text{CO}_2$, was degraded and the activity determined in the pyridine ring, the N-methyl group, and C-2' and C-5' of the pyrrolidine ring. The results support previous conclusions reached from $^{14}\text{CO}_2$ feedings. In addition, equal activity was found at C-2' and C-5', consistent with the glutamate-symmetrical intermediate hypothesis. However, the labelling pattern required is not derivable from any of the known glutamate biosyntheses. An attempt was made to reconcile the various data by suggesting a new glutamate biosynthesis. (Auth.)

- 472 Andersson, G., Hansson, E., Schmitterlöv, C.G. GASTRIC EXCRETION OF C^{14} -NICOTINE. Experientia **21**, 4 (1965) 211-13.

A quantitative analysis of the gastric excretion of ^{14}C -nicotine and its metabolites is described. Radiochemically pure ^{14}C -nicotine of a specific activity of 66 $\mu\text{Ci}/\text{mg}$ was prepared. The gastric excretion of radioactive nicotine from the stomach mucosa into the stomach was tested for mice, rats, and cats, by autoradiography and by measuring the radioactivity. Perfusion of rat stomach in situ resulted in pH-dependent nicotine excretion. The excreted radioactivity was traced to nicotine and to the degradation product cotinine.

- 473(2) Appelgren, L.-E., Hansson, E., Schmitterlöv, C.G. THE ACCUMULATION AND METABOLISM OF C^{14} -LABELLED NICOTINE IN THE BRAIN OF MICE AND CATS. Acta physiol. scand. **56** (1962) 249-57.

Whole-body autoradiograms of mice injected intravenously with (-)-nicotine-methyl ^{14}C (I) show an initial accumulation of radioactivity in the central nervous system. This high concentration of I and (or) its metabolites in the brain disappears within 30 min to 1 h. Autoradiograms of cat brain show a similar accumulation of radioactivity following injection of I. Only one I metabolite, cotinine, was found to occur in the brains of mice and cats. The subsequent disappearance of radioactivity from the central nervous system indicates a rapid outflow of I and (or) its metabolites. This pattern of rapid uptake followed by outflow is peculiar to the brain; in whole-body autoradiograms there is still a high level of radioactivity in other organs (liver, stomach, intestine, kidney, and salivary gland) when the brain is almost free of radioactivity. It is suggested that since cotinine has a much lesser pharmacological action than I, it may also have less affinity for tissues of the central nervous system. As cotinine is an oxidized form of I, it should be more polar and thus less fat soluble. There is significant accumulation of radioactivity in the ganglion cells. The I receptors in brain may not be able to serve as receptors for cotinine. This could explain the more diffuse distribution of radioactivity in the brain 30 min after the injection of I, when the major part of the radioactivity is present as ^{14}C in cotinine. (CA 58:1963, 14585g)

- 474 Bowman, E.R., Hansson, E., Turnbull, L.B., McKennis, H., Jr., Schmitterlöv, C.G. DISPOSITION AND FATE OF (-)-COTININE- H^3 IN THE MOUSE. J. Pharmacol. exp. Ther. **143**, 3 (1964) 301-B.

Intravenously injected cotinine- ^3H in the mouse was evenly distributed among various tissues, except for a high concentration in excretory organs. The metabolites demethylcotinine, hydroxycotinine, and 3-pyridylacetic acid were present in the urine. (CA 60:1964, 15004g)

- 475 Gholson, R. K., Chandler, J. L. R., Yang, K. S., Waller, G. R. NICOTINE BIOSYNTHESIS. *Fedn Proc. Fedn Am. Soc. exp. Biol.* 23, 2, Pt. I (1964) 528, Abstr. 2556. Presented at the "48th Annual Meeting, Chicago, 12-17 Apr. 1964".

Nicotinic acid-2,3,7- ^{14}C and quinolinic acid-2,3,7,8- ^{14}C were fed to young *Nicotiana tabacum* L. plants via a newly regenerated root system. Incorporation of these compounds into nicotine was 10% and 5.6% respectively. All ^{14}C from both precursors was located in the pyridine ring of the alkaloid. Nicotine isolated from plants fed nicotinic acid-2,3,7- ^{14}C was oxidized to nicotinic acid without loss of specific activity. This nicotinic acid was injected into castor seedlings and ricinine isolated 96 h later. Degradation of this ricinine showed that only carbons 2 and 3 were radioactive. These results indicate nicotine formation involves a decarboxylation of nicotinic acid with attachment of the pyrrolidine ring to the position of the pyridine ring formerly occupied by the carboxyl group of nicotinic acid. A free symmetrical pyridine derivative cannot be involved. A particulate enzyme catalyzing decarboxylation of nicotinic acid is present in the tobacco roots, but not in tobacco leaves or in castor roots. Nicotinic acid ribotide does not appear to be a substrate and decarboxylation of free nicotinic acid is not stimulated by the addition of ATP, PRPP, NAD, NADH, CoA, putrescine or ornithine. (Abstr.)

- 476 Fleeker, J., Byernum, R. U. THE ROLE OF GLYCEROL IN THE BIOSYNTHESIS OF THE PYRIDINE MOIETY OF NICOTINE. *J. biol. Chem.* 240, 10 (1965) 4099-4102.

A new degradation of the pyridine ring of nicotine is described which permits isolation of each ring carbon. Plants were fed glycerol-2- ^{14}C and glycerol-1,3- ^{14}C for this purpose. The location of the ^{14}C in the ring, with the use of this degradation, provides evidence that the carbon atoms of glycerol were incorporated in toto into positions 4,5, and 6 of the pyridine ring. Over 98% of the ^{14}C in the pyridine ring derived from glycerol-2- ^{14}C was in carbon atom 4 after a 4-h metabolism period. The pyridine ring of nicotine formed from glycerol-1,3- ^{14}C had 68% of the radioactivity divided between carbon atoms 4 and 6, whereas carbon 5 had about 2% of the radioactivity. Some ^{14}C from glycerol-1,3- ^{14}C was found in positions 2 and 3 of the pyridine ring. It is proposed that this incorporation results from conversion of labelled glycerol, by way of glycolysis and the tricarboxylic acid cycle, to methylene-labelled succinate which has previously been found to yield the pyridine ring of nicotine labelled in positions 2 and 3. (Essentially auth. summary)

- 477 Griffith, G. D., Griffith, T. METABOLISM OF THE METHYL GROUP OF NICOTINE IN *Nicotiana rustica*. *Pl. Physiol.*, Lancaster 39, 6 (1964) 970-73.

Experiments were carried out on tobacco plants with and without roots. The rate of methyl group metabolism in *N. rustica* L. var. *humilis* was studied by hydroponically feeding mature plants either methionine-methyl- ^{14}C or nicotine-methyl- ^{14}C and isolating nicotine from the plants after from 6 h - 9 d. Following methionine feeding, a major portion of the ^{14}C entering the methyl group of nicotine did so within 2 d. It appears that transmethylation from methionine to nicotine as well as catabolism of the ring structure of nicotine occurs almost exclusively in root tissue.

- 478⁽²⁾ Hansson, E., Schmiterlöw, C. G. PHYSIOLOGICAL DISPOSITION AND FATE OF C^{14} -LABELLED NICOTINE IN MICE AND RATS. *J. Pharmacol. exp. Ther.* 137 (1962) 91-102.

Nicotine-methyl- ^{14}C injected intramuscularly or intravenously into mice was distributed throughout all important organ tissues within a few minutes. Concentrations were especially high in the brain, adrenal medulla, stomach wall, and kidney. After 30 min or more the distribution picture changed, apparently because of rapid metabolism of the nicotine. Rat experiments gave similar results. A large amount of nicotine was excreted into the stomach via the fundus mucosa and 2-3% of the dose was excreted in the bile in rats during a 6 h period. From 60 - 80% of the radioactivity was found in the urine of mice and rats and 8-15% in the exhaled CO_2 of mice in the 24 h following the injection. Chromatographic examination of the urine radioactivity revealed at least eight metabolites of nicotine including cotinine and hydroxycotinine. (CA 57:1962, 13126i)

- 479 Hansson, E., Hoffmann, P. C., Schmiterlöw, C. G. METABOLISM OF NICOTINE IN MOUSE TISSUE SLICES. *Acta physiol. scand.* 61 (1964) 380-92.

Nicotine metabolism was investigated in tissue slices of various organs of the mouse using nicotine-methyl- ^{14}C and thin-layer chromatography. Liver, kidney and lung were found to metabolize nicotine, while brain, diaphragm, spleen, stomach, small intestine, and adrenal did not. The metabolic products identified were cotinine, γ -(3-pyridyl)- γ -oxo-N-methylbutyramide, hydroxycotinine, and $^{14}\text{CO}_2$. Two unidentified products were separated chromatographically.

- 480 Leete, E., Friedman, A.R. BIOSYNTHESIS OF NICOTINE ALKALOIDS. X. THE INCORPORATION OF GLYCEROL 2- ^{14}C INTO THE PYRIDINE RING OF ANABASINE. J. Am. chem. Soc. **86** (1964) 1224-26.

Nicotiana plants fed ^{14}C labelled glycerol formed anabasine with 38% of the radioactivity in the pyridine ring. Degradation studies showed high radioactivity in the C-2 C-3 and C-5 positions of the molecule and little in the C-4 and C-6 positions. These findings are consistent with the idea that nicotinic acid, a precursor of the pyridine ring is synthesized in the formation of anabasine. (BA 46: 1965, 58995)

- 481 Leete, E., Gros, E.G., Gilbertson, T.J. THE BIOSYNTHESIS OF ANABASINE. ORIGIN OF THE NITROGEN OF THE PIPERIDINE RING. J. Am. chem. Soc. **86**, 18 (1964) 3907-08.

A mixture of lysine-2- ^{14}C and lysine- ϵ - ^{15}N was fed to a sterile culture of excised Nicotiana glauca roots. In a 2nd experiment a mixture of lysine-2- ^{14}C and lysine- α - ^{15}N was administered. One month after feeding the tracers, the roots were harvested and extracted with CHCl_3 , affording nicotine and anabasine (I) which were separated by chromatography over Al_2O_3 . I was then degraded to determine the distribution of ^{14}C and ^{15}N in the molecule. Oxidation with KMnO_4 gave nicotinic acid, assayed as its Me ester. Decarboxylation of the acid with CaO gave pyridine, isolated as its oxalate. All of the ^{14}C in I was located at C-2', as found previously. The ϵ - and not the α -amino group of lysine was incorporated directly into the piperidine ring of I. The results were discussed. (CA 61, 1964, 13643b)

- 482 Leete, E., Gros, G.E., Gilbertson, T.J. BIOSYNTHESIS OF THE PYRROLIDINE RING OF NICOTINE. FEEDING EXPERIMENTS WITH ^{15}N -LABELED ORNITHINE-2- ^{14}C . Tetrahedron Lett. **11** (1964) 587-92.

Sterile root cultures of Nicotiana tabacum were fed with α - and δ - ^{15}N -labelled ornithines (I) (prepared according to Maimind et al., CA 53, 2105e) by the procedures of Dawson et al. (CA 55, 5608d). Each culture flask containing 30 ml nutrient solution was fed approximately 1 mg of a mixture of DL-ornithine-2- ^{14}C and ^{15}N -labelled I, and after 1 month, the roots were harvested. The nicotine (II) was isolated as the dipicrate and converted to the dipicchlorate for ^{15}N assay by mass spectrometry. Oxidation of II with KMnO_4 yielded nicotinic acid, isolated as the Me ester. Determination of the distribution of ^{14}C in the isolated II showed an equal and unique location at the C-2 and C-5 positions of the pyrrolidine ring. The degree of incorporation of ^{14}C and ^{15}N into II was tabulated. In two experiments a high specific incorporation of ^{14}C into the pyrrolidine ring of II was found. In experiment one with feeding of a mixture of I-2- ^{14}C and I- α - ^{15}N , no excess ^{15}N was detected in II. In the second experiment involving I- δ - ^{15}N , excess ^{15}N was detected in the pyrrolidine ring but not in the pyridine ring. The results were explained by postulation of ornithine- α -transaminase in tobacco roots and catalysis of the formation of $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{COCO}_2\text{H}$, resulting in loss of ^{15}N from I-2- ^{14}C - α - ^{15}N , followed by transamination with amino acids to I-2- ^{14}C containing essentially no excess ^{15}N . Decarboxylation of I to putrescine followed by oxidative deamination via 4-aminobutanol would give Δ^1 -pyrroline labelled equally at C-2 and C-5. In this oxidation half of the N of putrescine was lost and accounted for the specific incorporation of twice as much ^{14}C as ^{15}N in experiment two. An alternative mechanism through transamination of I-2- ^{14}C - δ - ^{15}N to α -oxo- δ -aminovaleric acid was discussed. (CA 60; 1964, 14841a)

- 483 Liebman, A.A., Morsingh, F., Rapoport, H. BIOSYNTHESIS OF NICOTINE IN Nicotiana glutinosa FROM CARBON-14 DIOXIDE. LABELING PATTERN IN THE PYRROLIDINE RING. J. Am. chem. Soc. **87**, 19 (1965) 4399-401.

A $^{14}\text{CO}_2$ biosynthesis was carried out, and the results of degradation of the aerial nicotine tabulated (Table 1). It had been previously shown by the authors that C-2' and C-5' contain essentially equal amounts of ^{14}C . The value found for C-3' in this experiment was lower by a factor of four than the value predicted by the symmetrical intermediate hypothesis. This was not due to a species

difference since the pathway of exogenous ornithine from to the pyrrolidine ring of nicotine could be shown to be the same for all *Nicotiana* species tested. The labelling pattern of the pyrrolidine ring formed from $^{14}\text{CO}_2$ exposure must be concluded to differ markedly from that produced by precursor feeding; the labelling pattern following short-term exposure to $^{14}\text{CO}_2$ must result predominantly from an unsymmetrical intermediate.

- 484⁽²⁾ McKennis, H., Jr., Wada, E., Bowman, E.R., Turnbull, L.B. DEMETHYLATION IN THE METABOLISM OF (-)-NICOTINE IN VIVO. *Nature*, Lond. **190** (1961) 910-11.

Nicotine-methyl- ^{14}C was synthesized in high yield by methylating (-)-nornicotine with formaldehyde- ^{14}C in the presence of formic acid. Labelled nicotine was administered intraperitoneally (0.2 mg/100 g) to male albino rat (~250 g), the approximate radioactivity of the dose being 24.8×10^3 cpm. Exhaled CO_2 was collected. A small but significant amount of ^{14}C -activity was present as urea. The fact that previous workers did not obtain any indication that nicotine is degraded to CO_2 may be attributed to a lower level of methyl- ^{14}C activity of the nicotine used by them. Since the radioactivity of randomly labelled nicotine- ^{14}C is excreted (Bennett et al.: *Archs int. Pharmacodyn.* **98**: 1954, 221) to the extent of 94% in the urine of rats, the addition of ^{14}C determined as CO_2 gives a total elimination which approaches 100%. The storage of nicotine or its metabolites after single doses occurs therefore only to an extremely limited extent.

- 485⁽¹⁾ Owen, F.B., Jr., Larson, P.S. FATE OF NICOTINE IN THE ANIMAL BODY. VIII. OBSERVATIONS ON THE NUMBER AND CHEMICAL NATURE OF NICOTINE METABOLITES IN THE DOG AND THE CAT. *Archs int. Pharmacodyn. Thé.* **115** (1958) 402-7.

From its absorption peak with CNBr and R_f values, 4-methylamino-4-(3-pyridyl)butyric acid is believed to be an end product of the metabolism of nicotine in the dog, although the amount excreted in this form is very small. Methylamine is probably not formed. At least three major and four minor peaks were found by paper chromatography. (CA 53: 1959, 15341)

- 486 Self, L.S., Guthrie, F.E., Hodgson, E. ADAPTATION OF TOBACCO HORNWORMS TO THE INGESTION OF NICOTINE. *J. Insect Physiol.* **10**, 6 (1964) 907-14.

Biosynthetically produced nicotine, randomly labelled with ^{14}C , was used. Larvae were offered tomato leaves treated with labelled and non-labelled nicotine (500 μg /larva). Radiometric, chromatographic, and spectrophotometric data show excretion and egestion of intact nicotine to be an explanation for the adaptation of the tobacco hornworm, *Protoparce sexta* (Johan.), to tobacco. There was no evidence for the metabolism of nicotine to less toxic metabolites after topical, injected, or ingested doses. Although nicotine was absorbed into the blood of the hornworm, a toxic dose did not appear to accumulate at the site of action.

- 487⁽¹⁾ Tso, T.C., Jeffrey, R.N. BIOCHEMICAL STUDIES ON TOBACCO ALKALOIDS. I. FATE OF LABELED TOBACCO ALKALOIDS SUPPLIED TO *Nicotiana* PLANTS. *Archs Biochem. Biophys.* **80** (1958) 46-56.

The ^{15}N -labelled alkaloids, nicotine, nornicotine, and anabasine, were supplied through the roots of *N. rustica* var. *brasilia* in water culture. ^{15}N and $^{14}\text{CH}_3$ doubly labelled nicotine was supplied similarly to *N. glauca* to study the fate of these alkaloids in *Nicotiana* plants. A majority of the labelled alkaloid supplied was metabolized and the label appeared in other compounds. The major alkaloid found was characteristic of the experimental plant, and was equally labelled with ^{15}N in both rings as was the alkaloid supplied. Some of the ^{15}N alkaloids supplied probably were converted to new alkaloids by a route more direct than through the general metabolic pool. The ^{15}N : ^{14}C ratio of the anabasine in *N. glauca* was half that of the ^{15}N , methyl- ^{14}C -labelled nicotine supplied. Thus the anabasine was not formed by mere rearrangement of the nicotine molecule. (CA 53: 1959, 11537g)

- 488⁽²⁾ Tso, T.C., Jeffrey, R.N., Sorokin, T.P. BIOCHEMICAL STUDIES ON TOBACCO ALKALOIDS. II. THE RELATIVE ABSORPTION AND ASSIMILATION OF C^{14} FROM C^{14}O_2 GAS AND FROM $\text{NaHC}^{14}\text{O}_3$ SOLUTION. *Archs Biochem. Biophys.* **92** (1961) 241-7.

Nicotiana plants were exposed in the presence of light to various amounts of $^{14}\text{CO}_2$ for different lengths of time and under different experimental conditions. After 1 h of exposure, ^{14}C activity was found in sugars, organic acids, pigments, and amino acids, in order of decreasing activity.

If the exposed plant was allowed to grow a few more days in the greenhouse, ^{14}C was incorporated gradually into the alkaloids. When $\text{NaH}^{14}\text{CO}_3$ was supplied from solution to the roots of *N. rustica*, ^{14}C activity was also found in pigments, amino acids, organic acids, and sugars, but almost no activity was found in alkaloids after exposure to 500 μCi of ^{14}C within 9 d. When a similar plant was grown in $\text{NaH}^{14}\text{CO}_3$ solution 124 h within 9 d and then in nutrient solution for 7 more d before analysis, ^{14}C activity gradually appeared in alkaloids. The total recovery of ^{14}C supplied to the roots from $\text{NaH}^{14}\text{CO}_3$ was only 1.6-1.75%, whereas 7.5-13.7% of that supplied to the leaf as $^{14}\text{CO}_2$ was recovered. (From CA 55: 1961, 1355a)

- 489⁽²⁾ Tso, T. C. BIOCHEMICAL STUDIES ON TOBACCO ALKALOIDS. III. THE INCORPORATION OF C^{14} AND N^{15} IN ALKALOID BIOSYNTHESIS. *Archs Biochem. Biophys.* 92 (1961) 248-52.

Incorporation of ^{14}C and ^{15}N by alkaloid biosynthesis into three species of *Nicotiana*: *N. glauca*, *N. glutinosa*, and *N. rustica*, in which anabasine, normicotine, and nicotine, respectively, are the principal alkaloids, was studied. The source of ^{14}C was $^{14}\text{CO}_2$ by photosynthesis or $\text{NaH}^{14}\text{CO}_3$ in water solution, while ^{15}N was supplied in nutrient solution as K^{15}NO_3 . ^{14}C was incorporated into the alkaloids rather slowly. No activity was found in the alkaloids from plants sampled 90 min after initial exposure to $^{14}\text{CO}_2$. As $^{14}\text{CO}_2$ -exposed plants grew, ^{14}C was incorporated into the alkaloids, but a gradual loss of total ^{14}C from the plant took place. $\text{NaH}^{14}\text{CO}_3$ was a poorer source of ^{14}C from the viewpoints of alkaloid biosynthesis and of total ^{14}C recovery than $^{14}\text{CO}_2$. The incorporation of ^{15}N into alkaloids was selective. In *N. glauca*, anabasine had the highest ^{15}N excess. In *N. rustica*, nicotine had the highest ^{15}N excess. In *N. glutinosa*, normicotine had the highest ^{15}N excess when ^{15}N was supplied starting from early stage of plant growth, while nicotine had the highest ^{15}N excess when ^{15}N was supplied only at a late stage of plant growth. Nicotine had the highest specific ^{14}C activity of the alkaloids in the experimental plants, despite the fact that the principal alkaloids of these species are different. The relative incorporation of ^{14}C and ^{15}N into alkaloids seems to indicate that the ^{14}C and ^{15}N of different alkaloids come from different pathways or precursors. (From Auth. summary)

- 490⁽²⁾ Tso, T. C., Jeffrey, R. N. BIOCHEMICAL STUDIES ON TOBACCO ALKALOIDS. IV. THE DYNAMIC STATE OF NICOTINE SUPPLIED TO *N. rustica*. *Archs Biochem. Biophys.* 92 (1961) 253-6.

Nicotine doubly labelled with ^{14}C and ^{15}N was supplied at intervals to *Nicotiana rustica* var. *brasilia* by placing the roots in a nicotine solution. The plant was supplied with complete nutrient solutions between exposures. Of the original ^{14}C activity, 34.4% was recovered and the remainder was presumably lost by respiration. The ^{14}C activity of the groups of compounds recovered from the plant decreased in the following order: alkaloids, free amino acids, pigments, fural after hydrolysis, amino acids after hydrolysis, sugars after hydrolysis, free organic acids, free sugars, insoluble residue, and organic acids after hydrolysis. Of the original ^{15}N excess, 91.6% was recovered. The amount of ^{15}N excess found in the plant was greatest in the insoluble residue after hydrolysis followed by the amino acids after hydrolysis, free alkaloids, free amino acids, and pigments. Much of the nicotine appears to have entered the plant as such and some remained unaltered. A larger proportion was metabolized, and the resulting C and N residues entered the general metabolism of the plant and appeared in all classes of compounds separated. These results indicate that nicotine supplied as in this experiment takes active part in the metabolism of a *Nicotiana* plant. (CA 56: 1961, 13555g)

- 491⁽²⁾ Tso, T. C., Jeffrey, R. N. BIOCHEMICAL STUDIES ON TOBACCO ALKALOIDS. V. THE INCORPORATION OF ^3H IN ALKALOID BIOSYNTHESIS. *Archs Biochem. Biophys.* 97 (1962) 4-8.

The incorporation of ^3H in alkaloid biosynthesis was studied by growing *Nicotiana rustica* var. *brasilia* plants in tritiated water. The rate of ^3H incorporation was very fast in the first 2.5 h, after which it was much slower for the remainder of the 70 h experiment. The relative rate of incorporation of ^3H in different classes of organic compounds was similar to that of ^{14}C from $^{14}\text{CO}_2$, except that incorporation of ^3H into the alkaloids was much more rapid. ^3H activity was detected in tobacco alkaloids 30 min after a 1 min exposure, whereas ^{14}C incorporation into the alkaloids was not detected in 30 min after a 60 min exposure. The relative changes of the ^3H specific activities of different alkaloids obtained from plants exposed for different lengths of time to tritiated water can best be explained by considering normicotine to be a precursor of nicotine under the experimental conditions. (CA 57: 1962, 2600h)

- 492 Yang, K. S., Gholson, R. K., Waller, G. R. STUDIES OF NICOTINE BIOSYNTHESIS. * J. Am. chem. Soc. **87**, 18 (1965) 4184-8.

Quinolinic acid was found to be an efficient precursor of nicotine in whole tobacco plants (*Nicotiana tabacum* L.). A method for the stepwise degradation of the pyridine ring of nicotine is described which involves the oxidation of nicotine to nicotinic acid, the biological conversion of nicotinic acid to ricinine, and the chemical degradation of ricinine. Using this degradation method it could be shown that glycerol is incorporated without randomization into carbons 4, 5, and 6 of the pyridine ring of nicotine. This degradation method was also used to confirm the mechanism of fusion of the pyridine ring of nicotinic acid with the pyrrolidine ring during nicotine biosynthesis, previously proposed by Dawson, et al. (J. Am. chem. Soc. **82**:1960, 2829-33, II/690). The following labelled substances were used in syntheses of nicotine: quinolinic acid-2,3,7,8-¹⁴C, nicotinic acid-2,3,7-¹⁴C, glycerol-1-¹⁴C and glycerol-2-¹⁴C, and quinolinic acid-3-H.

* A preliminary report of a portion of this work has been presented; see Gholson, R. K., Chandler, J. L. R., Yang, K. S., and Waller, G. R. in Fedn Proc. Fedn Am. Soc. exp. Biol. **23**: 1964, 528.

See also:

- 263 Adaptation of insects to tobacco. (Self, L. S., 1965)

8. Rotenoids

- 483 Fukami, J., Casida, J. E. METABOLISM OF ROTENONE-6a-¹⁴C BY RAT LIVER ENZYMES. Bull. ent. Soc. Am. **11**, 3 (1965) 156. Abstr. 40. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".

Four major and five minor ether-extractable rotenone-6a-¹⁴C metabolites are formed by the microsomal-NADPH₂ system. Addition of the liver soluble fraction yields metabolites extractable with butanol but not ether. Rotenolone I may be the initial product in one metabolic pathway. Dehydrorotenone-6a-¹⁴C yields completely different metabolites than those derived from rotenone-6a-¹⁴C. (Abstr.)

- 494 Nishizawa, Y., Casida, J. E. SYNTHESIS OF ROTENONE-6a-¹⁴C ON A SEMIMICRO SCALE. J. agric. Fd Chem. **13**, 6 (1965) 522-24.

Reaction of a 2 mM of methyl bromoacetate-1-¹⁴C with 3 mM of derritol produced 6a, 12a-dehydrorotenone-6a-¹⁴C in approximately 50% yield. Sodium boron hydride reduction gave the 12-hydroxy-6a-¹⁴C intermediate and subsequent Oppenauer oxidation produced rotenone-6a-¹⁴C. Yields for conversion of non-radioactive 6a, 12a-dehydrorotenone to rotenone were 17-25% but, with radioactive material of 2.36 mCi/mM, the yield was only 7.5%. Other oxidation procedures for the reduction product of 6a, 12a-dehydrorotenone are considered, as are possible explanations for the lower yield with the radioactive material. (Auth.)

9. Chemosterilants

- 495 Chamberlain, W. F., Hamilton, E. W. ABSORPTION, EXCRETION, AND METABOLISM OF ³²P-LABELED METEPA BY SCREW-WORM AND STABLE FLIES. J. econ. Ent. **57**, 6 (1964) 800-3.

The rate of absorption, excretion, and metabolism of ³²P-labelled metepa (specific activity 12 614 cpm/μg) by the screw-worm fly, *Cochliomyia hominivorax* (Coquerel), and the stable fly, *Stomoxys calcitrans* (L.), explain to a considerable extent the difference noted between the dosages required to sterilize these two species. On the basis of data obtained 6 h after treatment, the screw-worm fly absorbed only half as much radiolabelled material in proportion to its size as the stable fly. Excretion by the screw-worm fly was twice that of the stable fly, and metabolism by

the stable fly was about twice as fast as for the screw-worm fly. The principal metabolite was phosphoric acid, and it occurred in greater quantity in the screw-worm fly than in the stable fly. (Essentially auth.)

- 496 Chang, Shen Chin, METABOLISM OF C^{14} LABELED TEPA BY HOUSE FLIES. Bull. ent. Soc. Am. 11, 3 (1965) 156. Abstr. 41. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. -2 Dec. 1965".

Tepa- ^{14}C (uniformly labelled) with a specific activity of 12 mCi/mM was used in the metabolic study. The results from the radiometric, colorimetric and biological study will be discussed. (Abstr.)

- 497⁽¹⁾ Craig, A. W., Jackson, H. THE METABOLISM OF ^{32}P -LABELLED TRIETHYLENEPHOSPHORAMIDE IN RELATION TO ITS ANTI-TUMOUR ACTIVITY. Br. J. Pharmac. Chemother. 10, 3 (1955) 321-5.

Triethylenephosphoramidate (TEPA) containing ^{32}P was prepared (CA 44, 5805i) chromatographically pure. No specific localization of ^{32}P in rat tissues occurred after doses which effectively inhibited Walker carcinosarcoma and Jensen sarcoma. In tumour tissue the activity was distributed between the Cl_3CCO_2H -soluble material (32%), lipides (23%), nucleic acids (25%), and proteins (20%). Of the injected dose 80% was excreted in the urine in 24 h, the majority as TEPA. The only detected metabolite was inorganic P. Cytotoxic activity of TEPA may be due to interference by a small proportion of the dose administered with a highly susceptible cellular mechanism. (CA 50: 1956, 2067g)

- 498 Dame, D. A., Schmidt, C. H. UPTAKE OF METEPA AND ITS EFFECT ON TWO SPECIES OF MOSQUITOES (*Anopheles quadrimaculatus*, *Aedes aegypti*) AND HOUSE FLIES (*Musca domestica*). J. econ. Ent. 57, 1 (1964) 77-81.

^{32}P -labelled metepa was rapidly absorbed from glass surfaces by both mosquitoes (*A. quadrimaculatus* Say and *A. aegypti* (L.)) and house flies (*M. domestica* L.). House flies and *quadrimaculatus* absorbed approximately 7 μg per insect during a 4 h exposure on surfaces treated at 10 mg/ft² whereas *aegypti* picked up 2.5 μg . This uptake resulted in a severe reduction of mating ability in mosquitoes, coupled with 99% sterility in house fly and *aegypti* males. Metepa was found to be quite volatile on glass surfaces and highly sorptive on masonite. Under similar conditions *quadrimaculatus* absorbed 27 μg from masonite treated at 100 mg/ft² and 7600 μg from glass treated at 10 mg/ft². After 3 d of feeding on treated food, the amounts of the chemosterilant absorbed, expressed in μg -equivalents of ^{32}P metepa, were 3.0, 3.7, 1.7 in *quadrimaculatus*, house flies, and *aegypti*, respectively. These dosages caused sterility in all species without reducing male vigor. Exposure of mosquito larvae from the 3rd instar through pupation in water treated at 10 ppm resulted in low metepa uptake and very little induced sterility. The distribution of metepa in the insects was rapid and apparently non-selective. Excretion was rapid in insects exposed to residual deposits of 10 mg/ft². Insects exposed to treated larval medium and food retained a high percentage of their original radioactivity over prolonged periods; this activity undoubtedly represented detoxified metepa, however. (Auth.)

- 499 Painter, R. R., Kilgore, W. W. CHEMOSTERILANT EFFECT OF 5-FLUOROCROTIC ACID ON HOUSE FLIES. J. econ. Ent. 58, 5 (1965) 888-91.

When fed to adult house flies, *Musca domestica* L., at a level of 1.0% for 48 h after emergence, 5-fluorocrotic acid was found to be a permanent sterlant, eliminating oviposition. Although oviposition was greatly reduced at lower concentrations, a significant percentage of the eggs hatched and normal-appearing second generation flies were reared. Five-fluorocrotic acid-2- ^{14}C was incorporated into the ovaries for 48 h after removal of the chemical from the diet. But the testes did not at any time contain a significant quantity of the labelled 5-fluorocrotic acid. (Auth.)

- 500 Parish, J. C., Arthur, B. W. MAMMALIAN AND INSECT METABOLISM OF THE CHEMOSTERILANT THIOTEPA. J. econ. Ent. 58, 5 (1965) 976-9.

Thiotepa, tris (1-aziridinyl) phosphine sulphide, was synthesized with a ^{32}P label and its metabolic fate was studied in white rats and four species of insects. Thiotepa was administered topically at 100 mg/kg to the German cockroach, *Blattella germanica* (L.); house fly, *Musca domestica* L.; stable fly, *Stomoxys calcitrans* (L.); and boll weevil, *Anthonomus grandis* Boheman, and orally to white rats at 10 mg/kg or dermally at 25 mg/kg. The amount of thiotepa absorbed at 0, 1, 4,

and 24 h after treatment by different species of insects was determined. Maximum absorption had occurred by 4 h after treatment for all insects except the boll weevil. Tapa, the oxygen analogue of thiotapa, was the only chloroform-soluble metabolite of thiotapa recovered from insects. In German cockroaches, house flies, and stable flies the amount of thiotapa decreased with time after treatment; the opposite was true for boll weevils. During the 5-d experimental period, 24.3% of the administered thiotapa was eliminated in the urine of orally treated rats and 27.4% was eliminated in the urine of dermally treated rats. The orally and dermally treated rats eliminated 17.2 and 34.7% in the faeces, respectively. From 54-91% of the ^{32}P -materials eliminated in the urine and faeces of rats were hydrolytic products. Chloroform-soluble ^{32}P -materials recovered from the urine were 90% tapa from orally treated rats and about 50% tapa from dermally treated rats. Tapa was also the predominant product recovered in the chloroform extracts of faeces from orally or dermally treated rats. Three water-soluble products were isolated from the urine of rats, but were not identified. The liver and kidney contained higher concentrations of radioactive materials than fat, leg muscle, brain, reproductive organs, or blood. (Auth.)

See also:

- 155 Incorporation of glycine-2- ^{14}C into untreated and chemosterilant treated house flies. (Painter, R. R., Kilgore, W. W., 1965)

10. Synergists

- 501 Kuwatsuka, S., Casida, J. E. SYNTHESIS OF METHYLENE- ^{14}C -DIOXYPHENYL COMPOUNDS: RADIOACTIVE SAFROLE, DIHYDROSAFROLE, MYRISTICIN, PIPERONYL BUTOXIDE, AND DIASTEREISOMERS OF SULFOXIDE. *J. agric. Ed Chem.* 13, 6 (1965) 528-33.

Methylene- ^{14}C iodide, prepared by reduction of iodoform- ^{14}C was made to react with the appropriate catechol to yield the following methylene- ^{14}C -dioxyphenyl compounds with a specific activity of 1.0 mCi/mM: safrole, dihydrosafrole, myristicin, sulphoxide synergist {1,2-methylenedioxy-4-[2-(octylsulphonyl)propyl]benzene}, and piperonyl butoxide { -[2-(2-butoxyethoxy)ethoxy]-4,5-methylenedioxy-2-propyltoluene}. Yields from iodoform- ^{14}C were 31 to 55% on a 0.5- to 0.8-mM scale except with piperonyl butoxide, where the yield appeared to be related to the specific activity of the methylene- ^{14}C iodide used. The octylthio, octylsulphonyl, and octylsulphonyl analogues of sulphoxide synergist, substituted on the 1-, 2-, or 3-position of the propyl group, were prepared in non-radioactive form for comparative purposes. Sulphoxide synergist and the 1-octylsulphonyl analogue were resolved by chromatography into the enantiomorphs of the diastereoisomers about the sulphoxide grouping and the asymmetric carbon of the propyl grouping. The potency as synergists for the insecticidal activity of carbaryl (1-naphthyl methylcarbamate) and pyrethrum with houseflies (*Musca domestica* L.) was compared for all the non-radioactive methylenedioxyphenyl compounds prepared. (Auth.)

- 502 Pereira, J. F., Yamaguchi, S. ABSORPTION AND TRANSLOCATION OF ARSENATE ARSENIC BY COFFEE PLANTS. *Turrialba* 14, 2 (1964) 91-93. (In Spanish, with English summary)

Coffee plants (*Coffea arabica* L.) were treated with ammonium arsenate (^{75}As) and arsenic metabolites studied autoradiographically. No translocation occurred except in young leaves; marked absorption was observed in roots and in leaves.

- 503 Young, S. Y., Berger, R. S. THE METABOLISM OF S^{35} LABELED BAYER 9017. *Bull. ent. Soc. Am.* 11, 3 (1965) 157. Abstr. 44. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".

The metabolism of ^{35}S -labelled Bayer 9017, an experimental animal systemic, was studied in dairy calves. One calf was treated orally and another dermally, then held for 24 h. Blood, urine, and faecal samples were taken. The animals were then sacrificed, tissue samples taken and Bayer 9017 and metabolites were determined. (Abstr.)

See also:

- 84 The effect of malathion on the metabolism of amino acids in the German cockroach Blattella germanica. (Mansingh, A., 1965)
- 155 Incorporation of glycine-2-C-14 into untreated and chemosterilant treated house flies. (Painter, R. R., Kilgore, W. W., 1965)
- 263 Adaption of insects to tobacco. (Self, L. S., 1965)
- 329 Methylenedioxyphenyl compounds as inhibitors of the hydroxylation of naphthalene in houseflies. (Philleo, W. W. et al., 1965)
- 363 Absorption and distribution of DDT in the boll weevil and the influence of synergists on toxicity. (Land, J. D., 1963/64)
- 468 Metabolism in vivo of ¹⁴C-labelled pyrethrin I and cinerin I by house flies with special reference to the synergistic mechanism. (Chang, S. C., Kearns, C. W., 1964)

11. Repellents

See

- 462 Carbamate insecticides: synergism by organothiocyanates. (El-Sebay, A. H. et al, 1964)
- 1046 Procedure for bioassaying mosquito repellents in laboratory animals. (Lal, H. et al., 1963)

II

IONIZING RADIATIONS

A. CELLULAR AND GENETIC EFFECTS

1. General Articles. Surveys. Books. Progress Reports (Several Topics)

- 504 Atomic Energy of Canada Ltd., Chalk River (Ontario). ACTIVITIES OF AECL IN THE FIELDS OF BIOLOGY, HEALTH PHYSICS AND MEDICINE. AECL-2107, Nov. 1964, 34p.

Activities in the fields of biology, health physics, and medicine are summarized. Results are also reported from studies on the effects of γ -dose rate on the number of radio-induced mutations in the small wasp Dahlbomimus; the detection of electrical potentials in cockroach eyes following stimulation by x-radiation; and the effects of x-radiation on metabolism in the giant mitochondria involved in energy supply to wing muscles of the house fly.

- 505 National Inst. of Radiological Sciences, Chiba (Japan). BIOLOGICAL STUDIES. p. 50-56 of "Annual Report, 1963". NIRS-3. Dec. 1964, 93p.

Genetic research included work on the effects of chronic irradiation on sex-linked lethal mutation frequencies in Drosophila; comparison of frequency patterns between whole-body and fractional mutations; modification of x-ray induced visible mutation frequencies by chromosome structure; effects of nitrogen on mutation rates in x-irradiated germ cells; effects of penicillin feeding on reduction of radioinduced mutation rates; effects of temperature and genetic background on the pre-adult viability of lethal heterozygotes; and genetic effects of x-rays on the quantitative characters in a heterozygous population.

- 506(2) Kitzmiller, J. B. MOSQUITO CYTOGENETICS. A Review of the Literature, 1953-62. Bull. Wld Hlth Org. 29, 3 (1963) 345-55.

Available information is still superficial and limited to a few mosquito species. The author reviews and summarizes research in the field. Sexual differences in the salivary X-chromosomes have been reported for several species of Anopheles. Chromosomal polymorphism is common in some anophelines, but rare in others. Chromosomal mutation has been induced by means of x-rays. In his conclusion the author stresses that prospects are especially good for evolutionary and genetic studies involving chromosomal polymorphism.

- 507 Kondo, S. VARIATION IN MUTAGENICITY AND RADIATION RESISTANCE WITH GENOME COMPLEXITY AND EVOLUTION. Idengaku Zasshi (Jap. J. Genet.) 39, 2-3 (1964) 176-98.

After summarizing the mutagenic studies on higher and lower organisms carried out by the group the author discusses the RBE for mutations, comparing it with the RBE for somatic damage. The apparent RBE for mutagenicity reflects not only the efficiency of premutation induction, but also the depression of repair mechanisms. It is concluded that mutagenic factors are also involved differing with genome complexity. The increase in resistance to radiation-induced DNA damage with genome complexity is more noticeable with u.v. than with ^{32}P or x-rays. Based on the evolutionary point of view, a repair-tolerance model is proposed for mutagenesis to account for the differential factors in mutagenesis, which reflect differences in the mechanisms of repairing and tolerating premutational DNA damages among different organisms. Work on Drosophila and silkworm is cited.

- 508 Lewontin, R. A STUDY OF MATHEMATICAL MODELS OF MUTATION AND SELECTION IN MULTILOCUS SYSTEM. Annual Progress Report, September 1, 1963-August 31, 1964. TID-20714, Rochester, N. Y. Univ. 15 June 1964, 9p.

Progress is reported in genetic studies in Drosophila populations. A computer programme was developed for use in studies on the influence of linkage on changes in gene and gamete frequency in a hypothetical population of Drosophila consisting of 500 males and 500 females, each with

30 loci, mating at random with discrete generations. Data are also included from studies on 5-locus models, the effects of isolation by distance on populations of finite size, studies on auto-incompatibility, selection of polygenic characters, selection of components of fitness, and the intrinsic rates of increase in Drosophila populations. (NSA18:1964, 27018)

- 509(4) National Inst. of Genetics, Misima (Japan). RADIATION GENETICS IN ANIMALS. p.93-116 of "Annual Report of the National Institute of Genetics, No. 14, 1963". NP-14937, 1964.

Results are included from studies on radioinduced mutations in Drosophila melanogaster and silkworms.

- 510 Rico, M. GENETIC BASIS OF RESISTANCE TO RADIATION. Spain. Inst. Nac. Invest. Agron. B. 24, 50 (1964) 97-101. (In Spanish, with English summary)

Work on Drosophila melanogaster is discussed.

- 511 Rochester Univ., N. Y. Atomic Energy Project. RADIATION EFFECTS--GENERAL. p.1-54 of "University of Rochester, Atomic Energy Project. Brief Description of Most of the Research Programs Completed during 1964". UR-668. 1 Jan. 1965, 175p.

Some mention is made of the effects of x-irradiation on Drosophila spermatozoa.

2. Nuclear and Cytoplasmic Biochemistry, Physiology, and Ultrastructure

- 512 Bartlett, A. C., Bell, A. E. GENE NUMBER, EFFECT, AND MUTATION RATE FOR BODY WEIGHT IN Tribolium castaneum. TID-20082, Purdue Univ., Lafayette, Ind. nd, 7p.

x-radiation was used in a study of selection. Body weight in T. castaneum was estimated to be controlled by 607 pairs of genes. Each gene locus was estimated to have an average phenotypic effect of 0.0046 mg. The radiation-induced mutation rate of these quantitative genes was of the magnitude of 10^{-4} and 10^{-6} mutations/R/gene locus. (From auth.)

- 513 Buchholz, Ch. ELECTRON MICROSCOPIC FINDINGS IN THE IRRADIATED SUPRAESOPHAGEAL GANGLION OF ODONATA LARVAE (Calopteryx splendens Haar). Z. Zellforsch. 63, (1964) 1-24. (In German)

Four types of neurons were observed in the supraesophageal ganglia of Odonata larvae x-irradiated with 100 000 R during the Y and Z developmental stages. These were globular perikaryon, large perikaryon with large round nuclei, large cytoplasm-rich perikaryon with nuclei, and perikaryon with neurosecretory activity. Changes in all except the second type induced by irradiation included increased volume of neuroplasm and reduced size of nuclei. The nucleolus was visible in the karyoplasm of the large round nuclei. High concentrations of chromatin were visible in all four types of perikarya after irradiation. Differences between the perikarya were shown in the endoplasmic reticulum containing ribosomes, the dictyosomes, and the mitochondria. Very dark granules that suggested ribosomes concentrations were observed particularly in the perikarya with large round nuclei. The secretory vacuoles of the neurosecretory perikarya were reduced and clumped together because of loss of their membranes. Studies with the light microscope indicated increases in cell volume and nuclear swelling after irradiation with 40 000 to 50 000 R. Usually these changes were reversible, but after 50 000 to 150 000 R there were irreversible changes. These included localization and accumulation of tigroid material, with appearance of chromatin in the nucleus that shifted the nucleolus to the nuclear edge. Following this the nucleus shifted to the periphery of the cytoplasm, while the tigroid substance separated into five particles and finally disappeared. During this phase there was partial vacuolization of the cytoplasm. Complete necrosis was indicated by appearance of completely pyknotic residual bodies. (NSA19:1965, 43849)

- 514 Alexander, M. L., McKinley, K. CYTOLOGICAL DAMAGE ASSOCIATED WITH GENETIC MUTATIONS IN Drosophila WITH BETATRON TREATMENT. Radiat. Res. 22, 1 (1964) 166. Abstr. 4.

Treatment of premeiotic spermatogonia of Drosophila with 22 MeV betatron x-rays resulted in higher percentages of dominant lethals than 250 kVp therapy x-rays although the latter produced

more dominant lethals in postmeiotic cells. Disproportionate amounts of chromosome breakage with the two radiations were tested for correlation with the possible elimination of injured cells by cellular degeneration. With therapy x-ray greater numbers of cells may degenerate at meiotic divisions and fewer genetic dominant lethals be recovered in postmeiotic stages than with betatron. Genetic and cytological damage were tested with betatron for comparison to previous therapy x-ray tests. Mature sperm of *D. melanogaster* were treated with 3000 rad of betatron x-rays and genetic mutations checked at eight specific gene loci, ru h th sr pp cu sr es in the third chromosome. Sixty-one mutations were observed in 50 242 individuals to give an average mutation rate of 5.06×10^{-8} per rad/locus. Fifty-one of the induced mutations were tested for viability and 19 were homozygous viable and 32 lethal. In the cytological analyses, there have been no chromosome aberrations observed among viable mutations; among lethals, eight showed no chromosome aberrations, eleven contained deletions and one an inversion. Comparisons to results for therapy x-ray show that the mutation rates are similar. The proportion of viable and recessive lethal mutations is similar, but there appears to be an almost complete absence of translocations and inversions. The data indicate that chromosome breakage occurs equally frequently with both radiations but that the recovered breakage has a different distribution. (Abstr.)

- 515 Hess, O. THE EFFECT OF x-RAYS ON THE FUNCTIONAL STRUCTURES OF THE Y CHROMOSOME IN SPERMATOCYTES OF *Drosophila hydei*. *J. Cell Biol.* 25, 1, Pt. 1 of 2 (1965) 169-73.

At least five sites of the Y-chromosome of *D. hydei* form loops of specific morphology which seem to occur in correlation with a phase of activation of certain genes in spermatocyte nuclei. x-irradiation in doses of as low as 1000 R causes characteristic morphological alterations of the loops. Exactly the same alterations have been observed earlier after treatment with actinomycin. The alterations are reversible. As expected, and unlike actinomycin, x-irradiation causes also some irreversible damage; i. e. complete or partial suppression of loop regeneration, as well as breaks within the loops. The results are not inconsistent with the suggestion that in *Drosophila* spermatocytes the DNA-directed synthesis of RNA can be reversibly inhibited by x-irradiation. (Auth.)

- 516 Hildreth, P. E. FERTILIZATION IN *Drosophila*. II. TIME OF INACTIVATION OF GENE EFFECT. p. 133-44 of "Biology and Medicine Semiannual Report, Spring 1965". UCRL-16246, California Univ., Berkeley. Donner Lab. and California Univ., Berkeley. Donner Pavilion. nd, 190p.

For abstract, see 517.

- 517 Hildreth, P. E. FERTILIZATION IN *Drosophila*. II. TIME OF INACTIVATION OF GENE EFFECT. *Proc. natn. Acad. Sci. U. S. A.* 54 (1965) 736-41.

Previous experimenters found an inactivation effect of a suppressor gene in *D. melanogaster* when eggs in early stages after fertilization were irradiated. A repetition of these experiments with presently available stocks did not confirm the original findings. The data do not support the view that the gene action of Su-er is determined very early, or the alternative view that a substance upon which the gene Su-er acts is inactivated by x-rays after fertilization of the egg but before cleavage divisions have begun. (Auth.)

- 518(2) Ito, T., Tanaka, M. EFFECTS OF γ -IRRADIATION ON THE ACTIVITIES OF DIGESTIVE ENZYMES OF THE SILK WORM. *Nippon Sanshigaku Zasshi* (J. seric. Sci., Tokyo) 32 (1963) 330-37. (In Japanese)

When newly moulted 5th-instar larvae of *Bombyx mori* were irradiated with ^{60}Co γ -rays at dosages of 60 or 80 kR, invertase, β -glucosidase, and trehalase of the midgut as well as amylase and proteinase of the digestive juice were inhibited. The radiosensitivity varied according to the enzyme. With Me_2CO -dried midgut and lyophilized digestive juice, the rate of inhibition was highly related not only to the dosage of γ -rays but also to the concentration of enzyme. (CA 63:1965, 4624e)

- 519(2) Lezzi, M. DAS VERHALTEN DES PUFFMUSTERS DER SPEICHELDRÜSEN-CHROMOSOMEN VON *Chironomus* UNDER DEM EINFLUSS VON *Drosophila*-EINHALT. (Behaviour of the puff pattern of the salivary-gland chromosomes in *Chironomus* under the influence of *Drosophila* egg contents). Diplomarbeit. Eidgenössische Technische Hochschule, Zurich (Switzerland). 1961, 30p. (In German)

The behaviour of the puff pattern of *C. thummi* was examined under various conditions with special reference to both ends of the third and the right end of the second chromosome. In normal development, four stages with characteristic puff pattern can be distinguished: young larvae (beginning of 4th larval instar), older larvae (during the 4th instar), pre-pupae, and "red" pupae (immediately after pupal moulting). Rejuvenation of the puff pattern occurred under several conditions: in explants of glands in haemolymph or Ringer solution, and in larvae ligated in the regions of the glands. Rejuvenation was also brought about by x-rays when it proceeded in the partial absence of cytoplasm. In these experiments, larvae were exposed to 2000 R (at 1000 R/min) in the region of the gland. Rejuvenation further occurred on transplantation of salivary gland nuclei with a cytoplasmic sheath to *Drosophila* egg. The addition of pupal haemolymph to gland explant results in puff formation of the pupal stage; it cannot stop rejuvenation. The phenomenon of rejuvenation of the puff pattern is discussed with reference to energy supplies. *Drosophila* egg has proved a favourable medium for culturing nuclei.

- 520 McGrath, R. A., Leach, W. M., Carlson, J. G. CELL STAGES REFRACTORY TO THYMIDINE INCORPORATION INDUCED BY X-RAYS. *Expl Cell Res.* 37, 1 (1965) 39-44.
- Embryos of the grasshopper *Chortophaga viridifasciata* (De Geer) were used. Autoradiographic studies of hanging-drop preparations showed that grasshopper neuroblasts, trapped in mid-mitotic stages by colchicine and then exposed to x-rays (64 R - 75 000 R) did not incorporate ³H-thymidine or its derivatives into DNA. The intracellular pool of thymidine derivatives is not detectably changed by exposure to x-rays. The data show a correlation between radiation-induced incorporation of ³H-thymidine derivatives and cell stage at the time of irradiation. It is suggested that the synthesis-like condition, during which x-ray-induced incorporation of DNA precursors can occur, degenerates gradually after cells stop normal synthesis of DNA.
- 521 Oak Ridge National Lab., Tenn. RADIATION IMMUNOLOGY. p.112-8 of "Biology Division Semiannual Progress Report for the Period Ending February 15, 1965". ORNL-3768. May 1965, 205p.
- Progress is reported on a number of studies including work on the immunology of grasshopper neuroblasts.
- 522(a) Pavan, C., Basile, R. EFFECTS OF RADIATION ON THE SYNTHESIS OF NUCLEIC ACIDS IN POLYTENE CHROMOSOMES. *Natn. Cancer Inst. Monogr.* 14 (1963) 199-204.
- Experiments were done using larvae of *Rhynchosciara angelae* (Diptera, Scleridae) to study the effect of ionizing radiation on the synthesis of deoxyribonucleic acid (DNA). Different groups of larvae were exposed to 1250, 2500, 10 000, and 20 000 R from a source of γ -rays, and the effect of radiation on these chromosomes was analysed. Autoradiography and ³H-thymidine were used as radioactive precursor to DNA. In cells of the salivary gland of *R. angelae* the radiation (even the 20 000 R dose) seemed to stimulate the synthesis of DNA, as shown by the many cells incorporating ³H-thymidine and also by the higher intensity of incorporation in chromosomes that received radiation as compared to non-irradiated controls. (NSA19:1965, 8883)
- 523 Deleted
- 524 Yanders, A. F. BASIC FERTILIZATION PHENOMENA AND GAMETIC LETHALITY IN *Drosophila*. p.136 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- See also:
- 527 The effect of x-irradiation on spermatogenesis in *Drosophila melanogaster* Meigen. (Abro, A., 1964)
- 596 A study of gene and chromosome changes induced by ionizing radiations in *Drosophila melanogaster*. (Godfrey, R. K., 1964)
- 673 Evaluation of repair processes in x-irradiated flour beetles by means of the split-dose technique. (Ducoff, H. S., Bosma, G. C., 1964)
- 754 Phase cinematography studies on the effects of radiation and of some chemicals on cells and chromosomes. (Nakanishi, Y. H., Makino, S., 1964)

- 792 The effects of ionizing radiation on the sarcosomes of housefly flight muscle. (Carney, G. C., 1965)
- 793 Swelling and shrinkage properties of housefly sarcosomes after in vivo exposure to x-rays. (Carney, G. C., 1965)
- 801 Cytological effects of radiation on testes of the screw-worm fly, Cochliomyia hominivorax. (Riemann, J. G., 1964)
- 838 Irradiation effects on spermatogenesis in the gipsy moth, Portheia dispar (L.). (Rule, H. D. et al., 1965)

3. Meiotic and Mitotic Sensitivity

- 525 Abeleva, E. A. ANALYSIS OF THE CAUSE OF THE ANOMALOUS DEPENDENCE OF THE MUTATION FREQUENCY IN Drosophila SPERMATIDS ON THE IONIZING RADIATION DOSE. Radiobiologiya 4 (1964) 569-74. (In Russian)

Previous studies on the anomalous dependence of mutations on the radiation dose did not clarify the reason for the reduced efficiency of high-level doses. This problem was further investigated by assuming a differential radiation sensitivity of the cells at various stages of the spermatogenesis; the mutation and fertility curves of Drosophila males were compared after exposure to 1 and 3 kR of γ -radiation. It was found that the dose of 1 kR does not cause deviation from the expected linear correlation but the relative biological efficiency of the higher dose was considerably reduced. Experiments with crossing-over, carried out with the Yellow Miller strain of D. melanogaster, revealed that up to the 8th d after irradiation the male gametes produced a haploid chromosome set, thus indicating that the spermatogenesis occurred from the 4th-7th day after irradiation. On the 8th day meiotic division takes place; the 9th day is probably the period of growth of the later spermatogonia before the start of the meiosis. The mutability of the mature sperm, 1-3 d after irradiation, and of the growing spermatogonia at 1 kR were identical. The distribution of the mutability at the two dose levels agreed with the corresponding fertility curves. The data support the previously expressed assumption that the reduced relative biological efficiency of the high doses and the shift in the mutability of the spermatids are due to the death of the most genetically sensitive cells. (NSA18:1964, 41183)

- 526 Abrahamson, S., Friedman, L. D. x-RAY INDUCED MUTATIONS IN SPERMATOGONIAL CELLS OF Drosophila AND THEIR DOSE-FREQUENCY RELATIONSHIP. Genetics 49 (1964) 357-61.

Spermatogonial x-ray induced mutation rates were determined in adult Drosophila males. The mutation frequency was found to be proportional to dose for doses of 3000-12000 R. (Auth. summary)

- 527 Abro, A. THE EFFECT OF x-IRRADIATION ON SPERMATOGENESIS IN Drosophila melanogaster Meigen. Årbok Univ. Bergen, Matematisk-naturvitenskapelig serie 10 (1964) 1-121

The time of puparium formation in D. melanogaster is prolonged when 3rd-instar larvae are exposed to x-rays. The prolongation increases with increasing doses. Development of testis and spermatogenesis seem to proceed independently of the changes that accompany the metamorphosis. Secondary spermatogonia about to differentiate into spermatocytes are most sensitive to x-rays, followed by spermatocytes initiating the meiotic divisions. Low doses sometimes produce bizarre alterations in cell morphology. Supernumerary organelles occur frequently. (Auth.)

- 528 Alexander, M. L., Bergendahl, J. DOSE RATE EFFECTS IN THE DEVELOPING GERM CELLS OF MALE Drosophila. Genetics 49 (1964) 1-16.

The developing germ cells of D. melanogaster were treated with fast and fractionated doses of x-rays in 4 atm of Ar or in 3 atm of Ar + 2 atm O₂. An enhancement in biological damage was noted in all post-meiotic sperm and spermatid cells in tests when O₂ was present in combination with Ar. The rate at which radiation was administered did not affect mature sperm cells. Enhanced translocations and sex-linked recessive lethals were obtained for spermatids in Ar by giving the total radiation dose in two fractions 40 min apart. When O₂ was present with the Ar, similar values were obtained with a fast, continuous dose and with fractionated doses. Another type of dose rate effect was observed when spermatogonia were treated. The dominant lethal percentages were higher when doses were fractionated in both Ar and in Ar+O₂ tests. (Essentially auth. summary)

- 529 Bateman, A. J., Chandley, A. C. EFFECTS OF X-RAYS ON FEMALE GERM CELLS OF Drosophila melanogaster. Mutation Res. 2, 6 (1965) 506-22.

Distal segments of the X-chromosome show reduced recombination after x-rays. This reduction is confined to eggs laid 8 d and more after irradiation and persists at least until the 14th day. It is roughly proportional to dose over the range 1 krad-8 krad. Proximal segments of the X (between *f* and the centromere) show increased recombination after x-rays. The increase is first evident in eggs laid 4 d after irradiation and persists at least until the 11th day. The maximum effect follows 4 krad. Intermediate segments show increased recombination at doses up to 4 krad and reduced recombination at higher doses. It is concluded that the increases and decreases in recombination following x-rays are independent effects with different dose dependences. The increased recombination is attributed to the direct induction of crossing-over in early oocytes or oögonia in synapsed regions. It is postulated that the reduction in recombination is due to the disruption of synapsis, beginning at the telomere and extending towards the centromere as the dose is increased. It is supposed that when the pairing of oögonial chromosomes is disrupted the disruption persists through to the oocyte. The sensitivities of the various stages of oögenesis to induced crossing-over, reduced crossing-over, non-disjunction and dominant lethals are compared. (Auth.)

- 530 Carlson, J. G., Gaudin, M. E. GRASSHOPPER NEUROBLAST TECHNIQUES. p. 229-76 of "Methods in Cell Physiology. Vol. 1". Prescott, D. M., Ed. New York, Academic Press. 1964, 465p.

The selection of suitable species and various techniques (such as specimen collection, rearing, tissue culture) used in cytologic studies of grasshopper neuroblast, especially radiobiology experiments, are described. Methods of irradiation and observation of irradiated cells are reviewed. The closeness of these cells to the body surface makes them accessible to poorly penetrating radiations such as α -, β -, and u. v. -radiations. Grasshopper embryos may be exposed to the highly penetrating x- and γ -rays in vivo, i. e. within the intact chorion of the egg, or in vitro in cultures. Osmotic pressure of neuroblasts changes immediately after exposure to 100 R or more of x-rays. Culture medium isotonic to untreated cells is hypotonic to them after irradiation. With ^{32}P , neuroblasts can be exposed to a known amount of β -radiation. A method of treating neuroblasts with α -particles was developed. Because of the high LET and short paths of α -particles, it is necessary to use hanging-drop cultures. A radiation source prepared by electro-chemical deposition is described. Neuroblasts can be used for the experimental study of the effects of whole-surface irradiation. Either polychromatic or monochromatic u. v. radiation can be used to treat the neuroblast. Whole-cell irradiation of hanging-drop preparations of embryos is also described. Parts of the neuroblast can be irradiated with a microbeam of u. v. radiation. Various techniques for detection of modification of radiation effects are also outlined. To determine the effects of pretreatment and posttreatment with heat on x-ray-induced chromosome breakage, eggs are immersed in water at the temperature and for the time desired. The effects of O_2 on the mitotic response of neuroblasts to x-rays has been determined by exposing whole eggs to different concentrations of gaseous O_2 as well as to N_2 or CO_2 . Observations on irradiated neuroblasts can be made on living cells in hanging-drop cultures or on fixed and stained cells. Time-lapse photography has also been used. Chemical, gas, and microdissection techniques are also discussed. Extensive supporting documentation is included.

- 531 Erickson, J. E. MEIOTIC DRIVE IN Drosophila INVOLVING CHROMOSOME BREAKAGE. Dis. Abstr. 25, 5 (1965) 2716-7.

This represents the first experimentally produced case of meiotic drive which has been analysed in considerable detail, both genetically and cytologically. A stock was isolated from an irradiated population of Drosophila melanogaster which showed meiotic drive, defined as the unequal recovery, in the products of meiosis, of the members of a pair of homologous chromosomes. Males of this stock produce an excess of X- over Y-bearing sperms, resulting in a sex-ratio of approximately two females to one male. The effect is due to a factor on the X-chromosome, in or near the proximal heterochromatin, and is subject to depressed expression. The basic effect is an action against the Y-chromosome. Cytological study shows fragmentation of the Y, usually delayed to the second division in its appearance. It is assumed that the fragments lead to gametic death, accounting for the differential production of X and Y sperms. Additional confirmation of the conclusion that a reduced recovery of the Y-chromosome, rather than a gain of the X-chromosome, is responsible for the observed sex-ratio, was obtained by tests with XYY males, carrying marked Y-chromosomes. Fertility is greatly reduced in comparison with normal stocks, and responds to temperature in a pattern similar to that of sex-ratio, maximum fertility corresponding

to maximum recovery of female offspring. Cytological observations probably related to the low fertility are a high rate of non-disjunction, and first anaphase bridges involving both autosomes and sex chromosomes. (From DA)

- 532 Fahmy, O. G., Fahmy, M. J. RADIOSENSITIVITY OF THE STAGES OF SPERMATOGENESIS TO DIFFERENT MUTATIONS IN Drosophila melanogaster. Mutation Res. 1 (1964) 247-67.

The induction of sex-linked recessive lethals, XO males, and chromosome deletions were followed relative to non-disjunction (XXY females) and induced crossing-over in daily sperm samples from IX irradiated male D. melanogaster. Non-disjunction marked the sampling of meiotic spermatocytes, prior to and during anaphase I, and its yield was highest on the 10th-12th day, although a low rate occasionally occurred as early as the 8th, or as late as the 13th day. Accordingly, post-meiotic stages were mainly used during the first 9 d, and meiotic and pre-meiotic stages were sampled starting from the 10th d. Induced crossing-over marked the utilization of diploid germ cells and was substantially sampled on the 10th and later days. Small clusters of recombinants involving the same chromosome site occurred 12-13 d after treatment, possibly indicating the sampling of spermatogonia late in the mitotic cycle. The induction of sex-linked recessive lethals and XO males was high in the spermatid stages and decreased sharply in frequency with the increase in the rate of non-disjunction. The response for these mutations, therefore, was considerably lower in meiotic spermatocytes than in early spermatids. The mutation rate for the deletions (y^+ and B from the Y-chromosome) reached its peak before that of non-disjunction but remained high during the sampling of the latter aberrations. Radiosensitivity to the induction of deletions, therefore, although highest in the early spermatids, did extend to the late meiotic spermatocytes. (Auth.)

- 533 Grosch, D. S. BIOLOGICAL EFFECTS OF RADIATION. Bios 36 (1965) 55-62.

The effects of ionizing radiations at the cellular level are discussed, with particular reference to studies using Habrobracon.

- 534 Hannah-Alava, A. THE PREMEIOTIC STAGES OF SPERMATOGENESIS.* p. 157-226 of "Advances in Genetics. Vol. 13". Caspari, E. W., Thoday, J. M., Eds. New York, Academic Press. 1965, 378p.

Review article. The author considers maintenance of the germ line and spermatogonial multiplication, the chronometry of the various stages of spermatogenesis, and the genetic criteria for relating the temporal and spatial patterns of spermatogenesis. The radiosensitivity of spermatogonia is discussed in detail. Much of the work cited was done on Drosophila.

* An earlier publication of the same title, not for general distribution, appeared as TID-21562, Turku Univ. (Finland). Dept. of Genetics. 1964, 91p.

- 535 Hsu, F.-T., Ma, S. T., Chen, T. C. THE DISTURBANCE BY x-RAYS TO THE MEIOSIS AND SPERMIOGENESIS OF MALE Locusta migratoria manilensis Meyen. Acta ent. sin. 13, 5 (1964) 637-48. (In Chinese, with English summary)

- 536 Lefevre, G., Jr. THE MUTABILITY OF MATURE SPERM OF Drosophila melanogaster IRRADIATED* IN THE FEMALE AND IN THE MALE. Genetics 51 (1965) 381-90.

The mutability of fully mature, motile sperm of D. melanogaster was examined following comparable 4000 R irradiations of inseminated females and adult males. The frequency of sex-linked recessive lethal mutations induced in mature sperm irradiated in the female was found to be affected neither by the age of the male that provided the sperm nor by the length of time that the sperm had been mature before being utilized by the male. Thus, mature sperm, once in the female, exhibit a constant mutability. The mutation frequency observed following the exposure of inseminated females was significantly lower than the mutation frequency characteristic of sperm samples derived from the first mating after irradiation of 3- or 7-d-old males. The difference in the detected frequency of mutations induced in mature sperm under the two conditions of irradiation may be related to the fact that, when inseminated females are irradiated, both genomes of the F_1 progeny are exposed; whereas, only the paternal genome is exposed when adult males are irradiated. (Auth.)

* (x-radiation)

- 537 Lefevre, G., Jr., Jonsson, U. -B. x-RAY INDUCED MUTABILITY IN MALE GERM CELLS OF *Drosophila melanogaster*. Mutation Res. 1 (1964) 231-46.

As the time interval between irradiation and the initial mating increases, the sperm samples consist of ever less homogeneous mixtures of cells that were at varying stages of maturity at the time of irradiation. If the male mates at a regulated pace after irradiation, sperm samples can be obtained that enable one to measure separately, and with reasonable accuracy, the mutability of mature sperm, intermediate and late spermatid stages, and early spermatids. Even so, unless each male in an experiment mates the same number of times each day, sampling of the various stages will become more and more asynchronous, as some males will produce sperm derived from stages quite different from those sampled at the same time from other males in the same experimental group. Then, if mutation frequencies are collected in terms of days after irradiation, they will not accurately reflect the mutability of any particular germ cell stage. When appropriate experimental procedures are followed, the mutability of mature, motile sperm is found to be as high, or higher, in male irradiations as in irradiations of inseminated females. The sex-linked recessive lethal mutation frequency characteristic of mature, motile sperm approaches 4%/1000 R. Immotile sperm stages such as intermediate and late spermatids have a much lower mutability, less than 2%/1000 R. Early spermatids again have a high mutability, probably exceeding that of motile sperm. The actual mutation frequency encountered at any time following irradiation reflects the proportion of the various kinds of irradiated germ cells in the sperm sample assayed. The precise proportion in any given sperm sample will be related to the age of the male at the time of irradiation, his previous mating history, the length of time that has elapsed between the irradiation and mating, and the number of inseminations that have ensued since the irradiation. The inherent mutability of male germ cells can be correlated with their physiological state at the time of irradiation. Thus, rapidly differentiating early spermatids are highly mutable and radiosensitive. Later, after the major structural modifications of the cell have been accomplished, the immotile intermediate and late spermatids exhibit a low mutability. Finally, in the terminal step in their differentiation the spermatids acquire motility, thereby becoming transformed into functional spermatozoa whose mutability is simultaneously reset to a high level. (Auth.)

- 538 Lindsley D. L., Sandler, L. MEIOTIC BEHAVIOUR OF TANDEM METACENTRIC COMPOUND X CHROMOSOMES IN *Drosophila melanogaster*. Genetics 51 (1965) 223-45.

Well marked tandem metacentric compound X-chromosomes of two structural types were synthesized, and their behaviour in crosses was investigated. In addition to the data from these newly synthesized tandem metacentrics, previously published data on other tandem metacentrics were considered. The following conclusions emerge from an analysis of tandem metacentric data. The data do not fit the hypothesis that nullo-X eggs (detected as exceptional patroclinous males) result from the exclusion of double second-anaphase bridges from the egg nucleus; such bridges, therefore, probably result in inviable zygotes. The data are compatible with the hypothesis that nullo-X eggs arise through the loss of a fraction of the newly generated single-ring X-chromosomes and that ring loss is lower in the progeny of tandem metacentric X-bearing females that carry a marked Y-chromosome fragment than of those that carry none. The exchange distribution in tandem metacentrics, as in other tandem compounds, is comparable with that of free X-chromosomes, and the coefficient of non-randomness approximates unity. (Auth.)

- 539 Mandl, A. M. THE RADIOSENSITIVITY OF GERM CELLS. Rev. Camb. phil. Soc. Biol. 39, 3 (1964) 288-371.

The literature is reviewed. Considerable work on insects is included.

- 540 Meisner, H. M. INFLUENCE OF TONICITY ON MITOTIC RECOVERY IN x-IRRADIATED GRASSHOPPER NEUROBLASTS. Diss. Abstr. 25, 4 (1964) 2182-3.

For abstract, see 541.

- 541 Meisner, H. M. INFLUENCE OF TONICITY ON MITOTIC RECOVERY IN x-IRRADIATED GRASSHOPPER NEUROBLASTS. Physiol. Zool. 38 (1965) 276-88.

The influence of tonicity and other factors on mitotic recovery from 25 or 50 R was examined in hanging-drop preparations of *Chortophaga viridifasciata* neuroblasts. 6-d embryos (38°C) were cultured in either an inorganic salt-glucose medium (Carlson's) or an amino acid-inorganic salts-

glucose medium (Shaw's). In both the mitotic ratio of irradiated (50 R) to non-irradiated cells was reduced as tonicity was lowered. During the recovery period from 110 to 308 min, a 10% reduction of tonicity depressed the mitotic ratio 41% in Carlson's, and 85% in Shaw's medium. Under hypertonic conditions, neuroblast recovery from radiation was the same in both media. The higher pH of Shaw's medium (7.0 against 6.3) was the sole factor responsible for the lower mitotic ratio. Addition of egg yolk to cultures markedly enhanced the mitotic ratio after 50 R in either medium, but was less pronounced as tonicity increased. Addition of 3×10^{-5} M 2,4-dinitrophenol caused a slight reduction in mitotic rate in non-irradiated neuroblasts. After 25 R, however, the mitotic ratio of DNP treated cells during the recovery period was the same or markedly greater than the mitotic ratio of controls irradiated with DNP.

- 542 Nakajima, M. RADIATION EFFECTS ON GERM CELLS OF THE SILKWORM (In Japan). Annual Reports of Scientific Research Grants 1964, Ministry of Education: Radiation Effects - Cooperative Researchers, No. 13 (1965) 161-2.
- 543 Nakanishi, Y. H., Tamiko, I., Hatao, K. CYTOLOGICAL STUDIES ON THE RADIOSENSITIVITY OF SPERMATOGONIA OF THE SILKWORM. Idengaku Zasshi (Jap. J. Genet.) **40**, Suppl. (1965) 49-67.

A study of morphological features of spermatogonia of about 20 000 silkworm larvae at various developmental stages in relation to their radiosensitivity led to the conclusion that there are some specific types of spermatogonia in the silkworm which exhibit different sensitivities to radiation. Detailed analyses of the radiosensitivity of spermatogonia were undertaken in order to obtain quantitative cytological information concerning radiosensitivity. Careful microscopical examinations of serial sections of the testes made possible the accurate identification of six successive generations or stages of spermatogonia; they are referred to as spermatogonia-I, -II, -III, -IV, -V and -VI, on the basis of the number of the spermatogonia within each gonocyst. The relative radiosensitivity of spermatogonia at different stages was determined by scoring the number of gonocysts containing pycnotic spermatogonia-I to -VI following irradiation with 1000 R of x-rays at a dose-rate of 300 R/min. After irradiation, spermatogonia VI showed the highest value in pycnotic incidence, while those -V to -I were progressively less in number. An autoradiographic study with ^3H -thymidine revealed that there was a significant difference in percentage of labelled gonocysts among different stages of pycnotic spermatogonia. It seems most probable that there is a definite correlation between radiosensitivity of different stages of spermatogonia and degree of DNA synthesis in the cells at the time of irradiation. Furthermore, the spermatogonia-VI were most sensitive, producing chromosome clumping in late prophase, and became progressively less sensitive toward early stages of spermatogonia. Evidence of selective killing of highly radiosensitive spermatogonia was observed in larvae in the late developmental stage, while in newly hatched larvae spermatogonia in the early stages, which form the bulk of the germ cells, are less sensitive. It seems probable that spermatogonia-VI are most sensitive to x-rays in producing pycnotic degeneration and chromosome clumping, and that so far as the scope of the present experiments is concerned, the sensitivity to radiation decreases as follows; spermatogonia-VI, -V, -IV, -III, -II and -I. (From auth.)

- 544 Oak Ridge National Lab., Tenn. *Drosophila* CYTOLOGY AND GENETICS. p.47-59 of "Biology Division Semiannual Progress Report for Period Ending February 15, 1964". ORNL-3601. May 1964, 232p.

Progress is reported in studies of genetic damage in entire X-bearing and Y-bearing genomes x-irradiated in mature spermatozoa of *Drosophila melanogaster*; a search for sex-linked recessive lethals in *D. melanogaster* that can be transmitted by triploid females but not by diploid daughters; the effects of the amount and distribution of X-chromosome heterochromatin on x-ray-induced X-autosomal translocation frequencies; meiotic behaviour of tandem compound ring chromosomes and tandem metacentric compound X-chromosomes in *Drosophila*; preparation of a revised edition of the mutants of *D. melanogaster*; regulation of fourth chromosome nondisjunction by the length of a free X-duplication in *D. melanogaster*; the genetic explanation for the correlated appearance of diverse karyotype abnormalities within human kinships; spontaneous and x-ray-induced exchange in normal and inverted X-chromosomes in *Drosophila* females; abnormal chromosome behaviour associated with the mutant *claret-nondisjunctional* in *Drosophila*; and a study of mutant types at the notch locus in *Drosophila*. (NSA18:1964, 27004)

- 545 Oftedal, P. RADIOSENSITIVITY OF Drosophila SPERMATOGONIA. II PROTRACTED DOSES. Hereditas 51 (1964) 13-30.

On the basis of previous results obtained after acute treatments of Drosophila spermatogonia, a mathematical model for the cell population under irradiation was formulated. With this model, which is based on the assumption of variation in cell radiosensitivity with the mitotic cycle, and correlation between the sensitivities to killing and to mutagenesis, it is possible to predict that within a certain dose range, a higher frequency of scoreable mutations should be obtained with protracted doses than with acute. A test of these predictions, measuring the frequency of sex-linked recessive lethals after protracted exposure, is described. Experiments were first made with a ^{137}Cs source giving doses of 144 and 267 R over 8 h; subsequently, the effects of 300, 400, and 542 R/8 h were measured. The control mutation rate was 0.81 compared with 0.50, 0.66, 0.75, 0.40 and 0.38 for these respective doses. The frequencies of sex-linked recessive lethals found in the irradiated groups indicated an increase with dose up to about 300 R and a falling off for the higher doses of 400 and 542 R. The mutation frequencies obtained after protracted doses extended to higher values than those found after earlier acute treatments, but the general shape of the dose effect curve was the same. The value after 144 R/8 h was not different from those found after treatment with 25 R/min of x-rays. The value after 300 R/8 h was the highest obtained in studies of spermatogonial radiosensitivity. Comparison of the data with those previously obtained after acute treatments showed that the dose-rate effect expected on the basis of the model proposed was obtained. By protraction of doses over the relatively short period of 8 h, cell killing was apparently reduced to an extent that led to higher yields of observable mutations. The value for the mutagenic sensitivity e_{obs} for spermatogonia derived from the results was about 1.5×10^{-6} sex-linked recessive lethals/R. (NSA 19:1965, 10823)

- 546 Oftedal, P. THE RADIOSENSITIVITY OF Drosophila SPERMATOGONIA. I. ACUTE DOSES. Genetics 49 (1964) 181-93.

The frequency of sex-linked recessive lethals in D. melanogaster has been measured after irradiation of spermatogonia with 0, 55, 110, 160 and 300 R doses of 180 keV x-rays. A non-linear dose-effect relationship was found, with maximum effect of 0.14% lethals at 160 R, and practically no effect at 300 R. Differential killing in conjunction with sensitivity variations is invoked to explain the results. (Auth. summary)

- 547 Oftedal, P. RADIOSENSITIVITY OF Drosophila SPERMATOGONIA. III. COMPARISON OF ACUTE AND PROTRACTED IRRADIATION EFFICIENCIES IN RELATION TO CELL KILLING. Mutation Res. 1 (1964) 63-76.

The applicability of available data, discussed on the basis of 64 references to the literature, to the interpretation of radiation dose-effect curves for point mutations in terms of a mathematical model is considered. Heterogeneity in the exposed population as regards cell killing and mutation induction sensitivities is assumed, and a complete correlation between these sensitivities is postulated. The model is based on data from acute radiation treatment of Drosophila spermatogonia and predictions based on it have been found to hold for protracted exposures. The results of other investigations at low acute doses also appear to be compatible with the model. In general, it was found that low doses are more efficient than higher ones, when heterogeneous cell populations are exposed. The decrease in efficiency presumably takes place through the killing off of a class of highly sensitive cells. These cells are probably at a certain stage of the mitotic cycle, and may, in Drosophila spermatogonia, constitute about 10% of the total cell population. Low dose rates kill fewer of the sensitive cells, and therefore lead to higher mutation yields in an intermediate dose range, as shown by two previous investigations. Thus, it appears that the model described can be used to predict non-linear genetic dose-effect curves in treatments of heterogeneous cell populations with doses within the region of 1-3 times the LD50 for the most sensitive cells in the population. The slope of the curves will be steeper in the region of the lowest doses than in that of high doses. The model further predicts that with protracted doses, the same initial slopes will be found as for the lowest acute doses, but that the decrease in the steepness should take place at a relatively higher total dose. For a quantitative interpretation of a given dose-effect curve in terms of this model, it is necessary to have data on cell survival in the relevant dose region. For protracted treatments, normal cell cycle length as well as cell cycle disturbances under treatment should also be known. These conditions are not fulfilled at present for any material, so that the model may serve for the present mainly as a guide in planning further experiments and in curve fitting, as well as to indicate

the limitations of the present understanding of the dynamics of genetic radiation effects. (NSA19:1965, 3940)

- 548 Parker, D. R. DIFFERENTIAL RADIOSENSITIVITY IN GERM CELLS OF *Drosophila*. p. 140 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 549⁽¹⁾ Sado, T. RECOVERY OF IRRADIATED SPERMATOGONIA OF THE SILKWORM AND THE STAGE LIMIT FOR THE PRODUCTION OF FUNCTIONAL SPERM. Rep. natn. Inst. Genet., Misima 10 (1959) 119.

- 550⁽²⁾ Sado, T. SPERMATOGENESIS OF THE SILKWORM AND ITS BEARING ON RADIATION INDUCED STERILITY. J. Fac. Agric. Kyushu Univ. 12 (1963) 359-85.

A brief review is included on spermatogenesis in the silkworm, radiation effects on spermatogenesis, and radiation effects on silkworm germ cells. Studies were made on the relation between spermatogenesis of the silkworm and radio-induced sterility. It was concluded that irradiation of larvae in the early 5th instar causes firstly, a reduction in number of spermatozoa produced and secondly, the formation of non-functional sperm, resulting in the functional oligospermia of the treated insects. (NSA19:1965, 8865)

- 551⁽²⁾ Sado, T. SPERMATOGENESIS OF THE SILKWORM AND ITS BEARING ON RADIATION INDUCED STERILITY. PART II. J. Fac. Agric. Kyushu Univ. 12 (1963) 387-404.

Normal spermatogenesis of the silkworm is described with special reference to the correlation between the developmental stages of the larvae and the germ cell stages and to the duration of the successive stages of spermatogenesis. Radiation responses of spermatogenic cells were investigated by means of fertility tests and histological and cytological observations on the irradiated testes (or germ cells). The experiment was designed to investigate the reasons for the seeming contradiction between the findings on mice and adult *Drosophila* on the one hand, and those of the silkworm on the other as to the cytological causes of radio-induced sterility. An attempt was made to establish the latest larval stage at which irradiation yields spermatozoa treated exclusively as spermatogonia. (NSA19:1965, 10331)

- 552⁽¹⁾ Shaw, E. I. THE RELATION OF THE COMPOSITION OF THE CULTURE MEDIUM TO MITOTIC ACTIVITY AND TO X-RAY INDUCED MITOTIC INHIBITION IN THE NEUROBLAST OF THE GRASSHOPPER, *Chortophaga viridifasciata* (de Geer). Ph. D. Thesis. Tennessee Univ., Knoxville. 1955.

- 553 Sobels, F. H. RADIOSENSITIVITY AND REPAIR IN DIFFERENT GERM CELL STAGES OF *Drosophila*. p. 235-55 of "Genetics Today. Proceedings of the 11th International Congress of Genetics, The Hague, Netherlands, Sep. 1963, Vol. 2". Geerts, S. J., Ed. Oxford, Pergamon Press. 1965.

Various factors are involved in determining the final yields of mutations and chromosome aberrations in different stages of gametogenesis, following irradiation. The mutational response to x-rays in sperm and spermatids under different conditions is presented schematically. After irradiation in N_2 followed by exposure to air or O_2 roughly equal mutation frequencies are obtained from the two stages, because repair is inhibited in sperm, but favoured in spermatids. Irradiation in O_2 , on the other hand, always produces more mutations in spermatids than in sperm, because the repair process does not function; in addition, more initial damage is induced, and the O_2/N_2 enhancement ratio for premutational radiation damage is considerably higher in spermatids than in sperm. Pre-treatments with chloramphenicol or ribonuclease level off the differences between sperm and spermatids. The present position is summarized in the light of the author's own results and other data obtained under various conditions. (See also p. 271 for H. J. Muller's discussion of Sobels' findings of contrasting effects on *Drosophila* spermatids and spermatozoa.)

- 554 Traut, H. EVIDENCE FOR DIFFERENTIAL RADIOSENSITIVITY RATHER THAN RECOVERY IN SPERM SAMPLES FROM x-IRRADIATED *Drosophila melanogaster* MALES. Genetics 50 (1964) 167-71.

Sperm released the 1st day after the x-irradiation of 3- to 4-d-old males of *D. melanogaster* showed a higher mutation frequency than the 2nd day sperm. From a comparison of mutation frequencies of successive 1-d-broods from males which were mated immediately after irradiation with those from

males which had been stored for 1 d before they were mated, it seems likely that the difference between the mutation frequencies of the 1st and 2nd day is caused by a relatively low initial radiosensitivity of the 2nd day sperm rather than by recovery from radiation damage of the 1st day sperm owing to the 1 d storage period. (Auth.)

555 Virkki, N. INSECT GAMETOGENESIS AS A TARGET. Agr. Sci. R. 3, 3 (1965) 24-37.

Usually, gametogenesis occurs in insects during the latter part of ontogenesis (pupae or young adults) but there are remarkable deviations even between subfamilies. Ambient factors like temperature and photoperiod may considerably modify gametogenesis even in one and the same species, especially when the altitude or latitude range is large. Contrary to extrachromosomal features of gametogenesis, the karyotype of a species remains constant. Factors of high sensitivity to radiation are large nuclei and chromosomes, a low chromosome number, acrocentry, a localized centromere, much heterochromatin, and a slow prophase. Thus the target size, the relation of chromatin amount to number, location, and kind of centromeres, promise of breakability, and duration of the intermitotic stages should be considered when aiming at optimal effects from irradiation. A knowledge of the cytology of gametogenesis is clearly desirable in planning treatments for inducing sterility or effects in subsequent generations.

See also:

514 Cytological damage associated with genetic mutations in Drosophila with betatron treatment. (Alexander, M. L., McKinley, K., 1964)

516 } Fertilization in Drosophila. II. Time of inactivation of gene effect. (Hildreth, P. E., 1965)

517 }
556 The occurrence of deletions in the X-chromosome under influence of ionizing radiations in the spermatogenesis of Drosophila melanogaster. (Abeleva, E. A., Potekhina, N. A., 1964)

583 The dose-dependence of X-chromosome loss and non-disjunction induced by x-rays in oocytes of Drosophila melanogaster. (Traut, H., 1964)

587 x-ray induced X-Y exchange and nondisjunction in Drosophila spermatocytes. (Wu, C-k., 1964)

588 X-Y nondisjunction and exchange induced by x-rays in primary spermatocytes of the adult Drosophila. (Zimmering, S., Wu, C. K., 1964)

597 Rates of visible mutations as related to the maturity of male germ cells of Drosophila melanogaster at the time of radiation. (Hannah-Alava, A., 1961)

608 The relationship between radiation dose and mutation frequency in spermatogonia of Drosophila melanogaster. (McSheehy, T. W., 1964)

613 Cytochemistry and cell reproduction. (Oak Ridge National Lab., Tenn., 1965)

614 The mutagenic efficiency of acute and of protracted irradiations of Drosophila spermatogonia. (Oftedal, P., 1964)

620 Radiosensitivity of spermatogonia. (Sävhaugen, R., 1964)

627 Differential radiosensitivity as an explanation for so-called recovery in Drosophila sperm. (Trout, W. E., 1964)

629 Visible mutation frequencies induced in Momoniella oocytes by x radiation. (Whiting, P. W., Ray, D. T., 1965)

642 Cytogenetic investigations on radiation and chemically induced dominant lethal mutations in oocytes and sperm of the screwworm fly. (LaChance, L. E., Riemann, J. G., 1964)

643 Introduction of dominant lethal mutations in insect oocytes and sperm by gamma rays and an alkylating agent: dose-response and joint action studies. (LaChance, L. E., Crystal, M. M., 1965)

654 x-rays induced dominant lethals from irradiation of different stages of oögenesis in the silkworm. (Tazima, Y., Onimaru, K., 1959)

664 Change in the nature of radiation-induced mutation in the spermatids of Drosophila under the influence of arginine. (Abeleva, E. A., 1964)

665 Lethals in Drosophila spermatogonia after fractionated x-irradiation. (Baxter, R. C., 1964)

667 Genetic effect of combined x-ray and ethylenimine treatments. (Alexander, M. L., 1965)

701 Relative biological effectiveness of 14 MeV neutrons to γ -rays for inducing mutations in silkworm gonads. (Murakami, A., Kondo, S., 1964)

720 Features peculiar to the biological action of ultrafractional pulse radiation. (Skuratovich, A. A., Pravdina, G. M., 1965)

722 Post-radiation reduction of genetic damage in mature Drosophila sperm by nitrogen. (Sobels, F. H., 1964)

- 723 The role of oxygen in determining initial radiosensitivity and post-radiation recovery in the successive stages of Drosophila spermatogenesis. (Sobels, F. H., 1965)
- 726 Effect of temperature on radiation induced male sterility in the silkworm, Bombyx mori L. (Sugai, E., 1965)
- 727 Radiation mutagenesis in the silkworm. IV. Independence of radiation intensity as shown by induced sterility of spermatogenic cells. (Tazima, Y., 1968)
- 728 Independence of induced mutation-rate from radiation dose rate in the germ cells of hibernating silkworm embryo. (Tazima, Y., Onimaru, K., 1963)
- 729 Enhancement of radiation induced mutation frequency by post treatment of silkworm gonads with 5 bromodeoxyuridine. (Tazima, Y., Murakami, A., 1963)
- 735 Effect on genetic damage of post treatments given x-rayed Drosophila males. (Trosko, J. E., 1964)
- 738 The rate of gonadal mosaicism for lethals in late broods of Drosophila as compared with early when induced by x-rays, azaserine and quinacrine mustard. (Altenburg, E., Browning, L. S., 1964)
- 767 Gametogenesis and radiation effects in the cereal leaf beetle, Oulema melanopa. (Hoopingarner, R. A., Kumararaj, S., 1965)
- 780 Fifth report from Norsk Hydro's Institute for Cancer Research for 1963-1964. (Norsk Hydro's Inst. for Cancer Research, Oslo., 1965)
- 784 Temporal pattern of the early stages of spermatogenesis of adult Drosophila melanogaster males after treatment with x-rays. (Puro, J. A., 1961)
- 801 Cytological effects of radiation on testes of the screw-worm fly, Cochliomyia hominivorax. (Riemann, J. G., 1964)
- 806 Dose fractionation and recovery from x rays in Rhodnius. (Baldwin, W. F., Shaver, E. L., 1964)
- 902 Heavy ion localization of sensitive embryonic sites in Tribolium. (Slater, J. V. et al, 1964)
- 919 Fast-neutron effects on productivity of young and old flour beetles, Tribolium castaneum Herbst, and alterations at different temperatures and after exposure of either or both sexes. (Erdman, H. E., 1965)

4. Chromosome Aberrations and Damage to Cellular Organelles (including Breakage, Crossing-Over, Large Deletions, and Translocations)

- 556 Abeleva, E. A., Potekhina, N. A. THE OCCURRENCE OF DELETIONS IN THE X-CHROMOSOME UNDER INFLUENCE OF IONIZING RADIATIONS IN THE SPERMATOGENESIS OF Drosophila melanogaster. Radiobiologiya 4, 3 (1964) 468-69. (In Russian). English Translation: AEC-tr-6406. Radiobiology 4, 3 (1964) 208-11.

The frequency with which deletions in the X-chromosome occur is more than 6 times greater in spermatid than in sperm, whereas the frequency of sex-linked recessive and dominant lethals is only 2.5 times greater. Arginine does not appear to influence deletion frequency. Deletion frequency is highest on 8th day after irradiation, i. e. when radiation-induced crossing-over begins in males. The increase in frequency therefore presumably occurs not in the spermatid but in the diploid cells, the primary spermatocytes. A high mutation rate is maintained on the 9th and 10th day post-irradiation, which falls off sharply on the 11th day, and is then maintained on the same low level on the 12th day. The 9th and 10th day appear to correspond to the period of preparation of germinal cells for meiotic division, i. e. the early and late prophase of meiotic division.

- 557 Asman, Sister Monica, Ral, K. S. RADIATION-INDUCED CHROMOSOMAL ABERRATIONS IN Aedes aegypti. Bull. ent. Soc. Am. 11, 3 (1965) 172. Abstr. 347. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".

A reciprocal translocation, a primary trisomic and a pericentric inversion were detected in progeny resulting from irradiation of A. aegypti for four successive generations. The extra chromosome in the trisomic occurred more frequently as a univalent than a trivalent. Data on the disjunction of the interchange complex will be presented. (Abstr.)

- 558 Bowman, J. T., Jr. REVERSION OF THE WHITE-IVORY MUTANT IN Drosophila melanogaster. Diss. Abstr. 26, 4 (1965) 1872.

The sex-linked recessive mutant white-ivory (w^i) has been found to revert to an allele that is inseparable by several criteria from wild type. The frequency of spontaneous reversions is about 5×10^{-6} loci in homozygous females and about 0.2×10^{-5} loci in males and in females that are heterozygous for deletions that include the white region. In females that are heterozygous for w^i and one of a variety of other white mutants, w^i reverts with a frequency comparable to that of homozygous females. Following treatment of females with 4000 R x-rays, w^i reverts equally frequently in homozygotes and deletion heterozygotes although such treatment only rarely induces reversion in w^i in males. Induced reversions are commonly recovered as clusters, indicating that they are of gonial origin. The phenomenon is not correlated with recombination of outside markers, nor is its frequency increased by heterozygosity for autosomal inversion complexes. Experiments on the mechanism of reversion gave results compatible with the hypothesis that w^i is associated with a tandem duplication of a portion of the white region and that reversion occurs by sister strand crossing over within a double loop formed by intrachromosomal pairing of the duplicated segments. The hypothesis leads to certain predictions concerning the behaviour of small tandem duplications and to an explanation of the reversion of w^i with high frequency. (From DA)

- 559 Brosseau, G. E., Jr. NON-RANDOMNESS IN THE RECOVERY OF DETACHMENTS FROM THE REVERSED METACENTRIC COMPOUND X CHROMOSOME IN Drosophila melanogaster. Can. J. Genet. Cytol. 6 (1964) 201-6.

Non-random recovery of x-ray-induced reciprocal detachment products from a reversed metacentric compound-X-chromosome (attached-X) was investigated. The study was restricted to detachments resulting from exchange with the Y-chromosome, the use of a doubly marked Y ($B^s Y^+$) permitting ready identification of all the detachments. The distribution of the exchange points along the Y-chromosome was determined by the use of the fertility genes as markers. The findings support the hypothesis that non-random disjunction favours the recovery of some detachment products over others. Thus asymmetrical dyads must be present at the second meiotic division and therefore the exchange yielding detachments must occur between chromatids at the four strand stage. About 70% of the detachments had the break in $B^s Y^+$ located in a region which is homologous to a portion of the X suggesting that these regions were synapsed at the time of exchange. These results suggest that a significant fraction of x-ray-induced detachments may represent induced crossing over in heterochromatin rather than translocation. (Auth.)

- 560 Grell, R. F. THE TARGET FOR IRRADIATION-INDUCED CHROMOSOME LOSS IN Drosophila melanogaster FEMALES. p. 59-60 of "Biology Division Semiannual Progress Report for Period Ending August 15, 1964". ORNL-3700, Oak Ridge National Lab., Tenn. Nov. 1964.

Results obtained with 4000 R of x-irradiation point to an identical, single target on each chromosome which is responsible for irradiation loss. Females had been used which carried two non-homologues of about equal size, one an extra free fourth chromosome and the other a small, free, X duplication, as well as the two normal X's.

- 561 Halkka, O. x-RAY-INDUCED CHANGES IN THE CHROMOSOMES OF Limotettix (HOMOPTERA). Chromosoma 16, 2 (1965) 185-191.

Male L. striola were irradiated with a 400 R dose of x-rays. This treatment produced a variable number of chromosome fragments per cell. These fragments survived for 7 d, which is probably equivalent to more than one cell generation. A striking difference was observed in the manifestation of irradiation effects at the anaphase stages of the two maturation divisions. At the first division anaphase, bridge formations and lagging chromosomes were frequently found, while both these types of disturbance were practically absent at the second division. The conclusion was reached that all the peculiarities of irradiated leafhopper testicular cell progenies are best explained if it is assumed that 1) the chromosomes are holokinetic, and 2) the mode of meiosis is prereductional. (From auth. summary)

- 562 Hannah-Alava, A. THE BROOD-PATTERN OF x-RAY-INDUCED MUTATIONAL DAMAGE IN THE GERM CELLS OF Drosophila melanogaster MALES. * Mutation Res. 1 (1964) 414-36.

From the results of two experiments, comparisons were made of the frequencies of induced cross-overs in the third chromosome and three types of mutations (visibles at nine specific third chromosome loci, dominants and Minutes in all chromosomes) in successive broods of offspring from D. melanogaster males mated singly and sequentially up to 24 d following treatment with 3000 R x-rays. The highest frequency of cross-overs was in the 10 - 11 d broods, but large and continuing clusters were first found in the 12 - 13 d broods. Each mutational type, with the probable exception of the dominants, had a characteristic brood curve of mutation frequencies, but all were similar in that the rates were higher for spermatids (4 - 6 d) than for mature sperm (1 - 3 d). With one exception, the highest rates were in the 6 - 8 d broods, but as this was the period of excessive sterility the differences may not be significant. The rates in the post-sterile broods were substantially lower than the rates in the pre-sterile broods. The evidence supports the concepts of a stem-cell mechanism for maintenance of the germ line in D. melanogaster males, and points to the probability that the size and distribution of cross-over clusters is a reliable criterion for relating the temporal and spatial pattern of the spermatogonial stages. On the basis of this criterion, the 9 - 11 d broods, in all probability, were derived primarily from definitive, the 12th d brood from both definitive and predefinitive, and the later broods from predefinitive spermatogonia. Since the clusters of mutations were smaller than the cross-over clusters and seldom continued for more than two broods, it may be that radiogenetic damage to a predefinitive spermatogonium is accompanied by damage that leads to lethal loss of the cell after one or two predefinitive divisions. The progressive decrease in frequency of cross-overs and mutations in successively later post-sterile broods has been interpreted as the consequence of both random and lethal loss of the mutated predefinitive spermatogonia, but progressive repopulation of the testes by non-mutated cells could not be ruled out as a contributing factor. (Auth.)

* An outline of the same title appeared in p. 139 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 563 Hannah-Alava, A. THE BROOD-PATTERNS OF MUTATIONS AND CROSSING-OVER RECOMBINANTS IN SUCCESSIVE BROODS OF F_1 OFFSPRING FROM MALES TREATED WITH 3000 R OF X-RAYS. Period covered: Nov. 1, 1959 - Oct. 31, 1964. TID-21608, 3p.

Results are reported from studies on the frequencies of induced chromosome crossing-over recombinations and three types of visible mutations in successive broods of offspring from Drosophila melanogaster males that had been treated with 3000 R of x-rays and mated to females with appropriate third-chromosome markers for detecting mutations and/or crossing-over recombinants. (NSA 19; 1965, 10791)

- 564 Lewis, E. B. THE GENETIC AND CYTOLOGICAL EFFECTS OF HIGH ENERGY RADIATION. p. 128 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 565 Lindsley, D. L. CYTOGENETIC EFFECTS OF X RAYS ON WHOLE GENOMES OF Drosophila; THE INDUCTION OF SMALL DEFICIENCIES INCLUDING THE y^+ LOCUS. p. 108-9 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 566 Lucchesi, J. C. THE NATURE OF INDUCED EXCHANGES BETWEEN THE ATTACHED-X AND Y CHROMOSOMES IN Drosophila melanogaster FEMALES. Genetics 51, 2 (1965) 209-215.

Evidence has been presented that x-ray-induced exchanges between an attached-X and marked Y-chromosomes are not translocations but are influenced by the homologies existing between these two chromosomes and are probably the result of crossing-over. This evidence was based on a comparison of the distribution of breaks on Y^L when this arm is involved in an exchange with the attached-X and when it is involved in translocations and gross deletions. More critical evidence was obtained by comparing the relative proportion of exchanges involving Y^S (40% of all detachments) with the relative proportion of translocations and gross deletions involving the same arm (16% of all Y fragments). (Auth. summary)

- 567 Nicklas, R.B. CHROMOSOME VELOCITY DURING MITOSIS AS A FUNCTION OF CHROMOSOME SIZE AND POSITION. J. Cell. Biol. 25, 1, Pt. 2 (1965) 119-35.

Chromosome velocity has been studied in living Melanoplus differentialis spermatocytes by phase contrast cinemicrography. Melanoplus chromosomes (and bivalents) differ in length by as much as 1:3:5. As expected, no size-dependent velocity differences were detected in anaphase, and this is also shown to be true for the less predictable movements during prometaphase congression. The size of the X-chromosome can change during observation following x-irradiation, but this is equally without influence on velocity. However, an effect of position on velocity is found in both prometaphase and in anaphase: the chromosomes furthest from the central interpolar axis move 25% faster than more central chromosomes. A simple mechanical model relating frictional resistance and mitotic forces to chromosome velocity is discussed in detail. Calculations from the model suggest that a significant difference in the force acting on a large, as compared with a small chromosome is necessary to account for the observed similarity in velocity. Therefore, it is concluded that the mitotic forces are so organized or regulated that velocity is, within limits, independent of load. The implications of velocity-load independence in relation to the molecular origin of mitotic forces are discussed. (Auth.)

- 568 Oak Ridge National Lab., Tenn. Drosophila CYTOLOGY AND GENETICS. p. 47-60 of "Biology Division Semiannual Progress Report for the Period Ending February 15, 1964". ORNL-3601. May 1964, 232p.

This section deals with total radiation damage to entire genomes; a search for sex-linked recessive lethals in D. melanogaster than can be transmitted by triploid females but not by diploid daughters (x-rays being used in the experimental series); effects of the amounts and distribution of X-chromosome heterochromatin on x-ray-induced X-autosomal translocation frequencies; and spontaneous and x-ray-induced exchange in Drosophila females. The induction of chromosome puffs in Drosophila was studied with ribonuclease (p.63), and results are reported on amino acid and uridine incorporation in salivary glands treated with RNase (p.65).

- 569 Oak Ridge National Lab., Tenn. Drosophila CYTOLOGY AND GENETICS. p. 58-62 of "Biology Division Semiannual Progress Report for the Period Ending August 15, 1964". ORNL-3700. Nov. 1964, 197p.

This section deals with the detection and localization of recessive lethals at a specific locus; the target for irradiation-induced chromosome loss in females; distributive pairing in translocation heterozygotes; exchange in adjacent tandem duplication; cytology of x-ray-induced translocations; generally induced mutations in Drosophila; and mutants.

- 570 Oak Ridge National Lab., Tenn. Drosophila CYTOLOGY AND GENETICS. p. 62-65 of "Biology Division Semiannual Progress Report for Period Ending July 31, 1965". ORNL-3853. Nov. 1965, 222p.

Revision of a detailed catalogue of all the genetic material available for studies with fruit flies was continued. Results are reported from studies of cross-over suppressing translocations in populations of D. melanogaster. Males were exposed to 4000 R x-radiation and mated to marker females and individual females were back-crossed to marker males. The polytene chromosomes of 75 of these arrangements were examined. Data are included from studies on the timing of spermatogenesis in Drosophila with scintillation counting of ^3H -thymidine in inseminated females; the effects of chromosome size on the frequency of x-radiation-induced non-disjunction; and indicating that the Notch locus in Drosophila is a cistron. (From NSA 20:1966,6778)

- 571 Oster, L.I. FILICIDAL Y CHROMOSOMES. Genetics 50, 2 (1964) 274. Abstr.

x- and y-irradiation of mature spermatozoa of Drosophila melanogaster containing a Y-chromosome marked with small segments of the X, $sc^+(y^+ac^+)Y^S.Y^L(su-f^+B)^S$ (Brosseau, Drosoph. Inf. Serv. 32: 1958, 115) yielded 36 structurally altered but fertile Y-chromosomes which were detected genetically by loss of either or both of the terminal markers. Eight out of 11 cases involving loss of both y^+ and B^S proved to be ring-shaped upon cytological examination; also seven of the eight rings had lost both ac^+ and $su-f^+$, while one still retained $su-f^+$. Attempts to utilize these ring Y-chromosomes for the construction of new stocks revealed that introduction of each of the eight, as well as the only other ring-shaped Y in existence containing all the factors necessary for fertility, $Y^C:bw^+$ designated "MYR" (Oster and Iyengar, Drosoph. Inf. Serv. 29: 1955, 159), into certain

strains via the male results in the death of practically all the male progeny during early embryogenesis. Of more than 100 strains subsequently tested, including wild types from various localities and mutants of diverse kinds, 10% proved to be consistently sensitive to such killing of their male offspring. On the other hand, introduction of these "filicidal" Y-chromosomes via the female (i.e. using attached-X-chromosomes) into a sensitive strain does not result in the death of the male offspring. Conversion of the rings into rods also abolishes the effect. All of our other stocks involving structural changes of the Y excluding ring-formation, as well as a ring-shaped chromosome involving the long arm of the Y and its fertility factors but lacking Y^S and its fertility factors, Y^{LC} (Muller, Drosoph. Inf. Serv. 22:1948,73), do not exhibit this phenomenon. This curious incompatibility has never been reported before for the Y-chromosome, which is considered to be relatively inert genetically in *Drosophila*. While position effects and cytoplasmic interactions appear to be implicated, the exact mechanism underlying the action of these "filicidal" Y-chromosomes has yet to be elucidated. (Abstr.)

- 572 Parker, D.R. CHROMOSOME PAIRING AND INDUCED EXCHANGE IN *Drosophila*. Mutation Res. 2, 6 (1965) 523-9.

Fragments of Y-chromosomes were induced by irradiating* attached-X *D. melanogaster* females carrying a doubly marked Y-chromosome, and detected by loss of one of the Y markers. Slightly more than half of the 55 fragments recovered showed linkage of fourth-chromosome markers, implying a high frequency of association of Y and fourth-chromosomes in oocytes. Where such fragments were shown to have Y centromeres, a high incidence of non-disjunction from the attached X was found, suggesting that exchange between heterologues leads to their separation at Anaphase I, and frequent non-disjunction from their regular pairing partners. Lucchesi's assumption that fragments are not pairing-dependent for their formation is thus invalidated. It is suggested that non-reciprocal exchanges induced between the two Y arms may account for other fragments, these likewise being pairing-dependent. There is as yet no evidence that any exchange process occurs with appreciable frequency in oocytes in stage seven or earlier that is not dependent on regular, frequent associations of the chromosomes involved. (Auth.)

* 3000 R of x-rays within 12 h of emergence, at ~400 R/min.

- 573 Ramel, C., Goldman, E., Kjellstrom, T. A NOTE ON INTERCHROMOSOMAL EFFECTS OF TRANSLOCATIONS AND DEFICIENCY ON CROSSING OVER IN *Drosophila melanogaster*. Hereditas 52 (1964) 171-5.

Interchromosomal effects on crossing-over were studied in *D. melanogaster* with the use of two 2,3-translocations and one deficiency in chromosome two. The translocations and deficiency were induced by x-irradiation of spermatozoa in males. The translocations showed an increased recombination, the net result of which was a relative increase of the map length with 26% for T 7 and with 37% for T 10. The change of crossing-over was significant for all the intervals except the first one, y-ec, where T 7 did not show any significant difference versus the control. The pattern of increase seemed rather uniform along the X-chromosome. The deficiency data indicate no or, at most, a weak interchromosomal effect on crossing-over. Only one interval, ct-v, showed a difference versus the control, reaching a significance at the 5% level. The total map length was not affected to any appreciable extent. (NSA 19:1965,15090)

- 574 Ratty, F.J. THE MUTABILITY OF LOCI IN AN X-CHROMOSOME DUPLICATION OF *Drosophila melanogaster*. Genetics 52, 6 (1965) 1113-7.

Experiments reported in this paper indicate that genes located in an insertional translocation mutate at a higher frequency than in their normal configuration, and that this increase appears to be related to both the heterochromatic involvement of the insertion and to chromosomal heterozygosity.

- 575 Reddi, O.S. INTERACTION OF CHROMOSOME BREAKS IN THE SPERMATOZOA OF *Drosophila* INDUCED BY X RAYS AND FAST NEUTRONS. Drosoph. Inf. Serv. 39 (1964) 88.

- 576 Roberts, P. SPONTANEOUS AND X-RAY INDUCED EXCHANGE IN *Drosophila melanogaster*. Presented at the "15th Annual Meeting of the American Institute of Biological Sciences, Boulder, Colo., 23-28 Aug. 1964".

- 577 Ronen, A. INTERCHROMOSOMAL EFFECTS ON SOMATIC RECOMBINATION IN Drosophila melanogaster. Genetics 50, 4 (1964) 649-58.

Somatic crossing-over was studied in y/sn females. The frequency of single and twin spots per fly was higher in the presence of the autosomal inversions Curly and Dihaete, than in a control group where the autosomes were structurally and genetically homozygous. The spot-frequency was even higher in females which had been irradiated as 3rd instar larvae with 1170 R of x-rays. The data indicate that both spontaneous and induced recombination are restricted to the proximal part of the chromosome. In the irradiated group, there were fewer induced spots in the inversion-carrying females than in the normal ones. It is suggested that centric pairing in the X-chromosome, and therefore its change to undergo induced somatic recombination, are impaired in the presence of autosomal inversions. (Auth.)

- 578 Sävthagen, R. INDUCED CROSSING OVER AND TRANSLOCATIONS IN SPERMATOGONIA OF Drosophila melanogaster. Drosoph. Inf. Serv. 39 (1964) 109-10.

- 579 Sävthagen, R. INDUCED CROSSING OVER IN LARVAL SPERMATOGONIA OF Drosophila melanogaster. Drosoph. Inf. Serv. 39 (1964) 110-11.

- 580 Sävthagen, R., Kemmer, M. INDUCED CROSSING OVER IN LARVAL SPERMATOGONIA OF Drosophila melanogaster. Drosoph. Inf. Serv. 39 (1964) 110.

- 581 Tikhomirova, M.M. NON-DIVERGENCE OF CHROMOSOMES UNDER THE INFLUENCE OF x-RAYS OF VARIED HARDNESS AND INTENSITY. p. 44-58 of "Studies in Genetics". JPRS-31514. 115p. Translation: Issled. Genet. 2 (1964) 56-64.

During the irradiation of female imagoes of Drosophila the predominance of XO males is observed in the progeny in comparison with XXY females ($3.44 \pm 0.147\%$ and $0.20 \pm 0.034\%$). The hard x-rays applied in the experiment (200 kV) cause not only actual but also potential and long-duration breaks (± 1 h), which is confirmed by the great frequency of the appearance of males ($2.81 \pm 0.163\%$) in this group in comparison with the frequency of their appearance in a group where the irradiation was effected with soft rays ($1.84 \pm 0.124\%$ and $0.97 \pm 0.128\%$). In addition to this, the males appear with great frequency ($4.45 \pm 0.379\%$) in a group where there is additional high temperature (37°C) within 1 h after the irradiation with hard rays. The effect of the hard-ray after-effect is detected for a period of 1 h, and not detected within 2 h after irradiation. Soft rays (voltage of 50 kV) cause the appearance of rapidly repairable chromosome breaks which are maintained for less than 30 min, a fact which is corroborated by the absence of after-effect ($1.84 \pm 0.124\%$ and $1.76 \pm 0.145\%$; $0.97 \pm 0.128\%$ and $1.29 \pm 0.161\%$) and by the effect of the intensity. Soft rays of high intensity (1932 R/min) are more effective ($1.84 \pm 0.124\%$) than those same rays of lesser intensity. Possible mechanisms involved in the primary non-divergence of X-chromosomes during irradiation of Drosophila females are discussed. (NSA 20:1965, 3714)

- 582 Tikhomirova, M.M., Dubrova, S.E., Yanoosh, I.M. A COMPARATIVE STUDY OF THE RESULT OF RADIATION AFTER-EFFECTS ON CHROMOSOMAL NON-DIVERGENCE. p. 59-64 of "Studies in Genetics". JPRS-31514. 115p. Translation: Issled. Genet. 2 (1964) 65-68.

x-rays caused an after-effect on the non-divergence of X-chromosomes in two comparable lines of Drosophila. The after-effect result proved to be higher in the radioresistant w^a line in comparison with the Canton-S line. (NSA 20:1965, 3715)

- 583 Trant, H. THE DOSE-DEPENDENCE OF X-CHROMOSOME LOSS AND NON-DISJUNCTION INDUCED BY x-RAYS IN OOCYTES OF Drosophila melanogaster. Mutation Res. 1 (1964) 157-62.

The dose-dependence of X-chromosome loss and non-disjunction induced by x-ray was investigated in oocytes of D. melanogaster. The frequency of X-chromosome loss increases faster than linearly with dose, suggesting that this effect is based on both one and two hit events. Whereas the induction of single non-restituting chromosome breaks seems to be a plausible explanation for at least part of the one hit events, the two hit component, though statistically highly significant, is more difficult to interpret. One possibility, the induction of large deletions in the maternal X which would require two breaks and simulate the loss of the whole X-chromosome, was ruled out by special experiments. The dose-effect relationship for non-disjunction seems too complicated to permit a simple hit ex-

planation. Perhaps radiation-induced stickiness of the chromosome surface, an effect probably not caused by individual hits, prevents the X-chromosomes from separating at meiosis. Both the X loss and non-disjunction frequency show a stepwise increase with x-ray dose. Tentative explanations for this effect are given. (Auth.)

- 584(2) Volchkov, Yu. A., Aleksandrov, Yu. N. DEPENDENCE OF FREQUENCY OF OCCURRENCE OF PHENOCOPIES ON x-RAY DOSE. Vest. leningr. gos. Univ., Ser. Biol. 4 (1963) 95-105. (In Russian, with English summary)

Dependence of occurrence frequency of phenocopies on x-ray dose in *Drosophila* was studied for the purpose of comparison with corresponding data, available for mutations. Doses from 200 - 6000 R were used (altogether 17 different doses). The curve of the dependence, studied in the dose range from 200 - 3000 R statistically reliably does not differ from the exponential curve, thus similar to that of large chromosomal aberrations. Comparison of data concerning the occurrence of phenocopies and survival of pupae under different exposure doses as well as comparison of occurrence frequencies of phenocopies in males and females brings to the conclusion that there exists definite correlation between general radiation sensitivity of organisms and their predisposition to the occurrence of phenocopies, which also allows to draw an analogy between phenocopies and mutations, induced by ionizing radiation. (Auth.)

- 585 Warters, M. X-AUTOSOMAL TRANSLOCATIONS OF *Drosophila melanogaster*. p. 102-3 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- 586 Williams, B. J. CYTOLOGY OF x-RAY-INDUCED TRANSLOCATIONS. p. 61-2 of "Biology Division Semiannual Progress Report for Period Ending August 15, 1964". ORNL-3700, Oak Ridge National Lab., Tenn. Nov. 1964.
- 587 Wu, C.-k. x-RAY INDUCED X-Y EXCHANGE AND NONDISJUNCTION IN *Drosophila* SPERMATOCYTES. *Drosoph. Inf. Serv.* 39 (1964) 126-7.

- 588 Zimmering, S., Wu, C.-k. X-Y NONDISJUNCTION AND EXCHANGE INDUCED BY x RAYS IN PRIMARY SPERMATOCYTES OF THE ADULT *Drosophila*. *Genetics* 49 (1964) 499-504.

x-Irradiation of primary spermatocytes of adult yv/B^sY^+ *Drosophila melanogaster* males was demonstrated to produce a greater proportion of X-Y exchanges than X-Y non-disjunction. This result is consistent with the previous findings of Zimmering and Wu (see II/334) following irradiation of the prepupal testis, but is in disagreement with those reported by Sävthagen (ibid, 1017) and by Strangio (ibid, 1022, 1023) from experiments on adult males. (From auth.)

- 589 Zimmering, S., Kirshenbaum, G. RADIATION INDUCED DELETIONS IN SPERMATIDS AND SPERMATOCYTES OF *Drosophila*. *Z. VererbLehre* 95, 4 (1964) 301-5.

Males of the composition $XC2/B^sY^+$ were collected as prepupae, aged an additional 48 h, then irradiated with 1000 R of x-rays and brooded individually for 8 d with three virgin ywf females each day. Analysis suggests that brood d 1-3 represent the recovery of cells which were predominantly spermatids at the time of treatment, those from brood d 4-6 predominantly spermatocytes, and those from brood d 7-8 predominantly spermatogonia. The highest frequency of loss of individual Y-markers and "X0" males, as well as the smallest F_1 population size was found in broods 5 and 6, and especially in brood 6. Further analysis suggests that the vast majority of individual Y-marker losses recovered from diploid cells (spermatocytes, spermatogonia) arose independent of inter-Y arm exchange and Y-autosome translocations. In general, the data confirm the suggestive results of other investigators that deletions are recovered most readily from spermatocytes than from any other stage in spermatogenesis. (Essentially auth. summary)

See also:

- 527 The effect of x-irradiation on spermatogenesis in *Drosophila melanogaster* Meigen. (Abro, A., 1964)
- 529 Effects of x-rays on female germ cells of *Drosophila melanogaster*. (Bateman, A. J., Chandley, A. C., 1965)

- 530 Grasshopper neuroblast techniques. (Carlson, J. G., Gaulden, M. E., 1964)
- 532 Radiosensitivity of the stages of spermatogenesis to different mutations in Drosophila melanogaster. (Fahmy, O. G., Fahmy, M. J., 1964)
- 538 Meiotic behavior of tandem metacentric compound X chromosomes in Drosophila melanogaster. (Lindsley, D. L., Sandler, L., 1965)
- 544 Drosophila cytology and genetics. (Oak Ridge National Lab., Tenn., 1964)
- 596 A study of gene and chromosome changes induced by ionizing radiations in Drosophila melanogaster. (Godfrey, R. K., 1964)
- 604 "Yanders effect" - A re-examination. (Kishin, A. F., 1965)
- 611 The influence of radiation in altering the incidence of mutations in Drosophila (1963-64). (Muller, H. J., 1964)
- 616 Temporal distribution of x-ray induced recessive lethals and recombinants in the post-sterile broods of Drosophila melanogaster males. (Puro, J., 1964)
- 620 Radiosensitivity of spermatogonia. (Sävhaugen, R., 1964)
- 622 Radiation and mutation rate. (Stern, C., 1964)
- 638 Structures of salivary chromosomes and their contribution to the problem of evolution. (Frizzi, G., 1961)
- 645 Male sterilizing mutations in Drosophila and the lesion in spermatogenesis causing sterility. (Lindsley, D. L., 1964)
- 886 The effects of radiations on the genetic systems of organisms in relation to their physiological and biochemical systems. (Alexander, M. L., 1964)
- 874 x-ray damage as measured by dominant lethals, sex-linked recessive lethals and translocations in Drosophila melanogaster and oxygen and argon as its modifying factors. (Elequin, F. T., 1965)
- 683 The effect of cold pretreatment on radiation effects as related to age in Drosophila melanogaster. (Iyengar, S. V., 1964)
- 685 Effects of storing x-rayed spermatozoa on the frequency of translocations and sex-linked lethals in Drosophila melanogaster. (Kishin, A. F. E., 1963)
- 694 The failure of sulphhydryl compounds, AET, MEA, and glutathione to protect against x-ray induced chromosome aberrations in male Drosophila. (Mittler, S., 1964)
- 695 Studies of chemical protection against radiation induced genetic aberrations. (Mittler, S., 1964)
- 696 Studies of chemical protection against radiation induced chromosome aberrations. Final Report, September 1, 1961 - August 31, 1965. (Mittler, S., 1965)
- 698 ATP and radiation induced chromosome breakage in Drosophila. (Mittler, S., U. R., 1965)
- 706 Influence of interaction between EDTA and x-rays on mutation and crossover frequencies in Drosophila melanogaster. (Ondrej, M., 1965)
- 709 Occurrence of crossing over in Drosophila males under the influence of vibration, acceleration and γ -irradiation. (Parfenov, G. P., 1964)
- 712 Genetic effects of fast neutrons from nuclear detonations. Projects 23, 4 - 2314 and 23, 16 of operation upshot-knothole. (Plough, H. H., Ed., Sheppard, C. W., Ed., 1964)
- 714 Lack of mutagenic effect of irradiated Drosophila medium. (Reddi, O. S. et al., 1965)
- 715 Genetic effects of cosmic radiation in Drosophila melanogaster. (Reddi, O. S., Sanjeeva Rao, M., 1964)
- 721 The effect of post-treatment with N_2 or O_2 on the frequencies of recessive lethals and translocations produced by irradiation in N_2 or O_2 . (Sobels, F. H., 1963)
- 722 Post-radiation reduction of genetic damage in mature Drosophila sperm by nitrogen. (Sobels, F. H., 1964)
- 736 Induced mutation process - The effect of high temperature after irradiation on the frequency of occurrence of lethal mutations and chromosomal breaks. (Vatti, K. V., Yanoosh, I. M., 1964)
- 739 The sensitivity of the male germ cells of Drosophila to methyl methanesulphonate. (Bateman, A. J., Chandley, A. C., 1964)
- 743 Differential induction of chromosome deletions by natural and synthetic macromolecules in Drosophila melanogaster. (Fahmy, O. G., Fahmy, M. J., 1965)
- 746 On the mutagenic effects of x-radiation, N-nitroso-N-methyl-urethan, and N-nitroso-morpholine in Drosophila melanogaster. (Henke, H. et al., 1963/64)
- 750 Structural changes in chromosomes induced by malachite green. (Keyl, H.-G., Werth, G., 1958)

- 754 Phase cinematography studies on the effects of radiation and of some chemicals on cells and chromosomes. (Nakanishi, Y. H., Makino, S., 1964)
- 757 A comparison of genetic changes induced by a monofunctional and a polyfunctional alkylating agent in Drosophila melanogaster. (Snyder, L. A., Oster, I. I., 1964)
- 810 Genetic effects from simultaneous irradiation of immature and mature Drosophila virilis males. (Clayton, F. E., 1965)
- 878 Genetic and non-genetic radiation effects on Drosophila eggs. (Ulrich, H., Würgler, F. E., 1964)
- 902 Heavy ion localization of sensitive embryonic sites in Tribolium. (Slater, J. V. et al., 1964)
- 930 Chromosomal aberrations in a natural population of Chironomus tentans exposed to chronic low-level radiation. (Blaylock, B. G., 1965)
- 937 Lethal and semilethal chromosomes in irradiated experimental populations in Drosophila pseudoobscura. (Mourad, A. E.-K. M., 1964)
- 950 Radiation effects on Chironomus tentans. (Auerbach, S. L., 1964)
- 954 Chromosomal aberrations in a natural population of Chironomus tentans exposed to chronic low-level environmental radiation. (Blaylock, B. G., 1963/64)
- 955 Chromosomal aberrations in a natural population of Chironomus tentans exposed to chronic low-level environmental radiation. (Blaylock, B. G. et al., 1964)
- 959 Effects of radiation on competitive insects. (Erdman, H. E., 1964)

5. Recessive Mutations. Visible Mutations. Subvital and Sex Ratio Effects

- 590 Baldwin, W. F. VISIBLE MUTATION FREQUENCIES IN Dahlbominus OOGONIA PRODUCED BY ACUTE x-RAYS AND CHRONIC γ -RADIATION. Mutation Res. 2 (1965) 55-59.

In Dahlbominus, haploid males from unmated diploid females exhibit a small but significant difference in frequency of eye-colour mutations following acute or chronic irradiation of oogonia. One experiment on quality of radiation did not show any significant difference in frequency of mutations induced by 2 MVp and 300 kVcp radiation. A 2 MVp x-ray machine and a ^{60}Co -source were used. (Essentially auth. summary)

- 591 Baldwin, W. F., Shaver, E. L., Wilkes, A. MUTANTS OF THE PARASITIC WASP Dahlbominus fuscipennis (Zett.) Can. J. Genet. Cytol. 6 (1964) 453-66.

The main phenotypic effects of 12 visible mutants are reported in the arrhenotokous wasp, D. fuscipennis (Zett.) (Hymenoptera: Eulophidae). All but two of the mutations occurred among haploid males following irradiation* of wild females, the others during pedigree breeding of irradiated stock. Eight of the mutations affected pigmentation of the eyes or body, three produced morphological abnormalities in the wings and antennae and one reversed the sex ratio. All but the last one were controlled by recessive factors, each of which has been assigned a name and symbol. The sex reversing factor was dominant and sex-limited, being transmitted by females to their sons. Although tests for linkages between the mutations have not been completed, in initial crosses between four of the "bright" eye-colours and the wing mutations segregation was independent indicating that these arose as separate mutations. An account is given of the life history of the species and a description of the adult and immature stages of the wild stock as a basis for comparison with the mutant lines. A simple method is given for rearing large numbers in the laboratory. (Auth. summary)

* x- and γ -radiation, cf. Radiat. Res. 17: 1962, 127. Also 11/828.

- 592 Chandra, H. G. S. CYTOGENETIC STUDIES FOLLOWING HIGH DOSAGE PATERNAL IRRADIATION IN THE MEALY BUG, Planococcus citri (Risso). Diss. Abstr. 25, 4 (1964) 2423.

When females of P. citri are mated to heavily irradiated males (60 000-90 000 rep), the progeny is largely female and few or no sons survive, whereas the reverse is true when males irradiated with lower doses (16 000 R) are used. The daughters that develop after heavy paternal irradiation all

have unbroken chromosomes and they are therefore gynogenetic. The origin, development, chromosome constitution and breeding behaviour of these gynogenetic females have been studied. The majority of these females were triploid ($3N = 15$), some diploids and a few $3n-2n$ and $2n-n$ mosaics. The triploid polar body derivatives carry on a successful embryogeny when the zygote nucleus is unable to do so because of the heavily damaged paternal set. The chromosomes of mealy bug are holokinetic and consequently the paternal set, in spite of its heavy damage is not eliminated easily. It manages to divide with the undamaged maternal chromosomes but does not always segregate as successfully. Restitution, fragment loss, and sticky bridges were some of the mitotic abnormalities observed in these embryos. Most of the gynogenetic diploids probably arise through a doubling of the maternal contribution to the zygote during early cleavage division.

- 593 Falk, R., Rahat, A., Ben-Zeev, N. VIABILITY OF HETEROZYGOTES FOR INDUCED MUTATIONS IN Drosophila melanogaster. I. IRRADIATED X-CHROMOSOME. Mutation Res. 2, 5 (1965) 438-51.

The mean viability of Drosophila flies carrying a wild type and a marked irradiated X-chromosome was studied. The viability of hemizygotes as well as that of heterozygotes for each irradiated chromosome was calculated. Irradiation of nearly 3000 R induced about as many severe detrimentals (semi-lethals and subvitals) as lethals. The viability of heterozygotes for the severe detrimentals was even worse than that of the heterozygotes for lethals. The dominance of lethals and severe detrimentals was 5% and 15% respectively. Within the normal range the viability of hemizygotes for irradiated chromosomes was reduced by about 2% and a similar reduction was observed in the heterozygotes for these chromosomes. This suggests complete dominance for the slight deleterious effects. The significance of this study in relation to fitness and population structure is discussed. (Auth. summary)

- 594 Friedman, L. D. x-RAY INDUCED SEX-LINKED LETHAL AND DETRIMENTAL MUTATIONS AND THEIR EFFECT ON THE VIABILITY OF Drosophila melanogaster. Genetics 49 (1964) 689-99.

Tests were made on 2520 irradiated X-chromosomes taken from Drosophila laboratory stocks of Basc and Canton-S strains. Estimates were made on the proportions of lethals and the genetic load of lethals and detrimentals induced. The Basc chromosome is about 50% more responsive to radio-induced lethal mutation than the Canton-S chromosome. It was found that the lethals induced in the + chromosome compared favourably with those tested by other workers, producing an average frequency of about 2.5%/1000 R. The ratio of the load due to detrimental mutants to that for lethals was 0.125. This is where the load is the product of the frequency and the average effect on viability. This is a considerably lower value than was obtained in earlier experiments but is in general agreement with a recent study by Käfer. Possible reasons for the different results are discussed. (Auth.)

- 595 Glass, H. B. THE ACTION OF RADIATION AND OTHER MUTAGENIC AGENTS (1) INDUCING MUTATION IN Drosophila FEMALES, AND (2) IN CONTROLLING THE ACTION OF SPECIFIC SUPPRESSOR GENES. p. 104-6 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 596 Godfrey, R. K. A STUDY OF GENE AND CHROMOSOME CHANGES INDUCED BY IONIZING RADIATIONS IN Drosophila melanogaster. p. 255 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 597⁽²⁾ Hannah-Alava, A. RATES OF VISIBLE MUTATIONS AS RELATED TO THE MATURITY OF MALE GERM CELLS OF Drosophila melanogaster AT THE TIME OF RADIATION. TID-21459, Turku Univ. (Finland). Dept. of Genetics. 1961, 18p.

The effect of x-ray damage (measured by mutation rates at nine loci in the third chromosome, and dominants and Minutes in all chromosomes) on the male germ cells of D. melanogaster in different stages of maturity at the time of irradiation. It is based on the results from seven replicate experiments testing a total of 31 control males and 368 irradiated (3000 R) males mated sequentially at 2- or 3-d intervals for eight broods or until the male died. Each mutation type had a characteristic brood pattern of mutation rates. The lowest fertility, the lowest fecundity and the highest mutation

rates except for the Minutes was in brood-3 (6-8 d after irradiation and the initial mating of the parental male). The average mutation rate for 9 third-chromosome loci was: 0.19% (7.02×10^{-8} /R/locus) in brood-1, 1.17 (43.40) in brood-3, 0.08 (3.13) in brood-4, and 0.01 (0.26) in broods 5-8. A number of factors that could influence the brood pattern, e.g. age, viability and fertility of the male parent, genotype of the female parent and number of females were tested. Most were found to have an effect on the number of offspring/brood (particularly brood-1), but with the possible exception of number of females, the only detectable effect on the mutation rates appeared to be an increase in the variance.

- 598 Hannah-Alava, A. MUTATION RATES AT SPECIFIC AUTOSOMAL LOCI IN DIFFERENT SPECIES OF *Drosophila*. Final Report Covering Five Years, 1959-1964. TID-21601, Turku Univ. (Finland), Dept. of Genetics. 1964, 12p. IAEA 31/US. 12p.

Primary purpose of the work was to accumulate data on mutation frequencies of specific third-chromosome loci from cells in different stages of maturation at irradiation. Additional information was collected on spermatogonial mutation rates. Due to the experimental procedures used it was possible to obtain, in addition to the data on specific locus, frequencies for third-chromosome recessive lethals, dominant (visible) mutations and Minute mutations in all chromosomes. Male parents were exposed to a dose of 3000 R of x-rays. Cytomorphological studies of the testes were undertaken, also some isolated work on *Drosophila simulans*.

- 599 Hochman, B., Gloor, H., Green, M. M. ANALYSIS OF CHROMOSOME-4 IN *Drosophila melanogaster*. I. SPONTANEOUS AND x-RAY-INDUCED LETHALS. *Genetica* 35, 2 (1964) 109-26.

- 600 Ives, P. T. PATTERNS AND NATURE OF MUTAGENESIS INDUCED BY IONIZING RADIATION DURING SPERMATOGENESIS IN *Drosophila*. p. 134 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4303, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 601 Kang, Y. S., Kim, Y. J., Lee, C. C., Choi, C. C. THE GENETIC STUDIES OF *Drosophila* POPULATION. 1. ON THE FREQUENCIES OF SEX-LINKED RECESSIVE LETHAL MUTATION IN *D. melanogaster* IRRADIATED WITH x-RAYS. *Zoologica*, Seoul 3 (1964) 1-8. (Bag 29: 1965, 101601). (In Japanese)

- 602 King, J. L. THE FORMATION OF DUMPY VORTICES IN MOSAICS OF *Drosophila melanogaster*. *Genetics* 49 (1964) 425-38.

Certain alleles of the gene *dp* produce vortices, which are changes in the configuration of the dorsal surface of the thorax and in the distribution of thoracic chaetae and hairs. The *dp* alleles appear to affect the chaeta pattern through tissue movement, since they do not change the total number of bristle organs. Cellular changes which occur are bristle organs with doubled chaetae, and small "bald" areas devoid of chaetae and cell hairs. The vortices are associated with insertions of certain of the indirect flight muscles through deep invaginations of the hypodermis and cuticle. Vortex formation begins prior to normal attachment of the flight muscles; the formation of vortices is indirectly responsible for the development of doubled chaetae. x-Ray induced somatic crossing over produced mosaic patches which were homozygous for *dp* and homozygous or hemizygous for yellow on a heterozygous wild-type background. Thirteen mosaics, including eight involving recessive lethal alleles, were recovered from an estimated 7000 treated individuals. In the mosaic specimens, the dumpy recessives are non-autonomous; homozygous recessive patches bring about the vortex pattern in the adjacent heterozygous or homozygous dominant tissue, and, in three cases, in the heterozygous tissue of the opposite side of the thorax. The doubling of chaetae in the vortices is an indirect effect, since it sometimes occurs in the background tissue. The wild-type allele of *dp*, in response to specific developmental environments, appears to regulate (either directly or by intracellular inhibition) the production of a supracellular factor, which in turn affects tissue movement. The recessive alleles apparently fail to respond to these developmental environments, leading to a failure to regulate the production of the supracellular factor and thus to abnormal tissue movement. It is concluded that *dp* is not a prepattern gene with respect to the distribution of thoracic bristle organs, since it does not have any effect on the determination of bristle organ anlagen. The differentiation of doubled chaetae, however, is due to a physical change in the cellular environment, indirectly brought about by *dp*; in this minor respect *dp* can be considered a prepattern gene. (Auth.)

- 603 Kishin, A.F. RECESSION. THE EFFECT OF LEVEL OF FEEDING ON THE FREQUENCY OF x-RAY INDUCED SEX LINKED LETHAL IN D. melanogaster. Drosoph. Inf. Serv. 39 (1964) 101.
- 604 Kishin, A.F. "YANDERS EFFECT" — A RE-EXAMINATION. Am. Nat. 99 (1965) 89-96.
 Recessive lethals, and Y; 2; 3 translocations were scored in four successive collections from F_1 cultures of x-rayed Or-K males. Results showed no constant increase in the frequency of either, from early to late emergers. Experiments in which rates of development of lethal and non-lethal heterozygotes were compared suggest that lethal heterozygotes may have a slightly slower rate. Yander's findings that the rate of recessive lethals increases in the late emergers from F_1 culture of a Muller-5 test may still apply under crowded conditions.
- 605 Kvelland, I., Strømnaes, A. x-RAY INDUCED MINUTES IN Drosophila melanogaster SPERM EJACULATED IN CONSECUTIVE MATINGS. Hereditas 54, 2 (1965) 170-76.
 x-Ray (2000 R) induction of Minutes was studied in individual sperm ejaculates of males that were either 0-2 h, 24 h, or 72 h old at the time of irradiation. All males went through a 12-h mating period, then a 12-h period without females, and again a 12-h mating period. For all groups of males the frequency of Minutes was higher in the first than in the second mating period, although it reached statistical significance only between two particular series (24A and 24B). The difference in frequency of Minutes between age groups of males was significant when measured in the first mating period and not significant in the second mating period. The data supported Lünig's view that a change in mutation frequency does occur earlier after irradiation for sperm released by young but not older males. This may indicate sampling of sperm with different sensitivity at the time of irradiation. However, sequential numbers of ejaculates are also time-dependent; therefore, the data presented cannot exclude recovery with time coexisting with differential sensitivity. (Essentially auth. summary)
- 606 Lee, W.R. RADIATION INDUCED VIABILITY MUTATIONS IN THE HONEY BEE. p.130-31 of "Research and Development in Progress. Biology and Medicine. No.3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- 607 Magalhães, L.F. de, Toledo, J.S. de, Brito da Cunha, A. THE NATURE OF LETHALS IN Drosophila willistoni. Genetics 52, 3 (1965) 599-608.
 The analysis of several natural and radiation induced lethal chromosomes was reported. A radiation dose of 800 R from a 50 Ci- 137 Cs source was used. The same chromosome may behave either as though its lethality were due to a single locus, or as a synthetic lethal, depending upon which chromosome it is tested against. Synthetic lethals are lethal chromosomes produced by recombination between non-lethal chromosomes. Unilocal lethality or synthetic lethality are relative to the rest of the gene constellation, and are not absolute characters. A method is presented for analysing chromosomes with regard to the locations of lethality factors and their interrelations.
- 608 McSheehy, T.W. THE RELATIONSHIP BETWEEN RADIATION DOSE AND MUTATION FREQUENCY IN SPERMATOGONIA OF Drosophila melanogaster. Mutation Res. 1 (1964) 296-301.
 Data are presented on the rate of induction of second chromosome recessive lethal mutations in D. melanogaster following irradiation of spermatogonia with ^{60}Co γ -rays over a dose range 200-800 rad. The dose-response was linear, the line of best fit being $y = 0.455 + 1.33 \times 10^{-3} x$. The data are discussed in relation to recently reported work on sex-linked recessive lethals. It was concluded that the linear dose-response reported in this paper resembled that observed at high radiation doses. Furthermore, these data were not incompatible with the non-linear response reported at low radiation doses. (Auth.)
- 609 Mukai, T., Yoshikawa, I., Chigusa, S. RADIATION-INDUCED MUTATIONS RATES OF POLY-GENES CONTROLLING THE STERNOPLURAL BRISTLE NUMBER IN Drosophila melanogaster. Rep. natn. Inst. Genet., Misima 14 (1964) 96-97.
- 610 Mukherjee, A.S., Stern, C. THE EFFECT OF SEXCOMBLESS IN GENETIC MOSAICS OF Drosophila melanogaster. Z. VererbLehre 96 (1965) 36-48.

Gynandric basitarsi possessing areas heterozygous for the sex-linked mutant sexcombless (sc) and hemizygous for it, and mosaic basitarsi possessing sc+/+, sc/sc and +/+ areas have been studied for the developmental expression of sc and sc/sc patches in the sex comb region. The mosaic basitarsi were obtained as the result of somatic crossing-over following x-ray exposure of larvae. In order to observe the sex comb-forming potencies in these XX tissues the flies had been made homozygous for the gene tra which transforms females into phenotypic males. The development of sc+/+; tra/tra females is greatly prolonged over that of normal females. Five of the 63 gynandric and two of the 39 radiation-induced mosaics showed a single typical tooth, a sixth gynandric basitarsus had two teeth. In all other cases intermediate bristles, or macrochaetae, or both, have been found in y sc hemizygous or homozygous patches irrespective of their seize. The sc-initiated distortion of bristle arrangement found in non-mosaic sc male basitarsi has also been seen in many mosaic patches. The mutant gene sc acts autonomously and interferes with the process of seta-cell to tooth determination at a relatively early stage in development of a bristle organ. (Auth. summary)

- 611 Muller, H.J. THE INFLUENCE OF RADIATION IN ALTERING THE INCIDENCE OF MUTATIONS IN Drosophila (1963-64). p. 137 of "Research and Development in Progress, Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- 612 Muller, H.J. THE INFLUENCE OF RADIATION IN ALTERING THE INCIDENCE OF MUTATIONS IN Drosophila. TID-22160, Indiana Univ. Foundation, Research Div., Bloomington, Ind. Aug. 1965, 8p.
Interim report.
- 613 Oak Ridge National Lab., Tenn. CYTOCHEMISTRY AND CELL REPRODUCTION. p. 64-9 of "Biology Division Semiannual Progress Report for the Period Ending February 15, 1965". ORNL-3768, May 1965, 205p.
A report is made on progress in various studies including work on visible mutation frequencies induced in Mormoniella oocytes by x-radiation, and the black eye colours of Mormoniella.
- 614 Oftedal, P. THE MUTAGENIC EFFICIENCY OF ACUTE AND OF PROTRACTED IRRADIATIONS OF Drosophila SPERMATOGONIA. Hereditas 52, 2 (1964) 242. Abstr. Presented at the "3rd Meeting of the Scandinavian Association of Geneticists, Helsinki, Finland, 10-12 Jun. 1964".
A decreasing mutagenic efficiency for induction of sex-linked recessive lethals has been found for acute doses in the range 50 R-300 R. The same doses protracted over 8 h (or 2-4 cell generations) appear to have a constant efficiency, which is about as high as the zero dose efficiency for acute treatments. Higher protracted doses are less efficient (400 R-550 R). From the literature, it appears that doses an order of magnitude higher (3000 R-12 000 R) have a constant efficiency, 4-5 times lower than the zero dose efficiency found here. It is proposed that the changes in mutagenic efficiency with dose and with dose rate may be explained by considering the killing of a small class of sensitive cells. These cells presumably represent a definite part of the mitotic cycle. (Abstr.)
- 615 Pavan, C. A COMPARATIVE STUDY BETWEEN NATURAL LETHALS AND LETHALS INDUCED BY RADIATION IN POPULATION OF Drosophila willistoni. p. 132-33 of "Research and Development in Progress, Biology and Medicine. No. 3", Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- 616 Puro, J.A. TEMPORAL DISTRIBUTION OF x-RAY INDUCED RECESSIVE LETHALS AND RECOMBINANTS IN THE POST-STERILE BROODS OF Drosophila melanogaster MALES. Mutation Res. 1 (1964) 268-78.
The distributions of third-chromosome recessive lethals and cross-overs were studied in daily post-sterile broods of D. melanogaster males treated as adults with 3000 R x-rays and mated singly and sequentially up to the 24th day or until the male became permanently sterile. Following the period of excessive sterility on the 6th-9th day, with a clear-cut sterile period on the 8th day, a marked increase in fecundity was found on the 10th day. The highest incidence of cross-overs was

on the 10th day followed by a progressive decline in the later broods. The decrease in the frequency of lethals was not so evident, possibly because too few flies were tested in the latest broods. Despite the fact that clusters were to be expected, only singles were recovered from the 9th-10th day broods. Clusters were first found on the 11th day, but frequently not before the 12th day. Many clusters continued for several subsequent broods. It was concluded from continuing clusters that predefinitive gonidia, through repeated "cambial"-like divisions, preserve the continuous supply of sperm. Thus continuing clusters can be used as a genetic criterion for differentiating between the definitive and predefinitive gonidia. With the brood procedure used, treated definitive gonidia were sampled on the 9th-11th day, and predefinitive gonidia beginning from the 12th day. Hence the temporal pattern after the 12th day reflects the functional activity pattern of the stem cells. (Auth.)

- 617 Rasmuson, B. DISCRIMINATION OF MUTANTS WITHIN THE ω -LOCUS OF *Drosophila melanogaster*. *Hereditas* 52, 2 (1964) 244. Abstr. Presented at the "3rd Meeting of the Scandinavian Association of Geneticists, Helsinki, Finland, 10-12 Jun. 1964".

A method was outlined by which it should be possible to discriminate among different types of mutants in the ω -locus. The aim is the elucidation of the following problems concerning the fine structure of the ω -locus by the proposed scanning of mutations: (1) Frequency of coloured (leaky) mutants versus white (amorph) mutants; (2) frequency of male vital versus male lethal deficiencies; (3) the possible existence of lethal but non-deficient mutants; (4) how general the applicability is of point 3 among the interactions noted above, that deficiency of any site in the ω -locus acts as a suppressor of zeste. The result of a preliminary experiment using x-rays (5000 R) as inducer of mutations was reported. (From abstr.)

- 618 Roberts, P. MOSAICS INVOLVING ARISTAPEDIA, A HOMEOTIC MUTANT OF *Drosophila melanogaster*. *Genetics* 49, 4 (1964) 593-8.

The mutant gene, aristapedia, transforms the arista of the antenna into a leg-like organ. Because of the drastic nature of the transformation it has been suggested that aristapedia alters a pre-pattern. In order to test this, genetic mosaics were produced by x-ray induced somatic crossing over. The autonomy of mutant and wild-type mosaic areas indicates that the alleles at this locus determine the competence of cells to respond to a prepattern rather than altering a pre-pattern. (Auth.)

- 619 Saul, G.B., 2nd, Whiting, P.W., Saul, S.W., Heidner, C.A. WILD-TYPE AND MUTANT STOCKS OF *Mormoniella*. *Genetics* 52, 5 (1965) 1317-27.

The National Science Foundation stock centre at Dartmouth College contains most of the known wild-type and mutant stocks of *M. vitripennis*. The stocks are described and listed, and a preliminary indication of their association in linkage groups is provided. Some mutant stocks were the result of irradiation.

- 620 Sävthagen, R. RADIOSENSITIVITY OF SPERMATOGONIA. *Hereditas* 52, 2 (1964) 243. Abstr. Presented at the "3rd Meeting of the Scandinavian Association of Geneticists, Helsinki, Finland, 10-12 Jun. 1964".

Larvae from a Canton-S wild type stock were irradiated with 900 R x-rays. The age of the larvae at the time of treatment were 0-1 h, 4-5 h and 24-25 h, calculated from the time of hatching. At the time of eclosion the males (P males) were immediately separated from the females and mated individually to 3-4 virgin M5, *cn bw*; *e¹¹* females. Every 3rd day the males were transferred to new virgin M5, *cn bw*; *e¹¹* females for five consecutive 3-day mating periods (A, B, C, D and E). By use of the double-purpose stock (M5, *cn bw*; *e¹¹*) it was possible to detect in F₂ both induced sex-linked recessive lethals and II-III translocations. The offspring from mating periods C and D were not recorded. From the results it is evident, that the induction of translocations has not been confirmed for 1- and 5-h-old larvae respectively, whereas for 25-h-old larvae a few translocations are observed. Recessive lethals are observed in all mating periods. In the first mating period (A) a statistically significant difference is observed between the three larval groups (0.76%; 0.22%; 0.07%), while for mating period B and E no difference is observed between the larval groups. However for 25-h-old larvae there is also observed a statistically significant decrease in the number of observed recessive lethals in mating periods A (0.76%)-B

(0.38%)-E (0.06%). This reduction in the number of observed recessive lethals parallels fairly well the observed difference in mating period A between 1, 5 and 25-h-old larvae. (Abstr.)

- 621⁽²⁾ Shiomi, T., Inagaki, E. et al. MUTATION RATES AT LOW DOSE LEVEL IN Drosophila melanogaster. J. Radiat. Res. 4, 2-4 (1963) 105-10.

The problem of genetic effects from low dose level radiation is a very important one. We have tested the linear relationship between dose and mutation rates of Drosophila at doses as low as 8 R. The material used was the wild Canton-S strain which were isogenized every 4 months. Wild males were stocked for 1 week after their emergence, and irradiated with x-rays. Sex-linked recessive lethals were detected by M-5 method, and about 53 000 X-chromosomes including the control were examined. The straight line obtained at the high dose level was in good accord with that obtained by Spencer and Stern (1948). And the curve obtained at high dose level was found to be applicable at the low dose level as well. Among the 26 897 males treated, there were 25 cases which produced 2-15 lethals. How to treat the simultaneous occurrence of two or more lethals in a set of 20 tested chromosomes originated from one treated male is an important and troublesome problem. However, sufficient evidence is available to conclude that the linear relationship between mutation rates and radiation dose can be applied to low doses down to 8 R by using the sex-linked recessive lethal mutations in Drosophila, one of the most reliable indicators of mutation induction. (Auth.)

- 622 Stern, C. RADIATION AND MUTATION RATE. p. 140 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 623⁽¹⁾ Stevens, J.M., Le Roux, P.R. THE INDUCTION OF CONTINUOUS VARIATION BY x IRRADIATION IN Drosophila. p. 505-13 of "National Conference on Nuclear Energy. Application of Isotopes and Radiation". Atomic Energy Board, Pelindaba, South Africa. 1963.

The induction of continuous variation in sternopleural and abdominal chaetae number consequential to the irradiation of chromosome II of D. melanogaster was studied. Using an isogenic line that was obtained by the usual technique from an inbred line, two irradiation series, 500 and 1000 R were started. Each series comprised 25 lines characterized by having one specific chromosome II. The chromosome was kept exclusively in the male line and balanced against the CyL⁴ inversion. It was thus protected from recombination and to a large extent from the action of natural selection. Males were irradiated and mated to CyL⁴/Pm females having a homogeneous genetic background that was constantly renewed by a series of matings involving back-crossing to the isogenic line. After each irradiation the pairing affinity and lethality of the irradiated chromosome were tested. Only lethal-free chromosomes that did not impair fertility were kept. Mutations were thus allowed to accumulate in chromosome II and after every third or fourth generation of irradiation an assessment of the amount of variation produced in chaetae number was made by using a modified version of the diallel technique. In the 500 R series variation was detected in the number of abdominal chaetae at a dose of 3000 R and in sternopleural number at 4500 R. In the 1000 R series sternopleurals and abdominals responded at 9000 and 12 000 R respectively. About one third of the induced phenotypic variation is heritable in the narrow sense and could thus be utilized by selection. The additive variation increased linearly with dose and it was estimated that the additive variance increment per roentgen was $(1.6 \pm 0.2) 10^{-5}$ and $(3.7 \pm 1.4) 10^{-5}$ for sternopleurals and abdominals, respectively. These values are considerably lower than those obtained by others but estimates are free from chromosomal and genic recombination effects. (Auth.)

- 624⁽¹⁾ Tazima, Y., Onimaru, K. NATURE OF RADIATION INDUCED MUTATIONS DETECTED IN THE SILKWORM BY THE METHOD OF SPECIFIC LOCI. Rep. natn. Inst. Genet., Misima 10 (1959) 115-16.

- 625 Tokunaga, C., Stern, C. THE DEVELOPMENTAL AUTONOMY OF EXTRA SEX COMES IN Drosophila melanogaster. p. 1-25 of "Semiannual Report - Biology and Medicine, Fall 1964". Lawrence, J.H., Ed. UCRL-11833, Lawrence Radiation Lab., Univ. of California, Berkeley. 163p.

For subsequent publication and abstract, see 626.

- 626 Tokunaga, C., Stern, C. THE DEVELOPMENTAL AUTONOMY OF EXTRA SEX COMBS IN *Drosophila melanogaster*. Devl Biol. 11 (1965) 50-81.

In male flies the first legs possess a sex comb, tibial transverse rows of bristles, and basitarsal transverse rows. These structures are absent on the second and third legs. The recessive autosomal mutant *esc* (extra sex comb) transforms certain features of the second and third into those of first legs. In different legs the transformation may be incomplete. The different parts may be transformed independently of each other, resulting in an array of partially transformed legs which are epigenetic mosaics of changed and unchanged areas. Genetic mosaics consisting of *esc/esc* patches on *esc/+* legs were obtained in consequence of x-ray induced somatic crossing over. The age of larvae during irradiation varied from 27 to 120 h. The x-ray dosage varied from 700 R to 2400 R with a dose rate of about 80 R/min, the youngest larvae receiving the lower dosages. Some prepupae aged 120 to 130 h were also irradiated, with from 2100 R to 2400 R. By a translocation the *esc/esc* areas were marked by genetically yellow pigmentation on the background of wild-type *esc/+*. In the genetic mosaics *esc* acts autonomously in causing the appearance of sex combs and both types of transverse rows even in very small *esc/esc* areas. Wild-type colored sex comb teeth on second and third legs were induced by x-irradiation of *esc/+* males. The second legs of males with the combination *esc^Den/+* of *esc^D*, a dominant allele of *esc*, and *en* (engrailed) had a typical (primary) sex comb as well as the secondary comb normally placed by *en* on the first leg only. The gene *esc* as compared to *esc+* controls the terminal pattern of leg differentiation by changing the competence of imaginal disk cells to respond to a prepatter that is alike for both alleles. The changed response consists in a tendency in certain areas toward growth in a transverse direction coupled with differentiation in a closely packed row, of bristles or teeth. (Essentially auth. summary)

- 627 Trout, W.E. DIFFERENTIAL RADIOSENSITIVITY AS AN EXPLANATION FOR SO-CALLED RECOVERY IN *Drosophila* SPERM. Genetics 50 (1964) 173-9.

A decline in the sex-linked lethal mutation frequency from the first to the second day after x-irradiation was observed with rod- and ring-X chromosomes of *D. melanogaster* when males, irradiated 3-4 d after eclosion, were mated singly to females at either half-day or daily intervals. A rise in frequency was observed, however, if males had been exhaustively mated for 8 d after eclosion and were then irradiated. In all cases an intermediate mutation frequency was observed if males were not allowed to mate on the first day. On the other hand, the frequency for the second day for males which on the first day were given the opportunity to mate, but failed to do so effectively, was even lower than the second day frequency for males that mated on the first day. All these results support the concept of a differential sensitivity to x-rays associated with position in the genital tract, and mixing of sperm if matings are delayed, rather than a recovery process. (Auth.)

- 628 Whiting, A.R. THE COMPLEX LOCUS *R* IN *Mormoniella vitripennis* (Walker). p. 341-58 of "Advances in Genetics. Vol. 13". Caspari, E.W., Thoday, J.M., Eds. New York, Academic Press, 1965, 378p.

Review article. A number of eye-colour changes had been x-ray induced.

- 629 Whiting, P.W., Ray, D.T. VISIBLE MUTATION FREQUENCIES INDUCED IN *Mormoniella* OOCYTES BY x RADIATION. p. 65-66 of "Biology Division Semiannual Progress Report for the Period Ending February 15, 1965". ORNL-3768, Oak Ridge National Lab., Tenn. May 1965, 205p.

A summary is presented of earlier studies on the mutation frequencies induced in oocytes exposed to doses between 1136 and 5680 R, and of data collected from wasps irradiated with lower exposures (52.5 - 525 R). From the age of the females irradiated results were expected to represent mutations induced in oocytes in the first meiotic prophase stage of development. The higher dose data indicate that visible mutations are induced by more than one event (slope nearly 2), whereas the lower-dose portion of the curve indicates that, even when the data are corrected for spontaneous mutations the slope is still < 1.

- 630 World Health Organization, Geneva (Switzerland). GENETICS OF VECTORS AND INSECTICIDE RESISTANCE. Wld Hlth Org. tech. Rep. Ser. 268 (1964) 40p.

About ten useful markers have been isolated in Culex pipiens pipiens and in Culex pipiens fatigans. All three linkage groups have been distinguished. There is an evident tendency of the same mutant to occur in independent stocks. Thus scale-row, four-jointed palpi, R_2 (a wing-vein mutant), and kps and kpu (both palpal mutants) have occurred independently in both molestus and in fatigans. Most of these mutants have been recovered after x-irradiation. — In the course of x-ray experiments several anomalies in wing-vein pattern, tarsal shape and antennal form have been recovered from A. quadrimaculatus. None of these have yet been isolated.

- 631 Yanders, A.F. A RELATIONSHIP BETWEEN SEX RATIO AND PATERNAL AGE IN Drosophila. Genetics 51 (1965) 481-6.

D. melanogaster males aged 1, 7, or 14 d were mated at 24-h intervals to pairs of virgin females and transferred to new females at 24-h intervals for eight mating periods. The sex ratio of their progeny showed a trend toward a greater proportion of females, which was related to the age of the parent male at the time of mating. Irradiation of the males reduced the proportion of their female progeny, but the shift in sex ratio showed the same relationship to paternal age as in the untreated groups. An age-related, non-random meiotic segregation of sex chromosomes into functional and nonfunctional sperm provides a satisfactory explanation for these results. (Auth.)

See also:

- 14 Nonrandom distribution of lethals induced by tritiated thymidine in Drosophila melanogaster. (Kaplan, W.D. et al., 1964)
- 15 The distribution of sex-linked recessive lethals induced in Drosophila males by tritiated deoxycytidine. (Kaplan, W.D. et al., 1965)
- 21 On the mutagenic effectiveness of incorporated ^{14}C . (Kuzin, A.M. et al., 1964)
- 22 Mutagenic effect on mature Drosophila spermatozoa of P^{32} incorporated into DNA. (Lee, W.R. et al., 1965)
- 23 The mutagenic effect of tritiated uridine in Drosophila spermatocytes. (Olivieri, G., Olivieri, A., 1965)
- 24 Genetic effect of incorporated ^{14}C in Drosophila melanogaster. (Purdom, C.E., 1965)
- 26 The relative mutabilities of DNA in regions of the X-chromosome of Drosophila melanogaster. (Rudkin, G.T., 1965)
- 27 Mutations in Drosophila melanogaster grown on media containing carbon-14 labelled sugars. (Suomalainen, E. et al., 1956)
- 35 Localization, persistence and resultant genetic effect in invertebrates of ingested fourth period metals in stable and radioactive forms. (Grosch, D.S., 1964)
- 524 Basic fertilization phenomena and gametic lethality in Drosophila. (Yanders, A.F., 1964)
- 532 Radiosensitivity of the stages of spermatogenesis to different mutations in Drosophila melanogaster. (Fahmy, O.G., Fahmy, M.J., 1964)
- 536 The mutability of mature sperm of Drosophila melanogaster irradiated in the female and in the male. (Lefevre, G., Jr., 1965)
- 537 x-ray induced mutability in male germ cells of Drosophila melanogaster. (Lefevre, G., Jr., Jonsson, U.-B., 1964)
- 544 Drosophila cytology and genetics. (Oak Ridge National Lab., Tenn., 1964)
- 545 Radiosensitivity of Drosophila spermatogonia. II. Protracted doses. (Ofstedal, P., 1964)
- 546 The radiosensitivity of Drosophila spermatogonia. I. Acute doses. (Ofstedal, P., 1964)
- 582 The brood-pattern of x-ray-induced mutational damage in the germ cells of Drosophila melanogaster males. (Hannah-Alava, A., 1964)
- 563 The brood-patterns of mutations and crossing-over recombinants in successive broods of F_1 offspring from males treated with 3000 R of x-rays. Period covered: Nov. 1, 1959 - Oct. 31, 1964. (Hannah-Alava, A., 1964)
- 568 Drosophila cytology and genetics. (Oak Ridge National Lab., Tenn., 1964)
- 581 Non-divergence of chromosomes under the influence of x-rays of varied hardness and intensity. (Tikhomirova, M.M., 1964)
- 584 Dependence of frequency of occurrence of phenocopies on x-ray dose. (Volchkov, Yu.A., Aleksandrov, Yu.N., 1963)
- 589 Radiation induced deletions in spermatids and spermatocytes of Drosophila. (Zimmering, S., Kirshenbaum, G., 1964)

- 664 Change in the nature of radiation-induced mutation in the spermatids of Drosophila under the influence of arginine. (Abeleva, E. A., 1964)
- 665 Lethals in Drosophila spermatogonia after fractionated x-irradiation. (Baxter, R. C., 1964)
- 667 Genetic effect of combined x-ray and ethylenimine treatments. (Alexander, M. L., 1965)
- 669 Combined ICR 100 and x-ray analysis of the strandedness of the spermatozoan of Drosophila melanogaster. (Carlson, E. A., Novitski, E., 1964)
- 672 Genetic effect of small doses of ionizing radiation. (Dubinin, N. P. et al., 1964)
- 674 x-ray damage as measured by dominant lethals, sex-linked recessive lethals and translocations in Drosophila melanogaster and oxygen and argon as its modifying factors. (Elequin, F. T., 1965)
- 680 The influence of cosmic flight factors on the frequency of sex-linked recessive lethal mutations in Drosophila melanogaster. (Glembotskiĭ, Ya. L. et al., 1963)
- 681 Comparative studies of mutation frequencies induced by ^{32}P treatment and γ -irradiation in the male silkworm. (Ikenaga, M., Kondo, S., 1965)
- 682 The comparative pattern of mutagenesis in Drosophila spermatogenesis after x rays vs Co^{60} gamma radiation. (Ives, P. T., 1964)
- 684 Mutagenic effect of irradiated and unirradiated DNA in Drosophila. (Khan, A. H., Alderson, T., 1965)
- 685 Effects of storing x-rayed spermatozoa on the frequency of translocations and sex-linked lethals in Drosophila melanogaster. (Khishin, A. F. E., 1963)
- 688 Effect of 5-hydroxytryptamine (serotonin) on the radiation-induced rate of mutation in Drosophila melanogaster. (Künkel, H. A. et al., 1965)
- 690 The effect of mating intensity on mutation frequency patterns detected after irradiation of Drosophila melanogaster males. (Lefevre, G., Jr., Jonsson, U.-B., 1964)
- 691 Factors modifying mutation frequency patterns detected after irradiation of Drosophila melanogaster males. (Lefevre, G., Jr., 1965)
- 692 Study on the effect of catalase and peroxidase on radiation-induced mutability in Drosophila melanogaster. (Magdon, E., Winterfeld, G., 1965)
- 693 On the fractional- and whole-body mutations induced by soft x-rays in Drosophila. (Matsudaira, Y. et al., 1964)
- 694 The failure of sulphhydryl compounds, AET, MEA, and glutathione to protect against x-ray induced chromosome aberrations in male Drosophila. (Mittler, S., 1964)
- 699 Comparative studies of mutation frequencies induced by ^{32}P treatment and γ -irradiation in the male silkworm. (Mituo, I., Kondo, S., 1965)
- 700 Actinomycin D effects on the frequency of radiation-induced mutations in Drosophila. (Mukherjee, R., 1965)
- 701 Relative biological effectiveness of 14 MeV neutrons to γ -rays for inducing mutations in silkworm gonads. (Murakami, A., Kondo, S., 1964)
- 702 Comparison of fission neutrons and γ -rays in respect to their efficiency in inducing mutations in silkworm gonads. (Murakami, A. et al., 1965)
- 703 Modification of x-rays induced mutation rate in the silkworm by pre or post irradiation treatment with halogenated bases analogues. (Murakami, A., Tazima, Y., 1962)
- 705 Further data on the interaction between ultraviolet and ionizing radiations on the production of recessive lethals in Drosophila melanogaster. (Nicoletti, B. et al., 1964)
- 707 Modification of genetic damage produced by ionizing radiation. (Oster, I. I., 1964)
- 710 Induction of sex-linked recessive lethals and visible mutations by feeding x-irradiated DNA to Drosophila melanogaster. (Parkash, O., 1965)
- 711 On the radiomimetic effect of irradiated deoxyribonucleic acid (DNA_m) on Drosophila melanogaster. (Parkash, O., 1965)
- 712 Genetic effects of fast neutrons from nuclear detonations. Projects 23.4-23.14 and 23.16 of operation upshot-knothole. (Plough, H. H., Ed., Sheppard, C. W., Ed., 1964)
- 713 Effect of sulphhydryl reagents on the frequency of x-ray-induced autosomal recessive lethal mutations in Drosophila melanogaster. (Purdom, C. E., Bridges, B. A., 1964)
- 714 Lack of mutagenic effect of irradiated Drosophila medium. (Reddi, O. S. et al., 1965)
- 715 Genetic effects of cosmic radiation in Drosophila melanogaster. (Reddi, O. S., Sanjeeva Rao, M., 1964)
- 718 Effect of cold treatment post-irradiation on the loss of Seta dorso-centralis anterior in Drosophila melanogaster Sevelen and Berlin inbred. (Schleus, P., 1964)
- 721 The effect of post-treatment with N_2 or O_2 on the frequencies of recessive lethals and translocations produced by irradiation in N_2 or O_2 . (Sobels, F. H., 1963)

- 722 Post-radiation reduction of genetic damage in mature Drosophila sperm by nitrogen. (Sobels, F.H., 1964)
- 723 The role of oxygen in determining initial radiosensitivity and post-radiation recovery in the successive stages of Drosophila spermatogenesis. (Sobels, F.H., 1965)
- 724 The effect of temperature during irradiation on induced mutation frequency in Drosophila melanogaster sperm. (Sollunn, F.J., Strömnaes, Ø., 1964)
- 728 Independence of induced mutation-rate from radiation dose rate in the germ cells of hibernating silkworm embryo. (Tazima, Y., Onimaru, K., 1963)
- 729 Enhancement of radiation induced mutation frequency by post treatment of silkworm gonads with 5 bromodeoxyuridine. (Tazima, Y., Murakami, A., 1963)
- 730 Contribution from 14 MeV neutron experiments to the interpretation of the mechanisms of dose-rate effects on mutation frequency in silkworm gonads. (Tazima, Y., 1965)
- 731 Mechanisms controlling two types of dose-rate dependence of radiation-induced mutation frequencies in silkworm gonads. (Tazima, Y., 1965)
- 732 The increase in induced mutation frequency after fractionated irradiation of gonadal cells of the silkworm. (Tazima, Y., Murakami, A., 1962)
- 733 Further report in the increase of induced mutation frequency after fractionated irradiation of gonadal cells of the silkworm. (Tazima, Y., Onimaru, K., 1963)
- 734 Analysis of postirradiation modification of genetic damage in mature Drosophila melanogaster sperm. (Trusko, J.E., 1964)
- 735 Effect on genetic damage of post treatment given x-rayed Drosophila males. (Trusko, J.E., 1964)
- 736 Induced mutation process - I the effect of high temperature after irradiation on the frequency of occurrence of lethal mutations and chromosomal breaks. (Vatti, K.V., Yanoosh, I.M., 1964)
- 738 The rate of gonadal mosaicism for lethals in late broods of Drosophila as compared with early when induced by x-rays, azaserine and quinacrine mustard. (Altenburg, E., Browning, L.S., 1964)
- 741 Somatic mutations in the moth Ephestia. (Caspari, E.W., 1964)
- 742 Effects of DNA base analogues on the scales of the wing of Ephestia. (Caspari, E.W. et al., 1965)
- 744 Mutagenesis in relation to genetic hazards in man. (Fahmy, O.G., Fahmy, M.F., 1964)
- 745 Induction of lethal mutations in Drosophila melanogaster by DNA. (Gershenson, S., 1965)
- 746 On the mutagenic effects of x-radiation, N-nitroso-N-methyl-urethan, and N-nitroso-morpholine in Drosophila melanogaster. (Henke, H. et al., 1963/64)
- 747 The differential mutation effect of certain carcinogens. (Henke, H. et al., 1965)
- 751 Mutations induced by alkylating agents, x-rays and combined treatments. (Mazar-Barnett, B.K. de)
- 753 Mutagenic action of mitomycin C on Drosophila melanogaster. (Mukherjee, R., 1965)
- 755 Comparisons between mutagenic and cell-killing effects induced by radiation and radiation and radiomimetic substances. (Nakao, Y., 1965)
- 757 A comparison of genetic changes induced by a monofunctional and a polyfunctional alkylating agent in Drosophila melanogaster. (Snyder, L.A., Oster, I.I., 1964)
- 766 Effects of gamma radiation on the fertility of the two-spotted spider mite and its progeny. (Henneberry, T.J., 1964)
- 805 Radiosensitivity of female germ cell stages of Dahlbominus. (Baldwin, W.F., 1965)
- 835 Effects of low-level gamma-radiation on the immature stages of Dahlbominus fuscipennis (Zett.) (Hymenoptera: Eulophidae). (Riordan, D.F., 1964)
- 926 Genetic loads in irradiated experimental populations of Drosophila melanogaster. (Sankaranarayanan, K., 1964)
- 934 During several generations irradiated spermatogonia in Drosophila melanogaster. A population analysis. (Eiche, A., 1964)
- 935 On lethals and their suppressors in experimental populations of Drosophila willistoni. (Magalhães, L.E. de, et al., 1965)
- 939 Heterozygous effects of radiation-induced mutations on viability in homozygous and heterozygous genetic background in Drosophila melanogaster. (Mukai, T., Yoshikawa, U., 1964)
- 945 Inheritance of quantitative characteristics and methods for increasing the genetic mutability of populations. (Scossiroli, R.E., 1963)
- 946 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.S., 1964)
- 947 Genetic effects of x rays on quantitative characters in a heterogeneous population of Drosophila melanogaster. (Tobari, I., Nei, M., 1965)
- 949 Genetic variability in Aedes aegypti (Diptera: Culicidae). III. Plasticity in laboratory populations. (Vandehey, R.C., 1964)

6. Dominant Lethality. Sterility. Cell Killing

- 632 Anonymous. HOW FAR A FLY CAN FLY. Agric. Res., Wash. 13, 12 (1965) 5.
- Sterilization by means of irradiation was studied on Lucilia the blowfly. Using colour tags, a dispersion of up to 300 miles was traced. The practical significance for control measures of determining the limits of an infested zone is stressed.
- 633 Atwal, A. S., Sethi, S. L. EFFECT OF GAMMA RADIATION ON THE STERILIZATION OF Concya cephalonica Stanton (LEP.: PYRALIDIDAE). p. 6-7 in "Information Circular on Radiation Techniques and their Application to Insect Pests, No. 4". WP/31/4, International Atomic Energy Agency. Apr. 1964.
- 634(2) Drummond, R. O. EFFECTS OF GAMMA RADIATION ON THE FERTILITY OF THE COMMON CATTLE GRUB, Hypoderma lineatum (De Villers). Int. J. Radiat. Biol. 7 (1963) 491-5.
- At 9-13 d after collection from the backs of cattle as larvae, or 6-8 d before hee flies emerged, pupae of the common cattle grub, H. lineatum (de Villers), were exposed to 1000, 2500, 5000, or 7500 R of γ radiation from a ^{60}Co -source. Flies from irradiated pupae were mated with those from non-irradiated pupae to determine fertility of the treated individuals. At 5000 and 7500 R both sexes were completely sterilized; at 2500 R females were completely sterilized and males exhibited reduced fertility.
- 635 Elbadry, E. SUPPRESSION OF THE REPRODUCTIVE POTENTIAL OF THE POTATO TUBERWORM, Gnorimoschema operculella BY GAMMA IRRADIATION. J. econ. Ent. 57, 3 (1964) 414-5.
- The use of sterile females rather than of sterile males for control measures appears more promising since the sterile males were unable to compete satisfactorily with normal ones. Minimum sterilizing doses of γ -radiation for male and female pupae were 15 000 and 18 000 rad, respectively, at a dosage of 180 000 - 196 000 rad/h, from a ^{60}Co -source.
- 636 Erdman, H. E. DOMINANT LETHAL PROPORTIONS MODIFIED BY x-RADIATION, TEMPERATURES, AND COHABITATION IN SINGLE- AND MIXED-SPECIES POPULATIONS OF FLOUR BEETLES, Tribolium confusum AND T. castaneum. Radiat. Res. 22, 1 (1964) 187. Abstr. 59.
- Virgin 3-week-old adult Tribolium were given 0, 1575, and 2625 R of x-rays. Single-species populations (10 pairs per 20 g food) and mixed species populations (5 pairs each species per 20 g food) were kept at 25, 29, and 32°C and 65-70% relative humidity. Each 2 weeks, for 10 weeks, parents were supplied fresh food. Used food was reincubated whence adult F_1 were segregated as to species and counted. To assess radiation damage on the productivity in flour beetles, the proportions of induced dominant lethals, which in mixed species populations include lethals associated with coexistence, were calculated from the number of live adult F_1 . This method accounts for genetic, zygotic, larval and pupal lethality inclusively. Early-life (egg and young larval stages) lethality of the F_1 was estimated by subtracting observed larval-pupal deaths from calculated dominant lethal deaths. Statistical analyses of the data indicated that the frequency of dominant lethals induced by x-radiation increased with progressively higher exposures, but temperature and cohabitation influenced this frequency within a species. Cohabitation was responsible for some increase in lethality, but again temperature and x-ray exposure influenced the expression. Radiation alteration of productivity and induction of dominant lethals were influenced by x-ray dose temperature, species and cohabitation. In conclusion, for both species x-ray-induced dominant lethality in the F_1 occurred predominantly during early-life. The incidence of this lethality throughout the life cycle was greater for T. confusum than for T. castaneum. (Abstr.)

- 637 Flint, H. M. THE EFFECT OF COBALT 60 GAMMA RAYS ON THE BIOLOGY OF THE EYE GNAT, Hippelates pusio Loew. Diss. Abstr. 25, 7 (1965) 3803.

The effects of irradiation on the life processes of the gnat were studied, with a view to the possible application of the "sterile-male" technique for its eradication. Dose rate used was approximately 2500 R per min. Test insects were maintained at 80° ± 2°F and approximately 70% relative humidity. Fertility was assayed by egg hatch. Insects were considered to be sterile when egg hatch was reduced to ≤ 1%. Sterility tests were made on gnats treated as 24- to 36-h-old adults and pupae treated 2 d prior to emergence. The sterilizing dose for males treated as adults was 4550 R and for males treated as pupae the sterilizing dose was 3750 R. Females required 4900 R when treated as adults and 4700 R when treated as pupae. Males were found to compete normally with untreated males for fertilization of females when the males were sterilized in the adult stage. Males sterilized in the pupal stage were much less effective in competing for females. A partial recovery of fertility was observed in males 18 d after treatment when treated with 4500 R as pupae and up to 3000 R when treated as adults. Female gnats which had been treated in the pupal stage with the sterilizing dose did not lay eggs in the adult stage. However, egg production from females treated in the adult stage was approximately 2/3 that of control gnats. In mortality tests, adults were treated with doses as high as 135 000 R which caused death within 4 d. A dose of 5000 R showed no effect on the life span of treated adults during a 7 week test period. Pupae were found to be more sensitive to irradiation than adults. Emergence was prevented in half the treated pupae by a dose of 12 000 R. Last-instar-larvae were very susceptible to a dose of 3500 R as measured by adult emergence. Eggs which were only a few hours old were sensitive to doses as low as 100 R but within 48 h were able to withstand several thousand R. An examination of the morphology of ovaries from gnats treated as pupae revealed that growth was inhibited by doses as low as 500 R. The ovary was unable to develop any adult structure after a dose of 4500 R. Testes from gnats treated as pupae with 4500 R were retarded in growth but produced motile sperm. Cytological examination of treated testes revealed visible chromosomal abnormalities in pupae and adults treated with 2500 R. The diploid (2N) chromosome number from untreated larval brain tissues was found to be 8. (From DA)

- 638⁽²⁾ Frizzi, G. STRUTTURE CROMOSOMICHE SALIVARI E LORO CONTRIBUTO AL PROBLEMA EVOLUTIVO. (Structures of salivary chromosomes and their contribution to the problem of evolution). Rc. Semin. Fac. Sci. Univ. Cagliari 31 (1961) 1-. (In Italian)

Anopheles atroparvus were irradiated with dosages of 2000 R - 6000 R. The latter dose gave complete sterility but 3500 R produced the highest rate of chromosomal mutations. Both pericentric and paracentric inversions were most frequently found deficiencies and rarely translocations. Most of the inversions were in chromosomes II and III, very few in X.

- 639 Gomez-Nunez, J. C., Gross, A., Machado, C. GAMMA RADIATION AND THE REPRODUCTIVE BEHAVIOR OF MALE Rhodnius prolixus. Acta cient. venez. 15 (1964) 97-104. (In Spanish)

In view of the fact that R. prolixus is the principal vector of Chagas disease, a serious disease in regions of Latin America, radio-sterilization of the male insects was investigated since this technique has been used successfully in eradicating or eliminating other insect vectors of disease. The effects of 2500 R to 40 000 R doses of ⁶⁰Co γ-rays were compared with earlier results obtained with x-rays on the male insects. Fertility was reduced to 74.4% of normal after 2500 R. Fertility decreased with higher doses until only 0.3% fertility resulted at 20 000 R. Males exposed to 40 000 R were completely sterile and unable to mate because of radiation damage. Spermatogenesis was more susceptible to radiation than the mature sperm, so that sterility increased with time and mating frequency through the replacement of old sperm cells by new ones. Irradiated males mated more frequently than untreated ones and, as mating stimulates oviposition, the quantity of eggs laid by the females enclosed with them also increased. It was shown that 5000 R or less do not hinder the insect's mating ability, at least within a limited initial time period. For an equal degree of sterility, γ-radiation shows certain advantages over x-rays only when the dose does not exceed 7500 R; above this dose x-rays cause less change to the male's reproductive behaviour. Although 5000 R improved the male's mating capabilities for at least 9 weeks after irradiation, it did not produce the desired sterility. This is only obtainable with doses above the limit where mating-inhibiting damage appears. It is concluded that the sterile male technique is not applicable to R. prolixus. (From NSA 19:1965, 25914)

- 640 Hoenigsberg, H. F. NON LINEARITY IN DOMINANT LETHALS INDUCED WITH IRRADIATION IN *Drosophila melanogaster*. *Caldasia* 9, 42 (1964) 129-136.
- 641 Jefferies, D. J. SUSCEPTIBILITY OF THE SAW-TOOTHED GRAIN BEETLE, *Oryzaephilus surinamensis* (L.) TO GAMMA RADIATION. * p. 119-30 of "Entomology of Radiation Disinfestation of Grain". Cornwell, P. B., Ed. Oxford, Pergamon Press. 1966 **, 236p.
- The saw-toothed grain beetle, *O. surinamensis*, is more resistant to γ -radiation than *S. granarius*; 15300 rad is required for 99.9% sterility of adults and calculations show that at 30°C, the sterilizing dose for weevils (16000 rad) controls *O. surinamensis* for a period of 8-12 weeks. The efficacy of this dose under conditions likely to be experienced in commercial practice is discussed. (From auth.)
- * For an earlier report of the same title, AERE-R-3891, see II/1261.
- ** Since the work reported in this volume was carried out by the Entomology Group of the Wantage Research Laboratory, U. K. A. E. A., during the period 1955-61, individual papers are included in the present bibliography although they were actually not published in book form until 1966.
- 642 LaChance, L. E., Riemann, J. G. CYTOGENETIC INVESTIGATIONS ON RADIATION AND CHEMICALLY INDUCED DOMINANT LETHAL MUTATIONS IN OOCYTES AND SPERM OF THE SCREW-WORM FLY. *Mutation Res.* 1, 3 (1964) 318-39.
- Adult female *Callitroga hominivorax* containing oocytes in early prophase or early anaphase of the first meiotic division, and day-old males containing mature sperm were exposed to doses of γ -radiation or the alkylating agent, 2, 4, 6-tris(1-aziridinyl)-s-triazine (I) sufficient to induce 100% dominant lethals. These were characterized by chromosome bridges and fragments between dividing nuclei in the embryo, evident during the first and second meiotic divisions after γ -irradiation and persisting until development ceased during early cleavage. After treatment with I, these changes were detected only during cleavage divisions or after one replication of chromatin. (CA 62:1965, 2024h)
- 643 LaChance, L. E., Crystal, M. M. INTRODUCTION OF DOMINANT LETHAL MUTATIONS IN INSECT OOCYTES AND SPERM BY GAMMA RAYS AND AN ALKYLATING AGENT: DOSE-RESPONSE AND JOINT ACTION STUDIES. *Genetics* 51 (1965) 699-708.
- Adult female screw-worm flies containing oocytes in early prophase or early anaphase of the first meiotic division, and 1-d-old males containing mature sperm were exposed to graded doses of γ -radiation or the alkylating agent, 2, 4, 6-tris(1-aziridinyl)-s-triazine (=tretamine). Frequency of dominant lethal mutations induced by these treatments was determined by scoring hatchability of eggs produced by inseminated females. Crosses involved treated females \times untreated males or the reverse. Dose-response curves permit a comparison of radiation and tretamine treatments on the three stages of reproductive cells that differ greatly in their sensitivity to both radiation and chemical mutagens. Shapes of curves for both radiation and tretamine treatments are remarkably similar for the same cell stage. The relationship between dose and percentage of dominant lethals was non-linear for all cell stages. In testing for possible potentiation of one treatment by the other when treatments were applied consecutively, adult males and females were exposed to tretamine followed in 16 min by a exposure to γ -radiation. Doses used were known to produce less than 50% dominant lethals when given alone. Treated insects were crossed to untreated ones and frequency of dominant lethal mutations induced by combined treatments compared with those by single treatments was assessed. Results indicated that the effect of combined treatments on oocytes and sperm was merely additive, at best. Possible reasons for similarity of the dose-response curves elicited by basically different types of mutagens, shapes of curves, and absence of potentiation when treatments included both radiation and tretamine are discussed. (Auth.)
- 644 Lewis, L. F., Eddy, G. W. SOME EFFECTS OF GAMMA RADIATION ON THE HORN FLY. *J. econ. Ent.* 57, 2 (1964) 275-7.
- Both sexes of the horn fly, *Haematobia irritans* (L.), were sterilized by irradiating pupae with a γ -ray dosage of 5000 R from a ^{60}Co source. In every test in which irradiated pupae mixed with normal pupae were allowed to emerge together in screened cages, the resulting eggs were less viable than control eggs, which indicated that treated males competed for mates with normal males with some success. Horn fly longevity in these tests was apparently unaffected by the sterilizing

dosage. Methods are presented for obtaining horn fly eggs, for mass rearing these flies in the laboratory, and for sexing the newly emerged adults. (Auth.)

- 645 Lindsley, D. L. MALE STERILIZING MUTATIONS IN Drosophila AND THE LESION IN SPERMATOGENESIS CAUSING STERILITY. p. 106 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- 646 McClanahan, R. J. STERILIZATION OF THE CARROT RUST FLY BY IRRADIATION WITH CESIUM¹³⁷*. Can. Ent. 97, 10 (1965) 1042-5.

Laboratory studies were conducted with the carrot rust fly, Psila rosae (Fabricius), to determine the effect of irradiation on reproduction. Irradiation of 15-d-old pupae with 1.4, 2.8 and 4.3 kR did not adversely affect emergence. Treated females caged with normal males laid a few sterile eggs when the treatment was 1.4 kR but none at the higher doses. Normal females caged with treated males laid a normal complement of eggs, and the per cent hatch was 10, 2 and 0 with treatments of 1.4, 2.8 and 4.3 kR, respectively. When flies of both sexes from pupae treated at 3.0 kR were mixed with normal flies in a ratio of 6:1, the number of larvae were reduced by 93%. (Auth.)

* Contribution No. 61, Ent. Lab., Res. Branch, Canada Dept. of Agriculture, Chatham, Ont.

- 647(?) Myburgh, A. C. LETHAL AND STERILISING EFFECTS OF COBALT-60 GAMMA RAYS ON Argyroplote leucotreta. p. 514-25 of "National Conference on Nuclear Energy. Application of Isotopes and Radiation". Atomic Energy Board, Pelindba, South Africa. 1963.

Whereas extremely high exposure doses of γ -rays, ranging from nearly 200 - 400 kR, were required to inhibit development within each respective stage of metamorphosis of A. leucotreta Meyr, exposures between 10 and 120 kR, at a radiation intensity of 80 R per minute, inhibited development of moths from immature stages. Considerably lower exposure doses, ranging from approximately 5 to 70 kR, were required to achieve sterility. The stages of metamorphosis, from egg to adult, became progressively more resistant to the effects of γ -rays, while resistance also increased with age within each stage. Males were generally more resistant than females. A direct relation between radiation intensity and magnitude of effect on the species was evident. Possible application of γ -rays for control of A. leucotreta in packed fruit and in orchards is discussed. (Auth.)

- 648 Ostensson, L. STERILIZATION OF INSECTS. (BAG 29:1965, 52644). Mjolkpropagandan 4, 5 (1964) 139. (In Swedish)
- 649 Ouye, M. T., Garcia, R. S., Martin, D. F. DETERMINATION OF THE OPTIMUM STERILIZING DOSAGE FOR PINK BOLLWORM TREATED AS PUPAE WITH GAMMA RADIATION. J. econ. Ent. 57 (1964) 387-90.

The effect of γ -radiation from ⁶⁰Co on pupae and adults of the pink bollworm, Pectinophora gossypiella (Saunders), following pupal exposure was determined. Pupal sensitivity to γ -radiation was dependent on age at time of treatment - the older the pupae, the less susceptible they were. When 1- and 3-d-old pupae were irradiated, dosages inducing complete sterility also caused some pupal mortality and appreciable moth damage; however, irradiation of 5- or 7-d-old pupae induced almost complete sterility without pupal mortality or adult malformation. When males from irradiated 7-d-old pupae were mated with untreated females, complete sterility was achieved at 55 kR, and within the range of 30-80 kR no more than 3% of the oviposited eggs hatched at any one exposure dosage. Exposure at 40 kR was sufficient to sterilize females. Longevity of males from 7-d-old pupae treated with 35 through 90 kR was significantly shorter than that of the control. (Auth.)

- 650 Parfenov, G. P. THE DEVELOPMENT OF DOMINANT LETHALITY IN FRUIT FLIES EXPOSED TO VIBRATION, ACCELERATION, AND GAMMA RADIATION. Kosm. issled. 3 (1965) 643-51. (In Russian)

The combined and individual effects of vibration, acceleration, and 500 R doses of γ -radiation on fruit flies were studied using Domodedovo-18 and -32 strains. In each test, 1000 males were mated to the same number of virgin females 1 h after exposure to a stress. The eggs of these females were subsequently collected and examined for lethality. It was found that various vibration frequencies

did not injure the mature sperm of fruit flies. Egg lethality following exposure to vibration was attributed to lowered male sexual activity. Vibration with a frequency of 70 cps for 2 h or longer caused injury during the spermatid phase resulting in zygote lethality after fertilization. Regardless of the sequence, the total effect of vibration combined with radiation did not exceed the sum of each of the individual stressors. Exposure to 40 g for 20 min did not have a mutagenic effect or influence the radiation effect. A higher magnitude of acceleration (4000 g for 20 min) did not affect the spermatids but did affect mature germ cells. The effect was analogous to that of 200 to 250 R of γ -rays. The mechanism of the cellular effect of 4000 g was probably non-nuclear. Radiation followed by acceleration (4000 g) had a total effect equal to the sum of the individual effects. When the order was reversed, the radiation effect was modified. (NSA 20:1966, 14343)

- 651 Pendlebury, J. B., Jefferies, D. J., Banham, E. J., Bull, J. O. SOME EFFECTS OF GAMMA RADIATION ON *Rhizopertha dominica* (F.), *Cadra cautella* (Wlk.), *Plodia interpunctella* (Hübner.) AND *Lasioderma serricorne* (F.). * p. 143-56 of "Entomology of Radiation Disinfestation of Grain". Cornwell, P. B., Ed. Oxford, Pergamon Press. 1966, ** 236p.

Various effects of γ -radiation on four stored-products pests, which infest grain and cereal products in varying degrees, are examined with particular emphasis on susceptibility to radiation sterilization. *R. dominica*, described as the most destructive pest of grain, and *L. serricorne*, occasionally found infesting cereal products, are effectively sterilized by the dose (16000 rad) evaluated for the control of large populations of grain weevils. *C. cautella* and *P. interpunctella*, principally pests of dried fruits, but occasionally imported on infested cereals, are more resistant to radiation sterilization; 6000 rad is unlikely to be completely effective for their control. (Auth.)

* For an earlier report, AERE-R-4003, see II/305.

** Since the work reported in this volume was carried out by the Entomology Group of the Wantage Research Laboratory, U. K. A. E. A., during the period 1955-61, individual papers are included in the present bibliography although they were actually not published in book form until 1966.

- 652⁽²⁾ Sado, T. CYTOLOGICAL ESTIMATION OF LD 50 x RAY DOSE FOR SECONDARY SPERMATOGONIA OF THE SILKWORM. Rep. natn. Inst. Genet., Misima 13 (1961) 91-92.

- 653 Shipp, E. SUSCEPTIBILITY OF AUSTRALIAN STRAINS OF *Sitophilus* AND *Tribolium* SPECIES TO GAMMA RADIATION. p. 131-141 of "The Entomology of Radiation Disinfestation of Grain". Cornwell, P. B., Ed. Oxford, Pergamon Press. 1966*, 236p.

No differences could be detected between laboratory and wild strains of *S. oryzae* and *S. zeamais* in the lethal effect of γ -radiation. Wild strains of *S. granarius*, *T. confusum* and *T. castaneum* were more resistant than laboratory strains. In the five species, only slight differences between laboratory and wild strains were found in response to sterilization by irradiation. Sterilization at the 99.9% level was obtained with all species and strains at about 10 000 rad. The dose of 16 000 rad, previously evaluated for effective control of *S. granarius*, can therefore be recommended for use in commercial radiation disinfestation of grain in Australia. (Auth. summary)

* Since the work reported in this volume was carried out by the Entomology Group of the Wantage Research Laboratory, U. K. A. E. A., during the period 1955-61, individual papers are included in the present bibliography although they were actually not published in book form until 1966.

- 654⁽¹⁾ Tazima, Y., Onimaru, K. x-RAYS INDUCED DOMINANT LETHALS FROM IRRADIATION OF DIFFERENT STAGES OF OÖGENESIS IN THE SILKWORM. Rep. natn. Inst. Genet., Misima 10 (1959) 117.
- 655⁽¹⁾ Tazima, Y. SOME OBSERVATIONS RELEVANT TO THE POSSIBLE CAUSE OF RADIATION INDUCED STERILITY IN THE MALE SILKWORM. Rep. natn. Inst. Genet., Misima 10 (1959) 118.
- 656 Tilton, E. W., Burkholder, W. E., Cogburn, R. R. STERILIZING EFFECTS OF GAMMA RADIATION ON EIGHT INSECT AND ONE MITE SPECIES THAT INFEST STORED PRODUCTS. Bull. ent. Soc. Am. 10, 3 (1964) 163. Abstr.

Radiation-sterilized Trogoderma glabrum males competed favourably with non-sterilized males. All beetles tested after a single continuous dosage of 25 kR were sterile. None of the dosages used sterilized two of the moth species. Acanis siro reproduced after radiation with 25 kR but not after higher dosages. (Abstr.)

- 657 Vereecke, A., Pelerents, C. DE INVLOED VAN GAMMASTRALEN OP DE FECUNDITEIT EN FERTILITEIT VAN Tribolium confusum Duval. (The effect of γ -irradiation on fecundity and fertility of Tribolium confusum Duval). Meded. Landbouwsch. Opzoekings Gent 30, 2 (1965) 1017-27. (In Flemish, with English, French, and German summaries)

The applied doses ranged from 1000 - 10 000 rad. A marked periodic increase in fecundity was observed every 3 weeks for 1000 and 2000 rad. Dosages > 5000 rad caused egg laying to stop shortly after irradiation. At 7000 rad and beyond no recovery was observed. Sterility occurred after irradiation between 4000 and 5000 rad, when < 1% of the eggs laid by beetles which had been exposed to 4000 rad developed into adults.

- 658 Walker, D. W., Alemany, A., Figueroa, M. INDUCED STERILITY OF ADULT Diatraea saccharalis (Fab.) BY GAMMA IRRADIATION. Bull. ent. Soc. Am. 10, 3 (1964) 167. Abstr.

Irradiation of larvae or pupae at 8 kR and higher produced excessive mortality. Irradiation of virgin, newly-emerged adult males and/or females at 20 - 40 kR produced 2% hatch or less, irradiation at higher dosages produced mixed results. Behaviour and methods are discussed.

- 659 Andreev, S. V., Samoilova, Z. I., Martens, B. K. THE POTENTIAL APPLICATION OF γ -RADIATION FOR THE STERILIZATION OF Chloridea obsoleta FOR THE PURPOSE OF REDUCING ITS POPULATION. Radiobiologiya 4 (1964) 624-6. (In Russian)

Experiments were carried out with the weevil C. obsoleta, which causes considerable damage in cotton crops. A 550 R/min ^{60}Co source was used to irradiate the male insects after cocoon stage at a total dose of 3-15 kR. The young caterpillars were fed with tomato plant leaves, the mature ones with ground seeds. The optimum temperature for the culture was found to lie between 23 and 25°C, at a relative air humidity of 65-70%. It was found that up to 8 R, the life span and the fertility were not noticeably affected. The optimum dose for sterilizing the male for the purpose of reducing the total population lies between 8 and 10 kR. Doses of 15 kR and higher resulted in deformed butterflies with a short life. (From NSA 13:1964,41190)

See also:

- 14 Nonrandom distribution of lethals induced by tritiated thymidine in Drosophila melanogaster. (Kaplan, W. D. et al., 1964)
- 547 Radiosensitivity of Drosophila spermatogonia. III. Comparison of acute and protracted irradiation efficiencies in relation to cell killing. (Ofstedal, P., 1964)
- 550 Spermatogenesis of the silkworm and its bearing on radiation induced sterility. (Sado, T., 1963)
- 551 Spermatogenesis of the silkworm and its bearing on radiation induced sterility. Part II. (Sado, T., 1963)
- 585 X-autosomal translocations of Drosophila melanogaster. (Warters, M., 1964)
- 606 Radiation induced viability mutations in the honey bee. (Lee, W. R., 1964)
- 666 The effects of radiations on the genetic systems of organisms in relation to their physiological and biochemical systems. (Alexander, M. L., 1964)
- 674 x-ray damage as measured by dominant lethals, sex-linked recessive lethals and translocations in Drosophila melanogaster and oxygen and argon as its modifying factors. (Elequin, F. T., 1965)
- 675 x-ray and fast neutron effects on productivity of flour beetles. (Erdman, H. E., 1965)
- 677 Dose ratio of x-rays to fast neutrons in producing dominant lethals in flour beetles, Tribolium castaneum. (Erdman, H. E., 1965)
- 694 The failure of sulphhydryl compounds, AET, MEA, and glutathione to protect against x-ray induced chromosome aberrations in male Drosophila. (Mittler, S., 1964)
- 695 Studies of chemical protection against radiation induced genetic aberrations. (Mittler, S., 1964)

- 697 The effect of ATP upon radiation induced "dominant lethals" in Drosophila. (Mittler, S., Webster, M. C., 1964)
- 704 Effects of 2,4-dinitrophenol on the radioinduced dominant lethal factors in Drosophila melanogaster. (Nickel, E., 1965)
- 715 Genetic effects of cosmic radiation in Drosophila melanogaster. (Reddi, O. S., Sanjeeva Rao, M., 1964)
- 716 Influence of oxygen, helium, and metabolic inhibition on x-ray induced dominant lethality in stage 7 and stage 14 oocytes of Drosophila melanogaster. (Rinehart, R. R., 1964)
- 724 The effect of temperature during irradiation on induced mutation frequency in Drosophila melanogaster sperm. (Sollum, F. I., Strømnaes, Ø., 1964)
- 726 Effect of temperature on radiation induced male sterility in the silkworm, Bombyx mori L. (Suga, E., 1965)
- 727 Radiation mutagenesis in the silkworm. IV. Independence of radiation intensity as shown by induced sterility of spermatogenic cells. (Tazima, Y., 1958)
- 731 Mechanisms controlling two types of dose-rate dependence of radiation-induced mutation frequencies in silkworm gonads. (Tazima, Y., 1965)
- 734 Analysis of postirradiation modification of genetic damage in mature Drosophila melanogaster sperm. (Trosko, J. E., 1964)
- 740 Recent developments in research on radiation and chemical mutagen effects in insects. (Borstel, R. C. von, 1964)
- 748 Some effects of gamma radiation and a chemosterilant on the Mexican bean beetle. (Henneberry, T. J., et al., 1964)
- 749 Effect of chemosterilants against the oriental fruit fly, melon fly, and Mediterranean fruit fly. (Keiser, I., Steiner, L. F.)
- 755 Comparisons between mutagenic and cell-killing effects induced by radiation and radiomimetic substances. (Nakao, Y., 1965)
- 756 Radiosterilization vs. chemosterilization in house flies and mosquitoes. (Schmidt, C. H., Dame, D. A. et al., 1964)
- 757 A comparison of genetic changes induced by a monofunctional and a polyfunctional alkylating agent in Drosophila melanogaster. (Snyder, L. A., Oster, I. L., 1964)
- 766 Effects of gamma radiation on the fertility of the two-spotted spider mite and its progeny. (Henneberry, T. J., 1964)
- 801 Cytological effects of radiation on testes of the screw-worm fly, Cochliomyia hominivorax. (Riemann, J. G., 1964)
- 810 Genetic effects from simultaneous irradiation of immature and mature Drosophila virilis males. (Clayton, F. E., 1965)
- 811 Susceptibility of the grain and rice weevils, Sitophilus granarius (L.) and Sitophilus zeamais Mots. to gamma radiation. (Cornwell, P. B., 1966)
- 813 Some effects of gamma radiation on the potato tuberworm, Gnorimoschema operculella (Lepidoptera: Gelechiidae). (Elbadry, E., 1965)
- 823 Biological and histopathological effects of gamma radiation on three life stages of Anthonomus grandis Boheman. (Mayer, M. S., 1964)
- 829 The gamma irradiation of Glossina puparial stages and control. (Potts, W. H., 1965)
- 843 The effects of gamma radiation on the biology and behavior of forest insects and the possibility of their control. (Stark, R. W., Wood, D. L., 1964)
- 870 Susceptibility of laboratory and wild strains of the grain weevil Sitophilus granarius (L.) to gamma radiation. (Cornwell, P. B., 1966)
- 872 The effect of dose rate on the response of Tribolium confusum Duv., Oryzaephilus surinamensis (L.) and Sitophilus granarius (L.) to ⁶⁰Co gamma radiation. (Jefferies, D. J., Banham, E. J., 1966)
- 874 Susceptibility of Callosobruchus maculatus to high dose rate gamma irradiation. A preliminary study. (Neharin, A. et al., 1965)
- 887 A comparison of the susceptibility of the grain weevil Sitophilus granarius (L.) to accelerated electrons and ⁶⁰Co gamma radiation. (Bull, J. O., Cornwell, P. B., 1966)
- 899 The influence of temperature upon the radiation susceptibility of Sitophilus granarius (L.). (Pendlebury, J. B., 1966)
- 907 Field behavior of sexually sterile Anopheles quadrimaculatus males. (Dame, D. A., Woodard, D. B. et al., 1964)

- 924 A study of radiation on the biology and population dynamics of the cereal leaf beetle, Oulema melanopa (L.) order Coleoptera, family Chrysomelidae. (Myser, W. C., 1965)
- 991 Summary of the Mediterranean fruit fly investigation program June 1964 through May 1965. (Organismo Internacional Regional de Sanidad Agropecuaria, San Salvador (El Salvador), 1965)
- 996 Sterilization of the navel orangeworm, Paramyelois transitella (Walker), by gamma radiation (Lepidoptera: Phycitidae). (Husseiny, M. M., Madsen, H. F., 1964)
- 1001 Control of weevil populations (Sitophilus granarius (L.)) with sterilising and substerilising doses of gamma radiation. (Cornwell, P. B. et al., 1966)
- 1002 USDA research program and facilities for the use of gamma irradiation in the control of stored-product insects. (Laudani, H. et al., 1965)
- 1008 Procédé et installation pour la destruction d'insectes par rayonnements nucléaires. (Boisot, M., Henrion, B., 1964)
- 1010 The entomology of radiation disinfestation of grain. (Cornwell, P. B., Ed.)
- 1012 Application of ionizing radiation to grain disinfestation. (Goresline, H. E., 1965)
- 1018 Dosimetry, tolerance, and shelf life extension related to disinfestation of fruits and vegetables by gamma irradiation. (Ross, E., Brewbaker, J. L., 1965)
- 1270 The effect of radiation on the cockchafer, Melolontha vulgaris. (Lavrov, M. T., Bogomaz, V. A., 1958)

7. Pesticide Resistance. Pathogen Susceptibility

See:

- 893 Prospects of integrated radiation and microbial control of harmful insects. (Jafri, R. H., 1965)

8. Tumour Induction

- 660 Burnet, B., Sang, J. H. PHYSIOLOGICAL GENETICS OF MELANOTIC TUMORS IN Drosophila melanogaster. II. THE GENETIC BASIS OF RESPONSE TO TUMORIGENIC TREATMENTS IN THE tu^K AND tu bw; st su-tu STRAINS. Genetics 49 (1964) 223-35.

The inbred tu^K and tu bw; st su-tu strains of D. melanogaster have a low incidence of melanotic tumours when cultured on a complete, defined medium under germ free conditions. Sub-optimal balances of pentose nucleotides in the larval diet, cholesterol deficiency, an excess of L-tryptophan, and exposing embryos to x-irradiation, cause an increase in tumour penetrance in the two strains and their F_1 , but there are quantitative differences between them. The response of the tu^K strain to treatment is due to a gene of low penetrance (tu^K) on the second chromosome, and a recessive enhancer modifier (e-tu^K) on chromosome three. The response of the tu bw; st su-tu strain is also due to a tumour gene (tu bw) on the second chromosome, which in normal environmental conditions is hypostatic to a recessive third chromosome suppressor (su-tu). It is fully penetrant in the absence of environmental treatments in genotypes containing the dominant allele (+su-tu) of the suppressor locus. Dietary-environmental treatments that increase tumour penetrance are thought to influence the reaction controlled by the tumour gene, rather than to interfere with the action of a specific tumour suppressor. (Auth.)

- 661 Burnet, B., Sang, J. H. PHYSIOLOGICAL GENETICS OF MELANOTIC TUMORS IN Drosophila melanogaster. III. PHENOCRITICAL PERIOD IN RELATION TO TUMOR FORMATION IN THE tu bw; st su-tu STRAIN. Genetics 49 (1964) 599-610.

Attempts to define the phenocritical period for the tu gene, in the tu bw; st su-tu strain, by environmental treatments show that the period in which tumour penetrance can be influenced by x-rays differs in time and duration from the periods in which dietary environmental treatments are similarly effective. The x-ray sensitive period begins early in embryonic development and terminates after the beginning of the 1st-larval-instar. The sensitive periods for excess dietary tryptophan, cholesterol deficiency, and suboptimal balances of dietary nucleotides, are the same within the limits of

resolution of the experimental data, beginning towards the end of the second instar and terminating after the beginning of the 3rd instar. x-ray and dietary environmental treatments consequently influence tumour penetrance through temporally different developmental reactions. Since x-ray and dietary treatments cause an increase in tumour penetrance in strains homozygous for the tu bw second chromosome, irrespective of the allelic combination present at the suppressor locus on chromosome three, they have a direct influence on the penetrance of the tumour gene, rather than an indirect effect due to interference with the phenotypic expression of the suppressor. (Auth.)

- 662 Ghélélovitch, S. THE TUMORIGENIC EFFECT OF x RAYS ON Drosophila (D. melanogaster) AND ITS QUANTITATIVE DEVELOPMENT IN THE COURSE OF ONTOGENY. Bull. Ass. fr. Etude Cancer 51 (1964) 203-24. (In French).

The D. melanogaster strain cl tu has a hereditary predisposition to melanotic tumours. Another strain, 8, does not have the genetic predisposition to tumours. The cl tu larvae were exposed to x-rays at age 22, 48 or 70 h. Of the 22 h controls, 59.2 ± 2.9% developed tumours. After 600 R, 89.8 ± 2.3% developed tumours. After 1200 R, 100% had tumors, and after 2400 R, 93.4 ± 2.1%. Tumour development in the 48 h larvae was: control, none; 600 R, 60.6 ± 3.5%; 1200 R, 91.8 ± 2.1%; and 2400 R, 93.4 ± 1.8%. At 70 h, the results were: 600 R, 60.6 ± 4.1%; 1200 R, 83.7 ± 2.3%; and 2400 R, 97.7 ± 1.0%. In a second experiment, after exposure to 300 R, 84.4% of the 1st larval stage developed tumours. In the 2nd stage, 63.7% developed tumours, and in the 3rd stage, 54.2%. After 600 R the results were: embryos: 85.4% tumour growth; 1st stage: 80.7%; 2nd stage: 54.9%; and 3rd stage: 42.9%. Radiosensitivity depended on the developmental stage, not the age of the larvae. But the period of change in sensitivity did not correspond to the moulting period. Whether the irradiation was done to the eggs or larvae of a given stage, tumours did not become visible until the last day preceding pupation. With an appropriate dose of x-rays, tumours can be induced in almost all cl tu larvae, regardless of age. With large x-ray doses (over 2-3000 R) a threshold of inversion was reached. Beyond this threshold the incidence of induced tumours declined. In the cl tu and F₁(cl tu × 8) strains, the statistical distribution of tumours followed the Poisson series, until the multiplicity of tumours increased. In the heterozygotes there was an excess of larvae without tumours and a decrease in frequency of those with only one tumour. (NSA 19:1965, 27982)

- 663(2) Ghélélovitch, S. PHYSIOLOGIC FACTORS DETERMINING IN THE FORMATION OF MELANOTIC TUMORS IN Drosophila (D. melanogaster). INFLUENCE OF HEAT AND IRRADIATION. Bull. Ass. fr. Etude Cancer 50 (1963) 399-411. (In French)

The effects of heating and irradiation were combined to investigate the process of tumour development in this insect. In the various experiments x-irradiation (600-3000 R) either preceded or followed the application of heat to the larvae. Results showed that thermal treatment in all cases significantly decreased the number of pupae presenting tumours, but had no effect on the multiplicity of tumours appearing in those insects in which heat failed to have an effect. Heat also did not modify the size of the developed tumours, which were much larger in irradiated animals by comparison with the non-irradiated. Sensitivity to heat increased in both irradiated and non-irradiated larvae with increased age. Heat had less effect on irradiated than non-irradiated larvae; this was clearly demonstrated when heat was applied from the 24th-48th h of larval life. Tumour formation was inhibited in 50% of non-irradiated larvae, but larvae receiving 600 R at age 24 h were not affected. These results showed the necessity for distinguishing at least two stages in Drosophila tumour development. Three factors operate in the manifestation of this phenomenon: cellular sensitivity, which can be increased by irradiation; tumorigenic stimulus, the effectiveness of which depends on genetic constitution; and the promoting factor, which can be inhibited by heat. Heat may completely suppress the probability of tumour development but cannot modify the process quantitatively. (From NSA 19:1965, 8829)

9. Modifying Factors

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

- 664 Abeleva, E. A. CHANGE IN THE NATURE OF RADIATION-INDUCED MUTATION IN THE SPERMATIDS OF *Drosophila* UNDER THE INFLUENCE OF ARGININE. *Radiobiologiya* 4, 3 (1964) 426-31. (In Russian). English Translation: AEC-tr-6406. *Radiobiology* 4, 3 (1964) 138-46.

Distribution curves of the frequency of recessive sex-linked lethals induced by doses of 1000 R of γ -radiation from a ^{60}Co -source were plotted for 11 successive 1-d-matings. The flies had been raised on ordinary or arginine-containing medium. The curves differed substantially only in the region corresponding to irradiated spermatids (the phase of nucleoprotamine synthesis). The genetic radiosensitivity of males which had been given arginine at the most radiosensitive phases (5th-6th day) decreased almost to the level of sperm cells. A characteristic reduction in radiosensitivity in sperm of males which had received arginine occurred a day earlier. The phase of increased radiosensitivity was reduced. Support is lent to the supposition that the mutation process in spermatids is of a biochemical nature.

- 665 Baxter, R. C. LETHALS IN *Drosophila* SPERMATOGONIA AFTER FRACTIONATED x-IRRADIATION. p. 34-35 of "University of Rochester, Atomic Energy Project. Brief Description of Most of the Research Programs Completed during 1964". UR-668, Rochester Univ., N. Y. Atomic Energy Project. 1 Jan. 1965, 175p.

Experiments were carried out in order to measure the incidence of sex-linked lethal mutations induced in *D. melanogaster* spermatogonial cells after single and fractionated exposure to x-irradiation. When males are irradiated with a single dose of 2000 R and then aged for 20 d without females, the lethal frequencies found for each of 5 brood tests are remarkably similar to that found for brood 5 of the males aged for 20 d and then given a single dose immediately before brood testing. Spermatozoa not used in copulation are clearly either absorbed or ejaculated, and are definitely not retained for long periods of time. Dose fractionation results in a highly significant reduction of lethals induced in spermatogonial cells, not attributable to repair or recovery mechanisms at the cellular level. A total dose of 2000 R is genetically and biologically more effective in producing lethal mutations when given as a single dose than when fractionated over 20 d at 2000 R/d.

- 666 Alexander, M. L. THE EFFECTS OF RADIATIONS ON THE GENETIC SYSTEMS OF ORGANISMS IN RELATION TO THEIR PHYSIOLOGICAL AND BIOCHEMICAL SYSTEMS. p. 137 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID, 4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 667 Alexander, M. L. GENETIC EFFECT OF COMBINED x-RAY AND ETHYLENIMINE TREATMENTS. *Genetics* 52, 2, Pt. 2 (1965) 426. Abstr.

1-d-old males of *Drosophila melanogaster* were treated with 1500 R of 250 kVp x-rays or injected with 0.0004 ml of a 0.01 M concentration of ethylenimine, or the two treatments combined. Males were mated, individually, to three M-9 females (sc^{81} In $S w^a$ sc^8 ; Cy/B11¹) every three days. Sex-linked recessive lethals were observed in samples from six remating periods. The results for x-rays were typical for radiation treatment with 3.0% or 3.0% lethals induced in mature sperm in two separate experiments. The rates increased to 11.06% or 11.8% in period C which probably represents spermatids. In meiotic and premeiotic stages the lethal rates were 2% or less. With ethylenimine treatment, the lethal rates were 2.9, 2.2 and 1.0% for the first three remating periods for 1-d-old males. When 7-h-old adult males were injected, the rates were 5.6, 7.8 and 4.0% for the same three periods. The rate then drops to 1% or less as in all previous experiments. When the treatments were combined, the sex-linked recessive lethal rates were approximately additive for the rates of the radiation and chemical treatments in postmeiotic cells. For mating period A, the combined treatments gave 5.5% in the first experiment and 6.11% in the second. In period C, the rates were 16.9% for the first and 15.2% for the second experiment. Rates for the combined treatments are less predictable for meiotic and premeiotic germ cells. (Abstr.)

- 668 Bychkovskaya, I. B., Ochinskaya, G. K. STUDY OF THE "OXYGEN EFFECT" AT VARIOUS RADIATION DOSE RATES. *Radiobiologiya* 4, 1 (1964) 63-66. (In Russian). English Translation: AEC-tr-6404. *Radiobiology* 4, 1 (1964) 85-90.

Calandra granaria can tolerate anoxia for a limited period. x-Irradiation of the beetles was carried out at 200 kV and 20 mA, filter 0.5 mm of Al, 0.25 mm of Cu, at dose rates of 500 and 50 R/min. Oxygen concentrations from 0-21% were used. The dependence of radiation injury of the granary weevils on O-concentration of the medium at the time of irradiation was characterized by an S-curve with a sharp increase in injury at a certain O-concentration and an "oxygen ceiling". Within a certain range of O-concentrations, radiation injury varied with very small changes in O-concentration whereas variations in dose rate within a considerably wider margin did not affect it. The magnitude of the O-effect at various dose rates cannot be determined in a quantitative fashion as a simple function of the radical concentration per unit time and the O-concentration. The significance of this factor can be admitted only for very high dose rates, not investigated in this study.

- 669 Carlson, E. A., Novitski, E. COMBINED ICR 100 AND x-RAY ANALYSIS OF THE STRANDEDNESS OF THE SPERMATOZOAN OF *Drosophila melanogaster*. *Genetics* 50, 2 (1964) 239-40.

To test the chromatid composition of spermatids, Oregon-R wild-type males were injected with ICR 100 (monofunctional quinacrine mustard). Half of these males were irradiated with a 3000 x-ray dose 24 h after injection. The other half were not irradiated. A third batch of wild-type males were irradiated with 3000 R at the same time as the preinjected series, but no ICR 100 was received by these males. All three groups were mated to *ed dp cl* (echinoid dumpy clot) virgin females. The F_1 were scored phenotypically for mosaic and complete mutations at the dumpy locus. The results showed no conversion of ICR 100 mosaic dumpies into complete dumpies through loss of a non-mutant chromatid in spermatids assumed to bear two chromatids per chromosome. The lack of change in the ICR 100 mosaic dumpy frequency supports, but does not prove, the model of a spermatid containing one chromatid per chromosome. Loss of the single chromatid through breakage in this model should result in a total loss of the mosaic rather than its conversion to a complete mutant. The results are summarized as follows: for ICR 100 alone, 12 mosaic dumpies and 3 complete dumpies among 4740 progeny; for 3000 R alone, 6 mosaic dumpies and 9 complete dumpies among 6185 progeny; for combined ICR 100 + 3000 R, 23 mosaic dumpies and 7 complete dumpies among 4431 progeny.

- 670 Chopra, V. L. TESTS ON *Drosophila* FOR THE PRODUCTION OF MUTATIONS BY IRRADIATED MEDIUM OR IRRADIATED DNA. *Nature*, Lond. 208 (1965) 699-700.

Food (10% dried killed yeast, 10% sucrose, 3% agar in water) were exposed to 1 mrad of γ -radiation in a single exposure. In the first experiment, 24- and 48-h-old larvae were transferred to the irradiated food about 36 h after exposure (termination), and the frequency of sex-linked and second chromosome (autosomal) lethals determined simultaneously in both males and females. In a second experiment, the usual maize meal-molasses food was used. Young *Or-K* females, mated 24 h earlier were transferred to irradiated food for egg laying immediately after exposure, so that developing flies should be exposed to the full effect. Results (tabulated) do not provide any evidence for a mutagenic substance being produced in irradiated food. - DNA from herring sperm was exposed to 100 000 R of γ -radiation (31 min exposure), then mixed with *Drosophila* food, and flies were then allowed to oviposit on it. The development of the flies was considerably delayed, first emergence taking 14 d (controls 9-10 d). In 1089 chromosome from 91 males developing on the above food (2200 chromosomes from 167 control males) the percentage of sex-linked lethals was 0.18 (0.22). A mutagenicity of irradiated DNA for *Drosophila* is not supported.

- 671 Come, T. V. MORPHOLOGICAL AND REPRODUCTIVE VARIATION UNDER FOUR ENVIRONMENTAL PRESSURES IN AN INBRED STRAIN OF *Drosophila melanogaster*. *Diss. Abstr.* 25, 2 (1964) 764.

The primary objective of this study was to determine the effect of radiation induced mutations on the level of homozygosity, in an inbred line of *D. melanogaster*, as determined by variance in phenotypic responses. The study contained three major aspects: selection for thorax length, genotype-temperature interactions, and small population density effects. The study indicates that genetic variability for thorax length is present in this highly inbred stock. Also, the factors concerned with size are, at least in part, epistatic to viability. Numerous inconsistencies were observed in the results, but the following conclusions seem valid: 1. Radiation reduces fecundity and contributes to

a reduction in offspring body size. 2. Low larval density will affect body size, with or without irradiation. 3. Selection pressure reduces fecundity particularly in the lines selected for small size. 4. Selection pressure is effective in this inbred line, but not symmetrical. 5. Temperature variations can affect body size and fecundity. 6. Selection for large thorax has a positive effect on viability at higher temperatures. 7. At larvae densities below 50 there is a linear relationship between size and density. 8. At higher temperatures more females are produced. (From DA)

- 672 Dubinin, N. P., Arsenieva, M. A., Glembotskii, Ya. L., Dubinina, L. G., Kozlov, V. M., Shevchenko, V. A. GENETIC EFFECT OF SMALL DOSES OF IONIZING RADIATION. A/CONF. 28/P/386, 3rd UN International Conference on the Peaceful Uses of Atomic Energy. May 1964, 20p.

P. 1-5 describe an investigation on the effects of fractionated doses of γ -rays, neutrons (1 MeV), and protons (126-130 MeV) on lethal and sublethal sex-linked mutations in *Drosophila*. A comparison of a number of sex-linked recessive lethals and sublethals per 1 rad/10⁷ gametes induced by irradiation with small doses and by a single irradiation at a level of 1000 rad shows that small doses (20 rad in one treatment of fractionated irradiation at 5 rad per treatment) produce far more point mutations (mainly recessive lethals) than do high doses. It is concluded that the genetic effects of small doses are cumulative and that no efficient chemical protection against such effects is possible.

- 673 Ducoff, H. S., Bosma, G. C. EVALUATION OF REPAIR PROCESSES IN x-IRRADIATED FLOUR BEETLES BY MEANS OF THE SPLIT-DOSE TECHNIQUE. *Radiat. Res.* 22, 1 (1964) 185. Abstr. 53.

As a prelude to investigation of recovery mechanisms in irradiated insects, the rate and the degree of recovery in x-irradiated flour beetles (*Tribolium confusum* Duv.) have been measured by the split-dose technique. If larvae received a single dose, 80-100% survive (are alive 5 weeks later as normal-appearing adults) exposure to 2.5 kR, but 0-20% survive after 5 kR, under "standard" conditions (30°C, 60% relative humidity, medium consisting of 90% white flour-4% dried yeast). Larvae were exposed to an initial dose of 2.5 kR, and a second 2.5 kR dose was administered at varying time intervals afterwards; the existence of at least two distinct components of injury was apparent. One injury component is repairable within 4 h or less; the other is not demonstrably altered within 48 h. The two components are about equal in magnitude. Adults are much more radioresistant, having an LD50 of approximately 12 kR, but exhibit little or no repair with intervals up to 24 h between two 7 kR exposures. It seems likely that both the greater resistance and the absence of rapid repair are associated with the absence of mitotic activity in the somatic tissues of the adult insect. (Abstr.)

- 674 Elequin, F. T. x-RAY DAMAGE AS MEASURED BY DOMINANT LETHALS, SEX-LINKED RECESSIVE LETHALS AND TRANSLOCATIONS IN *Drosophila melanogaster* AND OXYGEN AND ARGON AS ITS MODIFYING FACTORS. *Diss. Abstr.* 26 (1965) 637.

D. melanogaster (Oregon-R strain) males, 17-24 h old, were x-rayed with two fractions of 500 R each, separated by an interval of 20 min. The two x-ray fractions in any given experiment were given in the same gas, either O₂ or Ar. During the interval between the two x-ray fractions, the flies were kept either in O₂ or in Ar. Within 1 h after the x-ray treatments each male was mated simultaneously to the following number of virgin females for the measurement of induced sex-linked recessive lethals, translocations and dominant lethals, respectively: (1) two or three γ Muller-5 females; (2) two or three bw, st females; (3) one female derived from the cross between the males of Canton-S strain and the females of Austin strain. For the experiment in which the flies were x-rayed in O₂ and were kept in Ar between the two x-ray fractions, an increase in the damage as measured by sex-linked recessive lethals, dominant lethals and translocations was observed in the spermatid stage over that observed in the experiment in which the flies were x-rayed in O₂ but kept in O₂ between the two x-ray fractions. Peak sensitivities occurred at the early spermatid and meiotic stages. In the absence of O₂ during treatment, the differential response is much less obvious. With the x-rays given in Ar, no significant difference was found in the induced sex-linked lethals and translocations between the Ar and O₂ treatments during the interval between two x-ray fractions. For the dominant lethal tests, the results were the opposite of what were expected. Of the total translocations recovered, the Y-chromosome was involved in less than half and showed no preference for either one of the two major autosomes (2 and 3). The frequency of the translocations involving chromosomes two and three is 2.6 times as great as the Y-A (autosome) translocations. Chromosomes two and three were about equally affected by the x-ray treatment. In the F₁ matings, a greater amount of sterility was observed in the translocation tests for the in-oxygen, x-ray treatment than for the in-argon, x-ray treatment. The in-argon, x-ray treatments had about the same number of

sterile matings as the controls. The pattern of sterile F_1 matings for sex-linked lethals is not consistent, indicating that the irradiated genomes behave differently in males and females.

- 675 Erdman, H. E. x-RAY AND FAST NEUTRON EFFECTS ON PRODUCTIVITY OF FLOUR BEETLES. p. 137-39 of "Hanford Biology Research Annual Report for 1964". BNWL-122, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Jan. 1965, 229p.

Effects of temperature, x-ray, and the sex irradiated were studied for the day-old flour beetle, Tribolium castaneum (Herbst). Onset of reproduction was earlier and productivity greater as temperature increased. A 4 kR exposure of females delayed reproductive onset by 2-3 d. Productivity was reduced by 2 and 4 kR. Radiation effect on productivity was additive when both sexes were x-rayed. The ratio of doses required to produce 50% dominant lethals was 2.4:1 relative to 250 kV potential x-rays and 4.6 MeV fast neutrons. (Auth.)

- 676 Erdman, H. E. EFFECTS OF A SULFOXIDE COMPOUND ON FLOUR BEETLES EXPOSED TO x-RAYS. p. 142 of "Hanford Biology Research Annual Report for 1964". BNWL-122, Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Jan. 1965, 229p.

The effects of various sulphoxide compounds on the sensitivity of flour beetles, Tribolium confusum and Tribolium castaneum to x-radiation was investigated. Results are presented in tabular form. (NSA 20:1966, 10504)

- 677 Erdman, H. E. DOSE RATIO OF x-RAYS TO FAST NEUTRONS IN PRODUCING DOMINANT LETHALS IN FLOUR BEETLES, Tribolium castaneum. HW-SA-3719, General Electric Co. Hanford Atomic Products Operation, Richland, Wash. Nature, Lond. 205 (1965) 99-100.

The dose ratio of 250 kV x-rays and fast neutrons of mean energy 4.6 MeV for 50% dominant lethals in flour beetles, T. castaneum, observed during 2 weeks post-irradiation are reported. The term dose ratio is used since dose-response curves (dominant lethals) were of the multihit type curves for x-rays and one-hit type for fast neutrons. Fast neutrons were found to be 2-3 times more effective than x-rays in producing 50% dominant lethality. The mean dose ratio of 2.4, which produced 50% dominant lethals in Tribolium, corresponds with the value of 3.4 in Drosophila. (NSA 19:1965, 10852)

- 678 Fahmy, O. G., Fahmy, M. L. GENETIC PROPERTIES OF EXOGENOUS DEOXYRIBONUCLEIC ACID AT VARIOUS LEVELS OF DEGRADATION IN Drosophila melanogaster. Nature, Lond. 207 (1965) 507-10.

Homologous DNA was exposed in the gel-state to a massive dose of γ -rays ($> 230,000$ R). Degradation of DNA by ultrasonics or γ -radiation did not alter the type of mutations induced, but only increased the mutagenic efficiency as regards the induction of small chromosome deletions (Minutes). These results, which show the inactivity of degraded homologous DNA as regards sex-linked recessive lethals, are in clear contradiction with Parkash's report (711) that these mutations were produced at a high rate (5.7%) among the progeny of flies fed with an unspecified sample of irradiated DNA (presumably heterologous), when it was further suggested that part of the macromolecule was incorporated into the nuclei of the fly's germ line.

- 679⁽²⁾ Fritz-Niggli, H., Diener, E., Schleuss, P. SAUERSTOFFEFFEKT NACH KONVENTIONELLER RÖNTGEN- UND HOCH ENERGETISCHER ELEKTRONENBESTRAHLUNG BEI EINER STRAHLEN-MODIFIKATION (PHÄNOKOPIE). (Oxygen effect after conventional x-ray and high-energy electron irradiation in a radioinduced modification (phenocopy)). Biophysik 1 (1963) 51-59. (In German)

By irradiation of 5-h pre-pupa of D. melanogaster the wing placement of the adult flies was changed in the sense of spreading. The origin of this radio-induced modification, which represents at the same time a phenocopy, is dependent on genetic factors, since two different inbred strains were distinguished from one another by their radiation sensitivity. The biological effectiveness of electrons and photons were compared. Irradiation in pure N_2 hindered drastically the origination of the anomaly (a reduction from 98% injuries by 5000 R of 30-MeV electrons to 5%). No difference in protective effect was observed for 30-MeV electrons or 180-keV photons. The oxygen effect was postulated to be a blocking of processes in the macromolecular region. (NSA 17:1963, 30307)

- 680⁽²⁾ Glembofskiĭ, Ya. L., Lapkin, Yu. A., Parfenov, G. P., Kamilova, E. M. THE INFLUENCE OF COSMIC FLIGHT FACTORS ON THE FREQUENCY OF SEX-LINKED RECESSIVE LETHAL MUTATIONS IN Drosophila melanogaster. Kosm. Issled. 1 (1963) 326-34. (In Russian)

Experiments carried out during Vostok-3 and -4 flights revealed various types of mutations in D. melanogaster. Data from these flights were correlated with data obtained during five previous flights. In spite of the great variety of reactions found, a certain parallelism was observed in the heredity of insects exposed to the same conditions. Weightlessness, vibrations, acceleration, and cosmic radiation are postulated to combine and produce some variations in mutagenic reactions. (NSA 18:1964, 41129)

- 681 Ikenaga, M., Kondo, S. COMPARATIVE STUDIES OF MUTATION FREQUENCIES INDUCED BY ^{32}P TREATMENT AND γ -IRRADIATION IN THE MALE SILKWORM. Mutation Res. 2, 6 (1965) 534-43.

A wild type strain (C 108), and a marker strain homozygous for pe (pink egg, V-0.0) and re (red egg, V-31.7) were used. The frequency of mutation induced in the male silkworm fed with ^{32}P on the 3rd d of the 4th instar (shortly before meiosis) was compared with that induced by γ -irradiation. The daily dose of γ -rays was carefully adjusted day by day so as to fit the daily change in the absorbed dose delivered to the gonad by the ingested ^{32}P . The gonad dose for the ^{32}P treated group was estimated by applying Loevinger's equation (see Loevinger et al. "Radiation Field and Their Dosimetry: Discrete Radioisotope Sources". p. 693-799 of "Radiation Dosimetry". Hine, G. H., Brownell, G. L., Eds., New York, Academic Press. 1956); the parameters involved in the equation were experimentally determined with special care for biological factors. Using the ^{32}P dose estimates thus determined, we found that the mutation frequency was equal for the ^{32}P and γ -ray groups at the same absorbed dose. The authors conclude that there could be no chance for a mutation induced by ^{32}P transmutation to show up under the existing conditions and that the proposed ^{32}P dosimetry is satisfactory.

- 682 Ives, P. T. THE COMPARATIVE PATTERN OF MUTAGENESIS IN Drosophila SPERMATOGENESIS AFTER X RAYS VS Co^{60} GAMMA RADIATION. Genetics 50, 2 (1964) 258. Abstr.

Irradiated by x-rays (110 kV, 10 mA, 1 mm Al) D. melanogaster Oregon-R/cn bw $\sigma^{\circ}\sigma^{\circ}$ were tested for X-linked mutations using the same exhaustive mating scheme for days 1-12 as reported in Genetics 48:1963, 981-95 for ^{60}Co tests. After 1 kR of x-rays the daily pattern of mutagenesis was very similar to that shown earlier by Oregon-R/mc-th $\sigma^{\circ}\sigma^{\circ}$ in the ^{60}Co γ study. The x-ray tests produced after 1 kR 188 mutations in 6837 tests (2.7%) of days 1-3 sperm, and 87 in 861 tests (10.1%) of day-6 sperm. After 2 kR there were 392 mutants in 7749 days-1 to 3 sperm (5.1%) and 150 in 768 days-5 to 7 sperm (19.5%). There was a similar linear dose-rate relationship between 1 kR and 2 kR throughout the days 1-12 period. There was no evidence of any difference in effect between x-rays and ^{60}Co γ -rays. (Abstr.)

- 683 Iyengar, S. V. THE EFFECT OF COLD PRETREATMENT ON RADIATION EFFECTS AS RELATED TO AGE IN Drosophila melanogaster. Genetics 50, 2 (1964) 258-59. Abstr.

Two age groups, young (0-24-h-old) and old (2-week-old) Drosophila males having the Y^c;bw⁺ (marked ring Y chromosome) were each divided into four series. (a) untreated young and old controls (Y, O); (b) males subjected to -8°C for 15 min (CY, CO); (c) males that received 2500 R (YX, OX); and (d) males that were subjected to -8°C for 15 min prior to irradiation (CYX, COX). Males of all series were mated to virgin females of a suitable stock that enabled the detection of exceptional males showing the loss of the Y-chromosome and/or its bw⁺ gene and the loss of the parental X-chromosome. Broods were made every 3d and cultures were maintained at 25°C. Combined results for the first four broods were as follows (exceptional males/total): Y, 9/3531 (0.25%); CY, 9/3700 (0.24%); YX, 18/2937 (0.61%) and CYX, 20/2706 (0.73%). O, 3/3143 (0.09%); CO, 4/1396 (0.28%); OX, 21/1778 (1.18%) and COX 6/1577 (0.38%). The control groups would show few if any losses of the parental X-chromosome, thus almost all exceptions would represent losses of the Y-chromosome. Results seem to indicate differential response of the two age groups to these physical agents. Sterility tests on all exceptional males have been carried out. Bilateral mosaics appeared only in the young group. Older males suffer a serious reproductive setback due to cold-pretreatment. (Abstr.)

- 684 Khan, A. H., Alderson, T. MUTAGENIC EFFECT OF IRRADIATED AND UNIRRADIATED DNA IN Drosophila. Nature, Lond. 208 (1965) 700-2.

The effects of adding irradiated DNA to chemically defined and axenic Drosophila medium were investigated. Calf-thymus DNA as a dry powder was exposed to 100 000 R (exposure time 6 min 12 sec). Newly hatched Or-K larvae were allowed to develop into adults on the above medium,

containing 5% irradiated or 5% unirradiated DNA. Results are tabulated. Both DNA experiments show a significant increase in F₂ autosomal recessive lethal-mosaicism compared with the control. Tables 2 and 3 show, however, that the irradiation of calf-thymus DNA, prior to its addition to the larval medium does not produce a significant increase in mutation in Drosophila.

- 685² Khishin, A. F. E. EFFECTS OF STORING x-RAYED SPERMATOOZOA ON THE FREQUENCY OF TRANSLOCATIONS AND SEX-LINKED LETHALS IN Drosophila melanogaster. Z. VeterinärLehre 94, 3 (1963) 280-4. (In English)

x-Rayed adult males of D. melanogaster were left with untreated females from 2-3 d after which the males were discarded. Sex-linked recessive lethals and translocations were scored in progeny produced during the first 2 or 3 d following irradiation, and after storage of the spermatozoa in the females for 8 d. The results obtained show that the frequencies of sex-linked lethals and of translocation involving the two large autosomes and the X-chromosome were unchanged by storage. In experiments in which Y, 2, 3 translocations were scored both the 2-3, and the Y translocations showed a slight increase. These experiments show that the strong storage effect on translocations produced by certain alkylating agents is peculiar to chromosomes treated by these chemicals. (Auth. summary)

- 686 Kondo, S. RBE OF FAST NEUTRONS TO γ -RAYS FOR MUTATIONS IN RELATION TO REPAIR MECHANISMS. Idengaku Zasshi (Jap. J. Genet.) 40, Suppl. (1965) 97-106.

A brief review of relative biological effects (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: The overall mutation frequency in silkworm gonads depends on the interaction of radiation with the intercellular repair mechanisms connected with certain multi-cellular organs, and the low mutation rate recovered on acute γ -irradiation of silkworm larvae at the late gonadal stage is due to stimulation of repair by radiation. (Auth.)

- 687 Künkel, H. A. GIBT ES EINEN GENETISCHEN STRAHLENSCHUTZ? (Does genetic radiation protection exist?). Atompraxis 10, 7 (1964) 301-5. (In German)

The various hypotheses being discussed at present in regard to the effective mechanism of chemical radioprotective substances admit (in contrast to previous views) the possibility that direct radiation effects, e.g. radiation-induced point mutations, can also be influenced by so-called protective substances. Extensive genetic experiments with Drosophila melanogaster and also with Bacterium coli have shown that application of cysteine and also of serotonin before irradiation reduces the induction of mutations. On the other hand, the compound aminoethylisothiuronium (AET), which is known to be especially effective against somatic radiation damage, caused a significant increase in the radiation-induced mutation rate. (Auth.)

- 688 Künkel, H. A., Trams, A., Henke, H. EFFECT OF 5-HYDROXYTRYPTAMINE (SEROTONIN) ON THE RADIATION-INDUCED RATE OF MUTATION IN Drosophila melanogaster. Naturwissenschaften 52, 23 (1965) 650. (In German)

The percentage of recessive, sex-linked, lethal mutations produced in D. melanogaster with 3000 rad was 7.9%, and was 1.6% in flies treated with 0.1 mm³ of a 1% solution of serotonin injected intra-abdominally. In flies treated with serotonin 10 min before irradiation, the percentage of recessive, sex-linked, lethal mutations was 15.8%. The results were not caused by the addition of the effects of the two mutagenic factors, but were produced by an irradiation-sensitizing effect of serotonin which, in different biological systems, can have a radioprotective effect. (CA 64:1966, 3940d)

- 689 Kuzin, A. M. THE THEORY OF BIOLOGICAL ACTION OF FAST NEUTRONS. Radiobiologiya 4, 1 (1964) 18-22. (In Russian)

The literature is reviewed on the RBE of irradiation by neutrons in comparison with γ -rays. From the classical target theory, neutron irradiation should be less effective because of the high ionization density and high loss of energy in passing through a structure. However, numerous experiments have shown that neutron irradiation is more effective than γ -irradiation. The neutron RBE values for 10 tissues including Drosophila are tabulated. Comparison of acute and chronic radiation effects indicates a higher RBE in the chronic action of small doses of neutrons. The cumulative damage from

neutrons is considered different from that due to γ -irradiation. The structural-metabolic theory proposed by this author earlier considers the damage due to structural, metabolic, and recovery factors, continuously taking place in the living cell. A formula is presented for calculating the effect.

- 690 Lefevre, G., Jr., Jonsson, U.-B. THE EFFECT OF MATING INTENSITY ON MUTATION FREQUENCY PATTERNS DETECTED AFTER IRRADIATION OF Drosophila melanogaster MALES. Genetics 50 (1964) 879-90.

The patterns of mutation frequencies detected at daily intervals following irradiation of adult males with 4000 R are strikingly affected by the mating regimen that is subsequently applied to them. This fact implies that differential mutability, not recovery from the genetic effects of irradiation, is responsible for the U-shaped mutation frequency curve observed after irradiation. When males are allowed to mate but once a day, the successive sperm samples generally contain a mixture of sperm derived from cells that were at different stages of maturity at the time of irradiation. Thus, the variation in mutation frequency at successive intervals after irradiation is minimal. Only when irradiated males mate several times each day is it possible to obtain sperm samples derived more or less homogeneously from single stages of spermatogenesis. Even then, if mutation frequencies are collected on a daily basis, changes within a 24 h period are completely obscured. Optimally, irradiated males must be provided each day with a succession of virgin females so that observed matings can be obtained and mutation frequencies determined separately from each consecutive insemination. When this technique is adopted, the mutation frequency is seen to change drastically within the course of the first three matings after irradiation of 3-d-old males, beginning with the high mutation frequency characteristic of fully mature, motile sperm (4% per 1000 R), but falling to the much lower level characteristic of immotile, immature sperm stages (1.0% per 1000 R). By the 4th or 5th day after irradiation, if the mating schedule is properly adjusted, the mutation frequency rises again to a level as high as (or higher than) that characteristic of mature sperm as germ cells irradiated in the highly mutable early spermatid stage come to be sampled. Although the pattern of mutation frequencies is strongly affected by mating intensity following irradiation of adult males, the overall mutation frequency is not, so long as the entire population of postmeiotic germ cells is sampled. (Auth.)

- 691 Lefevre, G., Jr. FACTORS MODIFYING MUTATION FREQUENCY PATTERNS DETECTED AFTER IRRADIATION OF Drosophila melanogaster MALES. Mutation Res. 2 (1965) 22-28.

The reduction in mutation frequency associated with premating irradiated males can be explained by the higher intrinsic mutability of fully mature as compared with less mature sperm; it cannot be explained by recovery from genetic effects of irradiation. This is supported by the fact that withholding irradiated virgin 2- and 7-d-old males from mating for 24 or 48 h also reduces the mutation frequency, but only to a level intermediate between that observed in the first mating immediately after irradiation of virgin males of comparable age, and that observed from matings made 24-48 h later. If in the meantime the males have been allowed to mate repeatedly. The change in frequency of mutations detected at successive intervals after irradiation is a dynamic reflection of the progress of spermatogenesis, as germ cells having different mutabilities because they were at different stages of development at the time of irradiation are sampled one after another. (From auth. summary)

- 692 Magdon, E., Winterfeld, G. UNTERSUCHUNGEN ZUR WIRKUNG VON KATALASE UND PEROXYDASE AUF DIE STRAHLENINDUZIERTE MUTABILITÄT BEI Drosophila melanogaster. (Study on the effect of catalase and peroxidase on radiation-induced mutability in Drosophila melanogaster). Strahlentherapie 126, 3 (1965) 427-31. (In German, with English and French summaries)

Solutions of peroxidase or catalase were injected abdominally into adult males of D. melanogaster of the wild Berlin strain prior to irradiation with a x-ray dose of 1500 R. Using the M-5-method, the incidence of recessive sex-linked lethals at different stages of spermatogenesis was determined. Peroxidase and catalase decreased the radiation-induced mutation rate only in germ cells still in a stage of division at the time of irradiation. No significant effect on mature sperm and spermatids was observed.

- 693 Matsudaira, Y., Ito, T., Yamasaki, S., Ishizaka, S., Domon, M. ON THE FRACTIONAL- AND WHOLE-BODY MUTATIONS INDUCED BY SOFT x-RAYS IN Drosophila. Idengaku Zasshi (Jap. J. Genet.) 38, 4 (1964) 288-89.

2-d-old Oregon-R males were exposed to 400 R, 720 R, and 1440 R of nearly monochromatic x-rays (1.54 Å) and mated with virgin females of $y\ w\ m\ f$ stock. F_1 females were examined for four marker genes. In the dose range employed more fractional-body mutants were induced than whole-body mutants. (Spontaneous mutation was not counted). A reverse relation has been reported by various workers in the high dose region (2000-5000 R), which appears to be consistent with results for yeast cells obtained over a wide range of doses, suggesting an analogous mechanism in two widely different organisms.

- 694 Mittler, S. THE FAILURE OF SULPHHYDRYL COMPOUNDS, AET, MEA, AND GLUTATHIONE TO PROTECT AGAINST x-RAY INDUCED CHROMOSOME ABERRATIONS IN MALE *Drosophila*. *Int. J. Radiat. Biol.* 8 (1964) 405-13.

Pre-treatment with the mammalian radioprotective sulphhydryl compounds AET, MEA, and glutathione did not protect the *Drosophila* testis from radio-induced genetic damage. Protection was not given to spermatozoa, spermatids, spermatocytes, and spermatogonia. The responses measured were production of recessive sex-linked lethals, translocations, deletions, loss of X- and Y-chromosomes and dominant lethals. MEA increased the recessive lethals in the 3-6 d brood. Pre-treatment with glutathione increased the incidence of XO males in the 6-9 d brood and post-treatment in 0-3 d brood. MEA and glutathione increased the percentage of eggs that failed to develop in dominant lethal tests. (Auth.)

- 695 Mittler, S. STUDIES OF CHEMICAL PROTECTION AGAINST RADIATION INDUCED GENETIC ABERRATIONS. p. 113 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 696 Mittler, S. STUDIES OF CHEMICAL PROTECTION AGAINST RADIATION INDUCED CHROMOSOME ABERRATIONS. Final Report, September 1, 1961-August 31, 1965. TID-22293, Northern Illinois Univ., DeKalb. Dept. of Biological Sciences. 1965, 41p.

Results are reported from a study on the mechanism of the radiation induced genetic changes. The protective effects of sulphhydryl compounds used to protect mammals, AET (aminoethylisothiourea dihydrobromide), MEA (mercaptoethylamine), and glutathione on radiation induced genetic damage of *Drosophila* testis were investigated. Protection was not given to spermatozoa, spermatids, spermatocytes and spermatogonia. The responses measured were production of recessive sex-linked lethals, translocations, deletions, loss of X- and Y-chromosomes, and dominant lethals as measured by the failure of fertilized eggs to develop. MEA did increase the recessive lethals in the 3-6 d brood. Pre-treatment with glutathione increased the incidence of XO males in 6-9 d brood and post-treatment in 0-3 d brood. MEA and glutathione increased the percentage of eggs that failed to develop in dominant lethal tests. Preliminary tests with pre-treatment with AET on radiation induced crossing-over in the male indicated that there was no protection but an enhancement of this radiation effect. (Auth.)

- 697 Mittler, S., Webster, M. C. THE EFFECT OF ATP UPON RADIATION INDUCED "DOMINANT LETHALS" IN *Drosophila*. *Genetics* 50, 2(1964) 269. Abstr.

To test the hypothesis that ATP would encourage rejoining chromosomes that have been broken by radiation, ATP (crystalline disodium) at concentration of 5 mg/ml of phosphate buffer was injected 0.1 µl into male Oregon-R *Drosophila* either before or after irradiation at 2000 R. The males were mated at ratio of one male to three females every 3 d. The "dominant lethals" were determined by failure of fertilized eggs to develop after 24 h. Pretreatment with ATP enhanced the "dominant lethals" in broods 0-3, 8-6, 6-9 d, however ATP increased the number of eggs which develop in the 9-12 d brood. Post-treatment with ATP on the other hand protected against "dominant lethals" in 0-3 and 9-12 d broods and had no effect on the 6-9 d brood, but enhanced the 3-6 d brood. (Abstr.)

- 698 Mittler, S., U. R. ATP AND RADIATION INDUCED CHROMOSOME BREAKAGE IN *Drosophila*. *Genetics* 52, 2 Pt. 2 (1965) 460. Abstr.

Approximately 0.1 µl of 5 mg of ATP/ml was injected into 2-16-h-old male $X^{C^2}Y^B, Y^{sc^4}Y^+$. These males along with a control group injected with saline solution were then irradiated with 2000 R of x-rays and mated daily to a new harem of $y\ w\ f$ at a ratio of one male to three females. The loss of the ring X-chromosome or the y^+ portion of the Y-chromosome was ascertained by the appearance

of exceptional (XO) y w f males. ATP did not prevent the loss or aid in the recovery of these chromosomes in the postmeiotic stages of spermatogenesis at the time of irradiation represented by the broods of day 0-1, 1-2, 2-3, 3-4 or 4-5. However, in the 5-6 d ATP brood there was significant reduction of XO males, 3.11% of the total offspring as compared to 4.46% in the control brood. In the next brood, day 6-7, there was no reduction of XO males; however, in broods which also represent cells in or about meiosis, days 7-8 and 8-9, there was a significant reduction of XO males in the offspring of the ATP-treated males. The control broods for days 7-8 and 8-9 had the greatest number of XO males, 7.5% and 7.25% respectively, and also the fewest offspring. There was also a reduction by ATP of XO males in brood day 9-10, which represent late spermatogonia at the time of irradiation. There were no significant differences between control and treated broods for days 10-11 and 11-12. (Abstr.)

- 699 Mituo, I., Kondo, S. COMPARATIVE STUDIES OF MUTATION FREQUENCIES INDUCED BY ^{32}P TREATMENT AND γ -IRRADIATION IN THE MALE SILKWORM. Mutation Res. 2 (1965) 534-43.
- The frequency of mutations induced in the male silkworm fed with ^{32}P on the 3rd day of the 4th instar (shortly before meiosis) was compared with that induced by γ -irradiation. The daily dose of γ -rays was carefully adjusted day by day so as to fit the daily change in the absorbed dose delivered to the gonad by the ingested ^{32}P . The gonad dose for the ^{32}P treated group was estimated by applying Loevinger's equation; the parameters involved in the equation were experimentally determined with special care for biological factors. Using the ^{32}P dose estimates thus determined, it was found that the mutation frequency was equal for the ^{32}P and γ -ray groups at the same absorbed dose. It was concluded that there could be no chance for the mutation induced by ^{32}P transmutation to show up under the present conditions and that the proposed ^{32}P dosimetry is satisfactory. (Auth.)

- 700 Mukherjee, R. ACTINOMYCIN D EFFECTS ON THE FREQUENCY OF RADIATION-INDUCED MUTATIONS IN Drosophila. Genetics 51, 3 (1965) 363-7.
- Oregon-R males of D. melanogaster were subjected to (1) actinomycin D + 600 rad of γ -rays; (2) 0.7 N NaCl + 600 rad of γ -rays; (3) actinomycin D; and (4) 0.7 N NaCl. Each treated male was tested for radiation-induced sex-linked recessive lethal mutations by the Muller-5 technique, for eight successive daily broods. The actinomycin D + γ -ray series showed a significant reduction in mutation frequency relative to the frequencies in the saline + γ -ray series in all the sperm samples from the 3rd- to 6th-d brood. The data are consistent with the model of a protein-dependent process of mutation fixation of radiation-induced premutational genetic damage. (Auth. summary)

- 701 Murakami, A., Kondo, S. RELATIVE BIOLOGICAL EFFECTIVENESS OF 14 MeV NEUTRONS TO γ -RAYS FOR INDUCING MUTATIONS IN SILKWORM GONIA. Idengaku Zasshi (Jap. J. Genet.) 39, 2/3 (1964) 102-14.
- The RBE of 14 MeV neutrons and ^{137}Cs γ -rays in the induction at marked loci of visible recessive mutations in early and in late gonial cells was investigated, and a dose-frequency curve for each radiation obtained. The curves were qualitatively similar, an initial linear part being followed by an exponential rise with increasing dose. A drop in mutation rate appeared after irradiation with neutron doses of 2000 rad for early and late spermatogonia and late oogonia. These data fit the selective killing hypothesis. Below 1000 rad more or less similar mutation rates were observed in early and late gonial cells of both sexes; above 2000 rad, the mutation frequency in late groups was much higher. The mutation frequencies in late gonial cells due to neutrons were much higher than after exposure to γ -rays, whereas they were almost equal for early gonial cells. The RBE was found to be very sensitive to the stage of the germ cell, being ~ 1 for early gonial cells and 2-3 for late gonial cells (at the level of 10^{-3} mutation frequency).

- 702 Murakami, A., Kondo, S., Tazima, Y. COMPARISON OF FISSION NEUTRONS AND γ -RAYS IN RESPECT TO THEIR EFFICIENCY IN INDUCING MUTATIONS IN SILKWORM GONIA. Idengaku Zasshi (Jap. J. Genet.) 40 (1965) 113-24.

An investigation was made of the effects of fission neutrons on the induction of visible recessive mutations in early and in late gonial cells of the silkworm. The results were compared with those of our previous reports, in which 14 MeV neutrons and ^{137}Cs γ -rays were used. Dose-mutation frequency curve for fission neutrons was essentially the same as that for other radiations, showing a slow rise in the lower dose range but a rapid rise in the higher dose range. Mutation response to

fission neutrons was almost similar for male and female gonial cells, although higher frequencies were observed for fission neutrons than for γ -rays or 14 MeV neutrons. When radiation doses producing a frequency of 10^{-3} of visible recessive egg-colour mutations were used as a criterion, the relative biological effectiveness of fission neutrons to γ -rays was about 1.7 to 2.4 for early stage gonla and 3.0 to 4.2 for late-stage gonla. Similar results have already been reported for 14 MeV neutrons, although the values were smaller. All the dose-frequency curves obtained in the recent series of our work with γ -rays, 14 MeV neutrons and fission neutrons are given in the present paper to make them available for further investigations in this field. (Auth.)

- 703²¹ Murakami, A., Tazima, Y. MODIFICATION OF x-RAY INDUCED MUTATION RATE IN THE SILKWORM BY PRE OR POST IRRADIATION TREATMENT WITH HALOGENATED BASES ANALOGUES. Rep. natn. Inst. Genet., Misima 13 (1962) 89-91.

- 704 Nickel, E. EFFECTS OF 2,4-DINITROPHENOL ON THE RADIOINDUCED DOMINANT LETHAL FACTORS IN Drosophila melanogaster. Strahlentherapie 126 (1965) 263-68. (In German)

The influence of 2,4-dinitrophenol on the radio-induced dominant lethal factors of D. melanogaster was investigated. Administration of DNP by food or by injection to 80- or 96-h-old male larvae 4 h prior to irradiation did not affect the number of the radio-induced dominant lethal factors. Dominant lethal factors produced by irradiation with 1000 R affected predominantly the early embryonic stages. The ineffectiveness of DNP, administered 4 h prior to irradiation, might be explained by a possible dissimilation or by the excretion of DNP. There were anomalies in the testes of adult males irradiated during the larva stage. (Auth.)

- 705 Nicoletti, B., Olivieri, A., Olivieri, G. FURTHER DATA ON THE INTERACTION BETWEEN ULTRAVIOLET AND IONIZING RADIATIONS ON THE PRODUCTION OF RECESSIVE LETHALS IN Drosophila melanogaster. Atti Ass. genet. ital. 9 (1964) 172-84. (In Italian)

The sex-linked recessive lethal mutation frequency induced by 4000 R of x-rays in mature sperms of D. melanogaster was significantly decreased by a u. v. post-treatment (λ 2537 Å, 3×10^6 ergs/cm² exposure dose). Use of smaller u. v. doses (1.8×10^6 ergs/cm²) did not result in a decrease of the x-ray induced recessive lethals. Spermatozoa and spermatids showed a similar sensitivity to u. v. induction of point mutation recessive lethals in a $X^{C-2}yB$ ring chromosome. The possible mechanism through which u. v. radiation determines these effects was examined. (Auth.)

- 706 Ondrej, M. INFLUENCE OF INTERACTION BETWEEN EDTA AND x-RAYS ON MUTATION AND CROSSOVER FREQUENCIES IN Drosophila melanogaster. p. 26-29 of "Induction Mutations Mutation Process. Proceedings of a Symposium, Prague, 1963". Published 1965.

A whole generation of Suchumi stock was put into a medium containing $2 \times 10^{-3}M$ EDTA. EDTA alone caused 0.49% lethals, x-rays alone 4.41%, and the combination of EDTA and x-rays 5.43%. If EDTA solution was given to 24-48-h-old males, an increased lethal effect was observed during the first days after the administration (9.57%). The combination of EDTA injection with x-irradiation resulted in lower original values of lethals (4.7%) with relative constant values even 6 d later. Virgin females were influenced by EDTA and x-rays, either alone or in combination. All types of treatment increased the cross-over frequency. (CA 64:1966, 10061c)

- 707 Oster, L. I. MODIFICATION OF GENETIC DAMAGE PRODUCED BY IONIZING RADIATION. p. 135 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.

- 708 Oster, L. I. MUTAGENIC EFFECTS OF CHRONICALLY AND INTENSELY DELIVERED RADIATION IN Drosophila. Idengaku Zasshi (Jap. J. Genet.) 40, Suppl.(1965) 83-96.

Results of recent experiments on the effects of varying the dose-rate of γ -radiation in Drosophila are presented and discussed in relation to previous findings and those of others. At the present time no clear-cut evidence for a dose-rate effect in the production of mosaically-expressed and whole-body point changes is available although further work is indicated. The latter would be aimed at ruling out the possibility of complications arising because of differential radiosensitivity masking repair mechanisms. On the other hand, in non-static cells (e.g. those which are more active, metabolically-speaking, and less mature than spermatozoa) processes involving multi-hit phenomena exhibit a distinct dosage dependence. (Auth.)

- 709 Parfenov, G. P. OCCURRENCE OF CROSSING OVER IN Drosophila MALES UNDER THE INFLUENCE OF VIBRATION, ACCELERATION AND γ -IRRADIATION. Kosm. Issled. 2, 4 (1964) 648-53. (In Russian). English Translation: FTD-TT-64882. Cosmic Res. (1964) 232-41.
- The influence of vibration, acceleration, and γ -irradiation on the incidence of crossing-over in Drosophila males is examined. It is customary to assume that this class of hereditary changes is governed by rebuilding of homologous chromosomes in the meiotic stages. This test was also used aboard artificial earth satellites to indicate the biological effect of cosmic radiation, and some results were obtained. To analyse the differences that arose, experiments were run with Drosophila specimens subjected to acceleration, vibrations, γ -irradiation, and combinations of these factors. The data obtained are discussed. (Auth. - NSA 18:1965, 41095)
- 710 Parkash, O. INDUCTION OF SEX-LINKED RECESSIVE LETHALS AND VISIBLE MUTATIONS BY FEEDING x-IRRADIATED DNA TO Drosophila melanogaster. Nature, Lond. 205 (1965) 312-3.
- The radiomimetic effects of DNA irradiation products (DNAm) were studied in D. melanogaster fed on DNA irradiated with 100 000 R radiation. Males emerging from larvae fed DNAm media were tested for sex-linked lethals by Muller's technique before mating with normal females. A number of visible mutations were found in the resultant cultures, in addition to a number of flies with gross morphological abnormalities. No conspicuous visible mutations or flies with morphological abnormalities were detected in cultures produced by flies fed normal DNA. Hence, the mutagenic effect of DNAm was definitely established. Assuming a spontaneous mutation rate of 0.17%, DNAm cultures showed a 32-fold increase over the spontaneous rate, an increase corresponding to a direct exposure of the spermatozoa to about 2000 R of x-ray. (NSA 19:1965, 10910)
- 711 Parkash, O. ON THE RADIOMIMETIC EFFECT OF IRRADIATED DESOXYRIBONUCLEIC ACID (DNAm) ON Drosophila melanogaster. Naturwissenschaften 52 (1965) 142.
- The mutagenic effect of DNA irradiated with a dose of 100 000 R at a rate of 625 R/min on D. melanogaster was investigated. The males from the larva that had grown on irradiated DNA were tested for the presence of sex-linked recessive lethals. A sex-linked recessive lethal rate of 5.7% was found, and an autosomal recessive lethal rate of 8.6%. In addition a number of visible mutations concerning the eye colour, body colour, and body size, abdominal malformation, and wing size and form were also detected. The results showed a 30-fold increase for the sex-linked lethals and 60-fold increase for the autosomal lethals. (NSA 19:1965, 38413)
- 712⁴⁰ Plough, H. H., Ed., Sheppard, C. W., Ed. GENETIC EFFECTS OF FAST NEUTRONS FROM NUCLEAR DETONATIONS. PROJECTS 23.4-2314 AND 23.16 OF OPERATION UPSHOT-KNOTHOLE. WT-820, Division of Biology and Medicine (AEC), Washington, D. C. Jan. 1954, 58p.
- A series of genetic test objects were exposed to fast neutron irradiation at Upshot-Knothole. Drosophila flies, Mormonella wasps, and several mouse strains constituted the animal specimens used. The data indicate that the relative biological effectiveness (RBE) for genetic effects from detonation neutrons compared with x- or γ -irradiation is high, observed values ranging from about 2-15 or more. The RBE for chromosome breakage from detonation neutrons is not significantly higher than that from cyclotron neutrons; this conclusion is subject to some uncertainties in dose determination. It is indicated that the RBE for the production of simple mutations by fast neutrons compared with x-rays tends to be low. The values are higher for gross chromosome aberrations. The genetic tests are of some value as biological dosimeters supplementary to physical dosimetry. The studies clearly indicate that for equal doses neutrons represent a greater potential genetic hazard than other forms of radiation from nuclear detonations. (From auth.)
- 713 Purdom, C. E., Bridges, B. A. EFFECT OF SULPHYDRYL REAGENTS ON THE FREQUENCY OF x-RAY-INDUCED AUTOSOMAL RECESSIVE LETHAL MUTATIONS IN Drosophila melanogaster. Nature, Lond. 203 (1964) 419.
- The induction of autosomal recessive lethals in D. melanogaster was studied by the brood analysis technique that tests germ cells irradiated at all stages of maturation. Prior to x-irradiation under anoxic conditions, the animals were injected with saline, saline plus N-ethylmaleimide, (NEM), or iodoacetamide (IA Am). A significantly higher mutation frequency was observed in the group treated with NEM compared to the saline-injected group, but not in the IA Am and saline injected groups. (NSA 18:1964, 36987)

- 714 Reddi, O. S., Reddy, G. M., Rao, J. J., Ebenezer, D. N., Rao, M. S. LACK OF MUTAGENIC EFFECT OF IRRADIATED Drosophila MEDIUM. Nature, Lond. 208 (1965) 702.

The basic medium (water, glucose, agar, yeast, propionic acid in the proportions of 100:10:3:10:0.4 in g) was exposed to 150 000 and 300 000 rad of γ -radiation, at 25 000 rad/min. Treated and control bottles were stocked with adult flies of the wild-type Or-K strain. When sufficient eggs had been laid the parents were discarded. Subsequent tests on progeny from mating under specified conditions were made for recessive sex-linked lethals and translocations, and for sex-linked visible mutations and large deletions. There appears to be no justification for a claim of genetic effects on Drosophila arising from the irradiated medium.

- 715 Reddi, O. S., Rao, M. S. GENETIC EFFECTS OF COSMIC RADIATION IN Drosophila melanogaster. Nature, Lond. 201 (1964) 96-7.

Dominant lethality was used as the measure of the genetical effect. 2 to 3-d-old males of the wild-type Oregon-K strain were sent in plastic food cups in a pressurized Al gondola at 8°N geomagnetic latitude to a height of 20 miles into the stratosphere. The compositions of charged particles there is 85% protons, 14% α -particles, and ~1% heavier charged particles, giving a dose of 0.7-0.8 mR/d/unit volume; for a 6-h flight 0.18-0.20 mR/unit volume would thus be received. Soon after descent, one lot of males was tested for dominant lethals in six successive broods of 3 d each, while the other lot was screened for sex-linked recessive lethals and translocations. Dominant lethals were determined by hatchability tests. A dual-purpose tester stock, $y\ sc^{SI}$ in 49 sc^+ ; bw; st, was used. There was no evidence for increased frequency of recessive lethals or translocations but hatchability tests showed a consistent reduction in the first three broods of the treated series, while in the later broods the difference between them and the controls became less significant. The induction of dominant lethals may account for this reduction.

- 716 Rinehart, R. R. INFLUENCE OF OXYGEN, HELIUM, AND METABOLIC INHIBITION ON x-RAY INDUCED DOMINANT LETHALITY IN STAGE 7 AND STAGE 14 OOCYTES OF Drosophila melanogaster. Genetics 49 (1964) 855-63.

Experiments designed to test the effects of various O_2 -tensions given before, during, and after the x-irradiation of adult females on the survival of stage 7 and stage 14 oocytes support the following conclusions: No significant differences in the relative radiosensitivity between stage 7 and stage 14 oocytes is attributable to differential amounts of intracellular O_2 . Extended He pre- or post-treatment causes a significant increase in x-ray induced dominant lethality in stage 7 oocytes. This increase in lethality is proportional to the duration of anoxia. No such sensitizing effect of helium treatment is observed with the stage 14 cells. The effect of anoxia in increasing dominant lethality is prevented when the flies are given anoxic treatments at 4°C. The effects of anoxic pretreatment are reversed when the cells are allowed to recover in air prior to irradiation. The results are interpretable in terms of a system that repairs chromosome breaks and that is depleted during prolonged anoxia. (Auth. summary)

- 717 Rinehart, R. R., Ratty, F. J. MUTATION IN Drosophila melanogaster CULTURED ON IRRADIATED FOOD. Genetics 52, 6 (1965) 1119-26.

Males and females were cultured on food irradiated with 150, 500, or 3000 kR of x- or γ -rays and offspring were tested for dominant, sex-linked, and F_3 lethality. In some experiments, control and irradiated food was stored for three weeks prior to its use. There was no decrease in F_1 offspring survival associated with culturing on irradiated food. There was an approximate two-fold increase in sex-linked recessive lethality in the 150, 500, and 3000 kR experiments. This increase can be attributed largely to an increase in gonial mutants. Aging the food prior to use resulted in a decrease in nongonial mutation; there is still, however, an effect of the irradiated food in increasing lethality above control levels, which was again associated with gonial mutations. F_3 lethality was not detectably increased whether mosaic, F_1 complete, or total F_3 lethality was considered. (Auth. summary)

- 718 Schleuss, P. EINFLUSS EINER KÄLTEBEHANDLUNG NACH BESTRAHLUNG AUF DEN AUSFALL DER SETA DORSO-CENTRALIS ANTERIOR BEI Drosophila melanogaster "SEVELEN" UND "BERLIN INZUCHT". (Effect of cold treatment post-irradiation on the loss of chaeta dorso-centralis anterior in Drosophila melanogaster Sevelen and Berlin inbred). Strahlentherapie 123, 1 (1964) 139-45. (In German)

Phenocopies "loss of the chaeta dorso-centralis anterior" (dca) and "spread wing" were produced by irradiation of 5-h-old pupae with 3000 rad. Differences in sensitivity between the wild strains were observed. Loss of the dca chaetas can also be produced by exposing 5-h-old pupae to cold ($2 \pm \frac{1}{2}^{\circ}\text{C}$). Exposure to cold has a radiomimetic effect. An extended cold period of 4 h, post-irradiation, has a protective effect, but the differences obtained with the t-test were not significant. The effects were more or less additive when prolonged for 12 h. After irradiating pupae of different ages ($4\frac{1}{2}$ - $5\frac{1}{2}$ h) an increase in radiation sensitivity could be observed for the modification "spread wings" every 15 min, a decrease for "loss of chaeta dca". The difference in sensitivity is probably caused by differences in rate of development in the two wild strains.

- 719 Semerdzhyan, S. P., Nor-Arevyan, N. G., Megroyan, Sh. G. EFFECT OF HIGH OXYGEN PRESSURE ON THE RADIATION EFFECT ON SILKWORM GRANULES. Izv. Akad. Nauk armyan. SSR 16, 11 (1964) 91-94. (In Armenian)

The effect of x-irradiation (1000-1500 R) on silkworm granules of 3rd and 6th generations subjected to ≤ 50 atm of O during irradiation was examined. After x-irradiation the granules were kept at 22°C for 17 d and then the percentage of surviving granules was determined. The high O pressure did not affect granule survival. A small decrease of granule sensitivity to x-ray was marked at 5 and 30 atm of O. The effect of O pressure depended on the x-ray dose. The inhibitor effect of O during irradiation indicated the biological action of x-rays was related to the chain of oxidation reactions. (CA 63:1965, 2169d)

- 720 Skuratovich, A. A., Pravdina, G. M. FEATURES PECULIAR TO THE BIOLOGICAL ACTION OF ULTRAFRACTIONAL PULSE RADIATION. Meditskaya Radiol. 10, 2 (1965) 28-35. (In Russian)

The authors report experiments concerned with studies of the biological action of ultrafractional radiation (four-tube x-ray apparatus with ion contactor on ignitrons). Experiments were performed on the eggs of Drosophila melanogaster. Curves of dependence of the biological effect on the dose (from 200 R-1200 R) were obtained. The injurious action of pulse radiations with different pulse-pause ratios is lesser than the biological effect of continuous radiation with a dose capacity of 1.3 R/sec and higher, and greater than the biological action of continuous irradiation with a dose capacity of 75 R/sec. The dose curves of pulse radiations occupy an intermediate position between the curves of continuous irradiations with dose capacities of 1.3 R/sec and 75 R/sec. The derived differences in the biological effect are explained in connection with the concept on the comparability of the total time of action and the duration of the mitotic cycle of the ovi-cell of D. melanogaster. (Tr-auth.)

- 721⁽²⁾ Sobels, F. H. THE EFFECT OF POST-TREATMENT WITH N_2 OR O_2 ON THE FREQUENCIES OF RECESSIVE LETHALS AND TRANSLOCATIONS PRODUCED BY IRRADIATION IN N_2 OR O_2 . (Abstr.) Int. J. Radiat. Biol. 6, 5 (1963) 492-3.

The aim of this study was to determine how post-treatment with N_2 and O_2 would affect the repair of pre-mutational damage and the realization of chromosome breaks, induced by x-irradiation in either N_2 or O_2 . Male flies, carrying a ring-shaped X-chromosome ($\text{X}^{\text{C}}\text{yB/sc}^1\text{Y}$), were pretreated for 25 min in either N_2 or O_2 and exposed to x-rays in the respective gases (3000 R in N_2 and 1000 R in O_2) at 100 kV, 4 mA, 1 mm Al at 46 R/sec. Subsequently they were post-treated with either N_2 or O_2 for 25 min. The males were mated to females of the genetic constitution y sc^1 in 49 sc⁶; bw; st^{PD} for 5 successive 2-d broods (6 females/male/brood). In this way the induction of sex-linked recessive lethal mutations and translocations between the second and third chromosomes could be followed simultaneously through the successive stages of spermatogenesis with different sensitivities to the mutagenic action of x-rays. If a dose of 3000 R is given under anoxic conditions, post-treatment with O_2 significantly reduces the mutation-frequency in spermatids, in comparison with that found after post-treatment with N_2 . This result is interpreted on the assumption that post-treatment with O_2 activates a repair system, which had been effectively inhibited by anoxia preceding and during radiation exposure. A similar result was obtained if, after radiation in N_2 , the flies were held anoxic for 25 min and then transferred to an O_2 atmosphere. Fixation of pre-mutational damage in N_2 thus does not seem to occur within 25 min after irradiation. After exposure to 1000 R in O_2 , however, the effect of post-treatment with O_2 equalled that of post-treatment with N_2 . The same mutation-frequencies were then observed as after exposure to 3000 R in N_2 , followed by post-treatment with N_2 . Post-treatment with O_2 did not affect the frequency of translocations induced by radiation in N_2 , but modified the translocation frequency after irradiation in O_2 . The discrepancies between the

results for mutations and translocations suggest that the process responsible for repair of pre-mutational damage differs from that involved in the restitution of chromosome breaks or in the conversion of potential breaks to real breaks. (From abstr.)

- 722 Sobels, F. H. POST-RADIATION REDUCTION OF GENETIC DAMAGE IN MATURE Drosophila SPERM BY NITROGEN. Mutation Res. 1 (1964) 472-7.

Earlier work showed that post-radiation modification of x-ray damage is strongly influenced by conditions existing at the time of exposure. Thus, when Drosophila males are exposed to x-irradiation under anoxia, and the effect of post-treatment with N_2 is compared to that with O_2 , the frequency of recessive lethal mutations is reduced by N_2 in sperm, but by O_2 in spermatids and spermatocytes. After irradiation in O_2 , however, post-radiation modification was not observed in either stage of spermatogenesis. These findings were interpreted to mean that repair of pre-mutational damage in sperm is favored by N_2 , but in spermatids and spermatocytes by O_2 , and that radiation in O_2 restricts the capacity to undergo repair. To verify whether the unexpected finding of post-radiation modification in mature sperm had been caused by shifts in the sampling of sperm cells with different radiosensitivities, the experiments were repeated with pure samples of mature sperm irradiated in the inseminated females. In summary, the results show that after irradiation with 4000 R in anoxia, post-treatment with N_2 consistently reduces the mutation frequency; the same was observed for autosomal translocations. After irradiation with 2000 R in O_2 , no post-treatment effect was found for lethals, but the frequency of translocations was significantly reduced by post-treatment with N_2 . (Auth.)

- 723 Sobels, F. H. THE ROLE OF OXYGEN IN DETERMINING INITIAL RADIOSENSITIVITY AND POST-RADIATION RECOVERY IN THE SUCCESSIVE STAGES OF Drosophila SPERMATOGENESIS. Mutation Res. 2 (1965) 168-91.

The role of oxygen in determining radiosensitivity to the induction of pre-mutational damage, and in processes of post-radiation repair was studied in different stages of spermatogenesis by comparing the effect of post-treatment with N_2 to that with O_2 after x-irradiation of Drosophila males in either N_2 or O_2 . Recessive lethals were scored in a ring-X-chromosome in 4-5 successive 2-d broods. After irradiation in N_2 , it was found that post-radiation recovery in sperm is favoured by N_2 , but in early spermatids and spermatocytes by O_2 . In late spermatids and spermatogonia no significant post-radiation modifications were observed. Post-radiation recovery by N_2 in mature sperm was further confirmed by results obtained from sperm, treated in the inseminated females. The results for early spermatids and spermatocytes indicate that a repair system which has been rendered ineffective by anoxia can be regenerated to normal functioning by post-treatment with O_2 . The time of mutation fixation in early spermatids could not be established definitely, but indications were obtained that in N_2 fixation does not occur within 25 min, whereas after 50 min the reversibility of the pre-mutational lesions is strongly decreased. In contrast to the observations after irradiation under anoxia, no post-radiation modification of the mutation frequencies by N_2 or O_2 was found after irradiation in O_2 for sperm, spermatids, or spermatocytes. Only in spermatogonia post-treatment with O_2 lowered the mutation frequency, as compared to that after N_2 post-treatment. It was concluded that radiation in O_2 produces more irreparable damage than radiation in N_2 . (NSA 19:1965,38463)

- 724 Sollunn, F. -J., Strömnaes, Ø. THE EFFECT OF TEMPERATURE DURING IRRADIATION ON INDUCED MUTATION FREQUENCY IN Drosophila melanogaster SPERM. Hereditas 51, 1 (1964) 1-12.

3-d-old males were tested for the induction of dominant lethals and recessive sex-linked lethals in three successive daily broods. The control males were exposed to a temperature of 22°C or 0°C for half an hour. The experimental males were exposed to the same temperatures for the same length of time while they were irradiated with 2500 R of x-rays. There are no significant differences between treatments for either type of lethals in the control series. In the experimental series there are significantly higher frequencies of both types of lethals in the series irradiated at 0°C than at 22°C. For sex-linked lethals at either temperature and for dominant lethals induced at 22°C the first brood has a significantly higher frequency than the second brood. The frequencies of dominant lethals induced at 0°C exhibit no statistically significant difference between the three broods. (Auth. summary)

- 725 Sollunn, F. -J., Strömnaes, Ø. THE EFFECT OF TEMPERATURE DURING IRRADIATION ON INDUCED MUTATION FREQUENCY IN Drosophila melanogaster SPERM. Hereditas 51, 1 (1964) 1-12.

8-d-old male *D. melanogaster* were tested for the induction of dominant lethals and recessive sex-linked lethals in three successive daily broods. The control males were exposed to a temperature of 22°C or 0°C for half an hour. The experimental males were exposed to the same temperatures for the same length of time while they were irradiated with 2500 R doses of x-rays. There were no significant differences between the effects of treatments for either type of lethals in the control series. In the experimental series there were significantly higher frequencies of both types of lethals in flies irradiated at 0°C than at 22°C. For sex-linked lethals at either temperature and for dominant lethals induced at 22°C the first brood had a significantly higher frequency than the second brood. The frequencies of dominant lethals induced at 0°C exhibited no significant difference between the three broods. Presumably the difference in temperature during irradiation is responsible for the observed differences in induced mutation rate. The frequency of dominant lethals increased about 40% when the temperature was lowered from 22°-0°C during irradiation, and the corresponding increase in recessive sex-linked lethals was about 90%. It is suggested that the temperature effect may act primarily on the breakage process and secondarily on the restitution process, or on both. Chemical reactions, which may be involved in the breakage as well as in the restitution processes, might be influenced by temperature changes, or the lowered temperature may change the viscosity within the nucleus, or it may change the stress in the chromosome coiling. To explain these data several other factors which may influence the mutation rate are proposed. Thus changes in oxygen pressure may be partially responsible for the higher frequencies induced at the lower temperature. However, possible inactivation of radioprotective systems at the lower temperature must also be taken into account. The oxygen effect may obscure the effect of protective systems when a comparison is made between temperature treatments within broods. However, a comparison of the frequencies between broods within temperature treatments indicates that radiation protective systems may be active in lowering the induced mutation rate from first to second brood. This conclusion is drawn from the data for the dominant lethal series. That the data for the sex-linked lethals do not exhibit exactly the same picture as for dominant lethals is ascribed to the different nature of the two types of lethals. (NSA 19:1965, 10822)

- 726 Sugai, E. EFFECT OF TEMPERATURE ON RADIATION INDUCED MALE STERILITY IN THE SILKWORM, *Bombyx mori* L. Jap. J. appl. Ent. Zool. 9, 4 (1965) 266-70. (In Japanese, with English summary)
- Post-irradiation temperature had a marked effect on male fertility. It was most noticeable at 48 h post irradiation when 30°C gave the highest percentage of unfertilized eggs, with a lower value obtained for 24°C, and an even lower value for 18°C. Cytological analysis showed spermatogonia to be most radiosensitive, and most liable to radiation killing; radiation-induced sterility, however, was determined by the state of the spermatocytes at the time of exposure. A 2000 R-dose (100 R/min) of γ -radiation from a ^{137}Cs source was given.
- 727⁽¹⁾ Tazima, Y. RADIATION MUTAGENESIS IN THE SILKWORM. IV. INDEPENDENCE OF RADIATION INTENSITY AS SHOWN BY INDUCED STERILITY OF SPERMATOGENIC CELLS. Rep. natn. Inst. Genet., Misima 9 (1958) 98-99.
- 728⁽²⁾ Tazima, Y., Onimaru, K. INDEPENDENCE OF INDUCED MUTATION-RATE FROM RADIATION DOSE RATE IN THE GERM CELLS OF HIBERNATING SILKWORM EMBRYO. Rep. natn. Inst. Genet., Misima 14 (1963) 98-99.
- 729⁽²⁾ Tazima, Y., Murakami, A. ENHANCEMENT OF RADIATION INDUCED MUTATION FREQUENCY BY POST TREATMENT OF SILKWORM GONIA WITH 5 BROMODEOXYURIDINE. Rep. natn. Inst. Genet., Misima 14 (1963) 100.
- 730 Tazima, Y. CONTRIBUTION FROM 14 MeV NEUTRON EXPERIMENTS TO THE INTERPRETATION OF THE MECHANISMS OF DOSE-RATE EFFECTS ON MUTATION FREQUENCY IN SILKWORM GONIA *Idengaku Zasshi* (Jap. J. Genet.) 39 (1964) 115-19.

Results are summarized from a series of studies on the mechanisms of dose-rate effects on mutation frequency in silkworm gonias. Data are reported on the effects of chronic and acute exposure to various doses of x-rays, γ -rays, and 14 MeV-neutrons on mutation frequencies induced by exposure at different larval stages. (NSA 19:1965, 21916)

- 731 Tazima, Y. MECHANISMS CONTROLLING TWO TYPES OF DOSE-RATE DEPENDENCE OF RADIATION-INDUCED MUTATION FREQUENCIES IN SILKWORM GONIA. Idengaku Zasshi (Jap. J. Genet.) 40, Suppl. (1965) 68-82.

As far as x- and γ -rays are concerned, the mutational response of young germ cells, mostly gonial stages, of the silkworm is not simple. At least two types of dose-rate dependence, with one being the reverse of the other, have been found in this insect. In one type the mutagenic effectiveness of chronic irradiation (0.1 R/min) is lower than that of acute irradiation (100 to 300 R/min) and in the other, mutagenic effectiveness is higher for chronic irradiation than for acute irradiation (Type II). Which type appears is solely dependent upon the developmental stage of the irradiated larva. Irradiation of newly hatched larva results in a Type I dose-rate dependence while irradiation at a later stage, around the time when the larvae are 8 d old, gives completely reverse results. The complexity in the dose-rate effect is entirely due to a drastic change in mutagenic effectiveness of acute irradiation in accordance with the developmental stage. The dose-mutation frequency curve shows the highest peak at hatching time but decreases rapidly thereafter. In contrast, the mutagenic effectiveness of chronic irradiation remains almost the same. In order to interpret the reverse type of dose-rate effect, a hypothesis involving selective cell killing was proposed. The hypothesis was based on the finding that the homogeneous germ cell population which is present at hatching time becomes gradually heterogeneous with the development of the larva and gonial cells at an advanced stage are highly sensitive to cell killing by radiation. It was also assumed that cell killing is more drastic for the acute than for the chronic exposure and that the cells sensitive to killing are also sensitive to having mutations induced in them. However, cytological evidence to support this hypothesis was not obtained. Secondly, a differential repopulation hypothesis was proposed but this was again found to be unsatisfactory. The dose-fractionation experiments, however, yielded very suggestive information for the interpretation of the dose-rate effect. When 1000 R acute irradiation was delivered in two fractions, 500 R + 500 R, separated by various time intervals from 2-48h, a remarkable increase in mutation frequency was observed throughout the period examined, showing a peak if the second dose was given 12 or 24 h after the initial exposure. A new hypothesis is proposed for the interpretation of the complicated features of the dose-rate effect as follows: a large part of the radiation-induced premutational damage is repaired during the post-irradiation recovery process; the degree and extent of repair primarily depends upon the total dose and dose rate; the occurrence of repair also largely depends upon cellular conditions, presumably metabolic activity, of the irradiated cell; and the final magnitude of the observed mutation frequency is determined by both factors in combination. (From auth.)

- 732⁽²⁾ Tazima, Y., Murakami, A. THE INCREASE IN INDUCED MUTATION FREQUENCY AFTER FRACTIONATED IRRADIATION OF GONIAL CELLS OF THE SILKWORM. Rep. natn. Inst. Genet., Misima 13 (1962) 87-9.

Silkworms were given single and fractionated 1000 R x-ray doses. Mutation frequency was estimated during the early larval stage from the 7th - 9th day after hatching by the specific locus method of *pe* and *re* loci. Higher mutation frequencies were found in groups given fractionated irradiation than in the single shot groups. Results also suggest that fractionated irradiation with 24-h intervals between fractions is more effective than with 48-h intervals. However, interval shortening proved to have a limit. (NSA 18:1964, 31143)

- 733⁽²⁾ Tazima, Y., Onimaru, K. FURTHER REPORT IN THE INCREASE OF INDUCED MUTATION FREQUENCY AFTER FRACTIONATED IRRADIATION OF GONIAL CELLS OF THE SILKWORM. Rep. natn. Inst. Genet., Misima 14 (1963) 97-98.

- 734 Trosko, J. E. ANALYSIS OF POSTIRRADIATION MODIFICATION OF GENETIC DAMAGE IN MATURE *Drosophila melanogaster* SPERM. Diss. Abstr. 25, 2 (1964) 769.

This study was conducted to elucidate the recovery phenomenon which is reported to be associated with post-irradiation modification of the genetic damage in mature *Drosophila* spermatozoa. In order to distinguish between differential sensitivity or other post-irradiation phenomena, the possible modifying effect of several variables was analysed. Variables such as storage of sperm in males and females, cold temperature, physiological condition of the females, and sperm loss were utilized. Sex-linked lethal mutation rate, egg-hatch and counts of total progeny were used to measure the damage in irradiated mature *Drosophila* spermatozoa. Comparisons of these measured criteria were made between sperm, either non-aged or aged under experimental conditions. The results indicate

that neither aging for 2 weeks nor cold temperature of 10°C changed the sex-linked mutation rate when the irradiated sperm were stored in the females. Pre-aging the females on minimal medium at room temperature prior to mating increased the frequency of detected sex-linked lethals. Although lower rates of biological damages were observed in the second sperm batch than in the first sperm batch of all irradiated males, the difference between the two sperm batches was smaller for the males stored at room temperature than non-stored or cold-stored males. The damage associated with the first sperm batch of cold-stored irradiated males was not different from that of the first sperm batch of non-stored irradiated males. These latter two observations were interpreted to indicate that mixing of sperm, rather than recovery, occurred in males stored at room temperature prior to mating. This explanation demands that the sperm population at the time of irradiation be heterogeneous and compartmentalized with respect to radiation sensitivity. The cold temperature storage did not significantly modify the measured damage. However, it was observed after comparing the results of the sex-linked and dominant lethal studies that the cold temperature post-treatment of the irradiated males may have increased the recovery of sex-linked lethals while decreasing the frequency of dominant lethals. (DA)

- 735 Trosko, J.E. EFFECT ON GENETIC DAMAGE OF POST TREATMENTS GIVEN x-RAYED Drosophila MALES. Genetics 49, 3 (1964) 401-9.

An increase in sex-linked lethal mutation rate after cold storage of irradiated sperm was noted when non-irradiated females were starved prior and subsequent to mating. Cold and aging during the storage of the irradiated sperm did not, per se, contribute to the increase of lethals. Evidence from post-irradiation storage of the male does not support a hypothesis for a recovery mechanism occurring in the sperm. The data are interpreted to indicate that the population of sperm at the time of irradiation is heterogeneous and compartmentalized with respect to radiation sensitivity, and that mixing of sperm can occur in the testes during post-irradiation storage. (Auth.)

- 736 Vatti, K.V., Yanoosh, I.M. INDUCED MUTATION PROCESS — THE EFFECT OF HIGH TEMPERATURE AFTER IRRADIATION ON THE FREQUENCY OF OCCURRENCE OF LETHAL MUTATIONS AND CHROMOSOMAL BREAKS. p.29-43 "Studies in Genetics". JPRS-31514, 115p. Translation: Issled. Genet. 2 (1964) 46-55.

The consecutive action of high temperature (+37°C) within 1 h after irradiation of Drosophila larvae with x-rays in a dosage of 100 R causes potential chromosomal injuries and sharply increases the frequency of lethal mutations (2.3 times) in comparison with their sum under the action of temperature and x-rays separately. The relative amount of potential damage exceeds by 1.53 times the number of actual lethal mutations. Under the conditions of a high spontaneous level of chromosomal breaks x-rays in the same dosage of 100 R do not cause actual breaks, producing only potential chromosomal breaks caused by high temperature. Their relative amount is equal to 0.73. The facts which have been derived emphasize that the state of the after-effect of low radiation dosages is characteristic both for lethal mutations and for chromosomal aberrations. The after-effect is hypothetically explained by the presence of both potential chromosomal injuries as well as their high capacity for closing the initial breaks. (NSA 20:1966, 3713)

See also:

- 27 Mutations in Drosophila melanogaster grown on media containing carbon-14 labelled sugars. (Suomalainen, E. et al., 1956)
505 Biological studies. (Japan. National Inst. of Radiological Sciences, Chiba., 1964)
507 Variation in mutagenicity and radiation resistance with genome complexity and evolution. (Kondo, S., 1964)
528 Dose rate effects in the developing germ cells of male Drosophila. (Alexander, M.L., Bergendahl, J., 1964)
530 Grasshopper neuroblast techniques. (Carlson, J.G., Gaulden, M.E., 1964)
552 The relation of the composition of the culture medium to mitotic activity and to x-ray induced mitotic inhibition in the neuroblast of the grasshopper, Chortophaga viridifasciata (de Geer). (Shaw, E.L., 1955)
540 Influence of tonicity on mitotic recovery in x-irradiated grasshopper neuroblasts. (Meisner, H.M., 1964)
541 Influence of tonicity on mitotic recovery in x-irradiated grasshopper neuroblasts. (Meisner, H.M., 1965)

- 553 Radiosensitivity and repair in different germ cell stages of Drosophila. (Sobels, F. H., 1965)
- 575 Interaction of chromosome breaks in the spermatozoa of Drosophila induced by x rays and fast neutrons. (Reddi, O. S., 1964)
- 583 The dose-dependence of X-chromosome loss and non-disjunction induced by x-rays in oocytes of Drosophila melanogaster. (Traut, H., 1964)
- 584 Dependence of frequency of occurrence of phenocopies on x-ray dose. (Volchikov, Yu. A., Aleksandrov, Yu. N., 1963)
- 603 Recession. The effect of level of feeding on the frequency of x-ray induced sex linked lethal in D. melanogaster. (Kishin, A. F., 1964)
- 608 The relationship between radiation dose and mutation frequency in spermatogonia of Drosophila melanogaster. (McSheehy, T. W., 1964)
- 636 Dominant lethal proportions modified by x-radiation, temperatures, and cohabitation in single- and mixed-species populations of flour beetles, Tribolium confusum and T. castaneum. (Erdman, H. E., 1964)
- 639 Gamma radiation and the reproductive behaviour of male Rhodnius prolixus. (Gomez-Numes, J. C. et al., 1964)
- 650 The development of dominant lethality in fruit flies exposed to vibration, acceleration, and gamma radiation. (Parfenov, G. P., 1965)
- 663 Physiologic factors determining in the formation of melanotic tumors in Drosophila (D. melanogaster). Influence of heat and irradiation. (Ghélelovitch, S., 1963)
- 751 Mutations induced by alkylating agents, x-rays and combined treatments. (Mazar-Barnett, B. K. de, 1965)
- 753 Mutagenic action of mitomycin C on Drosophila melanogaster. (Mukherjee, R., 1965)
- 882 Radiobiologic studies with Drosophila. (Baxter, R. C., 1964)
- 919 Fast-neutron effects on productivity of young and old flour beetles, Tribolium castaneum Herbst, and alterations at different temperatures and after exposure of either or both sexes. (Erdman, H. E., 1965)
- 920 Fast neutron effects on flour beetles. (Erdman, H. E., 1964)
- 921 Fast neutron effects on productivity of young and old flour beetles, Tribolium castaneum Herbst and alterations due to temperature and sex exposed. (Erdman, H. E., 1964)
- 923 Reproductive performance of x-rayed single-species and mixed-species cultures of Tribolium confusum and T. castaneum reared at different temperatures. (Erdman, H. E., 1964)
- 946 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. S., 1964)
- 959 Effects of radiation on competitive insects. (Erdman, H. E., 1964)

10. Comparative Studies (Radiation. Mutagenic Chemicals. Physical Factors)

- 737 Alexander, M. L., Glanges, E. GENETIC DAMAGE INDUCED BY ETHYLENIMINE. Proc. natn. Acad. Sci. USA 53 (1965) 282-8.

1-d-old males of Drosophila melanogaster were injected with a 10^{-2} M solution of ethylenimine. Ethylenimine is a powerful mutagen, but differs from both x-rays and other wellknown chemical mutagens in some characteristics. It resembles x-rays in producing chromosomal abnormalities since translocations are nearly as frequent as sex-linked lethals. Other chemical mutagens do not produce such a high proportion of rearrangements. It resembles chemical mutagens, such as the mustards, in producing delayed lethals and translocations which appear in the F_2 generation from F_1 's that appeared normal. The distribution of sex-linked lethals in the spermatogenic cycle is like that of x-rays. The distribution of F_2 or delayed lethals is different. A majority was recovered from progeny of germ cells which were most nearly mature (mature sperm, late spermatids). In contrast to the delayed mutations and to direct mutations produced by other agents, the frequency of autosomal (second chromosome) lethals was very high for all stages of germ cells. The rate averaged 19.75% for all stages (A-E, sperm to spermatogonia) as compared to 0.86% for sex-linked lethals obtained in the same irradiation test from the same irradiated parents. This major difference

exists despite the fact that the autosome is only about twice as long with approximately twice the number of gene loci as the X-chromosome. This demonstrates that mutation production may be grossly miscalculated if based only on the sex-linked mutations detected. The same treated males show three mutation cycles—depending upon whether one tests sex-linked recessive lethals, autosomal recessive lethals, or delayed sex-linked recessive lethals. The appearance of delayed translocations restricts the way such delayed mutations occur. (Auth.)

- 738 Altenburg, E., Browning, L.S. THE RATE OF GONADAL MOSAICISM FOR LETHALS IN LATE BROODS OF Drosophila AS COMPARED WITH EARLY WHEN INDUCED BY X-RAYS, AZASERINE AND QUINACRINE MUSTARD. Genetics 50, 2 (1964) 232. Abstr.

Males of Muller's Maxy stock were treated with x-rays in one series of experiments, azaserine in a second, and quinacrine mustard in a third, and the F_1 females were tested for lethals, both whole-body and gonadal mosaic, in early and in late broods derived from 3-d broodings of the treated males. Germ cells used in the first three broods were probably in postmeiotic stages at the time of treatment and those used in the fifth and later broods were probably derived from germ cells which were in premeiotic stages at the time of treatment, though of course the earliest brood in which sperm cells derived from premeiotically treated stages are used would depend partly on how frequently a male mated. However, only fertile broods derived from single males (mated to fresh females) were scored as broodings and therefore a brood represents at least one mating. In the case of all three series of experiments, the percent of mosaicism among the lethals underwent a reduction in the later broods, as follows (the figure for broods 1-5 is given first after each agent, and that for broods 7 and later next): x-rays, 45-9; azaserine, 80-47; quinacrine 85-62. (The two chemical series are still in progress and are about half as large numerically as the x-ray series at present). In the case of x-rays the results are not unexpected, since delayed effects are not usually ascribed to this agent. However, the greatly lowered rate of mosaicism among the chemically induced lethals in the later broods indicates that an appreciable amount of the mosaicism they induce is not due to delayed effects (which are regarded as distinctive of chemical mutagens) but to fractionals, when sperm are treated. (From abstr.)

- 739 Bareman, A.J., Chandley, A.C. THE SENSITIVITY OF THE MALE GERM CELLS OF Drosophila TO METHYL METHANESULPHONATE. Heredity 19, 4 (1964) 711-18.

Newly emerged $\sigma\sigma$ of D. melanogaster were injected intra-abdominally with methyl methane-sulphonate (MMS) in saline in doses of from 0.25 to 1.5×10^{-4} mg in a constant volume of 0.092 μ l. They were then mated daily to two Muller-5- $\varphi\varphi$ for sex-linked lethals and to two wild type $\varphi\varphi$ for egg-hatchability. Matings for the first 6 d after injection had a constant yield of sex-linked lethals; 8.78% for 1.5×10^{-4} mg MMS and proportionately less at lower doses. Hence sperm and spermatids show equal sensitivity to MMS. A period of sterility followed, ranging in duration from 1-3 d according to dose (spermatocytes). This was followed again by a mutation rate 1/4 of that for the first 6 d (spermatogonia). Egg hatchability (following treatment of sperm and spermatids) indicated that, relative to x-rays, MMS is more mutagenic for point mutations than for chromosome breakage (dominant lethals). The depression of hatchability after the highest dose 11.5×10^{-4} mg MMS is interpreted as physiological rather than genetical. (BA 46:1965, 55358)

- 740 Borstel, R.C. von RECENT DEVELOPMENTS IN RESEARCH ON RADIATION AND CHEMICAL MUTAGEN EFFECTS IN INSECTS. ORNL-P-388, Oak Ridge National Lab., Tenn. 20 Aug. 1964, 9p.

A model is presented which provides a reasonable explanation for most of the parameters associated with dominant lethality induced in sperm and an inherent explanation of the radio-resistance observed in Lepidoptera sperm.

- 741 Caspari, E.W. SOMATIC MUTATIONS IN THE MOTH Ephestia. December 1, 1961-August 1, 1964. TID-21097, Rochester, N.Y. Univ. ed, 64p.

Each scale of the hind wing of the moth Anagasta (Ephestia) is a single highly differentiated cell and normal variations are easily recognized. This system was used in studies of somatic mutations induced by x-radiation, 5-bromodeoxyuridine (BUD), or 5-fluorouracil (FU) applied to larvae 8 d after the last larvae molt. Some studies were also made on the development of the eye pigimentary system in the treated larvae and the role of DNA and RNA in the development of this

system. Scale aberrations induced by BDU and x-radiation showed considerable differences. Pupae treated with FU survived up to hatching time but their development was inhibited and eye pigment formation was affected. Methods are described by which relatively pure, double stranded, high molecular DNA was extracted from *Ephestia* larvae, pupae, and adults. Injection of DNA into larvae resulted in block scales with a frequency that indicated they were transformed cells. (NSA 18:1964, 41090)

- 742 Caspari, E.W., Muth, W., Pohley, H.-J. EFFECTS OF DNA BASE ANALOGUES ON THE SCALES OF THE WING OF *Ephestia*. *Genetics* 51 (1965) 771-94.

Ephestia larvae were treated with 5-bromodeoxyuridine (BDU) by injection of solutions of different concentrations 8 d after the last larval moult. Survival was high and no evidence for delay in development was found. BDU was therefore regarded as non-toxic for *Ephestia*. On the hind wings of treated animals, individual abnormal scales were found. They occur as single, abnormal scales or as homogeneous or heterogeneous clusters. These clusters are regarded as due to the same mutational event. The number of abnormal scales per wing increased in the range from 1-5 µg BDU/animal. At higher levels it reached a plateau at an average of 12 mutational events on a wing containing about 6.250 scales (about 2×10^{-3}). The scale abnormalities induced by BDU differed from those induced by x-rays in several ways. A lack of large clusters of aberrant scales induced by BDU may be explained by an inhibition of growth caused by the drug. The wings of animals treated with high concentrations of BDU (20 µg and over) were significantly smaller than those of controls injected with water. The induction of abnormal scales by BDU was suppressed by equimolar amounts of thymidine. The nature of the BDU-induced abnormal scales is discussed. On the basis of the evidence it is impossible to decide whether they represent point mutations, chromosome rearrangements, or genetically non-transmissible changes. The evidence seems to indicate, however, that more than one mechanism is involved. (NSA 19:1965, 24291)

- 743 Fahmy, O.G., Fahmy, M.J. DIFFERENTIAL INDUCTION OF CHROMOSOME DELETIONS BY NATURAL AND SYNTHETIC MACROMOLECULES IN *Drosophila melanogaster*. *Genetics* 52, 5 (1965) 861-73.

The Minute phenotypes induced by natural and synthetic macromolecules in wild-type (Oregon K) *D. melanogaster* were classified according to phenotypic expression and analysed for genetic position and physical nature in the salivary gland chromosomes. The proportion of severe Minute phenotypes (due to a deletion on the IV chromosome) was highest with deoxyribonucleoprotein, RNA, and DNA, intermediate with polyadenylic acid and histones, and lowest with some albumins and globulins and polymethacrylic acid. The same mutations in comparable (γ-) radiation experiments occurred at a frequency equal to the minimal level with macromolecules. Mutagenicity might be a manifestation of the specific chemical structure of nucleoproteins and nucleic acids. (CA 64:1966, 2477-de)

- 744 Fahmy, O.G., Fahmy, M.F. MUTAGENESIS IN RELATION TO GENETIC HAZARDS IN MAN. *Proc.R.Soc.Med.* 57 (1964) 648-50.

Experimental data are used as a basis for assessing the comparative genetic hazards to man of mutagenic chemicals and ionizing radiations. The mutagenic activity of alkylating compounds was compared to that of radiation on the basis of the efficiency of both classes of agents in the induction of sex-linked recessive lethals in the fruit fly. A standard volume (0.3 µl/fly) of a given drug concentration (usually about 10^{-2} M) was injected into the haemocoel of males (200 to 500 per test) around the testes, and their sperm was then tested for sex-linked recessive lethals. Comparable males were exposed to a measured dose of radiation and their progeny also scored for the same mutations. It was thus possible to determine the concentration of the injected compound which induced the same mutation rate as a given dose of radiation. This analysis revealed that all the alkylating compounds tested were mutagenic to various degrees. The highest mutagenicity occurred with triethylenemelamine which at a concentration of 4×10^{-4} M induced a mutation rate equivalent to 6000 R, while the lowest activity occurred with ethylene oxide which at a concentration of 10^{-3} M induced a mutation rate equivalent to about 30 R. Results are discussed in detail. The distribution of the hot spots (loci of high mutability) was very different for the various mutagens, thus demonstrating the significance of gene/mutagen interaction to the mutational process. Some aspects of the mutation load in man and the

concept doubling dose are discussed in terms of these experimental results. A table shows the physical doses of various chemical compounds which are mutagenically equivalent to the total exposure to radiation over a full reproductive generation (as well as to the estimated human doubling dose (35 R)). Hazards associated with the use of these compounds (for example, as drugs and insecticides) are discussed.

- 745 Gershenson, S. INDUCTION OF LETHAL MUTATIONS IN Drosophila melanogaster BY DNA. Genet. Res. 6 (1965) 157-62.
- Addition to the food of Drosophila larvae of DNA from calf thymus induced a considerable number of recessive lethal mutations in the second chromosome. An analysis of 66 such lethals showed that most of them affect the same segment containing probably some 30-35 sub-units capable of mutating together or separately. Results were compared with those from x-irradiating second chromosomes (500 R doses). (NSA 19:1965, 45876)
- 746 Henke, H., Höhne, G., Künkel, H.A. ÜBER DIE MUTAGENE WIRKUNG VON RÖNTGEN-STRAHLEN, N-NITROSO-N-METHYLURETHAN UND N-NITROSO-MORPHOLIN BEI Drosophila melanogaster. (On the mutagenic effects of x-radiation, N-nitroso-N-methyl-urethan, and N-nitroso-morpholine in Drosophila melanogaster). Biophysik 1 (1963/64) 418-21. (In German)
- The mutagenic effects of N-nitroso-N-methylurethan and N-nitroso-morpholine were compared with those of x-rays on D. melanogaster. Lethal factors as well as II/III translocations were determined by the hybridization method. Mutation rates for lethal factors were 0.60% in the controls, 7.92% in irradiated, 2.52% in N-nitroso-N-methyl-urethan-treated, and 2.17% in N-nitroso-morpholine-treated Drosophila. Mutation rates for translocations were 0, 2.94, 0.18, and 0.11%, respectively. (NSA 18:1964, 27097)
- 747 Henke, H., Höhne, G., Künkel, H.A., Trams, A. THE DIFFERENTIAL MUTATION EFFECT OF CERTAIN CARCINOGENS. Arch.Gynaek. 202, 1 (1965) 476-79. (In German)
- Intra-abdominal application of 0.2% N-nitroso-N-methylurethan, 1% N-nitrosomorpholine, and 1% N,N'-bis-(nitrosopiperazine) caused genetic translocations in greater number than irradiation in Drosophila melanogaster. The recessive, sex-linked changes were lethal at a lower rate than radiation changes. The compounds are all known carcinogens. Escherichia coli mutants induced by radiation were mostly of the serine-glycine type; N-nitroso-N-methylurethan application induced many other mutants, some of which had not appeared after irradiation. (CA 63:1965, 10372h)
- 748 Henneberry, T.J., McGovern, W.L., Smith, F.F. SOME EFFECTS OF GAMMA RADIATION AND A CHEMOSTERILANT ON THE MEXICAN BEAN BEETLE. J.econ.Ent. 57, 6 (1964) 813-5.
- Gamma radiation or the alkylating agent apholate sterilized male and female Mexican bean beetle, Epilachna varivestis Mulsant. With adults the effect was produced with ionizing radiation at 8 or 16 kR. Pupae were more susceptible - complete sterilization of females was obtained at doses of 1, 4, 8, or 16 kR and males were sterilized at doses of 4, 8, or 16 kR. Larvae were more susceptible to direct radiation effects than pupae and pupae more susceptible than adults. Adult male or female bean beetles dipped in an aqueous solution of 0.5% apholate or confined for 48 h on bean foliage sprayed with the same concentration in water were completely sterilized. Untreated female beetles mated with treated males (irradiated or exposed to apholate at effective doses) deposited about the same number of eggs as females of untreated pairs, but no eggs hatched. Treated female beetles (irradiated or exposed to apholate at effective doses) mated with untreated males deposited few or no eggs. Adult beetles of either sex irradiated in the pupal or adult stage or apholate-treated adults were shorter lived than untreated beetles. Untreated female beetles mated first with irradiated or apholate-treated males produced sterile eggs, but a subsequent mating with untreated males resulted in the production of viable eggs. (Auth.)
- 749 Keiser, I., Steiner, L.F., Kamasaki, H. EFFECT OF CHEMOSTERILANTS AGAINST THE ORIENTAL FRUIT FLY, MELON FLY, AND MEDITERRANEAN FRUIT FLY. J.econ.Ent. 58, 4 (1965) 682-5.

In tests conducted in Hawaii from 1959-1964 both sexes of one or more of three species of tephritid flies were sterilized without toxic effects by treating food and water with tepa, metepa, apholate, or tretamine, applying these materials topically to pupae or adults, or exposing adults to deposits of the chemosterilants. Methotrexate, aminopterin, colchicine, and 5-fluorouracil treatments sterilized females only. Tepa, apholate, and tretamine sterilized as effectively and efficiently as ionizing radiation. Tepa showed promise for field applications in combination with attractive protein hydrolyzates. In general, males were sterilized at lower concentrations than females; the melon fly, *Dacus cucurbitae* Coquillett, was the most susceptible; the oriental fruit fly, *D. dorsalis* Hendel, intermediate; and the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), the least susceptible to test materials. Treatments were most effective against newly emerged flies, but deposition of hatchable eggs in old gravid fertile females was inhibited within 24-48 h after treatment. In ratio tests mating effectiveness of irradiated and chemically sterilized fruit flies was compared. In one representative test, oriental fruit flies that had received 10 000 R of γ -radiation in the pupal stage 2 d before emergence, and newly emerged flies that had been exposed to 0.1% of tepa in the drinking water for 3 d were matched with different ratios of normal flies. Flies were sexed on the 3rd d (before sexual maturity) and crossmated the following day at 5:1, 10:1, 15:1, 20:1, and 30:1 ratios of treated to untreated flies. Equal numbers of each sex were used for both treated and untreated flies, with a total of 300 adults at each of the six ratios. Results showed that the two sterilization methods were similar in effectiveness. The 20:1 ratio gave nearly complete suppression in one generation. Results with 10:1 and 15:1 ratios were variable. Microscopically, gonads of chemosterilized and radiation-sterilized flies are alike. Both spermatogonia and spermatocytes are destroyed as in irradiated testes. Spermatids beyond the last division continue to develop, however, and become mature spermatozoa. If some spermatogonia escape destruction, recovery, partial or complete, may take place. In female fruit flies, both irradiated and chemosterilized, ovaries do not develop if flies are treated before the onset of sexual maturity.

- 750(1) Keyl, H.-G., Werth, G. STRUKTURVERÄNDERUNGEN AN CHROMOSOMEN DURCH MALACHITGRÜN. (Structural changes in chromosomes induced by malachite green). *Naturwissenschaften* 46, 14 (1959) 453-54. (In German)

Growing salivary gland nuclei of larvae of *Chironomus thummi* were tested with malachite green. Effects on development and in terms of chromosome breakage and recovery were examined. It was characteristic that, although cells and cell nuclei of a particular gland might be affected differently, the chromosomes of any one nucleus were affected similarly. Breakage observed in the chromosomes was of the same type as the kind produced by x-rays in 24-h-old larvae, and can be considered as genuine mutations. Other structural changes such as constrictions resulting from malachite green treatment are discussed.

- 751 Mazar-Barnett, B.K. de MUTATIONS INDUCED BY ALKYLATING AGENTS, x-RAYS AND COMBINED TREATMENTS. *Genetics* 52, 2, Pt.2 (1965) 459. Abstr. -

It was considered of interest to establish a comparison of the mutagenic effects of alkylating compounds, x-rays and combinations of the chemicals and radiation. A nitrogen mustard (NITROMIN) and a polyethyleneimine (THIO TEPA) were chosen as representative of two different groups of alkylating agents. Two series of experiments were carried out to determine the frequencies of sex-linked recessive lethal mutations induced in *Drosophila melanogaster*, one in mature and nearly mature oocytes, the other in mature sperm. The chemicals were injected intra-abdominally in 0.4% saline solution. The irradiation dose (800 R in all cases) was administered in the combined treatments at different intervals: pre-treatment 12 h prior to injection and post-treatments 30 min or 20 h after the injection. The results obtained show (1) that THIO TEPA has a more pronounced mutagenic effect than NITROMIN in both males and females. (2) The effect of combined treatments is at least additive with the nitrogen mustard, but not with the polyethyleneimine, with which no combined treatment has induced a recessive lethal frequency as high as that induced by the chemical alone. (3) Mature sperm shows a much higher sensitivity to all treatments than oocytes, but the relative mutation rates for the different treatments are about the same for both. Thus different interactions of the two chemicals with cytoplasmic constituents and/or x-ray products cannot explain the different mutation frequencies observed. These could be ascribed to different actions of the chemicals on DNA and/or interactions with x-ray products. (Abstr.)

- 752 Morgan, P.B., LaBrecque, G.C. STUDIES OF THE EFFECT OF MEAT EXPOSED TO GAMMA RADIATION OR CHEMOSTERILANTS ON THE REPRODUCTIVE CAPACITY OF A BLOW FLY Phaenicia cuprina (Wiedemann). Fla. Ent. 47, 1 (1964) 31-33.
- Raw beef (irradiated with 5, 25, and 50 Mrad of γ -radiation from ^{60}Co) had no effect on the development, egg deposition, percent hatch, or appearance of P, F₁, and F₂ generations of blowflies, P. cuprina, reared in the meat or allowed to feed on it in the adult stage. Egg production and fertility were affected when adults were fed meat treated with 1% and 0.5% of apholate and 0.5% and 0.25% of metapa. When the larval medium was treated with 0.1% of apholate, larval development was prolonged and did not progress beyond the pupal stage. A 0.05% concentration of metapa in the larval medium slightly extended the period of larval development but did not prevent development to the adult stage. (Auth.)
- 753 Mukherjee, R. MUTAGENIC ACTION OF MITOMYCIN C ON Drosophila melanogaster. Genetica 51 (1965) 947-51.
- Oregon-R males were treated in the following ways: mitomycin C (100 $\mu\text{g/ml}$); 0.7 N NaCl; mitomycin C (100 $\mu\text{g/ml}$) and γ -rays; and 0.7 N NaCl and γ -rays. Each treated male was tested for induced sex-linked recessive lethal mutations by the Muller-5 technique for eight successive daily broods. Mitomycin C is mutagenic in all cell stages in Drosophila, with a peak mutation frequency of 5.0% occurring in the third brood. The γ -ray series reached a peak of 5.8% in the fifth brood. Additivity of effect upon combined Mitomycin C and γ -ray treatment was not always indicated, significant decreases occurring in Broods 3 and 6 and an increase in Brood 8. (Auth.)
- 754 Nakanishi, Y.H., Makino, S. PHASE CINEMATOGRAPHY STUDIES ON THE EFFECTS OF RADIATION AND OF SOME CHEMICALS ON CELLS AND CHROMOSOMES. Int. Soc. Cell Biol. Symp. 8 (1964) 47-62.
- Includes effects of ultraviolet rays on Bombyx mori and effects of β -rays on the grasshopper Podisma sapporensis. (BAg 29:1965, 101311)
- 755 Nakao, Y. COMPARISONS BETWEEN MUTAGENIC AND CELL-KILLING EFFECTS INDUCED BY RADIATION AND RADIOMIMETIC SUBSTANCES. Idengaku Zasshi (Jap.-J. Genet.) 40, Suppl. (1965) 107-18.
- The mutagenic and cell-killing effects induced by x-rays and by chemical mutagens were compared using sex-linked recessive lethal mutation in Drosophila and visible mutation (egg colour mutants) detected by specific locus method in the silkworm. In the case of the induction of lethals and translocations by ethylenimine in Drosophila spermatozoa, we have noticed the production of high degree of sterility. And when we compared mutation and translocation frequencies between two groups which showed high and low sterility, we found the existence of parallelism between lethal or translocation frequencies and sterility. In the case of x-ray induced lethal mutations in Drosophila, there was no sign of correlation between mutation frequencies and sterility, even when x-ray doses were so high as to produce only a few progeny. There were also no apparent correlations between mutation frequencies and the number of eggs laid, between mutation frequencies and hatchability, and mutation frequencies and the percentages of dead eggs in the early developmental stages in the silkworm, when male moths were x-irradiated with the dose of 2 kR. The circumstances were the same as before even when the male moths were irradiated with fairly high dose of x-rays (10 kR). When the female moths were irradiated with high dose of x-rays (10 kR) (and in this case the lethality amongst eggs was very high), we could not find any difference in the mutation frequencies between two groups which have comparatively high hatchability, and those which have low hatchability. The patterns of induction were compared between mutation and lethals at various stages of embryonic development in the silkworm, and it was found that the changes of the percentages of dead eggs at the pigmented egg stages and at the bluish egg stage agreed with those in mutation frequencies. The relationship between mutation induction and the production of cell-killing is discussed. Especially, the relationship of these facts to the hypothesis of selective cell killing is considered to explain the cause of dose rate effect in mutation induction by radiation. (Auth.)
- 756 Schmidt, C.H., Darne, D.A., Weidhaas, D.E. RADIOSTERILIZATION VS. CHEMO-STERILIZATION IN HOUSE FLIES AND MOSQUITOES. J. econ. Ent. 57, 5 (1964) 753-6.

Laboratory tests were conducted during 1961 and 1962 to compare the effectiveness of males of the house fly, *Musca domestica* L., and the common malaria mosquito, *Anopheles quadrimaculatus* Say, sterilized by apholate or tepa and by γ -radiation. For radiosterilization, house fly pupae were treated 31-54 h prior to eclosion with 2850 R and mosquito pupae at least 24 h old with 10 000 or 12 000 R from a ^{60}Co source supplying 736 ± 33 R/min. For chemosterilization, house fly male adults 1 d old were fed 1% apholate in the diet for 3 d and mosquito male adults for 3-4 d after emergence. Mosquito male adults 0-24 h old were also exposed to contact residues containing 7 mg/ft² of tepa. The most important criterion of effectiveness was the reduction in number of viable egg batches from females confined with both treated and untreated males. Results from chemosterilization equaled or surpassed those from radiosterilization. With mosquitoes, highly competitive, yet permanently sterile, males were more attainable with chemothan with radiosterilization. With house flies either method seemed adequate, but the slightly greater degree of recovery after irradiation than after chemosterilization must be considered. (Auth.)

- 757 Snyder, L.A., Oster, I.I. A COMPARISON OF GENETIC CHANGES INDUCED BY A MONOFUNCTIONAL AND A POLYFUNCTIONAL ALKYLATING AGENT IN *Drosophila melanogaster*. *Mutation Res.* 1 (1964) 437-45.

A comparison of the spectra of genetical changes induced in mature spermatozoa by a mono- and a polyfunctional alkylating agent and by γ -rays was made using multipurpose stocks having an Y-chromosome genetically marked at both ends. Gamma-rays, typical of ionizing radiations, cause higher frequencies of entire Y- (or X-) chromosome losses than of partial losses of the Y-chromosome. Polyfunctional triethylene melamine, in contrast, was found to induce substantially fewer entire chromosome losses than the sum of losses involving the marker loci on either arm of the Y. Based on a limited sample of partial losses, the relative incidence of sterility among males having lost one or the other of the marker loci after treatment with the polyfunctional chemical was almost twice that found in comparable groups of males following irradiation. Similar data obtained after treatment with monofunctional quinacrine mustard appear to agree with those obtained using the polyfunctional compound, but are too limited to be conclusive. Both the monofunctional and polyfunctional chemicals were found to induce high frequencies of mutations at the dumpy locus, and in both cases very high proportions of these changes were mosaically expressed. On the basis of these results it appears unlikely that the number of reactive groups present in an alkylating compound influences the relative frequency of mosaic changes produced. (Auth.)

See also:

- 642 Cytogenic investigations on radiation and chemically induced dominant lethal mutations in oocytes and sperm of the screw-worm fly. (LaChance, L.E., Riemann, J.G., 1964)
 643 Introduction of dominant lethal mutations in insect oocytes and sperm by gamma rays and an alkylating agent: dose-response and joint action studies. (LaChance, L.E., Crystal, M.M., 1965)
 667 Genetic effect of combined x-ray and ethylenimine treatments. (Alexander, M.L., 1965)
 669 Combined ICR 100 and x-ray analysis of the strandedness of the spermatozoan of *Drosophila melanogaster*.
 822 Studies on the rate of spermatogenesis in *Drosophila*: effects of x-rays and streptonigrin. (Marín, A.O., 1965)
 922 Age, temperature, coexistence, and x-radiation effects on flour beetles' productivity. (Erdman, H.E., 1964)

B. DEVELOPMENTAL AND PHYSIOLOGICAL EFFECTS ON THE ORGANISM

1. General Articles. Surveys

- 758⁽²⁾ Chiang, S.H. STUDY ON THE BIOLOGICAL EFFECTS OF RADIATION OF INSECTS. I. BIOLOGICAL EFFECTS OF EXTERNAL α AND GAMMA RADIATION. J. Agric. For. 12 (1963) 114-41. (In Chinese, with English summary)
- 759 Menhinick, E.F. STRONTIUM-90-YTTRIUM-90 BETA SOURCE. p.78-9 of "Health Physics Division Annual Progress Report for Period Ending July 31, 1964". ORNL-3697, Oak Ridge National Lab., Tenn. Oct. 1964.
- Interest was focused on the effects of β -rather than γ -radiation. Because of low penetration, smaller organisms receive higher tissue doses of β -radiation than larger ones, and insect eggs higher doses than adults. The part played by chitinous shielding, the additive effects of β - and γ -radiation, dose rate effects, and techniques for measuring β -radiation are factors to be considered. Three plane β -sources of 100, 1000, and 10 000 R/h on the surface were constructed to answer some of these questions. The construction of a plane ^{90}Sr source (rather than a point source, to simulate surface contamination) is described. A source 13 in. in diameter gave uniform surface dose rates from the centre up to 1 in. from the edge; 70 mCi of ^{90}Sr - ^{90}Y gave 100 R/h (surface rates) through 5 mil of Al, 0.7 Ci gave 1000 R/h, and 7.0 Ci gave 10 000 R/h.
- 760 Viado, G.B., Manoto, E.C. EFFECTS OF GAMMA RADIATION ON THREE SPECIES OF PHILIPPINE INSECT PESTS. Scient. Rev. 5, 3 (1964) 11-15.

See also:

- 505 Biological studies. (Japan. National Inst. of Radiological Sciences, Chiba, 1964)

2. Biochemistry. Physiology. Pathogen, Parasite, and Pesticide Susceptibility. Reproductive Potential

- 761 Ammon, F.-J. ON THE QUESTION OF THE MODE OF ACTION OF A RADON-CONTAINING ATMOSPHERE ON EMBRYONIC STATES OF Drosophila melanogaster. Biophysik 2 (1964) 29-41. (In German)
- An investigation was made of the biological action mechanism of radon and its decay products on Drosophila eggs in an atmosphere enriched with radon. It was found that the reduction of the hatching rate of the eggs is due in the first place to α -radiation which is caused by the deposition of radon decay products on the eggs and their support. The dose-effect curves for the lowering of the hatching rate were plotted. (NSA 18:1964, 27100)
- 762 Bonifay, M., Niauxat, P., Bourcart, R. CONTRIBUTION A L'ETUDE DE LA RADIO-SENSIBILITE DE CERTAINS ARTHROPODES SAHARIENS. ETUDE DE LA TENUEUR DE LEURS PARTIES MOLLES EN ACIDES NUCLEIQUES. RAPPORT EVENTUEL AVEC UNE RADIO-RESISTANCE ELEVEE. C.r. Séanc. Soc. Biol. 158, 3 (1964) 486-90.
- The scorpion, Androctonus amoreuxi was exposed to 100 000 R and three species of Tenebrionides (Pimelia angulata lesnei (Peyer.), P. a. explata (Peyer.), and Ocnerna hispida (Forsk)) to 20 000-45 000 R. Determinations of the RNA and DNA contents of their entire soft tissues before and after γ -irradiation showed, within a few days, a large decrease in DNA but very little change in RNA. Some relation appears to exist between the radiosensitivity of a species and the average level of RNA in its tissues.

- 763 Elbadry, E. THE EFFECT OF GAMMA RADIATION ON HOST-PARASITOID RELATIONSHIPS. Diss. Abstr. 24,12, Pt.1 (1964) 4929.

This investigation was designed to test the possible effect of γ -radiation on host-parasitoid relationships, and illustrated the possibility of using parasitoids as indicators of non-symptomatic pathological conditions induced in a host by sublethal dosages of γ -rays. The experimental animals selected for this work included the potato tuberworm, Gnorimoschema operculella Zeller, as the host insect and three species of its internal parasitoids: the egg-parasitoid, Trichogramma semifumatum (Perkins); the polyembryonic egg-larval parasitoid, Copidosoma koehleri Blanchard; and the larval-parasitoid, Macrocentrus ancylovorus Rohwer. The host insect decreases in radiosensitivity as the immature stages progress in development (see ref.813). The effects on the parasitoid-host relationship are described (see 764), and were marked. Only the egg-parasitoid, T. semifumatum (Perkins), which lacks any intimate physiological relationship with a live host was not materially affected by dosages heavy enough to cause host mortality.

- 764 Elbadry, E. SOME GAMMA RADIATION EFFECTS ON HOST-PARASITOID RELATIONSHIPS. Ann. ent. Soc. Am. 58, 2 (1965) 209-12.

The encyrtid Copidosoma koehleri Blanchard, when reared in previously irradiated potato tuberworm (Gnorimoschema operculella (Zeller)) hosts, showed symptoms of nutritional deficiency which included lessened polyembryony, slower development, and higher mortality in the various stages of the life cycle. The host larvae, irradiated before hatching from the egg, were smaller than normal, weighed less, and stored much less of the supracaudal fat tissue on which C. koehleri subsists during its polyembryonic stage. The larval period of the braconid Macrocentrus ancylovorus Rohwer was lengthened in such hosts, and there was greatly increased mortality of the adults within their cocoons. However, previous irradiation of the host eggs had no effect on the development of the trichogrammatid egg parasite T. semifumatum (Perkins). Dosages of 0.5-2 krad applied directly to polyembryos of C. koehleri in previously unirradiated hosts induced pathological conditions. Embryos grew abnormally large and many failed to complete their embryonic development, and the embryonic period generally was lengthened. Though irradiation damage was thus evident at a very early stage in C. koehleri, its expression in M. ancylovorus was generally delayed until the adult stage. The percentage of emergence of adults from cocoons was reduced by low dosages given to eggs or larvae, and when such dosages were given to second-stage larvae the females that survived to adulthood were crippled, with short wings and curled ovipositors and antennae. (Auth.)

- 765 Green, G.W. THE CONTROL OF SPONTANEOUS LOCOMOTOR ACTIVITY IN Phormia regina Meigen. - II. EXPERIMENTS TO DETERMINE THE MECHANISM INVOLVED. J. Insect Physiol. 10,5 (1964) 727-52.

When adults of P. regina are fed to repletion on sucrose solutions, spontaneous locomotor activity is immediately and markedly reduced, increasing again upon subsequent deprivation at a rate dependent upon the concentration of the sucrose solution ingested. Various operative techniques were employed in an attempt to elucidate the mechanisms involved in the control of spontaneous locomotor activity in relation to nutritional state. The rate of crop emptying and its effect on locomotor activity was investigated with x-rays after feeding radiopaque substances ("hypoaque sodium") in sucrose solution. The results of the various experiments suggest that spontaneous locomotor activity is controlled by a hormone released from the corpus cardiacum. Release of the corpus cardiacum factor to the haemolymph appears to be under the control of receptors in the foregut capable of monitoring the presence or absence of foodstuffs in that region of the alimentary tract.

- 766 Henneberry, T.J. EFFECTS OF GAMMA RADIATION ON THE FERTILITY OF THE TWO-SPOTTED SPIDER MITE AND ITS PROGENY. J. econ. Ent. 57, 5 (1964) 872-4.

Females of the two-spotted spider mite, Tetranychus telarius (L.), mated to γ -irradiated males produced fewer female progeny and more non-viable eggs as the dosage of radiation increased. At a dosage of 32 kR there were male progeny and non-viable eggs but no female progeny. Virgin females exposed to γ -radiation and mated to untreated males produced fewer males and females as the dosage increased from 1-24 kR, and after exposure to 32 kR produced only

non-viable eggs. Surviving female progeny of males irradiated at 8 kR or more were incapable of reproduction, and female progeny of males irradiated at 2 or 4 kR produced fewer males and females and more non-viable eggs than female progeny of untreated parents. Evidence for sperm inactivation or death was observed at doses of 96 kR and above. (Auth.)

- 767 Hoopingarner, R.A., Kumararaj, S., French, A.L. GAMETOGENESIS AND RADIATION EFFECTS IN THE CEREAL LEAF BEETLE, Oulema melanopa. Ann.ent.Soc.Am. 58, 6 (1965) 777-81.

Gametogenic development was followed, using histological sections, from emergence of the adult through diapause and oviposition. Some spermatozoa were mature at emergence, and the testes had mainly mature sperm upon entering diapause. Oocyte development did not begin until the subsequent spring after mating took place. Dosages as low as 500 R of x-rays reduced egg production and viability. Complete loss of egg viability occurred when both sexes were irradiated with 5000 R. Loss of egg production occurred with dosages above 5000 R. Spermatozoa were situated within the spermathecae up to and including dosages of 20 000 R to both sexes. (Auth.)

- 768 Hoover, D.L., Floyd, E.H. A STUDY OF THE CAPABILITY OF THE RICE WEEVILS Sitophilus sasakii AND S. oryzae TO REPRODUCE PARTHENOGENETICALLY. Ann.ent.Soc.Am. 58, 4 (1965) 565-7.

Observations on more than 1000 virgin females of S. oryzae (L.) (sasakii (Tak.)) and 1000 of S. zeamais Motsch. (oryzae, auct.) from emergence as adult insects to natural death of all individuals indicated that parthenogenesis does not occur in either of these species. The results also indicated that the virgin females do not oviposit. Irradiation of virgin females of S. zeamais (doses of 1000 R and 1500 R of x-rays at 100 R/min were administered) with x-rays did not stimulate oviposition. (From auth.)

- 769 Jones, A.W. A STUDY OF THE EFFECTS OF RADIATION UPON HOST-PARASITE RELATIONSHIPS. p.5 of "Research and Development in Progress. Biology and Medicine, No.3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr.1964, 290p.

- 770(*) Kalmykov, P.G. CHANGES OF OXIDATION PROCESSES IN FLIES FOLLOWING γ -IRRADIATION. p.55-56 of "Problemy Parazitologii". Trudy 4-oi Konferentsii Instituta Zoologii, Akad.Nauk Ukr. SSR, Lvov, 1963.

The tissue respiration under conditions of inhibited cytochrome oxidase by HCN was studied in flies after 0.5, 4, 24, and 48 h following γ -irradiation by a dose of 1, 2, 3, and 5 kR. The tissue respiration in the non-irradiated flies under conditions of inhibited cytochrome oxidase was decreased by 70-78%. In the irradiated flies after HCN application a relatively smaller inhibition of the tissue respiration was observed. (CA 61:1964, 15007e)

- 771 Kalmykov, P.G. CHANGE OF OXIDATION PROCESSES IN INSECTS UNDER THE INFLUENCE OF γ -RAYS. Radiobiologiya 5 (1965) 505-10. (In Russian)

Gamma irradiation (^{60}Co) of winged flies (Protophormia terrae-novae R.D.) and also the eggs, larvae, and pupal stages to 100-300 R decreased the oxygen consumption. The depression continued throughout metamorphosis and subsequent generations regardless of the stage that was irradiated. Breathing was depressed less in irradiated flies poisoned with cyanide than in un-irradiated. The slight depressing action of HCN on breathing in irradiated flies indicates that γ -irradiation has a destructive effect on cytochrome oxidase. (tr-auth.)

- 772(*) Karpov, A.E. EXPERIMENTAL ACTIVATION OF LATENT POLYHEDRAL VIRUS AT THE EMBRYONIC STAGES OF THE SILKWORM. Dopov. Akad. Nauk, ukr. RSR 15 (1963) 661-64.

- 773 Kikkawa, H. Botyu-Kagaku 29 (1964) 37-.

Adult males from a susceptible, isogenic strain (Canton) were subjected to doses of radiation ranging from 2000-3000 R and then mated with non-treated females of the same strain. Some 53 500 F₁ larvae from this cross were reared on media containing 0.5 ppm of parathion, a concentration normally lethal to susceptible individuals. Four larvae survived to adulthood,

and by a series of mating to S marker strains they yielded a strain exhibiting intermediate parathion resistance between the parental susceptible and a resistant (Hikone) strain. This resistance was located on chromosome 2 at the same locus (84.5) as that of other parathion R strains (Kikkawa, H., Rep. scient. Wks Osaka Univ. 9:1961,1). Cited in Adv. Pest Control Res. 6:1965, 207-8.)

- 774 Lassota, Z. URIC ACID IN NORMAL AND γ -IRRADIATED EGGS OF Bombyx mori. Acta biochim. pol. 12, 3 (1965) 271-78. (In English)

The uric acid content of B. mori eggs remained constant during diapause and post-diapause embryogenesis. The total N content of the eggs was also constant during this time. Irradiation at diapause with 20 kR of γ -rays, which inhibited the hatching of larvae, did not influence the uric acid content. Uric acid accumulated in dead eggs, whether irradiated or ones which had been stored 10 months at 4°C, only after 10 d of postdiapausal incubation at 25°C. (CA 63:1965, 7317d)

- 775 Lassota, Z. OXYGEN UPTAKE AND AMMONIA RELEASE IN NORMAL AND γ -IRRADIATED EGGS OF Bombyx mori. Acta biochim. pol. 12, 4 (1965) 369-77.

In normal B. mori eggs, O uptake at 4°C was 37 μ l/g/h. Gradual increase in storage temperature to 25°C increased this to 81 in control and to 88 μ l/g/h in γ -irradiated eggs (20 or 200 kR). During incubation at 25°C, the respiration rate in the eggs increased to a maximum of 750 μ l/g/h a few hours before hatching. In eggs irradiated with 20 kR, respiration increased gradually to a maximum of 300 μ l/g/h. In eggs irradiated with 200 kR, there was no increase in the rate of O uptake, although respiration continued at the initial rate for 18 d. Irradiation completely inhibited hatching, eggs irradiated with 20 kR being blocked at the stage corresponding to late gastrula and those irradiated with 200 kR at blastula. Enhancement of respiration due to temperature involved mainly later stages, beginning with blastokinesis. There was no release of NH_3 in irradiated eggs. (CA 64:1966, 5408g)

- II/1270 Lavrov, M.T., Bogomaz, V.A. THE EFFECT OF RADIATION ON THE COCKCHAFER, Melolontha vulgaris. Zash. Rast. 6 (1958) 53. (In Russian)*

Cockchafers were irradiated, using ^{60}Co in the form of a solution of its chloride, with an activity of 405 mCi. After 6 d the insects had received 20851 R. Though the egg-laying capacity of the females had not been greatly impaired no larvae were produced. Such considerable doses of γ -rays were shown to affect the sexual glands in the first place and seem to bring about the complete sterilization of males. The mortality of irradiated M. vulgaris was 2.6-10.8% lower than in controls. The irradiated insects were more mobile and agile, and also consumed more leaves than the controls. Direct irradiation of the cockchafer is concluded to be inappropriate as a method for rapid extermination but can be put to advantage in sterilizing pupae and adults.

* No abstract was available in Vol. II/1270.

- 776 Maynard, E.A. INVESTIGATION OF THE EFFECTS OF RADIATION ON THE HAEMOCYTES OF Tenebrio molitor L. p.43-44 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr.1964, 290p.

- 777 Menhinick, E.F. METABOLISM OF CRICKETS. p.76-8 of "Health Physics Division Annual Progress Report for Period Ending July 31, 1964". ORNL-3697, Oak Ridge National Lab., Tenn. Oct.1964.

To determine the extent to which radiation may affect energy requirements and thereby cause changes in community structure, a study was made of the feasibility of simultaneous measurements of different aspects of energy flow: ingestion, defecation, O_2 -consumption, and production. Over a period of 42 d the crickets consumed an average of 435 mg meal/individual and 4 mg of dead crickets; 160 mg was lost in faeces, standing crop increased 38 mg, skins weighed 2 mg, and mortality accounted for 8 mg; this gave a total production of 48 mg. O_2 -consumption for this period was 166 ml at STP. The effects of radiation on energy flow, and the relation of isotope uptake, loss, and equilibrium with energy flow are being studied.

- 778 Neidinger, J.W., Baratz, R.A., Moos, W.S. OXYGEN UPTAKE OF THREE LIFE STAGES OF Tenebrio molitor PRIOR AND SUBSEQUENT TO MASSIVE DOSES OF LOW ENERGY x-RAYS. Atompraxis 11, 9-10 (1965) 564-8.

The pre- and post-irradiation oxygen uptake of T. molitor, larvae, pupae and adults was measured at 45 kV x-rays at doses of 4.6×10^4 to 1.4×10^5 R and a dose rate of 760 R/s were employed to irradiate the beetles. Comparison of experimental animals and controls shows trend to reduced O_2 -consumption at lower doses and enhanced O_2 -consumption at the higher. (Auth.)

- 779(2) Niaussat, P., Pascaud, A., Grenot, C., Pierre, F. CONTINGENT RELATION BETWEEN THE RESISTANCE TO γ -RADIATION OF CERTAIN ARTHROPODS OF THE SAHARA AND THE NUCLEIC ACID CONTENT OF THEIR TISSUES. Bull. Soc. Méd. milit. Franc. 57 (1963) 295-9. (In French)

Several scorpions and coleoptera indigenous to the Sahara were irradiated with γ -rays. The LD50/30 (continuous whole-body irradiation) was found to be $\sim 100\,000$ R for Androctonus amoreuxi and $\sim 30\,000$ R for Pimelia angulata, compared with 60 000 R for Drosophila melanogaster and 20 000 R for Tribolium confusum. The relation between this high resistance and the content of tissue in DNA and RNA was examined. The scorpions (7 animals) were found to contain a mean of 11.35 ± 1.33 mg RNA phosphate and 1.02 ± 0.20 mg DNA phosphate per 100 g soft parts. For two specimens of Pimelia (imago) these values were 14.6, 15.6 and 2.41, 4.58, respectively. For comparison, the values for Drosophila larvae are reported to be 42, 53 and 2.92, 3.12; the salivary glands of Drosophila have values 33.8, 42.6 and 3.9, 4.2, respectively. These results do not permit conclusions but allow the question to be proposed: is there a relation between radiation resistance and the tissue content in DNA of an organism? These species studied all have low DNA values, and the morphology of scorpions has scarcely evolved since the Silurian period. The content of DNA in the venom is found to be practically zero. (NSA 18:1964, 36965)

- 780 Norsk Hydro's Inst. for Cancer Research, Oslo. FIFTH REPORT FROM NORSK HYDRO'S INSTITUTE FOR CANCER RESEARCH FOR 1963-1964. NP-15585. 1965. 68p.

Among many other studies some work on the effects of injected ^{91}Y on reproduction in Drosophila is reported, and on the radiosensitivity of Drosophila spermatogonia to x-rays.

- 781 Piechowska, M.J. EFFECT OF IONIZING RADIATION ON THE ENDOCRINE SYSTEM IN INSECTS. Bull. Acad. pol. Sci. Cl. II Sér. Sci. biol. 13 (1965) 139-44.

Celerio euphorbia at different stages of homodynamic development was used to study the effect of ionizing radiation on the functions of the endocrine system in this insect. Caterpillars and pupae were irradiated with γ -rays from ^{60}Co at a dose of 2800 R. All groups studied were affected by this dose but the resulting changes differed widely. The youngest caterpillars were the least resistant; in 95%, growth and increase of weight stopped and death occurred between the 15th and 25th day after irradiation. In older caterpillars the damage by irradiation was less severe. In the surviving caterpillars deficiency in weight was observed, the difference being greater for animals irradiated during instar III than during instar IV. In the groups irradiated at later stages of development the mortality did not differ from that in the control group; after eclosion, however, external malformations of the adult moths appeared. The injuries were the greatest in animals irradiated at the end of the V instar; 40% of the eclosed moths exhibited deformations of head, both pairs of wings and of legs. They could fly only with difficulty, if at all; some could not even walk. In males, only spermatocyte cells in earlier development stages were present. In females, both ovaries and ova were underdeveloped, and only a few ripe eggs, if any, were found. Immaturity of ova was evaluated from the composition and number of protein fractions obtained in paper electrophoresis. In normal ripe ova only four fractions were found, their distribution being similar to that of corresponding haemolymph fractions. In ova from females irradiated during the instar III and IV five fractions were found, their proportions being dependent on the extent of injury caused by irradiation. In the females with no ripe eggs, the amount of fraction I was small and that of fraction IV twice that in the control. When more ova were ripe, the proportion of fraction I was markedly higher. Generally, the less the ovaries were affected and more ripe eggs were present, the greater was the similarity in distribution of the protein fractions with the control, and vice versa. The underdevelopment of the reproductive organs and ova observed in these experiments in C. euphorbiae may be related to a radiation-induced disturbance in the hormonal system. This suggestion is corroborated by the observation

that γ -rays also have an inhibitory effect on the excretion of the juvenile hormone during the moulting of caterpillars. (NSA 19:1965, 45861)

- 782 Po-Chedley, D.S. EFFECT OF x-RAYS ON THE MEAL WORM, Tenebrio molitor, EMBRYO. I. CHANGES IN THE PROTEIN AND FREE α -AMINO NITROGEN FRACTION. Terminal Summary, October 15, 1964. NYO-2814-1, D'Youville Coll., Buffalo, 1964, 7p.

Data are presented on daily survival curves and the protein electrophoretic patterns observable for normal and x-irradiated embryos. 20 free ninhydrin-positive substances were tabulated which had been detected in T. molitor. Variations in concentration reach a max., generally on the 4th day of growth. Slight changes occur during the remaining interval leading to larval eclosion. Results of x-irradiation on the amino acid pool of 4-d-old embryos are tabulated. The changes (decreases) induced in concentration were not permanent; a gradual readjustment was observed during the 72 h which followed. Hatching was delayed by ~3 d. Changes in concentration were shown graphically. Radiation resistance increases with developmental progress.

- 783 Po-Chedley, D.S. THE EFFECTS OF x-RAYS ON THE MEAL WORM, Tenebrio molitor, EMBRYO. p.180 of "Proceedings of the 12th International Congress of Entomology, London, 8-16 Jul.1964". Freeman, P., Ed. London, Royal Entomological Society of London, 1965.

Findings are reported on proteins and free amino acids found in the developing meal worm embryo, the variations observed following x-ray stimulation, and the preparation of survival curves for the x-irradiated embryo. Data for the meal worm embryo shows that its resistance to x-irradiation increases with each day of embryological growth. The dosages required to yield a 50/8 MLD effect ranged from 150 R for the one-day-old embryo to 41 000 R for the 8-d-old embryo. The survival curves obtained for this period of development indicate that resistance to irradiation builds up rapidly to the 4th day of growth. After that interval the resistance increases at a slower rate. The α -amino N content, free amino acids and derivatives, detected in the developing embryo also showed a progressive increase in concentration during this period of growth. A total of 20 free ninhydrin positive compounds have been identified on one and two-dimensional paper chromatograms for the normal embryo. There was a general increase in concentration for these compounds during the course of embryological development. Paper electrophoretic patterns of the proteins found in normally developing embryos are represented by two distinct anodal fractions separated by an area of low concentration. The effects of x-irradiation on the embryo are characterized by a third and fast moving anodal fraction. When this occurred in the older embryos, 4-6 d old, the induced fraction gradually subsided and disappeared in about 72 h. These embryos successfully completed their embryological growth. During this same period there was a disturbance in the amino acid "pool" in that asparagine, arginine, histidine, phenylalanine, serine, threonine, tryptophane, tyrosine and valine increased in concentration while α -alanine, aspartic acid, cystine, glutamic acid, glutamine, glycine, methionine and proline decreased in concentration in comparison with normal values. These variations were gradually readjusted to normal conditions by the surviving embryos during the post-irradiation period. As amino acids provide some protective action, a part of the radiation resistance of insects may be explained by means of this physiological factor. (From abstr.)

- 784⁽¹⁾ Puro, J.A. TEMPORAL PATTERN OF THE EARLY STAGES OF SPERMATOGENESIS OF ADULT Drosophila melanogaster MALES AFTER TREATMENT WITH x-RAYS. TID-21466, Turku Univ. (Finland). Dep. of Genetics. 1961, 16p. Paper presented at "2nd International Congress on Radiation Research, Harrogate, Yorkshire, 5-11 Aug.1962".

For further details see: II/896.

- 785 Rockstein, M., Bhatnagar, P.L., Dauer, M. THE EFFECTS OF HIGH LEVEL x-IRRADIATION ON ADULT HOUSE FLY FLIGHT ABILITY AND LONGEVITY. Bull.ent.Soc.Am. 11, 3 (1965) 158. Abstr.78, Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov.-2 Dec.1965".

Whereas x-irradiation dosages of up to 8000 rad to the pupae produces reduction in life span of adult males and females, higher doses result in increased male longevity and a marked retardation in otherwise normal wing loss, with a maximum (optimal) effect at 30 000 rad. (Abstr.)

786⁽¹⁾ Semin, V.S. Sci.Comm.Moldavian Conn.Minist. 5(1959) 46.

Females of the vine pest, Phylloxera, treated with 10 000 R of radiation are reported to begin to lay eggs parthenogenetically earlier than controls. (From "Insect Control", ref.1062)

787 Touchberry, R.W., DeFries, J.C. GENETIC EFFECTS OF GAMMA-IRRADIATION ON EGG PRODUCTION AND ADULT EMERGENCE OF Drosophila melanogaster. Genetics 49, 3 (1964) 287-400.

Newly emerged male and female flies from one inbred and one randombred population were subjected to 0, 500, 1000, or 1500 R of γ -radiation and then mated in all possible combinations within populations, resulting in a four \times four factorial arrangement of treatments. Daily egg production over a 10-d period was determined from two replicated experiments for the treated flies, their untreated progeny (Generation 1) and grand-progeny (Generation 2). Generation 2 resulted from full-sib matings of members of Generation 1. Eggs laid each day which resulted in viable adults were determined for Generations 1, 2, and 3 (Generation 3 resulting from two generations of full-sib mating). Mean daily egg production was not significantly affected by irradiating males or females with 1500 R or less of γ -rays; however, irradiation of the female parent with 2000 R or more of x-rays had a marked depressing effect on egg production. Irradiation of the male parent did not affect egg production appreciably. The partial linear and quadratic regression coefficients of daily egg production on day of oviposition for each pair of flies indicated no significant differences associated with levels of irradiation of males or females. Large linear depressing effects associated with irradiation of both male and female parents were found in Generation 1 for mean daily percent adult emergence. Treatment of the males had a significant effect on descendants. The weighted partial linear and quadratic regression coefficients of percent adult emergence on day of oviposition were determined for each pair of flies. Analyses of the differences of these coefficients indicated that secondary spermatocytes and early spermatids were more sensitive to radiation induced genetic damage than were spermatozoa, later spermatids, primary spermatocytes, and spermatogonia. Less differential effect was found for irradiation of females than males. Nevertheless, gametes treated as primary oocytes were more susceptible to damage than those treated as oogonia. Irradiation of male Drosophila resulted in four to five times as much genetic damage in the gametes as did irradiation of the female. Evidence of this greater damage is also present in the gametes produced by the progeny and grand-progeny of irradiated males, the extent of the damage being approximately halved each generation. (From auth.)

788 Wharton, D.R.A., Wharton, M.L., Lola, J.E. WEIGHT AND BLOOD VOLUME CHANGES INDUCED BY IRRADIATION OF THE AMERICAN COCKROACH. Radiat. Res. 25(1965) 514-25.

Exposure of the cockroach to 10 000 rad of β -radiation from a 2-MeV Van de Graaff electron accelerator caused an early and continuous loss of body weight, except on the 3rd day after irradiation. The body weight of the whole irradiated insect on the 3rd day after irradiation was greater than that of the fed or the starved controls because of an excessive intake of water, much of which is retained in the crop. Body weight became more irregular with dehydration and an increasing mortality rate. Percent weight losses in the intestine, fat body, and gonads were greater than in the body at large. The fat body lost less weight in the irradiated insects than in the controls, possibly because of the lower metabolic rate or of retained metabolic water. The blood volume percent (μ l/100 mg of body weight) was much reduced post-irradiation, and an increasing number of insects failed to bleed as the mortality rate rises. The percent total body water of the whole irradiated insect was greater than in the fed and similar to that of the starved controls. The similarity was due to the generally large intake of water by the irradiated insects. When the intestines were removed, the body water was found to be less and differently distributed in the irradiated insect. The probable causes of water changes are discussed. (Auth.)

789 Yanders, A.F. THE EFFECTS OF x-RAYS ON INSEMINATION AND SPERM RETENTION IN Drosophila. Genetics 49, 2 (1964) 309-17.

The effect of x-rays on insemination success and retention of sperm during storage in inseminated females was studied by direct microscopic estimates of the relative fullness of excised ventral receptacles in female D. melanogaster dissected at intervals following mating. Males were treated at 12 x-ray dose levels ranging from 500-75 000 R and mated for 24 h to untreated, virgin

females. The insemination success in groups of females dissected immediately after the mating period was significantly lower in treated groups than in the controls at all doses of 4000 R or more. The reduction in insemination was proportional to ~ 0.0066 times the dose in kiloröntgens at doses to 40 kR, and was even more extreme at doses of 60 kR and 75 kR. Males were treated with 4000, 25 000, or 50 000 R of x-rays and mated for 24 h to virgin untreated females. The insemination success in females dissected immediately after the mating period was lower in each treated group, and the retention of sperm after 7 and 14 d of storage in the females was drastically reduced in the 25 000 and 50 000 R groups. Inseminated females were treated at eight x-ray dose levels ranging from 5000 R to 50 000 R and dissected at times ranging from 2 h-17 d after irradiation. Reductions in the success of sperm retention were first noted 24 h after irradiation at the highest dose levels, and became evident even at lower doses within the 17-d storage period. It is concluded that some aspect of sperm behaviour, possibly motility, is affected by x-rays at doses within the range commonly employed in genetic studies. This finding is significant for the analysis of induced mutation rates in *Drosophila*. (Auth.)

See also:

- 19 Some physicochemical indexes of gaseous exchange in the housefly *Musca domestica* and of DNA nucleotide composition of first-generation larvae, following internal γ -irradiation by phosphorus-32. (Kharmlav, V.P., 1964)
- 657 The effect of γ -irradiation on fecundity and fertility of *Tribolium confusum* Duval. (Verecke, A., Pelerents, C., 1965)
- 666 The effects of radiations on the genetic systems of organisms in relation to their physiological and biochemical systems. (Alexander, M.L., 1964)
- 671 Morphological and reproductive variation under four environmental pressures in an inbred strain of *Drosophila melanogaster*. (Come, T.V., 1964)
- 675 x-ray and fast neutron effects on productivity of flour beetles. (Erdman, H.E., 1965)
- 739 The sensitivity of the male germ cells of *Drosophila* to methyl methanesulphonate. (Bateman, A.J., Chandley, A.C., 1964)
- 752 Studies of the effect of meat exposed to gamma radiation or chemosterilants on the reproductive capacity of a blow fly *Phaenicia cuprina* (Wiedemann). (Morgan, P.B., Labrecque, G.C., 1964)
- 813 Some effects of gamma radiation on the potato tuberworm, *Gnorimoschema operculella* (Lepidoptera: Gelechiidae). (Elbadry, E., 1965)
- 814 Differential responses of germ cells in flour beetles, *Tribolium castaneum* Herbst, due to x-ray dose, hypothermia, sex exposed and age. (Erdman, H.E., 1964)
- 817 The effect of gamma irradiation on the varo race of *Bombyx mori*. II. Irradiation of eggs in the early and late embryonic stages. (Gubicza, A., Molnar, I., 1964)
- 819 Possibilities of controlling *Callosobruchus subinnotatus* Pic (Bruchidae) by gamma rays. (Huque, H., Khan, M.A., 1964)
- 820 Effects of ionizing radiation on eggs and adult insects. (Lippold, P.C., Gambrell, F.L., 1965)
- 823 Biological and histopathological effects of gamma radiation on three life stages of *Anthonomus grandis* Boheman. (Mayer, M.S., 1964)
- 825 Effects of gamma radiation on the postembryonic stages of a dermestid beetle, *Anthrenus vorax* Waterhouse. (Nair, K.S., George, J.C., 1965)
- 839 The effect of x rays on adult *Hyalomma asiaticum*. Communication I. (Sidorov, V.E., Grokhovskaya, I.M., 1964)
- 854 The effects of gamma radiation on the fertility and longevity of *Hippelates pusio*. (Flint, H.M., 1965)
- 861 Effects of gamma rays on mortality, longevity and fecundity of some species of fruit flies. (Narayana, E.S., et al., 1963)
- 869 Susceptibility of the confused flour beetle, *Tribolium confusum* Duv., and the rust-red flour beetle, *Tribolium castaneum* (Herbst), to gamma radiation. (Banham, E.J., Crook, L.J., 1966)
- 888 Modifications of productivity in flour beetles, *Tribolium castaneum* Herbst, due to x-ray dose, hypothermia and the sex exposed. (Erdman, H.E., 1965)
- 890 Synergistic action of radiation and of *Bacillus thuringiensis* toxin on protozoan diseases of insects. (Jafri, R.H., 1963)

- 891 Influence of pathogens on the life span of irradiated insects. (Jafri, R.H., 1964)
- 892 Influence of pathogens on the life span of irradiated insects. (Jafri, R.H., 1965)
- 893 Prospects of integrated radiation and microbial control of harmful insects. (Jafri, R.H., 1965)
- 895 Factors influencing biomagnetic environments during the solar cycle. (Levengood, W.C., 1965)
- 910 Some observations on the mating activity and fertility of Drosophila melanogaster males. (Kvelland, I., 1965)
- 913 The effects of x-radiation on plateaued populations of Tribolium castaneum in regard to reproductive fitness and response to selection. (Bell, A.E., 1964)
- 914 The effects of x-radiation on plateaued populations of Tribolium castaneum in regard to reproductive fitness and response to selection. (Bell, A.E., 1964)
- 919 Fast-neutron effects on productivity of young and old flour beetles, Tribolium castaneum Herbst, and alterations at different temperatures and after exposure of either or both sexes. (Erdman, H.E., 1965)
- 920 Fast neutron effects on flour beetles. (Erdman, H.E., 1964)
- 921 Fast neutron effects on productivity of young and old flour beetles, Tribolium castaneum Herbst and alterations due to temperature and sex exposed. (Erdman, H.E., 1964)
- 922 Age, temperature, coexistence, and x-radiation effects on flour beetles' productivity. (Erdman, H.E., 1964)
- 923 Reproductive performance of x-rayed single-species and mixed-species cultures of Tribolium confusum and T. castaneum reared at different temperatures. (Erdman, H.E., 1964)
- 924 A study of radiation on the biology and population dynamics of the cereal leaf beetle, Qulema melanopa (L.), order Coleoptera, Family Chrysomelidae. (Myser, W.C., 1965)
- 1001 Control of weevil populations (Sitophilus granarius (L.)) with sterilising and substerilising doses of gamma radiation. (Cornwell, P.B. et al, 1966)
- 1014 Effects of continuous and fractionated doses of gamma radiation on the survival and fertility of Sitophilus granarius (L.). (Jefferies, D.J., 1966)

3. Tissue. Organ

- 790 Baldwin, W.F., Sutherland, J.B. EXTREME SENSITIVITY TO LOW-LEVEL x-RAYS IN THE EYE OF THE COCKROACH Blaberus. Radiat. Res. 24 (1965) 513-8.
- Electroretinograms were induced in the compound eyes of B. giganteus by x-rays. The response increased with dark adaptation, an effect that appears to be associated with the migration of eye pigments. The magnitude of the response depended on the total dose of x-rays over the range from 0.09 to 22.4 MR and was independent of dose rate from 1.2 to 41 R/min. The reaction in the ommatidia appeared to be stimulated by single photons. Thus, a refinement of techniques for the measurement of ERG's from single ommatidia may permit the detection of a response at even smaller doses. (Auth.)
- 791 Baroughi-Bonab, H. STUDY OF THE POST-EMBRYONIC DEVELOPMENT OF THE OVARY IN Ephestia kühniella Z. (LEPIDOPTERA, PYRALIDAE). 1. EFFECT OF IONIZING RADIATIONS. Fd Irrad. 8 (1965) A13-A14.
- Female caterpillars were irradiated with doses ranging from 2000-15000 rad. Nymphosis, which took place within 7 d in the controls, was delayed from 9 d in the 2000 rad group to 31 d in the 14000 rad group. Duration of nymphosis was only slightly affected by irradiation. Radiation effects on ovaries and oogenesis at the various dosages are discussed. Chrysalids were affected less than final-stage caterpillars. (NSA 20: 1966, 18329)
- 792 Carney, G.C. THE EFFECTS OF IONIZING RADIATION ON THE SARCOSES OF HOUSEFLY FLIGHT MUSCLE. Dis. Abstr. 25, 9 (1965) 4917.
- An investigation concerning the examination of sarcosomes which had been exposed to in vivo and in vitro doses of x-rays in the range of 50 000 to 200 000 R at 5000 R/min is described. Sarco-

some were extracted from the flies within 1 h of irradiation and were studied with respect to their morphology, respiration, uptake of inorganic phosphate, and cytochrome c content. Since the wing-beat frequency of flies appears to be dependent, at least partially, on the cytochrome c content of the muscle tissue, one experiment was carried out to measure the frequency before and after the flies were exposed to a dose of 50 000 R. The results indicated a considerable alteration in the physiological properties of the sarcosomes as a result of irradiation in vivo. Irradiated sarcosomes swelled much more than control preparations when suspended in 0.1N KCl solution. Also, a more rapid leakage of cytochrome c was detected in isolated sarcosomes from irradiated flies. On the basis of a limited number of experiments there was evidence that the uptake of inorganic phosphate and the synthesis of ATP (as indicated by the P/O ratio) was impaired in sarcosomes which had been irradiated in vivo at doses above 50 000 R. There was no evidence, however, to indicate that house fly cytochrome c was appreciably altered by in vivo irradiation at doses below 100 000 R. Wing-beat frequency was depressed by about 40% in an experiment in which flies were tested before and immediately after irradiation. No changes in the cytochrome c content of sarcosomes were detected as a result of in vitro irradiation. In conclusion, it may be stated that the radiation effects detected appear to stem from changes in the properties of the sarcosomes. (From DA)

- 793 Carney, G.C. SWELLING AND SHRINKAGE PROPERTIES OF HOUSEFLY SARCOMES AFTER IN VIVO EXPOSURE TO x-RAYS. Radiat. Res. 25 (1965) 637-45.

The swelling behaviour of *Musca domestica* sarcosomes, situated between the fibrils of the flight muscles, suspended in unbuffered 0.1 M KCl solution was studied after in vivo exposure to x-rays in the dose range 25 to 100 kR. The irradiated sarcosomes swelled more rapidly than the controls and at a rate proportional to dose. Reversal of swelling was obtained by the addition of ATP in the form of its acidic disodium salt. Neutralized ATP had no effect on the swelling rate. The contraction of sarcosomes in response to ATP was less pronounced after in vivo irradiation. The difference between treated and control sarcosomes with respect to their swelling behaviour and their response to ATP is discussed in relation to their energy-supplying function and the depression in wing-beat frequency which results from irradiation. (Essentially auth. summary)

- 794 Elbadry, E. THE EFFECT OF GAMMA IRRADIATION ON THE HEMOCYTE COUNTS OF LARVAE OF THE POTATO TUBERWORM, *Gnorimoschema operculella* (ZELLER). J. Insect Path. 8 (1964) 327-30.

The effect of ^{60}Co γ -irradiation on total haemocyte counts (THC) and differential haemocyte counts of larvae in 3 instars of the potato tuberworm was evaluated. Irradiation with 3000 and 9000 rad had a noticeable effect on the total haemocyte counts. The THC decreased in treated larvae, regardless of whether they were subjected to irradiation at an early stage of development or at an advanced stage. By comparing the 3-larval-instar that had been subjected to 3000 or 9000 rad, it was clear that the 3rd instar was less affected as to the reduction of THC, which indicates that the 3rd-instar larva is more resistant than earlier instars to the effect of irradiation on blood cells. However, statistical analysis revealed no significant difference between THC of larvae of the same age treated with 3000 and 9000 rad. The THC of insects vary greatly with technique, species, stage of development, various physiological states within a stage, and many other factors. For example, in some cases, the THC increase briefly with bacterial infections but in others may show no change or may even decrease. The THC may be greatly affected by the nutritional state, and this might be an explanation for the decrease of THC or irradiated tuberworm larvae. Irradiated larvae were of smaller size and lighter weight than non-irradiated controls. Also studied was the effect of γ -rays in the differential haemocyte count. Three cell types were recognized, namely, plasmatocytes, adipohaemocytes, and spheroid cells. In untreated insects, the plasmatocytes were found to constitute about one-third of the total blood cells. No conclusions could be drawn from the results obtained, except that the blood picture is not significantly changed by irradiation. Some morphological changes in the plasmatocytes were observed. Small numbers of plasmatocytes had an elongated shape with slightly larger nuclei. (NSA 19:1965, 33860)

- 795 Girardie, A. ACTION DE LA PARS INTERCEREBRALIS SUR LE DEVELOPPEMENT DE *Locusta migratoria* L. J. Insect Physiol. 10, 4 (1964) 599-609. (With English summary)

The destruction of the pars intercerebralis in the last two larval stages (IV and V) of the gregarious phase of L. migratoria by x-rays or cauterization alters the normal development of this insect. Moulting is stopped or delayed as after the removal of the ventral glands. Animals which moult have their metamorphosis, pigmentation, and development of the oocytes similar to animals which have been implanted with active corpora allata: the fifth moult results in metathetic animals, or imperfect adults, or normal adults, and most animals are green. The other animals remain dark or become pale. The destruction of the pars intercerebralis can also completely prevent the growth of the terminal oocytes in the ovaries. The operated locusts contain in the sixth stage extremely large volumes of blood which greatly distend the abdomen. From all this it can be concluded that the pars intercerebralis in L. migratoria exerts control over the activity of the central glands and the corpora allata. The pars intercerebralis without the intermediacy of the corpora allata acts also on the chromatic adaptation, on oocyte development, and on metabolism, (Auth.)

- 796 Larsen, W. CELL PROLIFERATION IN AN INSECT TISSUE CULTURE. Life Sci. 3, 2 (1964) 103-6.

Fragments of heart, pieces of head, Malpighian tubules, and digestive tract were isolated from 66-d-old embryos of the cockroach, Blaberus craniifer, and placed in Ringer solution. The isolated portions were transferred to culture dishes containing medium T.C. 199 to which both lactalbumin hydrolysate and yeast autolysate had been added. Renewal of the culture medium was made only when pH changes indicated that fresh medium was necessary. No insect blood was used. Six of 30 heart fragments proliferated round hollow balls of tissue; new growth was not initiated until the fragments had been in the culture fluid for almost 5 months. In one case a heart fragment did grow new tissue in 199 alone without added hydrolysate, but the new growth did not take place until one year after the fragment had been exposed to 10 000 R of x-irradiation.

- 797 Larsen, W. SURVIVAL OF ISOLATED EMBRYONIC HEART FRAGMENTS FOLLOWING TREATMENT WITH SOME RADIATION PROTECTING CHEMICALS. Life Sci. 3 (1964) 539-43.

Heart fragments from 82-d-old embryos of the cockroach, Blaberus craniifer, were placed in screw-cap glass vials each containing 5 ml of culture fluid to which penicillin, streptomycin, and mycostatin had been added. There were four hearts in each vial. The fragments were exposed to γ -irradiation from a ^{60}Co source at a rate of 92 820 rad/h. Heart beat was selected as the function to determine survival of the tissues. Of 56 heart fragments exposed to 82 000 rad over half stopped beating for a 24 h period following irradiation. This interval of inactivity was designated as the initial shock period. A period of recovery followed during which 90% of the heart fragments started to function again. Some hearts of the irradiated control group continued to beat for 10 d. It was found that by adding bis (2-amino-4-sulphonamide-phenyl) disulphide (ASPD) the shock period did not appear and the survival time was extended. Using AET, the survival curve followed the general pattern of an untreated control group. There was an initial shock period and a period of recovery. Survival time was slightly longer. The efficacy of AET was seen better at 44 000 R where heart fragments functioned for 59 d. Using isoleucine the survival time was no longer than that of the controls (10 d). (NSA 19: 1965, 13103)

- 798 Larsen, W. THE EFFECTS OF X IRRADIATION ON THE EMBRYOS OF INVERTEBRATE EMBRYOS. TID-21877, College of Southern Utah, Cedar City, 1965, 13p.

The effects of x-radiation at dosages ranging from 50-12 000 R on the development of embryos of the ovoviviparous cockroach, Blaberus craniifer, exposed at various ages ranging from 1-52 d were studied. Approximately 3750 embryos were examined and microscopic sections made of the specimens exhibiting gross deformities, cessation of growth, or abnormalities in size. Embryos were found to become resistant to x-radiation suddenly just prior to the stage of dorsal closure. Embryos that had passed this stage when irradiated continued to develop normally until dosages reached levels of 2000 to 5000 R. Gross abnormalities ranged from individual slightly retarded in growth to embryos represented by an amorphous mass. Typical abnormalities found are described. Tissue cultures of heart fragments, gut sections, and Malpighian tubules of Blaberus were prepared and survived for periods varying from 5 months-2.5 yr. The effects of γ -radiation at dosages up to 93 000 rad were studied, the use of heart function in heart fragments in testing various radioprotective chemicals, and the effects of oxygen and hypothermia on radiosensitivity were investigated. Results are summarized. Data are also included from studies of reactions of heart fragments from

embryos of *Blaberus* to several vital stains and the effects of various growth hormones on the growth pattern of embryonic insect organ cultures. (NSA 19:1965,29903)

- 799 Monro, J., Bailey, P.T. INFLUENCE OF RADIATION ON OVARIAN MATURATION AND HISTOLYSIS OF PUPAL FAT BODY IN DIPTERA. *Nature*, Lond., 207 (1965) 437-8.

The effects of x-radiation on ovarian development and histolysis of the pupal fat-body was studied in *Dacus tryoni* that were treated in the pupal stage with 8000 R of γ -radiation given to: the whole body, the anterior third of the body, or the posterior third of the body. Results were interpreted to mean that radiation blocked an abdominal stimulus, thus indirectly preventing ovarian development. Radiation did not act hormonally and the contention was supported that it directly damaged the ovarian nurse cells, which in turn probably reduced demand on the pupal fat-body and delayed its histolysis. (NSA 19:1965,38406)

- 800 Nachtigall, W. UNTERSUCHUNGEN AM ELEKTRORETINOGRAMM ÜBER DIE WIRKUNG IONISIERENDER STRAHLEN AUF DAS KOMPLEXAUGE VON INSEKTEN. (Electroretinogram studies on the effects of ionizing radiation on the compound eye of insects). *Biophysik* 2, 3 (1965) 145-65. (In German)

Heavy doses of x-rays have a damaging effect on the insect eye, low doses a stimulating effect. Electroretinograms (ERG) formed by periodic light flashes were damaged by medium doses of x-rays. As a result a third ERG component could be distinguished in insects which show various types of ERG. The insect eye reacts to x-rays flashes with an ERG. This has a more or less similar form to the light ERG, except for a longer latent period. The threshold dose is < 10 mR. Possible mechanisms of action are discussed. Most of the work was carried out on *Calliphora erythrocephala* (Meig.). Altogether 100 individuals were used belonging to 17 species (Diptera, Lepidoptera). Results are based on 62 experiments and 3500 ERG photos.

- 801 Riemann, J.G. CYTOLOGICAL EFFECTS OF RADIATION ON TESTES OF THE SCREW-WORM FLY, *Cochliomyia hominivorax*. *Genetics* 50, 2 (1964) 279. Abstr.

A study was made of the cytological effects on screw-worm testes of from 51-6200 R of γ -radiation. Most of the youngest primary spermatocytes were killed after having received only 100 R, the older secondary spermatogonia after 500 R, and in different tests all primary spermatogonia were destroyed at levels from 1500-3000 R. Some cells of all three classes were killed even at the 51 R level. Few, if any more, spermatocytes were killed with higher radiation doses than with 100 R, and in all cases the surviving cells apparently went through the meiotic divisions. However, increased chromosomal damage was evident with increased dosage, and at the highest radiation level most of the spermatids formed from irradiated spermatocytes failed to develop into mature sperm although they failed to degenerate. On the other hand, those cells that were irradiated as spermatids did develop into normal appearing sperm. — The stage and time at which death occurred in different cell types was also investigated. It was found that all susceptible cells died prior to division and that decay became evident later in the more resistant types than in those less so. — In testes where some primary spermatogonia survived a dose of 1500 R the first divisions of their spermatocyte descendants were found on the 7th or 8th after irradiation. (Abstr.)

- 802 Seidel, F. ANALYSE DES DIFFERENZIERUNGSVERLAUFS IM INSEKTENEI (*Gryllus*) MITTELS UV- UND RÖNTGENBESTRAHLUNG. (Analysis, by means of x- and u.v.-irradiation, of the course of differentiation in the insect egg (*Gryllus*)). *Zool. Anz.*, Suppl., 27 (1964) 121-43. (In German)

Work done by the author and his group is reviewed. *Gryllus domesticus* eggs were used in the studies. The process of differentiation is initiated by a differentiation centre where the cells first aggregate and begin to show segments and organ formation, etc. Thirty hours after oviposition it was possible to recognize 20-40 contraction foci: subsequently, streaming was noted on the egg surface and, later, a combination of the two. Vitellophages become active close to the egg surface shortly before yolk contractions and initiate dissolving of yolk material at the cell surface. Finally, already 25 h after oviposition, the reproductive activity of the cells starts to become very noticeable. General irradiation with x-rays can alter cell reaction, cell viscosity, and therefore sensitivity to conditions within the yolk-entoplasm system. x-irradiation may cause inverse development of the

embryo or after blastoderm aggregation, depending on the stage irradiated. Regulatory activity and differentiation are discussed. The radiosensitivity of different cells (type, location, age) to irradiation and the extent to which irradiation affects their regulatory activity are described and discussed. Depending on the age of the "Keimanlage" cells at the time of irradiation, the defects will be noticed in different but definitely localized parts of the animal's anatomy. The complexity of the whole process of differentiation as studied with x-rays (and u.v.) is discussed.

- 803 Smith, J.C., Kimeldorf, D.J. THE BIOELECTRICAL RESPONSE OF THE INSECT EYE TO BETA-RADIATION. J. Insect Physiol. 10, 5 (1964) 339-47.

Beta-radiation can induce a bioelectric reaction in the compound eye of the insect. The electroretinogram is indistinguishable from that produced in response to a light stimulus. A difference exists between light and β -radiation in the time course of the dark-adaptation process. It was demonstrated that the disparity depends upon the interaction of distal pigment with the light stimulus. An electroretinogram was elicited by a β -radiation exposure dose of 0.25 mR at a radiation dose rate of 20 mR/sec. Moths, Agrotis ypsilon (Rottemburg) and Pseudaletia unipuncta (Haworth), of the family Noctuidae were used.

- 804 Sun, S., Lee, W. HISTOPATHOLOGICAL STUDIES ON THE EFFECTS OF GAMMA IRRADIATION ON THE OVARIAN TISSUES OF Ostrinia nubilalis (Hübner). Acta ent. sin. 14, 5 (1965) 432-31. (In Chinese, with English summary)

See also:

- 519 Behaviour of the puff pattern of the salivary-gland chromosomes in Chironomus under the influence of Drosophila egg contents. (Lezzi, M., 1961)
- 533 Biological effects of radiation. (Grosch, D.S., 1965)
- 598 Mutation rates at specific autosomal loci in different species of Drosophila. (Hannah-Alava, A., 1964)
- 606 Radiation induced viability mutations in the honey bee. (Lee, W.R., 1964)
- 762 Contribution à l'étude de la radiosensibilité de certains arthropodes sahariens. Etude de la teneur de leurs parties molles en acides nucléiques. Rapport éventuel avec une radiorésistance élevée. (Bonifay, M. et al., 1964)
- 767 Gametogenesis and radiation effects in the cereal leaf beetle, Oulema melanopa. (Hoopingarner, R.A. et al., 1965)
- 776 Investigation of the effects of radiation on the haemocytes of Tenebrio molitor L. (Maynard, E.A., 1964)
- 779 Contingent relation between the resistance to γ -radiation of certain arthropods of the Sahara and the nucleic acid content of their tissues. (Nlaussat, P. et al., 1963)
- 809 On the development of oocytes in the Nauphoeta cinerea (Blattoidea) during x irradiation of the head. (Caprotti, M. et al., 1965)
- 824 The protection of the olive tree at the present time. (Melis, A., 1962)
- 838 Irradiation effects on spermatogenesis in the gypsy moth, Porthetria dispar (L.). (Rule, H.D., et al., 1965)
- 839 The effect of x rays on adult Hyalomma asiaticum. Communication I. (Sidorov, V.E., Grokhovskaya, I.M., 1964)

4. Developmental Stage Response. Delayed Development

- 805 Baldwin, W.F. RADIOSENSITIVITY OF FEMALE GERM CELL STAGES OF Dahlbomimus. Mutation Res. 2, 6 (1965) 530-3.

Male progeny from females irradiated as adults showed approximately 5 times as many eye-colour mutations as those irradiated in the larval stage. Also, the frequency of mutants increased with age of the adult, being approximately twice as high at 108 h of age as at 12 h. This phenomenon has been attributed to a larger number of radiosensitive oocytes in the ovarioles of the older adults. A 1500 Ci ^{60}Co -source was used, and exposure rates of 100 R/min and 1000 R/min.

In *Rhodnius prolixus*, moulting delay is proportional to the radiation dose. Mitosis in the epidermis of this insect prior to moult is not initiated until the bug obtains a blood meal; thus, it is possible to irradiate the epidermis while all the cells are in interphase, and, by holding the insects in an unfed condition, to maintain the cells in this stage for periods up to several weeks or months. As daughter cells produced by division in the epidermis are responsible for forming the new cuticle, mitotic inhibition following irradiation is reflected directly in a delay in moulting after a blood meal. It was shown earlier that recovery from radiation damage, of the kind that leads to delay in moulting, does occur during interphase in the epidermis of *Rhodnius*; the present work was designed to investigate the effects of dose fractionation on recovery from x-irradiation in interphase cells. The different treatments were: single exposure to 6000 R; divided exposure to 3000 R + 3000 R; and a single exposure to 3000 R. When the dose was split, the second half was given immediately before feeding. The data showed that recovery from the radiation-induced damage which delays the moult in *Rhodnius* is related to the interval between irradiation and feeding. The rate of recovery was rapid during the first 16 h, as shown by the decrease of about two days in median moulting time in all groups during this comparatively short period. However, an interval of 250 h was required to produce a further comparable decrease in moulting time. After single and divided doses of 6000 R the rate of recovery was comparable with both treatments. In both cases, the median moulting time progressed from approximately 27 d at 0 time to 23 d at an interval time of 250 h. At intervals greater than 250 h, however, recovery from moulting delay continued in the groups irradiated with single doses of 6000 R, whereas, in the divided dose, the amount of recovery was the same at 2048 h as at 250 h. After a single dose of 3000 R, the median moulting time decreased rapidly, and at 250 h was equal to the value for non-irradiated controls. Thus the recovery from radiation damage, as shown by a decrease in moulting delay, occurred during mitotic interphase, when the epidermal layer of cells responsible for manufacturing the new cuticle was in a non-dividing state. The absence of cell division made it possible to demonstrate recovery processes in *Rhodnius* without the complications found in tissues composed of dividing and nondividing cells. Therefore, a cell given the first fraction of a dose is the identical cell that receives the second or subsequent doses. (NSA 19:1965,94)

Previous studies have shown the feasibility of using radiation as a quarantine treatment for insect-infested products. They indicated that relatively small dosages of γ -rays applied to eggs and larvae of the oriental fruit fly *Dacus dorsalis* will prevent development beyond the pupal stage. The plausibility of using radiation in quarantine treatment was strengthened by results of dosage-mortality studies conducted to determine the effectiveness of γ -rays in preventing development of immature stages of the Mexican fruit fly *Anastrepha ludens*. At doses of 250-2000 R eggs about 1 d old were γ -irradiated (^{60}Co) and held in covered petri dishes at 77°F until hatch counts were made 7 d later. Mature larvae also were irradiated at similar doses, allowed to pupate, and mortality was based on the number of adult flies that later emerged. In addition, pupae 5-7 d old were exposed to radiation doses up to 25 000 R. A γ -ray dose of 50 000 R administered to 1 d old flies (requiring nearly 6 h exposure time) was only 50% lethal to both sexes over a 3 week period, indicating that adults were much more difficult to kill than the other stages. The order of susceptibility is larva > egg > pupa > adult. x-rays were equally lethal to this fly and followed the same order of susceptibility of the life stages. Dosages used in this study approximated the amounts of radiation needed to prevent subsequent development of each stage. For example, 50 000 R killed only 50% of the adult flies exposed, but adult flies surviving irradiation as eggs and larvae in mangoes were sterilized by a dose of only 1000 R. This suggested that commodities may be rendered safe from the quarantine standpoint by relatively small amounts of irradiation without concern for killing the insects outright. In this way a quarantine treatment schedule might be based on the minimum γ -ray dose which would prevent normal development of the particular insect stage or stages involved. (NSA 19:1965,13011)

- 809 Caprotti, M., Cioci, M., Springhetti, A. ON THE DEVELOPMENT OF OOCYTES IN THE Nauphoeta cinerea (BLATTOIDEA) DURING x IRRADIATION OF THE HEAD. Radioter. Radiobiol. Fis. med. 20 (1965) 57-74. (In Italian)
- x-irradiation of the head of the insect N. cinerea changed the development of the oocytes. Exposure to 10 000 R of adult N. cinerea or of fast-stage nymphs slowed the development of oocytes; 25 000 R radiation stopped the development of oocytes in adult N. cinerea through lesion of corpus allatum, and x-irradiation of N. cinerea head from the 5th - the 16th day after moulting increased the development of oocytes in adult N. cinerea as if the functions of corpus allatum were increased. (Auth.)
- 810 Clayton, F. E. GENETIC EFFECTS FROM SIMULTANEOUS IRRADIATION OF IMMATURE AND MATURE Drosophila virilis MALES. Genetics 52, 5 (1965) 1081-92.
- Males, 2½ - 5 h and 6 h old, were x-rayed simultaneously with 500, 1000, 1500, and 2000 R. Progeny from two successive 24 h mating periods were checked for dominant lethals and translocations. The susceptibility of sperm bundles and motile spermatozoa was similar at all dosage levels as determined by dominant lethals and translocations from period 1. From period 2, dominant lethals and translocation rates increased following irradiation of immature males but decreased when mature males were treated; this occurred at all levels of radiation with the exception of the 500 R test, in which translocation rates for the 2 d were similar. (Auth. summary)
- 811 Cornwell, P. B. SUSCEPTIBILITY OF THE GRAIN AND RICE WEEVILS, Sitophilus granarius (L.) AND Sitophilus zeamais Mots.* TO GAMMA RADIATION, p. 1-18 of "The Entomology of Radiation Disinfestation of Grain". Cornwell, P. B., Ed. Oxford, Pergamon Press, 1966**, 236p.
- S. zeamais is more susceptible than S. granarius in all developmental stages to the killing and sterilizing effects of γ -radiation. Irradiated eggs and larvae of S. granarius are incapable of development to adults after 5600 rep; those of S. zeamais fail to develop after 4000 rep. Pupae and pre-emerged adults of S. granarius are not prevented from developing even at 20 000 rep. Complete mortality of S. granarius (S. zeamais) within 28 d (21 d) of emergence is obtained when stages in grain are treated with 11 200 rep (8000 rep). The survival curve for adult weevils is characterized by delayed mortality after irradiation. Immature stages are markedly susceptible to sterilization. A dose of 11 200 rep is completely sterilizing to adults of both species (0.03% progeny production). Substerilizing doses result in two breaks in adult fertility, 0-2 d and 9-15 d after irradiation. Tests with large populations indicate that 15 000 rep is marginal for effective control, allowing some residual fertility, whilst 18 500 rep is completely sterilizing which (16 000 rad) is therefore recommended for control of the grain and rice weevils in industrial application.
- * Previously known as Sitophilus oryzae (L.) (large strain).
 ** Since the work reported in this volume was carried out by the Entomology Group of the Wantage Research Laboratory, U.K.A.E.A., during the period 1955-61, individual papers are included in the present bibliography although they were actually not published in book form until 1966.
- 812 Crossley, D. A. Jr., Shanks, M. H. RADIATION SENSITIVITY OF IMMATURE STAGES OF THE GIANT MILKWEED BUG, p. 58-59 of "Health Physics Division Annual Progress Report for Period Ending July 31, 1965". ORNL-3849, Oak Ridge National Lab., Tenn. Oct. 1965, 263p.
- Oncopeltus fasciatus (Dallas) was exposed to γ -radiation from a ^{60}Co source, at 14.4 rad/sec. Clutches of 20 eggs were given 0, 0.5, 1, 2, 4, 8, or 16 krad. Nymphs received an additional 32 and 64 krad. Subsequently, the insects were maintained at 75°F (16-h day). Comparatively low doses affected hatchability. 1-d-eggs after 500 rad showed > 50% hatchability reduction; no eggs hatched after 2000 rad; 8000 rad were required to halt all embryonic development. Older eggs (the stage duration is 5 d) are less sensitive. Adults showed a radiation response similar to the nymphal stages. The mean survival of adult controls was 26 d, reduced to 23 d after 8000 rad, and to 8 d after 16 000 rad. The major reduction in survival occurred in the vicinity of 8000 and 16 000 rad, as with nymphs. A radiation profile would therefore show little change in radiosensitivity except for the egg stages.

- 813 Elbadry, E. N. SOME EFFECTS OF GAMMA RADIATION ON THE POTATO TUBERWORM, Gnorimoschema operculella (LEPIDOPTERA: GELECHIIDAE), Ann. ent. Soc. Am. 58, 2 (1965) 206-9.

Eggs and newly hatched larvae survived dosages up to 9 krad. Immature stages that developed from irradiated eggs suffered retardation of development and reduction in size and weight, and the adult moths that emerged were structurally malformed. Females were in many ways more sensitive to irradiation than were males, and all dosages delivered to the eggs reduced the fecundity of the adults that developed from them. Dosages of 24-96 kR given to mature larvae prevented pupation; lesser dosages caused retardation of pupal development; and adult malformation started with dosages of 6 kR. Again adult fecundity was severely affected. Reduction in fertility of the eggs produced was most evident with females irradiated as 8-d-old pupae, but reduction in egg deposition was shown by those irradiated earlier in the pupal stage. The tendency for adults to be malformed also was more pronounced when early pupal stages were irradiated. Adults exposed to 24 kR shortly after emergence laid sterile eggs and those given 96 kR were sluggish, with all body movements diminished. (Auth.)

- 814 Erdman, H. E. DIFFERENTIAL RESPONSES OF GERM CELLS IN FLOUR BEETLES, Tribolium castaneum Herbst, DUE TO x-RAY DOSE, HYPOTHERMIA, SEX EXPOSED AND AGE. HW-SA-3747. General Electric Co. Hanford Atomic Products Operation, Richland, Wash. 12 Oct. 1964, 21p.

Day-old virgin flour beetles, T. castaneum, were x-irradiated with 0, 500, 1000, 2000, and 4000 R. Ten replicates of control, male-, female-, and both-exposed mating combinations were established at 25, 29, and 32°C in 65-70% relative humidity. Each pair was given 5 g of acclimated food daily for 2 weeks. The number of fertile pairs and the number of F_1 adults were measured on the day of reproductive onset. Reproductive onset was delayed 2-3 d in females given 4000 R x-ray doses, but no delay was observed in exposed males. For both-exposed, a progressive delay was induced by 2000 or 4000 R. For male- or female-exposed groups irradiated from 29-32°C, no modification in reproductive onset was found, but a delay was evident at lower temperatures. The 2000 or 4000 R exposures and decreased temperatures synergistically delayed reproductive onset for both-exposed pairs. The number of fertile pairs after 4000 R were reduced in female-exposed groups more than in male-exposed groups. A saturation effect in both-exposed combinations at 29°C was indicated. x-ray doses of 2000 R and higher reduced productivity. Males were more productive after 4000 R than were females. Viability or lethality effects were additive when both sexes of mating combinations were exposed to 2000 or 4000 R. The modifications of the three parameters investigated for productivity are discussed from the standpoints of temperature effects, and dose effects on the degree of development, and differentiation of male and female germ cells. The dose-response curves were the multi-hit type, implicating chromosomal aberrations as the cause of altered productivity. (NSA 19: 1965, 43715)

- 815 Farrow, M. G., Ulrich, V. x-RAY AND GAMMA RAY IRRADIATION OF Mormoniella vitripennis. Acad. Sci. Proc. 35 (1964) 21-28. (BAG 28: 64, 105875)

- 816 Godwin, P. A., Rule, H. D., Waters, W. E. SOME EFFECTS OF GAMMA IRRADIATION ON THE GYPSY MOTH, Porthetria dispar. J. econ. Ent. 57, 6 (1964) 986-90.

Pupae and larvae of the gypsy moth, P. dispar (L.), were irradiated with a ^{60}Co γ -source. The effect of various dosages on pupal survival, adult longevity, mating success, egg numbers, egg viability, and F_1 survival are reported. The irradiation of pupae more than 9-d-old with 20 000 R resulted in very few crippling defects of the treated insects and reduced egg hatch to a low level. (Auth.)

- 817 Gubicza, A., Molnar, I. THE EFFECT OF GAMMA IRRADIATION ON THE VARO RACE OF Bombyx mori. II. IRRADIATION OF EGGS IN THE EARLY AND LATE EMBRYONIC STAGES. Annls Inst. biol. Tihany 31 (1964) 3-13. (In Hungarian)

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 the larvae and on the health and fecundity of adult moths hatched from irradiated eggs. (NSA 20: 1966, 18345)

- 818⁽²⁾ Huque, H. SOME OBSERVATIONS ON THE EFFECT OF IONIZING RADIATION AGAINST DESERT LOCUST. Pakist. J. Sci. 15, 6 (1963) 267-70.

In experiments in Pakistan, hatching was prevented by exposing the eggs of *Schistocerca gregaria* (Forsk.) to 90 and 120 kR γ -radiation from a ^{60}Co source. When hoppers in the 2nd to 5th instars were exposed to doses varying from 2.5-7 kR, all died, and the mortality rate increased with the increase in dose. The rate of metabolism was affected, and the hoppers lived longer than normal for that particular stage but could not moult. When young adults were exposed to high doses varying from 15-120 kR, death occurred within 96 h. (From auth. summary)

- 819 Huque, H., Khan, M.A. POSSIBILITIES OF CONTROLLING *Callosobruchus subinnotatus* Pic (BRUCHIDAE) BY GAMMA RAYS. Fd Irrad. 4, 3 (1964) A2-A7.

Phaseolus aureus grain was used to culture *C. subinnotatus*. Effects of γ -radiation were studied on eggs, full grown grubs, newly formed pupae, and longevity and fecundity. Results are tabulated, and it is concluded that eggs, grubs, pupae, and adults of *Callosobruchus* can be controlled successfully with doses of 2.5 to 3, 5, 20, and 5 kR respectively. (NSA 18:1964,23270)

- 820 Lippold, P.C., Gambrell, F.L. EFFECTS OF IONIZING RADIATION ON EGGS AND ADULT INSECTS. Bull. ent. Soc. Am. 11, 3 (1965) 158. Abstr. 79. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".

Various levels and dosage rates of ^{60}Co irradiation were evaluated against egg and adult stages of the European chafer, milkweed bug, and plum curculio. Longevity, fecundity, feeding and hatch data were obtained from some of these species. (Abstr.)

- 821⁽²⁾ Lukacsovics, F., Gubicza, A. THE EFFECT OF GAMMA RAYS ON "VARO" RACE OF *Bombyx mori* L. (LEPIDOPTERA). I. STUDY OF THE DIAPAUSE OF EGGS. Annls Inst. biol. Tihany 30 (1963) 67-72. (In Hungarian, with German summary)

- 822 Martin, A.O. STUDIES ON THE RATE OF SPERMATOGENESIS IN *Drosophila*: EFFECTS OF X-RAYS AND STREPTONIGRIN. Z. VererbLehre 96 (1965) 28-35.

The rate of spermatogenesis in adult *Drosophila melanogaster* was measured by use of ^3H -thymidine as a radioactive tracer. A comparison of the results for control and irradiated males revealed indications of a radio-induced lag. The time tables of spermatogenesis stages were identical for the first three broods. However, late spermatids appeared in brood four of the control group, but not until brood five in the irradiated flies. Mature sperm appeared in brood five of the control, but not until brood six of the x-rayed. Primary spermatocytes persisted longer in the streptonigrin-treated samples than in the controls. Also, the progress of cells through spermatogenesis was about 24 h faster in the adult testis as opposed to that of the immature testis. The results support the suggestion that x-rays effect a rate change in the progress of cells through spermatogenesis, as seen by comparison between the control and irradiated adult males. Two sets of evidence (one for larval and one for adult *Drosophila*) point to a retardation of the rate of gametogenesis induced by x-rays. (From NSA 19:1965,31889)

- 823 Mayer, M.S. BIOLOGICAL AND HISTOPATHOLOGICAL EFFECTS OF GAMMA RADIATION ON THREE LIFE STAGES OF *Anthonomus grandis* Boheman. Diss. Abstr. 25, 1 (1964) 49.

A study of the effects of γ -radiation on the boll weevil was accomplished in three major phases. The first phase tested the hypothesis that the amount of mating by boll weevils is a function of age and/or the length of time males and females are confined together. In this series of investigations the amount of mating in a 24 h interval was linearly related to the increase in age of the male and was not dependent upon the age of the female. The second phase of the study was designed to test the effect of γ -radiation on egg-hatch, pupal ecdysis, and adult longevity. Adults from irradiated eggs and pupae were mated. Most of the dose-response curves were approximately sigmoid. Adults that developed from eggs and pupae that had been irradiated did not live as long as the control insects. Matings indicated that no dosage tolerated by an immature stage was sufficient to sterilize the resulting adult. However, 8000 R was found to be sufficient to sterilize adult males that were 12 and 36 h old at the time of treatment. Females treated with 8000 R laid virtually no eggs and died sooner than the controls. The third phase of research was a study of the histology of the testes, ovarioles, and midgut at various times after treatment with 8000 R. After treatment the

testes decreased in size, and after 5 d they resembled a sac-like mass of sperm with few or no meiotic patterns visible. The nurse and follicle cells were affected most adversely in the female reproductive system. The effect on the midgut cells was an inhibition of mitosis within the regenerative nidi, with consequent slow degeneration of the midgut epithelium. (NSA 18:1964, 41216)

- 824⁽²⁾ Meelis, A. LA DIFESA DELL'OLIVO NELL'ATTUALE MOMENTO. (The protection of the olive tree at the present time). Redia 47 (1962) 1-79. (In Italian, with English summary)

Laboratory investigations on the effect of malathion on the nerve ganglia and the mesenteron of *Dacus oleae* showed that this product inhibits cholinesterase but does not cause morphological injuries such as result from γ -radiation at 12 000-20 000 R, and serious injuries resulted only from doses of 30 000 R or more. Adult emergence was prevented by doses of 35 000-50 000 R. In field tests on chemical control various chemicals were applied, including Ekatin (20% thiomeron), dimethoate (Rogor), Dimeton (containing phosphamidon), diazinon, and sugar-bait sprays poisoned with sodium arsenite.

- 825 Nair, K.S.S., George, J.C. EFFECTS OF GAMMA RADIATION ON THE POSTEMBRYONIC STAGES OF A DERMESTID BEETLE, *Anthrenus vorax* Waterhouse. Entomologia exp. appl. 8, 4 (1965) 241-48.

The postembryonic stages of *Anthrenus flavipes* Lec. (*vorax* Waterh.) proved susceptible to γ -radiation in doses of 5, 10, 15 and 20 krad. Pupation was more or less completely inhibited, but some larvae pupated after repeated moults, reduction in size and regrowth and gave rise to normal adults. The percentage of successful moults decreased with increasing doses. At the lower doses, more last-instar larvae died in the prepupal stage; at the higher ones, mortality in the larval stage was higher. Irradiation of the early prepupa hampered the pupal moult; that of the late prepupa did not but produced certain malformations in the adult. In the pupal stage, the later the pupa was irradiated, the less susceptible it was, radiation being more harmful during the first three days after pupation than later. Pre-emergent adults and pupae, 5-6 d old, were exposed to different doses of radiation, and data on the fecundity and fertility of the various mating combinations of irradiated and non-irradiated males and females are presented and discussed. (From auth.)

- 826⁽²⁾ Ooi, H. STUDIES ON THE EFFECT OF GAMMA-RAYS IRRADIATION AT EMBRYONIC STAGES UPON THE LARVAL AND COOON CHARACTERS IN THE SILKWORM. Nippon Sanshigaku Zasshi (J. seric. Sci., Tokyo) 30, 5 (1961) 401-4.

- 827⁽¹⁾ Podolyan, V.Y. THE BIOLOGICAL EFFECT OF RADIOACTIVE COBALT (^{60}Co) ON THE PREIMAGINAL STAGES OF THE CARRION FLY *Protophormia terrae novae* R.D. Tezisy Dokladov 3-go Soveshchaniya Vsesoyuznogo Entomologicheskogo Obshchestva, 1957. No pagination.

- 828⁽¹⁾ Podolyan, V.Y. THE BIOLOGICAL EFFECT OF RADIOACTIVE COBALT (^{60}Co) ON THE PREIMAGINAL STAGES OF THE CARRION FLY *Protophormia terrae novae* R.D. Trudy voenno-med. Akad. RKKA 105 (1959). No pagination.

- 829 Potts, W.H. THE GAMMA IRRADIATION OF *Glossina* PUPARIAL STAGES AND CONTROL. p. 254-55 of "Proceedings of the 12th International Congress of Entomology, London, 8-16 Jul, 1964" Freeman, P., Ed. London, Royal Entomological Society of London, 1965.

The number of flies emerging from the puparia was not affected by irradiation at doses of 3000, 6000 or 12 000 rep, given at 6000 R/h, but it was halved by a dose of 30 000 rep, given at 6000 R/min. There was no impairment of the vigour of the males that had been subjected to the dose of 6000 rep, as shown by their ability to compete successfully for females with untreated males; however, their length of life was about halved. Observation of the routine matings showed that males treated at this dose mated just as readily as the untreated ones, and males were observed to couple with the females from 10-91 d after irradiation had been effected. In view of the slow reproduction rate of the fly, the collection of wild puparia for irradiation is proposed. Further investigations are essential to determine: 1. Whether the degree of sterilisation of *Glossina* can be increased, without decreasing the length of life of the male, by use of repeated small doses of

γ -radiation; 2. Confirmation that any residual fertility of the males that may remain, after the maximum sterilisation possible without undue decrease in the length of life of the male, will result in only a reduced female productivity; 3. Confirmation of a complete, or nearly complete, sterilising effect on the female; 4. Determination of the stage of puparial development at which irradiation (a) has the greatest sterilising effect, on both sexes, and (b) has the least effect in shortening the life of the male. 5. Exploration of the effect of doses below those needed for sterilisation, to determine whether dominant lethal genes may be produced in F_1 and F_2 generations.

- 830 Qureshi, Z. A., Mills, R. B., Wilbur, D. A. SENSITIVITY OF VARIOUS STAGES OF Anguimoides GRAIN MOTH TO GAMMA RADIATION. Bull. ent. Soc. Am. 10, 3 (1964) 163, Abstr. 60.
The effects of γ -radiation on the eggs, larvae, prepupae, and pupae of known ages have been determined. The results regarding the viability of eggs, emergence, structural abnormality, fertility and longevity of adults are reported.
- 831 Qureshi, Z. A., Wilbur, D. A., Mills, R. B. EFFECTS OF GAMMA RADIATION ON EARLY, INTERMEDIATE AND LATE LARVAE OF Anguimoides GRAIN MOTH. Bull. ent. Soc. Am. 11, 3 (1965) 158. Abstr. 80. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".
Three stages of Sitotroga cerealella larvae were exposed to doses of γ -radiation between 2 and 25 kR. Larval mortality and developmental period and adult weights, structural abnormalities, fecundity and fertility are reported. (Abstr.)
- 832 Qureshi, Z. A., Wilbur, D. A., Mills, R. B. EFFECTS OF GAMMA RADIATION ON PREPUPAE AND PUPAE OF Anguimoides GRAIN MOTH. Bull. ent. Soc. Am. 11, 3 (1965) 158. Abstr. 81. Presented at the "Annual Meeting of the Entomological Society of America, New Orleans, 29 Nov. - 2 Dec. 1965".
Prepupae and pupae (early and late) of Sitotroga cerealella were exposed to doses of γ -radiation between 3 and 25 kR. Effects on pupal survival and length of development and adult structural abnormalities, weight, fertility and fecundity are reported. (Abstr.)
- 833 Ratty, F. J. ESTIMATION OF SENSITIVITY OF Drosophila melanogaster LARVAE TO IRRADIATION USING A THIRD-ORDER ROTABLE DESIGN. p. 19 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- 834 Reichle, D. E. RADIATION PROFILE OF THE EVERGREEN BAGWORM. p. 56-58 of "Health Physics Division Annual Progress Report for Period Ending July 31, 1965". ORNL-3849, Oak Ridge National Lab., Tenn. Oct. 1965, 263p.
Eggs of Thyridopteryx ephemeraeformis (Lepidoptera), in sets of 25, were exposed to 14.4 R/sec from a ^{60}Co γ -source, at dose levels of 100 (2^n), where $n = 1, 2, \dots, 9$, and at increasing time intervals after breaking dormancy. It was thus possible to analyse dose-age interactions. A graph involving 4000 individuals was plotted, the number of individuals hatching at each dose level being expressed as a percentage of the controls for that egg stage. Mean hatching time for control was 14 ± 0.07 d, mean percentage hatching 82.0 ± 3.9 . 2-d-eggs did not hatch at doses ≥ 1600 rad while 25 600 rad were required to prevent hatching of 3-to 12-d-eggs. Eggs thus appear to be ~ 16 times more radiosensitive during early embryonic development than in stages immediately preceding hatching. 1-d-old larvae were 4 times more resistant than pre-hatch eggs. Eggs in the dormant state may not be as radiosensitive as those in initial stages of development. 1-d eggs showed a significant decrease in hatching at 400 rad, while 8-d-eggs to day-old larvae were unaffected by doses below 3200 rad. Alterations in normal behavioral patterns were detectable in the larval stage (e.g. the construction of a larval case or "bag", within 1-2 d after hatching was impaired at certain dose levels. The enhancing effect on hatching of low doses needs verifications. - The greater part of the life cycle (October-April, or about 60% of total time) is passed in the egg stage, i.e. the most radiosensitive stage.
- 835 Riordan, D. F. EFFECTS OF LOW-LEVEL GAMMA-RADIATION ON THE IMMATURE STAGES OF Dahibomimus fuscipennis (Zett.) (HYMENOPTERA: EULOPHIDAE). Can. J. Zool. 42 (1964) 675-84.

The experiments were designed to provide data on the effects of relatively low radiation doses administered at low rates. Immature stages of the chalcid were irradiated for 24 h on each of the first 16 d of development at dose rates of 12, 24, and 48 R/h. The numbers of females available to be mothers of the F_2 generation was calculated to be reduced by 94%, 84%, and 42%, respectively, at the three rates of dosage when irradiation was commenced within 24 h after oviposition. The greatest damage was produced by irradiation at 48 and 24 R/h during days one, two, or three when the insects are eggs or very young larvae or when hatching would be taking place. After day three, resistance rose steadily until it reached a peak coinciding with the late larval stage, which is probably a time of developmental rest. Resistance to irradiation at all dosages decreased through the pupal stages, in fact, for the 12 R/h dosage the lowest survival values were reached on days 14-16. The numbers of male adults from unmated mothers showed some reduction from irradiation at 48 R/h, notably for irradiation days one, two, and three when the numbers were reduced to 67, 49, and 67%, respectively, as compared with the non-irradiated controls. There was evidence of another effect, namely, that irradiation lowered the vitality of the ensuing all-male populations, as in many cases they failed to emerge from the host cocoons. Females irradiated at immature stages failed to parasitize the hosts provided (*Neodiprion*), and examinations of hosts from which no parasites emerged failed to reveal the presence of unhatched eggs or dead larvae. Thus it is considered that complete sterilization of some females occurred, and many females not sterilized laid fewer viable eggs than the controls. The only effect definitely demonstrated in those males surviving irradiation in the immature stages was complete sterility. A prominent effect on the progeny of irradiated mated mothers was an increase in the average numbers of male progeny. (From NSA 19:1965,95)

- 836 Rockstein, M., Dauer, M., Bhatnagar, P.L. ADULT EMERGENCE OF THE HOUSE FLY, *Musca domestica*, FROM x-IRRADIATED PUPAE. *Ann. ent. Soc. Am.* 58, 3 (1965) 375-9.

Pupae of the house fly, *M. domestica* L., when exposed to single doses of x-rays, varying between 10 000-30 000 rad, show a correlation between dosage and emergence. At 10 000 and 15 000 rad 90.1%-73.9% of the flies, respectively, emerge. This figure declines to 42.5% at 20 000 and 19.5% at 30 000 rad. The number of flies dying in the pupal stage correspondingly increases with an increase in radiation dose. The implications of these results are discussed. (Auth.)

- 837 Rockstein, M., Dauer, M., Bhatnagar, P.L. EFFECT OF x-IRRADIATION ON EMERGENCE OF ADULT HOUSE FLIES. *Bull. ent. Soc. Am.* 10, 3 (1964) 166. Abstr. 116.

Exposure of 2500 1- to 2-d-old pupae to 10 000 rad resulted in 90% emergence and 2% partial emergence; 15 000 R - 74% emergence and 17% partial emergence; 20 000 R - 43% emergence and 18% partial emergence; 30 000 R - 20% emergence and 1% partial emergence.

- 838 Rule, H.D., Godwin, P.A., Waters, W.E. IRRADIATION EFFECTS ON SPERMATOGENESIS IN THE GYPSY MOTH, *Porthetria dispar* (L.) *J. Insect Physiol.* 11, 4 (1965) 369-78.

In connexion with a detailed study of the effects of γ -irradiation on the gypsy moth, histological examination was made of normal larvae in instars I to V and pupae to determine the timing and sequence of spermatogenesis. Similar examination was made of pupae that had been irradiated as instar IV and V larvae with dosages ranging from 500-20 000 R. Spermatogenesis occurred in the larval period, and meiotic activity began in instar IV. Fully formed spermatozoa were first observed in instar V. The appearance of gonadal tissues of treated and untreated specimens in the pupal stage is described. All irradiation dosages caused some cytological damage; instar IV larvae exposed to 20 000 R died in 7-10 d. The major gross effects of irradiation were: degeneration of germinal cysts, shattering of sperm bundles within the follicles, plugging of the entrance to the vas deferens by interstitial and other tissue (this occurred with higher dosages only), thickening of testes walls and septa and of the vas deferens, and clumping of fat-body cells around the testes. One or more of these morphological changes might be related to the sterile condition. (Auth.)

- 839 Sidorov, V.E., Grokhovskaya, I.M. THE EFFECT OF x-RAYS ON ADULT *Hyalomma asiaticum*. COMMUNICATION 1. *Medskaya Parazit.* 33, 5 (1964) 560-63. (In Russian, with English summary)

Hungry adult ticks (*H. asiaticum*) were irradiated with 200, 400, 800, 1500, 3000, 6000, and 12 000 R/min. Each group included 50 males and 50 females. None of the doses was lethal,

and the main functions (feeding, digestion, excretion, growth) were not affected. Ticks receiving doses from 200-3000 R did not lose the ability to suck blood. Copulation took place during sucking. Females in the 3000 R group did not lay eggs but lived up to 6 months after satiation. Those that received smaller doses laid eggs. Oviposition was reduced throughout. Larvae developed from eggs laid by females receiving doses only up to 800 R. Doses greater than 1500 R completely destroyed the function of the ovaries. It was concluded that doses of 3000 R and above may be used in tick control.

- 840 Stark, R.W. EFFECTS OF ACUTE DOSES OF GAMMA RADIATION ON TWO FOREST INSECTS. Presented at the "Meeting of the American Institute of Biological Sciences, Denver, Colo., Aug. 1964".

For abstract, see 843.

- 841 Stark, R.W., Wood, D.L. EFFECTS OF ACUTE DOSES OF GAMMA RADIATION ON TWO FOREST INSECTS. Bull. ecol. Soc. Am. 45 (1964) 106. Abstr.

For abstract, see 843.

- 842 Stark, R.W., Wood, D.L. THE EFFECT OF GAMMA RADIATION ON THE SAWFLIES, Neodipteron fulviceps, COMPLEX. "48th Annual Meeting-Pacific Branch-of the Entomological Society of America, Long Beach, Calif., 16-18 Jun. 1964".

For abstract, see 843.

- 843 Stark, R.W., Wood, D.L. THE EFFECTS OF GAMMA RADIATION ON THE BIOLOGY AND BEHAVIOR OF FOREST INSECTS AND THE POSSIBILITY OF THEIR CONTROL. AED-CONF. 1964-158-5, Gmelin-Institut für Anorganische Chemie und Grenzgebiete, Frankfurt am Main (West Germany). Presented at the "15th Annual Meeting of the American Institute of Biological Sciences, Boulder, Colo., 23-28 Aug. 1964".

Sterilization of adult males and female Ips confusus (Coleoptera: Scolytidae) exposed to γ -radiation as newly emerged adults was almost complete at 7500 R and 10 000 R, respectively. Male mating behaviour (sperm transfer, gallery pattern) was unaffected by dosages up to 60 000 R, and so, essentially, was the capacity of either sex to establish galleries. Longevity was reduced by > 5000 R. LD50 for males occurred after 11.5 d at 7500 R (29 d in controls). Mortality of progeny resulting from males irradiated at sub-sterilization levels was higher than in the controls. The dosage to achieve significant population reduction with minimum effect on longevity and other biological activity is believed to be approximately 7500 R. It was concluded that irradiation of feeding stages of the sawfly, Neodipteron fulviceps (Hymenoptera: Diprionidae) for sterilization was not practical. Differences in development, feeding behaviour and cocoon formation were caused by ≥ 20 000 R. Exposure in the cocoon (pre-pupae and pupae) was successful to some extent. Oviposition was retarded at all radiation levels and eclosion of eggs from irradiated adults was low. — The sterilization 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.

- 844 Teulade, P. VARIATIONS DE LA SENSIBILITE AUX RAYONS X DES ŒUFS DE Bombyx mori, EN FONCTION DU DEVELOPPEMENT EMBRYONNAIRE ET DE LA DUREE D'HIVERNATION. Thesis. Troisième cycle Faculté des Sciences Lyon. (1964) 103p.

- 845 Teulade, P. IRRADIATION CONTINUE A FAIBLE DEBIT DE DOSE DES ŒUFS DE Bombyx mori, ET NOTION DE DEBIT DE DOSE EFFICACE. J. Insect Physiol. 11, 4 (1965) 379-86. (With English summary).

When the eggs of the silkworm B. mori are submitted to low-level continuous γ -radiation from ^{60}Co at the dose-rates of 15 and 37 R/h, one finds that: (1) for a similar total dose delivered at aforementioned dose-rates, the effects with 37 R/h are more pronounced than those with 15 R/h, and (2) the time of development and the mortality increase as a linear function of the dose. The recovery takes place during irradiation and partly counterbalances the lethal effect of radiations, so limiting the efficient dose-rate. Therefore, only a fraction of the total dose delivered in a continuous low-level irradiation is active. This explains the significance of the dose-rate. The

linear relationship between the total dose and the effects seems the result of a combination between the efficient dose-rate and the fluctuations of radiosensitivity in relation with the embryonic development. (Auth.)

- 846 Tilton, E.W., Brower, J.H. IRRADIATION STUDIES WITH INSECTS INFESTING BULK-GRAIN AND PACKAGED COMMODITIES. TID-22414. Stored-Product Insects Research and Development Lab., Savannah, Ga., 28 Oct. 1965, 6p.

γ -radiation effects on grain beetles, the merchant grain beetle Oryzaephilus mercator and the confused flour beetle, Tribolium confusum, and on almond moths, Ephesia cautella, were investigated. For each treatment, 30 individuals (each in a closed gelatin capsule) of each stage (egg, larva, pupa, and adult) were used for each replicate. Dosage levels included: 0, 10, 20, 30, 50, and 100 krad. Following irradiation, virgin adults were paired with non-irradiated virgin adults from the same original populations for sterility studies. Preliminary results indicated that mortality was high for all stages at all treatment levels.

- 847 Tobias, C.A. STUDIES ON HEAVILY IONIZING PARTICLES - HILAC STUDIES. p. 12 of "Research and Development in Progress. Biology and Medicine. No. 3". Abstr. TID-4203, Division of Technical Information Extension, (AEC), Oak Ridge, Tenn. Apr. 1964, 290p.
- 848 Valencia, R.M., Valencia, J.L. THE RADIOSENSITIVITY OF MATURE GERM CELLS AND FERTILIZED EGGS IN Drosophila melanogaster. p. 345-60 in "Mammalian Cytogenetics and Related Problems in Radiobiology". New York, Pergamon Press, 1964.

See also:

- 527 The effect of x-irradiation on spermatogenesis in Drosophila melanogaster Meigen. (Abro, A., 1964)
- 641 Susceptibility of the saw-toothed grain beetle, Oryzaephilus surinamensis (L.) to gamma radiation. (Jefferies, D.J., 1966)
- 647 Lethal and sterilising effects of cobalt-60 gamma rays on Argyroplote leucotreta. (Myburgh, A.C., 1963)
- 657 The effect of γ -irradiation on fecundity and fertility of Tribolium confusum Duval. (Vereecke, A., Pelereys, C., 1965)
- 675 x-ray and fast neutron effects on productivity of flour beetles. (Erdman, H.E., 1965)
- 774 Uric acid in normal and γ -irradiated eggs of Bombyx mori. (Lassota, Z., 1965)
- 775 Oxygen uptake and ammonia release in normal and γ -irradiated eggs of Bombyx mori. (Lassota, Z., 1965)
- 778 Oxygen uptake of three life stages of Tenebrio molitor prior and subsequent to massive doses of low energy x-rays. (Neidinger, J.W. et al., 1965)
- 781 Effect of ionizing radiation on the endocrine system in insects. (Piechowska, M.I., 1965)
- 782 Effect of x-rays on the meal worm, Tenebrio molitor, embryo. I. Changes in the protein and free A-amino nitrogen fraction. (Po-Chedley, D.S., 1964)
- 783 The effects of x-rays on the meal worm, Tenebrio molitor, embryo. (Po-Chedley, D.S., 1965)
- 784 Temporal pattern of the early stages of spermatogenesis of adult Drosophila melanogaster males after treatment with x-rays. (Puro, J.A., 1961)
- 787 Genetic effects of gamma-irradiation on egg production and adult emergence of Drosophila melanogaster. (Touchberry, R.W., DeFries, J.C., 1964)
- 791 Study of the post-embryonic development of the ovary in Ephesia kühniella Z. (Lepidoptera, Pyralidae). I. Effect of ionizing radiations. (Baroughi-Bonab, H., 1965)
- 795 Action de la pars intercerebralis sur le développement de Locusta migratoria L. (Girardie, A., 1964)
- 849 x-irradiation of pupae of the house fly Musca domestica L., and adult survival. (Bhatnagar, P.L. et al., 1965)
- 850 Influence des rayons x au cours de l'embryogénèse de Gryllus domesticus L. (Orthoptère). (Bluzat, R., 1964)
- 853 x-irradiation of pupae of the house fly, Musca domestica L., and male survival. (Dauer, M. et al., 1965)

- 854 The effects of gamma radiation on the fertility and longevity of Hippelates pusio (Flint, H. M., 1965)
- 858 Radiation sensitivity of insects. (Menhinick, E. F., Dodson, G. J., 1964)
- 871 Egg mortality after gamma irradiation of adults of the omnivorous leaf roller. (Jacklin, S. W. et al., 1965)
- 874 Susceptibility of Callosobruchus maculatus to high dose rate gamma irradiation. (Neharin, A. et al., 1965)
- 877 Effects of ionizing radiation on pests in cereals. II. Effects of cobalt-60 radiation on Tyroglyphus farinae mites. (Szyszko, E. et al., 1962)
- 887 A comparison of the susceptibility of the grain weevil Sitophilus granarius (L.) to accelerated electrons and ^{60}Co gamma radiation. (Bull, J. O., Cornwell, P. B., 1966)
- 889 Effect of low temperature on radiosensitivity of Drosophila pupae. (Giavelli, S., Parazzi, E., 1963)
- 898 Relative biological effectiveness of 14.1 MeV fast neutrons in killing dormant silkworm eggs. (Murakami, A., Kondo, S., 1963)
- 900 The effect of rearing medium on the susceptibility of Tribolium confusum Duv. and Sitophilus granarius (L.) to gamma radiation. (Shipp, E., 1966)
- 901 Oxygen dependence for radiation sensitivity during development in insects. (Slater, J. V. et al., 1964)
- 902 Heavy ion localization of sensitive embryonic sites in Tribolium. (Slater, J. V. et al., 1964)
- 920 Fast neutron effects on flour beetles. (Erdman, H. E., 1964)
- 921 Fast neutron effects on productivity of young and old flour beetles, Tribolium castaneum Herbst and alterations due to temperature and sex exposed. (Erdman, H. E., 1964)
- 924 A study of radiation on the biology and population dynamics of the cereal leaf beetle, Quilema melanopa (L.) order Coleoptera, family Chrysomelidae. (Myser, W. C., 1965)
- 925 Effect of continuous low-level gamma-irradiation on successive generations of Dahlbomimus fuscipennis (Zett.) (Hymenoptera: Eulophidae). (Riordan, D. F., 1964)
- 927 } Long term effects of acute low-level x-rays on the population dynamics of the yellow fever
928 } mosquito, Aedes aegypti. (Willard, W. K., 1965)
- 996 Sterilization of the navel orangeworm, Paratylenchus transitella (Walker), by gamma radiation (Lepidoptera: Phycitidae). (Hussey, M. M., Madsen, H. F., 1964)
- 1013 Radiation treatment of grain and grain products. (Henderson, L. P., 1964)
- 1031 The killing of silkworm pupae and the preservation of silkworm cocoons by gamma rays. (Kipiani, R. Ya., Tsetskhladze, T. V., 1957)
- 1032 The killing of cocoons by irradiation from radioactive sources. (Molnar, I. et al., 1963)
- 1033 A study of silk cocoons from the eggs of Bombyx mori L. irradiated with Co^{60} . (Molnar, I. et al., 1964)

5. Malformations. Histopathological Changes

See:

- 659 The potential application of γ -radiation for the sterilization of Chloridea obsoleta for the purpose of reducing its population. (Andreev, S. V. et al., 1964)
- 798 The effects of x irradiation on the embryos of invertebrate embryos. (Larsen, W., 1965)
- 799 Influence of radiation on ovarian maturation and histolysis of pupal fat body in diptera. (Monro, J., Bailey, P. T., 1965)
- 813 Some effects of gamma radiation on the potato tuberworm, Gnorimoschema operculella (Lepidoptera: Gelechiidae). (Elbadry, E., 1965)
- 816 Some effects of gamma irradiation on the gypsy moth, Porthetria dispar. (Godwin, P. A. et al., 1964)
- 817 The effect of gamma irradiation on the varo race of Bombyx mori. II. Irradiation of eggs in the early and late embryonic stages. (Gubicza, A., Molnar, I., 1964)
- 823 Biological and histopathological effects of gamma radiation on three life stages of Anthonomus grandis Boheman. (Mayer, M. S., 1964)