

- 773 Reller, J. CHOLINESTERASE-BESTIMMUNG IN ENDPLATTEN MIT RADIOAKTIVEM DIISOPROPYL-FLUOROPHOSPHAT. (The evaluation of cholinesterase in endplates by means of radioactive diisopropylfluorophosphate.) Thesis, Eidgenössische Technische Hochschule, Zürich (Switzerland). Zürich 1966, 56p. (In German)
- The uptake of ^{14}C - and ^{32}P -DFP by end plates in the mouse diaphragm was determined by densitometric evaluation of contact autoradiographs. Treatment with ^{14}C -DFP gave autoradiographs of better resolution which allowed individual end plates or groups of end plates to be distinguished on autoradiographs instead of the end-plates band appearing as a diffusely blackened zone when the diaphragms were incubated in ^{32}P -DFP. DFP binding and cholinesterase activity were found to correspond closely. Pre-treatment with physostigmine (10^{-5} M) gave negative autoradiographs. The amount of DFP bound and the cholinesterase activity were found to correspond closely. The end plates proved saturated at a concentration of 10^{-5} M ; a similar DFP concentration decreased the cholinesterase activity to <5% of the original value. The approx. number of 2.2×10^7 DFP molecules required for the saturation of an end plate coincides with the number of active centres of cholinesterase. The amount of DFP bound by degenerating end plates was studied in mice killed at various intervals after phrenectomy. Qualitatively, the changes visible on autoradiographs agreed with the histochemical changes observed.

- 774 Reynolds, H. T., Metcalf, R. L., Fukuto, T. R. SYSTEMATIC INSECTICIDAL ACTION OF O-METHYL O-PARA-METHYLTHIOPHENYL METHYLPHOSPHONOTHIONATE AND RELATED COMPOUNDS. *J. econ. Ent.* 59, 2 (1966) 293-299.

32 O, O-dialkylphosphates and phosphorothioates and the comparable O-alkyl alkylphosphonates and alkylphosphonothionates, all incorporating the p-methylthiophenyl ester or its sulfoxide or sulfone oxidation products, were investigated in the laboratory and four of the best of these in the field of systemic action in cotton plants. The relation of structure to systemic activity was analysed and O-methyl O-p-methylthiophenyl methylphosphonothionate (XI) was somewhat the best of the series studied. Metabolism within the cotton-plant environment, studied by ^{32}P labelling, followed the typical pattern of oxidation to sulfoxide and then to sulfone together with oxidation of $\text{P}=\text{S}$ to $\text{P}=\text{O}$. This fact re-emphasises the importance of the methylthio-group in providing a delayed period of toxicity during and following absorption and translocation. Typically, the systemic readily translocated to the leaves with the highest amounts entering the rapidly growing upper leaves. Much smaller amounts entered the bracts but not the fruiting portion of the developing squares. Field results showed promise with the best compound within the series for seed treatment or in-furrow granulated treatments applied at time of planting. Granulated soil treatments to large plants, however, were inferior to other types of systemic compounds with a much higher water solubility. (Auth.)

- 775 Ridgway, R. L., Lindquist, D. A. SYSTEMIC ACTIVITY OF SHELL SD-9129 IN COTTON PLANTS. *J. econ. Ent.* 59, 4 (1966) 961-964.

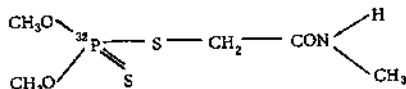
^{32}P -labelled SD-9129 was used. It was 98% or more cis isomer. (Cf. Bull and Lindquist 1966, ref. 700). The systemic activity of Shell SD-9129 (dimethyl phosphate ester with 3-hydroxy-N-methyl-cis-crotonamide) in cotton plants was studied by bioassay and radioassay. The insects and a mite used for bioassay were the cotton aphid, *Aphis gossypii* Glover; the boll weevil, *Anthonomus grandis* Boheman; and the carmine spider mite, *Tetranychus telarius* (L.). After application to lower leaves, little or no SD-9129 was found in untreated leaves above treated lower leaves. However, relatively large amounts were found in nectar of the cotton plant after the toxicant was applied to the stem. SD-9129 was not particularly effective as a systemic insecticide when it was applied to cotton seed or to the soil.

- 776 Ridgway, R. L., Walker, H. J., Hanna, R. L., Owen, W. L. FERTILIZERS IMPREGNATED WITH SYSTEMIC INSECTICIDES FOR CONTROL OF COTTON INSECTS. *J. econ. Ent.* 60, 2 (1967) 592-594.

Greenhouse and field tests were conducted to compare the effectiveness against cotton insects of granules and fertilizer impregnated with phorate, disulfoton, and American Cyanamid CL-47031 (cyclic ethylene (diethoxyphosphoryl)dithiolimidocarbonate) and applied to cotton plants. ^{32}P -disulfoton was used. Bioassays and radioassays of treated plants indicated that the levels of uptake from both formulations were similar after in-furrow and sidedress applications. Phorate and disulfoton were stable on I grade of fertilizer for more than three months.

- 777 Roderbourg, J., Vervier, R. CONTROLE DE L'EXTRACTION DE RESIDUS DE DIMETHOATE SUR EPINARDS AU MOYEN DE DIMETHOATE MARQUE AU P 32. (Developing extraction methods for dimethoate residues in spinach using ^{32}P -dimethoate.) *Meded. Landbouogesch. OpzoekStns Gent* 30, 3 (1965) 1873-1878. (In French, with French, Flemish, English and German summaries)

Les auteurs étudient différents modes d'extractions et de purification d'extraits végétaux (épinard) contenant du diméthoate au moyen de diméthoate au ^{32}P . Le diméthoate marqué possédait une activité spécifique de 10 mCi/mg, avec une formule comme suit:



Le diméthoate a été utilisé sans porteur afin d'obtenir un rendement de comptage de ses radiations assez élevé tout en maintenant des concentrations de produits aussi faibles que celles qui sont rencontrées dans la pratique (~ mg de diméthoate/g d'épinards). A chaque lot d'épinards soumis à l'analyse on a ajouté 5,7 mg de diméthoate radioactif (57,2 $\mu\text{g/g}$ d'épinards). Les auteurs démontrent les avantages de l'emploi de tels éléments radioactifs pour la mise au point de méthode appropriée d'extraction de résidu.

- 778 Roderbourg, J., Vervier, R. CONTROLE DE L'EXTRACTION DE RESIDUS DE DIMETHOATE SUR EPINARDS AU MOYEN DE DIMETHOATE MARQUE AU P 32. AED-Conf-067-1, Gmelin-Institut für Anorganische Chemie und Grenzgebiete, Frankfurt am Main (West Germany). 1965, 7p.
- La méthode d'extraction décrite a été étudiée au moyen de diméthoate marqué au ^{32}P que l'on ajoutait à des extraits d'épinards non traités de manière à chiffrer le rendement de cette opération et le taux de récupération du diméthoate. Le ^{32}P -diméthoate possédait une activité spécifique de 10 mCi/mg. Il paraît que la méthode d'extraction des auteurs s'adapte parfaitement au processus analytique employé et a permis de détecter des doses de diméthoate inférieures au 0,1 ppm.
- 779 Roderbourg, J., Vervier, R. DEVELOPING EXTRACTION METHODS FOR DIMETHOATE RESIDUES IN SPINACH USING RADIOACTIVE DIMETHOATE. Paper presented at the "17th International Symposium of Crop Protection. 1965". (Location?)
- 780 Roulston, W.J., Schuntner, C.A., Schnitzerling, H.J. METABOLISM OF COUMAPHOS IN LARVAE OF THE CATTLE TICK *Boophilus microplus*. *Aust. J. biol. Sci.* 19, 4 (1966) 619-633.
- [^{32}P]Coumaphos, a phosphorothionate, was rapidly absorbed and metabolised by cattle tick larvae dipped in aqueous suspensions of the acaricide. One metabolite was shown by chromatographic, spectroscopic, and cholinesterase inhibition evidence to be the oxygen analogue, a more potent in vitro cholinesterase inhibitor than the parent compound. Other water soluble metabolites were only tentatively identified. Sublethal doses were metabolised mainly to water-soluble materials and a small quantity of oxygen analogue whereas lethal doses, producing complete mortality in 2-3 h, yielded almost equal amounts of the oxygen analogue and water-soluble materials. In vivo inhibition of cholinesterase in treated larvae was dose-dependent and preceded death. (Auth. summary)
- 781 Sato, Y., Miyamoto, J. AN ASPECT CONCERNING THE MOVEMENT OF DIMETHOATE FROM ITS GRANULAR FORMATION IN SOIL. *Nyaku Seisan Gijyutsu* 16 (1967) 23-28.
- ^{32}P -labelled dimethoate (I)-coated granules consisting of labelled I 5, poly(vinyl alcohol)2, and clay 93% were applied to sandy loam soil at a depth of 1 cm. In H_2O -saturated soil, I slowly moved horizontally and vertically. When H_2O was added to the soil surface, I moved downward with H_2O , the rate increasing with the amount of H_2O while the horizontal movement was slower. More than 80% of applied I was found undecomposed 7 d after application. (CA 66: 1967, 11489j)
- 782 Schuntner, C.A., Thompson, P.G. DETECTION AND ESTIMATION OF [^{14}C] DIAZINON IN VIVO BY COUNTERCURRENT DISTRIBUTION AND INHIBITION ASSAY. *Biochim. biophys. Acta* 115, 1 (1966) 225-7.
- An estimate of diazoxon (diethyl 2-isopropyl-6-methyl-4-pyrimidinyl phosphate) was attempted in larvae of the cattle tick, *Boophilus microplus*, treated with [ethoxy- ^{14}C] diazinon. Although satis-

factory resolution of the authentic nonradioactive compound could be obtained on paper- and gas-chromatograms, results with extracts of [^{14}C] diazinon-treated larvae were not quantitative nor readily reproduced. A countercurrent distribution system was devised to resolve mixtures of authentic diazoxon, diazinon and related water-soluble compounds, and to allow liquid scintillation counting of the tube contents with minimal quenching. (A better assay of diazoxon after countercurrent distribution is obtainable by the esterase inhibition method.) Larval extracts could thus be used directly in the lower phase without solvent evaporation. A radioactive peak in countercurrent distributions of extracts of [^{14}C] diazinon-treated larvae corresponded exactly with authentic diazoxon, and also had esterase inhibition properties which, when converted to equivalent diazoxon, gave a reasonable fit to the radioactivity curves.

- 783 Schuntner, C. A., Schnitzerling, H. J. SEPARATION OF ^{32}P -LABELED DIOXATHION COMPONENTS ON A SILICIC ACID COLUMN. *J. Chromat.* **27**, 1 (1967) 272-275.

A mixture of the *cis* and *trans* isomers of *p*-dioxane-2,8-dithiol S, S-bis (O, O-di-Et phosphorodithioate), the dioxene derivative *p*-dioxene-2-thiol S-(O, O-di-Et phosphorodithioate), and several minor insecticidally active compounds was separated on a 105 mm x 6 mm glass column packed with 1 g solvent-washed and activated silicic acid, partly deactivated with 15% vol/wt H_2O , lightly ground to a slurry with 10% C_6H_6 in *n*-hexane. A gradient of 10% C_6H_6 in *n*-hexane was used as eluant for the 12 1-ml fractions, 75% C_6H_6 in *n*-hexane for fractions 13-21, and 100% C_6H_6 for the remainder. The mixture components were identified by infrared. (CA 67: 1967, 10655a)

- 784 Schwarz, H., Dedek, W. DAS VERHALTEN VON RADIOAKTIV MARKIERTEM TRICHLORPHON NACH POUR-ON APPLIKATION (AUGIESSVERFAHREN) ZUR DASSELLARVENBEKÄMPFUNG BEIM RIND. (The behaviour of radioactively labelled trichlorphon following pour-on application for combating *Hypoderma* larvae in cattle.) *Mh. VetMed.* **20** (1965) 958-960. (In German)

The percutaneous resorption of the active substance was studied on two test cows using different doses, and the concentration of active substance in the blood and milk were determined. ^{32}P -trichlorphon was used. Quantities as low as 0.01 ppm could still be detected with certainty. The concentration of active substance in the blood necessary for killing the parasites are discussed, in connection with available experimental data.

- 785 Schwarz, H., Dedek, W. UNTERSUCHUNGEN ZUM NACHWEIS VON ^{32}P -MARKIERTEM TRICHLORPHON IM FLEISCH BEIM SCHWEIN. (Studies on the detection of ^{32}P -labelled trichlorphon in pork.) *Zentbl. VetMed.* **13b** (1966) 489-494. (In German, with English, French and Spanish summaries)

^{32}P -trichlorphon was injected subcutaneously to two pigs at 25 mg/kg body weight. The trichlorphon had a high specific activity and was administered in the form of Bubulin, which contains 500 g trichlorphon, 5 g 2-PAM* and 1.5 g atropine sulphate, dissolved in polyglycol ad 1000 ml, as manufactured by VEB Serumwerk Bernburg. The trichlorphon level in pork was determined by extraction with chloroform. The level in the meat was always lower than in blood; 2 h after injection 5 ppm were found in the meat. Already within 6-7 h the level had dropped to one tenth.

*puridine-2-aldoxime methiodide.

- 786 Schwarz, H., Dedek, W. DAS VERHALTEN VON RADIOAKTIV MARKIERTEM TRICHLORPHON NACH RÜCKENWÄSCHE ZUR DASSELLARVENBEKÄMPFUNG BEIM RIND. (The fate of radioactively-labelled trichlorphon after dorsal scrubbing of cattle against botfly larvae.) *Mh. VetMed.* **21** (1966) 945-947. (In German, with Russian and English summaries)

500 ml of an aqueous solution (2%) of ^{32}P -trichlorphon were applied to cattle by dorsal scrubbing. Residues amounted to max. concentrations of 0.2 ppm in the blood and 0.15 ppm in milk. The use of aqueous trichlorphon for controlling botfly larvae in cattle is discussed. No objections to the use of such milk for human consumption have so far been voiced in international recommendations.

- 787 Schwarz, H., Dedek, W. THE BEHAVIOUR OF ^{32}P -LABELED ORGANOPHOSPHORIC INSECTICIDES AFTER INTRACISTERNAL ADMINISTRATION IN CATTLE. RESORPTION OF BIOLOGICALLY ACTIVE SUBSTANCES FROM THE UDDER OF CATTLE. I. TRICHLORFON. Arch. exp. VetMed. **21**, 4 (1967) 1031-1035. (In German)

Trichlorfon administered intracisternally to milk cows is absorbed unchanged into the blood from the udder, appearing in the blood and milk within a few minutes after infusion. Only traces of unchanged trichlorfon remain in the milk 6-7 h after injection, the major portion being metabolised in the udder. (CA 68:1968, 86364k)

- 788 Shishido, T., Fukami, J. STUDIES ON THE SELECTIVE TOXICITIES OF ORGANIC PHOSPHORUS INSECTICIDES. II. THE DEGRADATION OF ETHYL PARATHION, METHYL PARATHION, METHYL PARAOXON AND SUMITHION IN MAMMAL, INSECT AND PLANT. Bokyu-kagaku **23**, 3 (1963) 69-76. (Japanese summary)

The in vitro degradation of several phosphorus insecticides (labelled with ^{32}P) by homogenates of rat liver, larvae of *Chilo suppressalis* or adults of *Periplaneta americana* (L.), and plant tissue (cauliflower) was investigated. The supernatant fraction of the rat-liver homogenate was more effective in degrading methyl-parathion, methyl-paraoxon [dimethyl p-nitrophenyl phosphate] and fenitrothion (Sumithion) to water-extractable metabolites than were the mitochondria and washed microsome fractions, the latter two being similar in effect. The supernatant fraction degraded parathion to a very small extent as compared with methyl parathion and fenitrothion. In the insect homogenates, degradation activity was similar in the supernatant and in the washed microsome and mitochondria fractions. No degradation of methyl parathion or methyl paraoxon was evident in the plant homogenates. The water-extractable metabolites were subjected to ion-exchange chromatography, and five were found. Four of them were identified as phosphoric or phosphorothioic, dialkyl phosphorothioic, desalkyl phosphorothioic and desalkyl phosphoric acid. With the supernatant of the rat-liver homogenate, the principal metabolites of methyl parathion, methyl paraoxon and fenitrothion were desmethyl-parathion (O-methyl O-p-nitrophenyl phosphorothioic acid), desmethyl-paraoxon (methyl p-nitrophenyl phosphoric acid) and desmethyl-fenitrothion (O-methyl O-3-methyl-4-nitrophenyl phosphorothioic acid), respectively. In the case of parathion, the production of desethyl-parathion [O-ethyl O-p-nitrophenyl phosphorothioic acid] was very slight. Relatively small amounts of these metabolites were produced by the supernatant of the insect homogenates. (RAE-A 55: 1967, ref.197)

- 789 Smith, G.N. BASIC STUDIES ON DURSABAN INSECTICIDE. Down to Earth **22**, 2 (1966) 3-7.

Approximately 70% of ^{36}Cl - or ^{14}C -labelled Dursban (O-O-di-Et O-3,5,6-trichloro-2-pyridyl phosphorothioate) (I) in a Me_2CO solution applied to Fe, Pb, Al, and stainless steel sheets was lost by evaporation in 24 h when held in a control chamber (45-50% humidity, day temperature 92°F for 16 h., night temperature 76°F for 8 h.). In the case of Cu sheets, the metal reacted with I, while with painted surfaces I was carried into the paint layer. With Whatman No. 1 filter paper, 83% was lost in 3 d, but with a formulation containing surfactants, 52% remained after 12 d. I tended to exhibit a high persistence in situations where volatility was not a factor, i.e., soils. I as a dry powder was very stable to u.v. light. In the presence of water, hydrolysis was appreciable and the resulting 3,5,6-trichloropyridin-2-ol was very susceptible to u.v. light decomposition. Approximately 80% of I applied to a plant was lost by evaporation, ~20% remained in the treated area and was degraded and 1-2% was unchanged. When plants were grown in a solution containing 50 ppm I, 60% of the compound plated out on the roots, which metabolised it translocating the decomposition products to other parts of the plant. In the rat, labelled I was rapidly metabolised and detoxified products were rapidly eliminated via the urine and faeces except for small amounts which accumulated in the fat and were slowly eliminated once medication was discontinued. Fish also metabolised labelled I rapidly, the majority of the radioactivity being found in the viscera with small amounts in the skin and meat. The varying anticholinesterase activity of different lots of I was ascribed to the presence of small amounts of its O-analogue, which was a potent cholinesterase inhibitor. A I sample purified by thin-layer chromatography gave no cholinesterase inhibition. (CA 65: 1967, 17629c)

- 790 Smith, G.N., Watson, B.S., Fischer, F.S. THE METABOLISM OF [^{14}C] O, O-DIETHYL O-(3,5,6-TRICHLORO-2-PYRIDYL) PHOSPHOROTHIOATE (DURSABAN) IN FISH. J. econ. Ent. **59**, 6 (1966) 1464-1475.

The new Dursban[®] insecticide is effective in controlling mosquitoes. The active ingredient of this insecticide is *O*, *O*-diethyl *O*-(3,5,6-trichloro-2-pyridyl) phosphorothioate. In spraying Dursban to control mosquitoes, the chemical will come in contact with the fish, plants, and soil in the environment. In investigations with [¹⁴C] labelled insecticide, it was found that the Dursban is rapidly absorbed from the water by plants and soil particles, but very slowly metabolised. Fish absorb the compound at a much slower rate, but rapidly metabolise it. The detoxified products are then eliminated into the water. Under natural conditions the majority of the Dursban will be absorbed by the plants and soil particles thus limiting the amount which can be taken up by the fish. (Auth.)

- 791 Smith, G.N., Watson, B.S., Fischer, F.S. DURSCHAN INSECTICIDE. UPTAKE AND TRANSLOCATION OF *O*, *O*-DIETHYL *O*-(3,5,6-TRICHLORO-2-PYRIDYL) PHOSPHOROTHIOATE-³⁶Cl AND *O*, *O*-DIETHYL *O*-(3,5,6-TRICHLORO-2-PYRIDYL) PHOSPHOROTHIOATE-¹⁴C BY BEANS AND CORN. *J. agric. Fd Chem.* **15**, 1 (1967) 127-131.

The uptake and translocation of ³⁶Cl-labelled Dursban and ¹⁴C-labelled Dursban by leaves and corn plants were studied. Both root and leaf absorption were insignificant. Only 1-2% of the radioactivity was translocated into the plant. These were largely breakdown products such as the 3,5,6-trichloro-2-pyridinol. In foliar spray treatment, most of the radioactivity was lost from the leaf by volatilization. Since absorption and translocation of Dursban or its decomposition products were insignificant, the only place a significant amount of radioactivity could be found was on the treated area. (CA 66:1967, 54495w)

- 792 Smith, G.N., Watson, B.S., Fischer, F.S. DURSCHAN INSECTICIDE. METABOLISM OF *O*, *O*-DIETHYL *O*-(3,5,6-TRICHLORO-2-PYRIDYL) PHOSPHOROTHIOATE-³⁶Cl IN RATS. *J. agric. Fd Chem.* **15**, 1 (1967) 132-138.

When *O*, *O*-diethyl *O*-(3,5,6-trichloro-2-pyridyl) phosphorothioate-³⁶Cl is fed as a single dose to rats, the radioactivity is eliminated rapidly via the urine (90%) and faeces (10%). The products excreted are 3,5,6-trichloro-2-pyridyl phosphate-³⁶Cl (75-80%), 3,5,6-trichloro-2-pyridinol-³⁶Cl (15-20%), with traces of *O*, *O*-diethyl *O*-(3,5,6-trichloro-2-pyridyl) phosphorothioate. Only the *O*, *O*-diethyl *O*-(3,5,6-trichloro-2-pyridyl) phosphorothioate-³⁶Cl accumulates in the tissues. This accumulates in the fat and is liberated slowly. (CA 66:1967, 54496x)

- 793 Smith, G.N., Watson, B.S., Fischer, F.S. INVESTIGATIONS ON DURSCHAN INSECTICIDE. METABOLISM OF *O*, *O*-DIETHYL *O*-(3,5,6-TRICHLORO-2-PYRIDYL) PHOSPHOROTHIOATE AND 3,5,6-TRICHLORO-2-PYRIDINOL IN PLANTS. *J. agric. Fd Chem.* **15**, 5 (1967) 870-877.

Studies on the absorption, translocation, and metabolism of [³⁶Cl] Dursban, [¹⁴C] Dursban, [³⁶Cl] 3,5,6-trichloro-2-pyridinol, and [¹⁴C] 3,5,6-trichloro-2-pyridinol in plants show that Dursban is not absorbed into the plant, although it accumulates on the surface of the roots. Once it enters the plant it appears to be metabolised to form primary hydrolysis products where the phosphorus is still attached to the 3,5,6-trichloro-2-pyridinol. The rate at which the 3,5,6-trichloro-2-pyridinol enters the plant depends on the pH of the solution. The sodium salt enters the plant more than five times faster than the free pyridinol. The pyridinol undergoes metabolism with the liberation of chloride and the formation of several decomposition products. (Auth.)

- 794 Spiller, D. DIGEST OF AVAILABLE INFORMATION ON INSECTICIDE MALATHION. *Adv. Pest Control Res.* **4** (1961) 249-335.

The use of ³²P-labelled malathion is described in two chapters of this digest: (1) Concerning the residues in animal products where no detectable malathion was found in cuts of foreleg, hindleg, and rump of heifers sacrificed two weeks after application of 0.5% ³²P-malathion emulsion spray, but water-soluble metabolites were detected in meat cuts and in thymus, thyroid, pancreas, liver, and bone to the extent of 0.05-2.0 ppm. (2) Where the effects of malathion on pest nematodes is concerned when hens were fed 100 ppm of ³²P-malathion in the diet and large numbers of dead round worms were eliminated in the droppings in the first few days. (Battelle Institute Card File)

- 795 Stiasni, M., Rehinder, D., Deckers, W. ABSORPTION, DISTRIBUTION, AND METABOLISM OF *O*-(4-BROMO-2,5-DICHLOROPHENYL)-*O*, *O*-DIMETHYLPHOSPHOROTHIOATE (BROMOPHOS) IN THE RAT. *J. agric. Fd Chem.* **15**, 3 (1967) 474-478.

Bromophos is a new phosphorothioate insecticide of extremely low mammalian toxicity. It is widely used in controlling mosquitoes and flies. ^3H -Bromophos with a final activity of 2.5 mCi/mM and ^{32}P -Bromophos were used. Bromophos is absorbed via the intestine. The distribution pattern shows no accumulation. The main excretory route is in urine. Metabolic detoxication takes place by hydrolysis of the methyl phosphate and/or the phenyl phosphate bond. Neither Bromophos nor its oxygen analogue are found in urinary excretion products.

- 796 Stone, B.F., Brown, A.W.A. MECHANISMS OF RESISTANCE TO FENTHION IN *Culex fatigans*. Bull. ent. Soc. Am. 13, 3 (1967) 189. Abstr. 42, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Larvae of a fenthion-resistant strain of *C. fatigans* absorbed only about half as much ^{32}P -fenthion as its susceptible counterpart strain. Of the material absorbed, the resistant strain hydrolysed almost twice as high a proportion as the susceptible strain. A strain of intermediate resistance metabolised less and absorbed more than the resistant strain. The metabolites are being investigated. (Abstr.)

- 797 Uchida, T., Zachitsch, J., O'Brien, R.D. RELATION BETWEEN SYNERGISM AND METABOLISM OF DIMETHOATE IN MAMMALS AND INSECTS. Toxic. appl. Pharmac. 8 (1966) 259-265.

Dimethoate, ^3H -labelled in the methoxy group, was used. Its metabolism in insects was examined in two ways. (1) In vitro: usually 20 female *Musca domestica* were homogenized in 10 ml of buffer, the homogenate being treated with ^3H -dimethoate, fractionated and counted. (2) In vivo: 36 female *M. domestica* or 10 milkweed bugs (mixed sexes) were injected abdominally with 1 μl of ^3H -dimethoate in water and treated topically with 1 μl of EPN. EPN synergizes the toxicity of dimethoate profoundly in female mice, mildly in female guinea pigs, and not at all in female house flies (Wilson and G strains) or milkweed bugs. These findings parallel the observations that EPN blocks dimethoate metabolism profoundly (80%) in mice, less in guinea pigs (60%), and not at all in house flies and milkweed bugs. The data give strong support to the view that synergism in this pair of compounds is caused by blockade of metabolism. However, the ability of EPN to distinguish between the amidase and phosphatase pathways is not so clear-cut as in the corresponding carboxyesterase and phosphatase pathways for malathion, whose toxicity is also synergized by EPN.

- 798 Walker, P.T. PHORATE FOR INSECT CONTROL IN MAIZE. (I. CONTROL OF FRIT FLY.) II. UPTAKE AND DISTRIBUTION OF RADIOACTIVE PHORATE. Tropical Pesticides Research Unit Report No.293. Porton Down, Salisbury, England. March 1965.

... In previous years furrow treatment was most effective. Radioactive tracing of ^{32}P -phorate showed that uptake of phorate is longer but less intense after furrow treatment... Phorate metabolism is discussed. Methods of radioactive granule preparation, plant extraction, radioassay, and autoradiography are described, with references. (From auth. summary)

- 799 Whetstone, R.R., Phillips, D.D., Sun, Y.P., Ward, L.F., Jr., Shellenberger, T.E. 2-CHLORO-1-(2,4,5-TRICHLOROPHENYL) VINYL DIMETHYL PHOSPHATE, A NEW INSECTICIDE WITH LOW TOXICITY TO MAMMALS. J. agric. Fd Chem. 14, 4 (1966) 352-356.

Single doses of the ^{32}P -labelled compound (I) in soybean oil were administered via stomach tube to male and female rats of a Wistar-derived strain. Dosages were 1.0 mg (2.3 μCi) equivalent to 5.1 mg/kg of body weight for the males and 0.8 mg (2.3 μCi) or 4.9 mg/kg for the females. The excretion of metabolites is tabulated. The ^{32}P in the urine was present in metabolites of I, no intact I being detected. Dimethyl hydrogen phosphate, and "desmethyl I" were identified. Compounds in the faeces were not identified. 2-Chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate (SD 8447) has shown excellent toxicity to several species of insects in laboratory and field tests but is remarkably safe to laboratory mammals in acute and two-week feeding tests. The poor solubility or partition properties of the compound may limit penetration and translocation in mammals so that amounts of the compound in blood and tissues are low enough to be metabolised without toxic effect.

- 800 Winteringham, F.P.W. LABELLED REAGENTS AND SUBSTRATES IN PESTICIDE ANALYSIS. p.96-100 of "Radioisotopes in the Detection of Pesticide Residues. Proceedings of a Panel. Vienna, Austria, 12-16 Apr. 1965". STI/PUB/123, International Atomic Energy Agency, Vienna (Austria). 1966, 118p.

The possibility of exploiting the radiometric technique for the differentiation and determination of organophosphate and carbamate residues is under investigation. The experimental and theoretical bases for this approach are discussed.

- 801 Young, S. Y., III. **RADIOSYNTHESIS AND METABOLISM OF METHYLTHIO ARYL PHOSPHOROTHIONATES IN CALVES AND BLOOD SUCKING ARTHROPODS.** *Diss. Abstr.* 28, 1 (1967) 226-B.

A technique was developed for the radiosynthesis of ^{35}S -labelled p-hydroxyaryl methyl thioethers which can be used as intermediates in the synthesis of several organophosphorus insecticides. This technique was then used to synthesise ^{35}S -Bayer 9017 (O-O-diethyl-O- [^{35}S -4-(methylthio)-3,5-xylyl] phosphorothioate). The Bayer 9017 was purified on a Florisil column with gas chromatography being used to monitor the elution of the ^{35}S -Bayer 9017 and side reaction products from the column. The metabolism and associated residues of ^{35}S -Bayer 9017 were studied in dairy calves using radiotracer techniques. Two calves were treated, one orally at the rate of 50 mg/kg with a solution containing 52% of Bayer 9017 and the 2nd calf treated dermally, at the rate of 310 mg/kg with a solution of 2% Bayer 9017. The calves were held for 24 h after treatment during which time blood samples were taken at 4 h intervals with urine and faeces collected quantitatively. ^{35}S -Bayer 9017 and its metabolites were isolated and identified by selective solvent extraction and thin-layer co-chromatography. Bayer 9017 was quickly degraded in the calves to hydrolytic products and rapidly eliminated in the urine primarily as water soluble conjugates of the phenols. The peak concentrations of radioactivity in the urine of both calves were reached at 6 h after treatment. Little elimination of ^{35}S -materials occurred in the faeces and most that was excreted consisted of organo-soluble materials. Bayer 9017 and all five of its oxidation products were found in both the urine and faeces. - Levels of radioactivity in the blood in both calves were highest at 12 h after treatment with the level in the calf treated dermally being somewhat higher than in the calf treated orally. Residues of Bayer 9017 present in most tissues were much higher in the calf treated dermally; residues in the muscle tissue were six times higher than in the calf treated orally. Much of the radioactivity in the tissues was present as hydrolytic products, primarily as water soluble conjugates with little free phenols being present in most tissues. Activation of Bayer 9017 occurred in both the thiophosphoryl and thioether groups with all five possible oxidation products being present. - In the 3rd phase of this investigation, the absorption and metabolism of ^{35}S -fenthion in two species of blood sucking arthropods, the stable fly, *Stomoxys calcitrans* (L.), and bed bug, *Cimex lectularius* L., were studied. Eight groups of each species were treated topically with one μl of a 0.4 ppm solution of fenthion in acetone. Two replicates of each species were sacrificed at 0, 1, 4, and 24 h after treatment. It was observed that nearly 90% of the ^{35}S -fenthion was absorbed by the stable fly. Activation in this insect was rapid with 35% of the absorbed dose being present as oxidation products after one hour. All five possible oxidation products were present. However, after 24 h much of the absorbed dose had been degraded and one-half of this dose had been excreted as water soluble conjugated phenols. - Absorption of fenthion by the bed bug was not as rapid as in the stable fly. Only 50% of the application was absorbed after 24 h. Degradation and excretion were also slower in the bed bug and only 18% of the absorbed dose was excreted after 24 h. The oxidation products formed in the bed bug were similar to those found in the stable fly. (DA)

- 802 Zuckerman, B. M., Miller, C. W., Devlin, R. M., Tomlinson, W. E., Norgren, R. L. **PARATHION STUDIES ON BEAN GROWN IN STERILE ROOT CULTURE.** *J. econ. Ent.* 59, 5 (1966) 1157-60.

Details of the extraction, chromatographic and autoradiographic procedures are given. ^{35}S -parathion was used. Parathion was detected in young bean leaflets 2 h following application to soil of plants grown in sterile root culture. Studies of accumulation of parathion within the plant during 24 h following soil application indicated that uptake continued during this period, but slowed considerably after 6 h. Results of analysis for parathion degradation products from tissue extracts indicated that most, if not all, of the parathion molecule remained intact within the plant after >22 h. Higher concentrations of parathion occurred at outer margins than in the central portions of the leaf blade. The insecticide appeared to be transported selectively by certain leaflet veins. Younger leaflets accumulated higher concentrations than did older leaflets over the same period. Parathion was not detected in root exudates 24 h following foliar application. Several species of sucking insects [the citrus mealybug, *Planococcus citri* (Risso), an aphid, *Macrosiphum pelargonii* (Kaltenbach), and the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood)] apparently fed but did not die after being exposed to leaves for 24 h following soil application. In one test, low levels of parathion or parathion-associated metabolites were detected in extracts from insects after 24 h exposure.

See also:

- 488 The artificial feeding of phosphamidon to *Myzus persicae*: I. Intraspecific differences exhibited by this aphid on feeding through a parafilm membrane. (Parry, W.H. et al., 1967)
- 586 The use of isotopes to study pesticide translocation in natural environments. (Peterle, T.J., 1966)
- 610 The relation between physical properties and uptake of insecticides by eggs of the large milkweed bug. (Bracha, P. et al., 1966)
- 835 Degradation of insecticides by the human and the rat liver. (Matsumura, F. et al., 1966)
- 1726 Electron microscope radioautography as a quantitative tool in enzyme cytochemistry. I. The distribution of acetylcholinesterase at motor end plates of a vertebrate twitch muscle. (Salpeter, M.M., 1967)
- 1757 Radioactive nuclides in pesticide chemistry. II. (Dedek, W., 1967)

1.5.5. Carbamates

- 803 Abdel-Wahab, A.M., Kuhr, R.J., Casida, J.E. FATE OF ^{14}C -CARBONYL-LABELLED ARYL METHYLCARBAMATE INSECTICIDE CHEMICALS IN AND ON BEAN PLANTS. J. agric. Ed Chem. 14, 3 (1966) 290-298.

Studies with eight ^{14}C -carbonyl-labelled aryl methylcarbamates demonstrate that such insecticide chemicals are degraded with the carbamate moiety intact when applied to glass or silica gel surfaces or leaves of growing bean plants, or injected into the stems of such plants. Methylcarbamates-carbonyl- ^{14}C of the following phenols were examined: 1-naphthol (carbaryl), 2-isopropoxyphenol (Baygon), 3-isopropylphenol (UC 10854), 3,5-diisopropylphenol (HRS-1422), 2-chloro-4,5-xyleneol (Banol), 4-methylthio-3,5-xyleneol (Mesurol), 4-dimethylamino-3,5-xyleneol (Zectran), and 4-dimethylamino-3-cresol (Matacil). Rates of loss vary considerably with the nature of the surface (inert or plant), the light, and the compound. Oxidative changes occur on and/or in the plant: Mesurol degrades to sulfoxide and sulfone analogues; Zectran and Matacil form several methylcarbamate derivatives, including the 4-methylamino, 4-amino, 4-methylformamido, and 4-formamido analogues. Little or no formation of organoextractable degradation products, containing an intact methylcarbamate moiety, occurs with the other compounds. The fate of the radiocarbon, 6 d after injection into bean plants, varies considerably: with Baygon and UC 10854 the majority of the radiocarbon is in the water phase; with Zectran and Matacil it appears in the unextractable portion; with Mesurol, it shows up as loss, possibly as the result of expiration as $^{14}\text{CO}_2$. Loss from the plant surface is not directly related to the volatility of the compounds, nor is degradation in the plant related to the rate of non-enzymatic hydrolysis. It appears that the relative stability of the methylcarbamate grouping to photooxidation and metabolism, in certain cases, allows the formation of degradation products involving only alteration of the ring or a ring substituent. (Auth.)

- 804 Abdel-Wahab, A.M. DEGRADATION OF METHYLCARBAMATE INSECTICIDES ON PLANT FOLIAGE. Diss. Abstr. 27, 10 (1967) 3428-B - 3430-B.

The following methylcarbamates labelled with ^{14}C in the carbonyl position were examined: Banol (2-chloro-4,5-xylyl methylcarbamate), Baygon (2-isopropoxyphenyl methylcarbamate), carbaryl (1-naphthyl methylcarbamate), HRS-1422 (3,5-diisopropylphenyl methylcarbamate), Matacil (4-dimethylamino-3-cresyl methylcarbamate), Mesurol (4-methylthio-3,5-xylyl methylcarbamate), UC 10854 (3-isopropylphenyl methylcarbamate), and Zectran (4-dimethylamino-3,5-xylyl methylcarbamate). - Volatility of the labelled methylcarbamates was investigated under laboratory conditions. Rate of loss of the compounds from glass surfaces was characteristic of a first-order reaction except in the cases of Matacil, Mesurol and Zectran where two components with different rates of loss were evident. The complex nature of the volatility curve for Zectran was due to the formation of degradation products which were more stable and less volatile than the original compound. Stability of the methylcarbamates to light was examined by exposure of non-labelled compounds on silica gel plates. All the carbamates were stable when exposed in the dark, or to visible or long wavelength ultraviolet light. On exposure to short wavelength u.v. light, carbaryl was unaffected,

Zectran was extensively degraded, and the other compounds were of intermediate stability. These carbamates were also applied to the leaves of growing young bean plants and the plants were exposed outdoors to direct sunlight. Leaf samples were taken at intervals up to 72 h after treatment, and washed with chloroform to recover the labelled materials from the leaf surfaces. The total recovered radioactivity was determined and the degradation products were quantitatively analysed by thin-layer chromatography, radioautography and scintillation counting. The persistence of these methylcarbamates can be divided into three categories according to the % of total carbonyl- ^{14}C remaining (original compounds plus carbamate-degradation products) after 3 d of exposure on the foliage: (a) those in which <10% was recovered, including Baygon and UC 10854; (b) those in which 20-35% was recovered, including Banol, HRS-1422 and Matacil; (c) those in which >45% was recovered, including carbaryl, Mesurol and Zectran. Zectran and Matacil appeared to be the least stable compounds and were each decomposed to yield more than ten carbamates within 24-h exposure. Mesurol was oxidized in part to its sulfoxide and sulfone derivatives on exposure to sunlight on foliage, and limited evidence indicates that Matacil is converted to its 4-methylamino and 4-formamido analogues. The four major degradation products of Zectran on bean foliage have been tentatively identified. Identification was based on co-chromatography with authentic samples prepared by oxidation of Zectran by neutral permanganate. The four products were 4-methylformamido-3,5-xylyl methylcarbamate; 4-methylamino-3,5-xylyl methylcarbamate; 4-formamido-3,5-xylyl methylcarbamate. Considerable specificity in biological activity occurred within the series of Zectran degradation products. Zectran was more potent than any of these compounds to houseflies (*Musca domestica* L.) following topical application, or as an in vitro inhibitor of fly head cholinesterase. The 4-methylamino and 4-amino analogues were very potent when assayed for anticholinesterase activity using human plasma or for toxicity on injection into mice. The two formamido analogues were of lower biological activity. (From DA)

- 805 Abdel-Wahab, A.M., Casida, J.E. PHOTOOXIDATION OF TWO 4-DIMETHYLAMINOARYL METHYLCARBAMATE INSECTICIDES (ZECTRAN AND MATACIL) ON BEAN FOLIAGE AND OF ALKYLAMINOPHENYL METHYLCARBAMATES ON SILICA GEL CHROMATOPLATES. *J. agric. fd Chem.* 15, 3 (1967) 479-487.

Carbonyl- ^{14}C -labelled samples of Zectran and Matacil, with a specific activity of 1.0 mCi/mM and a radiochemical purity >99%, were used. Dimethylamino-labelled Zectran and Matacil were prepared by reaction of amino Zectran (4-amino-3,5-xylyl methylcarbamate) and Matacil (4-amino-3-cresyl methylcarbamate), respectively, with either formaldehyde- ^{14}C or formaldehyde- ^3H (see ref. III/451). A 64-80% yield was finally obtained of Zectran-N-methyl- ^{14}C (0.20 mCi/mM), Zectran-N-methyl- ^3H (10 mCi/mM), and Matacil-N-methyl- ^{14}C (0.4 mCi/mM). Photodecomposition of Zectran and Matacil deposits on bean foliage involves extensive oxidation of the dimethylamino moiety but, apparently, not of other groups. The methylcarbamate degradation products include the toxic 4-methylamino and 4-amino analogues, the less toxic 4-methylformamido and 4-formamido analogues, and trace amounts of other unidentified, biologically active methylcarbamates. Zectran is less stable than Matacil to photooxidation. In the photodecomposition, the dimethylamino moiety is stepwise demethylated and, concurrently, one of the methyl radicals is oxidized to the formamido group. Many alkylaminophenyl methylcarbamates appear to be susceptible to these reactions.

- 806 Andrawes, N.R. METABOLISM OF 2-METHYL-2-(METHYLTHIO)-PROPIONALDEHYDE O-(METHYLCARBAMOYL)-OXIME (TEMIK) IN MAMMALS AND INSECTS. *Diss. Abstr.* 28, 2 (1967) 724-B.

Four separate radiolabelled preparations of the parent compound and two preparations of its sulfoxide derivative were used. These preparations were as follows: 2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl-carbonyl- ^{14}C)oxime, 2-methyl-2-(methylthio- ^{35}S)propionaldehyde O-(methylcarbamoyl)oxime, 2-methyl-2-(methyl- ^{14}C -thio)propionaldehyde O-(methylcarbamoyl)oxime, 2-methyl-2-(methylthio)propionaldehyde-2- ^{14}C O-(methylcarbamoyl)oxime, 2-methyl-2-(methylsulfinyl)propionaldehyde O-(methylcarbamoyl-carbonyl- ^{14}C)oxime, and 2-methyl-2-(methylsulfinyl- ^{35}S)propionaldehyde O-(methylcarbamoyl)oxime. Degradation of Temik, in vitro, by various subcellular fractions of rat liver was found to be inefficient unless these systems were fortified with reduced nicotinamide-adenine dinucleotide phosphate. The greatest metabolism occurred after incubation of Temik with the 15 000 G solubles fortified with NADPH, which resulted in degradation of 95% of the material. Five chloroform-extractable metabolites were formed by

this enzyme system. These metabolites were isolated by thin layer chromatography and tentatively identified as: 2-methyl-2-(methylsulfinyl)propionaldehyde O-(methylcarbamoyl)oxime, 2-methyl-2-(methylsulfonyl)propionaldehyde O-(methylcarbamoyl)oxime, 2-methyl-2-(methylthio)propionaldoxime, 2-methyl-2-(methylsulfonyl)propionaldoxime. The major metabolite formed by the 15 000 G solubles of rat liver was the methylsulfinyl derivative of Temik which constituted approx. 50% of the total materials. Additional degradative product(s) of a water soluble nature were present. Oral administration of Temik to rats resulted in approx. 80% of the dose being eliminated in the urine within 24 h. An additional 4% of the dose was detected in the faeces. Total elimination of Temik residues required 24 d. Studies with carbonyl-¹⁴C Temik revealed that approx. 60% of the administered dose was hydrolysed within 24 h as indicated by the amount of carbon dioxide-¹⁴C that was evolved by the rats. Only a trace amount of Temik, per se, was found in the excreta, indicating a very rapid degradation of the carbamate within the animals. Analysis of urine from treated rats indicated the presence of the same metabolites that were formed by the rat liver enzymes. In addition, two chloroform-extractable metabolites were isolated from the urine and tentatively identified as: 2-methyl-2-(methylsulfinyl)-propionitrile and 2-methyl-2-(methylsulfonyl)propionitrile. The latter metabolite was the major metabolite present in the urine one week after treatment. Orally administered methylsulfinyl derivative of Temik was excreted by rats more slowly than the parent compound. With carbonyl-¹⁴C material, this compound resulted in approx. 36% of the dose given off as carbon dioxide-¹⁴C by the rats after 24 h. Degradation resulted in most of the urinary metabolites detected after Temik treatment. However, a major part of the administered sulfinyl compound was eliminated unchanged in the urine indicating that this material was more stable to enzymatic attack than the parent compound. Boll weevils, *Anthonomus grandis* Boheman, and house flies, were treated topically with Temik. From 40-80% of the applied material was absorbed during the 1st hour after dosing. Most of the absorbed material was eliminated by defecation. Temik was metabolised to its sulfinyl and sulfonyl derivatives by both insect species. The former was the major metabolite during the first 4 h. In vitro anticholinesterase studies showed that the sulfinyl analogue of Temik was a 3-5 times more potent cholinesterase inhibitor than Temik. Conversely, Temik was more toxic than its sulfinyl analogue when applied topically to boll weevils and house flies. (From DA)

- 807 Andrawes, N.R., Dorough, H.W. METABOLIC FATE OF CARBARYL-NAPHTHYL-C¹⁴ IN BOLL WEEVILS AND BOLLWORMS. *J. econ. Ent.* 60, 2 (1967) 453-456.

Adult boll weevils, *Anthonomus grandis* Boh., were treated topically and bollworm, *Heliothis zea* (Boddie), larvae and adults were treated by injection with carbaryl-naphthyl-¹⁴C. Hydrolytic as well as oxidative mechanisms were involved in the degradation of the carbamate in both species. Chloroform-extractable metabolites tentatively identified were: 1-naphthol; 1-hydroxy-5,6-dihydro-5,6-dihydroxynaphthalene; 5,6-dihydro-5,6-dihydroxy-1-naphthyl N-methylcarbamate; and 1-naphthyl N-hydroxy-methylcarbamate. Unknown metabolites of a water-soluble nature were predominant in both insect species. (Auth.)

- 808 Andrawes, N.R., Dorough, H.W., Lindquist, D.A. DEGRADATION AND ELIMINATION OF TEMIK IN RATS. *J. econ. Ent.* 60, 4 (1967) 979-987.

Four separate preparations of radiolabelled Temik were used (carbonyl-¹⁴C-, S-methyl-¹⁴C-, ³⁵S-, tert-butyl-¹⁴C-Temik), as were two preparations of its sulfoxide derivative (³⁵S-Temik sulfoxide and carbonyl-¹⁴C-Temik sulfoxide). Oral administration of Temik (2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl) oxime) to rats resulted in approx. 80% of the dose being eliminated in the urine within 24 h. An additional 4% of the dose was detected in the faeces. Only a trace amount of Temik, per se, was found in the excreta, indicating a very rapid degradation of the carbamate within the animals. The following metabolites were isolated from the urine by extraction with chloroform and tentatively identified: (a) 2-methyl-2-(methylthio)propionaldoxime; (b) 2-methyl-2-(methylsulfinyl)propionaldoxime; (c) 2-methyl-2-(methylsulfonyl)propionaldoxime; (d) 2-methyl-2-(methylsulfinyl) propionitrile; (e) 2-methyl-2-(methylsulfonyl)-propionitrile; (f) 2-methyl-2-(methylsulfinyl) propionaldehyde O-(methylcarbamoyl) oxime and (g) 2-methyl-2-(methylsulfonyl) propionaldehyde O-(methylcarbamoyl)-oxime. Approx. one-half of the metabolites in the urine could not be extracted into organic solvent and their identity was not determined. The methylsulfinyl derivative of Temik was excreted more slowly than the parent compound when given orally to rats.

- 809 Baker, M.W., Crampton, E.L., Harrison, I.R., Watkins, T.I. RESIDUES OF BUTACARB IN SHEEP MUSCLE, FAT, LIVER AND KIDNEY FOLLOWING DIPPING FOR THE CONTROL OF SHEEP BLOWFLY (*Lucilia* spp.). J. Sci. Fd Agric. **18**, 9 (1967) 392-395.

Sheep were dipped in butacarb and subsequently slaughtered and assays were done on meat, fat, kidney and liver residues. Two methods of analysis have been used, a radiotracer and a chemical method. Even after two dippings residues were appreciably less than 1 ppm in all the tissues. In the 1st series of radioactive assays lambs were dipped in a mixture containing doubly (^3H and ^{14}C) labelled butacarb (3,5-di-*t*-butylphenyl-N-methylcarbamate) by tritiating purified 3,5-di-*t*-butylphenol, and then synthesising butacarb from it by reacting with phosgene, then with ^{14}C -methylamine. In another series butacarb was labelled with ^{14}C only (N-methyl grouping, prepared from ^{14}C -methylamine). They indicated that the tissue residues did not contain hydrolytic breakdown products of the drug.

- 810 Baron, R.L. METABOLISM OF BANOL (6-CHLORO-3,4-XYLYL METHYLCARBAMATE) IN THE RAT. Bull. ent. Soc. Am. **12** (1966) 264. Abstr. 54, at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

The metabolic fate of Banol following sub-acute intoxication was observed in rats using the molecule labelled in three positions (methyl ring, carbonyl and N-methyl). The distribution of the carbamate, isolation and characterisation of metabolic products, and studies on a pharmacodynamic stress-response relationship to metabolism was discussed. (From abstr.)

- 811 Baron, R.L., Doherty, J.D. METABOLISM AND EXCRETION OF AN INSECTICIDE (6-CHLORO-3,4-DIMETHYLPHENYL N-METHYLCARBAMATE) IN THE RAT. J. agric. Fd Chem. **15**, 5 (1967) 830-836.

The metabolic fate of the carbamate insecticide Banol, following acute oral administration to the rat, was investigated. Recovery in urine, faeces, tissues, and as expired $^{14}\text{CO}_2$ of the administered dose of ring-methyl- ^{14}C , carbonyl- ^{14}C , and N-methyl- ^{14}C -Banol was 100, 99, and 80%, respectively. Urinary water-soluble metabolites include methylamine and three to five groups of acidic conjugated components. One of these groups, the uronic acids, comprising 78-81% of the acidic components, was resolved into four components. Indirect evidence has been presented for the conjugation of Banol and a uronic acid to form a carbamate N-glucuronide. Physical stress affected the rate of release of $^{14}\text{CO}_2$ following administration of N-methyl- ^{14}C -Banol. Physical stress appears to have a selective effect on the hydrolytic pathway of carbamate degradation. (Auth.)

- 812 Bartley, W.J., Heywood, D.L., Steele, T.E.N., Skraba, W.J. SYNTHESIS OF C^{14} -LABELED 2-METHYL-2-(METHYLTHIO)PROPIONALDEHYDE O-(METHYLCARBAMOYL)OXIME. J. agric. Fd Chem. **14**, 6 (1966) 604-607.

The synthesis of 2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl)oxime (Temik) with a ^{14}C tag at three different sites in the molecule has been accomplished. These were: S-methyl- ^{14}C Temik, obtained by reaction of methyl- ^{14}C -mercaptan with 2-chloro-2-methyl-1-nitrosopropane dimer; tert- ^{14}C Temik, obtained in an eight-step synthesis starting with tagged barium carbonate; and N-methyl- ^{14}C Temik resulting from reaction of the appropriate aldehyde oxime with methyl- ^{14}C isocyanate. The tagged methyl isocyanate was prepared in good yield by a new method involving reaction of N,N'-carbonyldiimidazole and methyl- ^{14}C -amine hydrochloride. The N-methyl- ^{14}C sulfoxide of Temik [2-methyl-2-(methylsulfinyl)propionaldehyde O-(methyl- ^{14}C -carbamoyl)oxime] was prepared by peracid oxidation of labelled Temik. (Auth.)

- 813 Bull, D.L., Lindquist, D.A., Coppedge, J.R. ABSORPTION AND METABOLISM OF TEMIK[®] BY INSECTS. Bull. ent. Soc. Am. **12** (1966) 264. Abstr. 55, at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

The absorption and metabolism of Temik[®] by adult boll weevils and tobacco budworm larvae were compared using thin-layer chromatography and conventional radiometric procedures. The Temik used was radiolabelled in three different positions with ^{14}C or with ^{35}S . (Abstr.)

- 814 Bull, D.L., Lindquist, D.A., Coppedge, J.R. METABOLISM OF 2-METHYL-2-(METHYLTHIO)PROPIONALDEHYDE O-(METHYLCARBAMOYL) OXIME (TEMIK, UC-21149) IN INSECTS. J. agric. Fd Chem. **15**, 4 (1967) 610-616.

The fate of radiolabelled 2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl)oxime (Temik, UC-21149) in insects was examined. Samples of Temik labelled either with ^{14}C at the S-methyl (specific activity 4.9 mCi/mM), tertiary (3.9 mCi/mM), and carbonyl (2.5 mCi/mM) positions, or with ^{35}S (initial specific activity of 10.8 and 55.8 mCi/mM) were used. Adult boll weevils, *Anthonomus grandis* Boh., *Musca domestica* L., 3rd- or 5th-instar bollworms, *Heliothis zea* (Boddie), and tobacco budworms, *Heliothis virescens* (F.) were tested. Topically applied Temik was absorbed rapidly by adult *Anthonomus* but very slowly by 3rd-instar *Heliothis virescens* (F.). Oxidation at the sulphur atom was the predominant reaction in both species of insects, yielding primarily the sulfoxide derivative of Temik and to a lesser extent the sulfone. Traces of N-demethyl derivatives in excreta of the tobacco budworm indicated some oxidation at the N-methyl position. The principal products of hydrolysis were the sulfoxide and sulfone derivatives of 2-methyl-2-(methylthio)propionaldehyde oxime.

- 815 Camp, H.B., Arthur, B.W. ABSORPTION AND METABOLISM OF CARBARYL BY SEVERAL INSECT SPECIES. *J. econ. Ent.* 60, 3 (1967) 803-807.

The absorption and metabolism of ^{14}C carbaryl was studied in the house fly, *Musca domestica* L.; stable fly, *Stomoxys calcitrans* (L.); boll weevil, *Anthonomus grandis* Boheman; and rice weevil, *Sitophilus oryza* (L.). Following topical applications of carbaryl, the percentage of the applied dose absorbed by each species of insect within 24 h was: stable fly 56.7%, housefly 37.3%, boll weevil 12.2%, and rice weevil 3.3%. Five metabolites, including 1-naphthol, were isolated from insects by Florosil and thin-layer chromatography; four metabolites were unidentified. Carbaryl was quite stable in both species of weevils. The major metabolite in the faeces of houseflies was a highly polar material. There were no qualitative differences in number of metabolites isolated from houseflies, boll weevils, and rice weevils, but there were quantitative differences in each metabolite present in the internal extract. The species specificity of carbaryl appeared to be functions of rate of absorption and enzymatic degradation within the particular insect species. (Auth.)

- 816 Coppedge, J.R., Lindquist, D.A., Bull, D.L., Dorough, H.W. FATE OF 2-METHYL-2-(METHYLTHIO)PROPIONALDEHYDE O-(METHYLCARBAMOYL) OXIME (TEMIK) IN COTTON PLANTS AND SOIL. *J. agric. Ed Chem.* 15, 5 (1967) 902-910.

The metabolic fate of ^{35}S -, ^{14}C -(carbonyl), ^{14}C -(S-methyl)-, and ^{14}C -(tertiary) Temik as well as ^{35}S -Temik-sulfoxide, ^{35}S -Temik-sulfone, and ^{35}S -oxime was studied in young mature excised cotton leaves. The fate of ^{35}S -Temik was also studied in soil. In the cotton plant, Temik [10% granular formulation of UC-21149, 2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl) oxime] was rapidly metabolised to its sulfinyl derivative (Temik-sulfoxide); further oxidation to the sulfonyl compound (Temik-sulfone) was slow. No evidence of oxidative N-demethylation was found. The sulfinyl derivative was degraded primarily by hydrolysis to a sulfinyl-oxime. Both Temik-sulfoxide and Temik-sulfone were stable in cotton. Relatively large amounts of radioactivity were lost from ^{14}C -Temik-treated excised cotton leaves. In the three soil types studied under laboratory conditions, Temik was degraded more slowly than in cotton. However, similar metabolites were recovered from both cotton plants and soil.

- 817 Dorough, H.W. CARBARYL- ^{14}C METABOLISM IN A LACTATING COW. *J. agric. Ed Chem.* 15, 2 (1967) 261-266.

Carbaryl-naphthyl- ^{14}C (1-naphthyl N-methylcarbamate) administered in the feed to a lactating cow at single doses of 0.25 and 3.05 mg/kg resulted in radiolabelled residues in the milk for as long as 80 h after treatment. Approx. 0.35% of each dose was detected in the milk. Max. concentrations were found in 6-h samples which, following the two treatments, were 0.063 and 0.950 ppm, respectively. The major chloroform-extractable metabolite from the milk was tentatively identified as 5,6-dihydro-5,6-dihydroxy-1-naphthyl N-methylcarbamate. Approx. 30% of all residues in the 6-h samples was this product. After the 0.25 mg/kg treatment, 70% of the dose was detected in the urine and 11% in the faeces. The percentages of the 3.05 mg/kg dose excreted in the urine and faeces were 58 and 15, respectively. Analysis of 27 tissue samples, taken 6 d after the 3.05 mg/kg treatment, revealed that residues were highest in the liver, kidney, and ovaries, although these residues were present only in trace amounts. (Auth.)

- 818 Dorrough, H. W., Ivie, G. W. TEMIK-S³⁵ (UC-21149) METABOLISM IN A LACTATING COW. Bull. ent. Soc. Am. **13**, 3 (1967) 189. Abstr. 30, at "New York Meeting of the Entomological Society of America, New York, N. Y., USA, 27-30 Nov. 1967".
- Percentages of a 0.1 mg/kg dose of Temik eliminated in the urine, milk and faeces of a dairy cow were 90.2, 3.0, and 2.9. Milk residues consisted primarily of organic solvent extractables and of small quantities of water soluble and unextractable products. (Abstr.)
- 819 Egan, H. IUPAC COMMISSION ON TERMINAL RESIDUES. J. Ass. off. analyt. Chem. **50**, 5 (1967) 1071-1073.
- The commission discussed the present position regarding knowledge of the nature of terminal residues of carbamates, including carbaryl. An evaluation was presented by J. W. Cook (Division of Food Chemistry, Food and Drug Administration, Washington, D.C. 20204). A number of studies are cited (Dorough, Knaak, Casida et al.) in which radioisotopes had been used in metabolic and residue studies on various animals, in animal tissues and animal products.
- 820 Friedman, A. R., Lemin, A. J. METABOLISM OF 2-CHLORO-4,5-DIMETHYLPHENYL N-METHYLCARBAMATE IN BEAN PLANTS. J. agric. Fd Chem. **15**, 4 (1967) 642-647.
- The insecticide Banol, 2-chloro-4,5-dimethylphenyl N-methylcarbamate, is absorbed from solution and metabolised to a water-soluble metabolite by bean plants. This metabolite was shown to have the carbamate side chain intact and to have the ring modified by hydroxylation and conjugation with glucose. The synthesis of Banol-4-methyl-¹⁴C is described, via 4-bromo-3-methylphenol, 4-bromo-3-methylphenyl benzyl ether, 4-carboxy-¹⁴C-3-methylphenyl benzyl ether, 4-hydroxymethyl-¹⁴C-3-methylphenyl benzyl ether, 3,4-dimethylphenol (4-methyl-¹⁴C), 2-chloro-4,5-dimethylphenol (4-methyl-¹⁴C), and 2-chloro-4,5-dimethylphenyl N-methylcarbamate 4-methyl-¹⁴C.
- 821 Gemrich, E. G., II. ENZYMATIC DEGRADATION OF 2-CHLORO-4,5-DIMETHYLPHENYL N-METHYLCARBAMATE BY THE FAT BODIES OF *Blaberus giganteus*. J. agric. Fd Chem. **15**, 4 (1967) 617-621.
- 2-chloro-4-¹⁴C, 5-dimethylphenyl N-methylcarbamate (4-methyl-¹⁴C Banol, 4.76 mCi/mM), N-methyl-¹⁴C Banol (6.10 mCi/mM), and carbonyl-¹⁴C Banol (0.539 mCi/mM) were used. The mixed function oxidase character of an enzyme system responsible for the degradation of 2-chloro-4,5-dimethylphenyl N-methylcarbamate has been demonstrated using the fat body of the cockroach, *B. giganteus*. Optimum conditions are reported for the microsomal fractions. Of at least three chloroform-soluble degradation products formed by the microsomal system, one has been tentatively identified as 2-chloro-4,5-dimethylphenyl N-hydroxymethylcarbamate.
- 822 Georgioulou, G. P. DEVELOPMENT AND CHARACTERIZATION OF RESISTANCE TO o-ISOPROP-OXYPHENYL METHYLCARBAMATE IN THE MOSQUITO *Culex pipiens quinquefasciatus* Say. Nature, Lond. **207**, 4999 (1965) 883-884.
- When larvae of *C. pipiens fatigans* Wied. (*quinquefasciatus*, auct.) of a strain from southern California containing both DDT- and dieldrin-resistant individuals were selected with aprocarb (Bayer 39007) by exposing the progeny of survivors of each generation to approx. the dose that would kill 90%, resistance increased rapidly in the first selected generation and more slowly thereafter, the LC 50's for the parent and F₁ generations being 0.29 and 3.12 parts per million, respectively. The resistance ratios (defined as the LC 50 for the resistant strain divided by the LC 50 for the susceptible strain) of the selected strain to various carbamate and a few organophosphorus insecticides ranged from 1.6 for fenitrothion (Sumithion) to 6.4 and 8.3 for the m-tert-butylphenyl and the o-isopropylphenyl methylcarbamates, respectively, and 10.8 for aprocarb itself. The ratios observed are deemed to indicate a certain low-level specificity of the resistance mechanism for the ortho-substituted phenyl methylcarbamates though cross-resistance extended also to a variety of other carbamates as well as to malathion and fenitrothion, which had ratios of 3.1 and 4.2, respectively. There was also a small intensification of the initial DDT- and dieldrin-resistance of the parental strain. When a substrain separated from the F₁ selected generation, for which the LC 50 was 2.16 ppm was reared with exposure to insecticide for ten further generations, the LC 50 for the last two of these combined was 1.5 ppm, indicating that the resistance was stable. When 4th-instar larvae of the normal and selected strains were exposed for 2 h to ¹⁴C-labelled aprocarb at 10 ppm and

extracts of them chromatographed and tested for radioactivity, the proportions of metabolites recorded for the two strains were 12.4 and 30.4%, respectively, indicating a 2.5-fold increase in the efficiency of the resistant strain in carbamate detoxication. Crossing experiments indicated that the resistance is controlled by a polygenic system. (RAE-A 54: 1966, 112)

- 823 Hassan, A., Zayed, S.M.A.D., Bahig, M.R.E. CARBAMATE ESTERASE, AMINE OXIDASE AND CATALASE AS INTERFERING ENZYMES IN THE METABOLISM OF SEVIN. *Naturwissenschaften* 53, 20 (1966) 529-530. (In English)

For assaying carbamate esterase activity, larval haemolymph of the cotton leaf worm, *Prodenia litura*, was incubated with ^{14}C -Sevin (substrate) at 37°C for 2 h. The $^{14}\text{CO}_2$ evolved during the reaction was trapped in 1 N NaOH solution and determined as $\text{Ba}^{14}\text{CO}_3$, and the amount of $^{14}\text{CO}_2$ was taken to be proportional to the enzyme activity. The transformation of H^{14}COOH to $^{14}\text{CO}_2$ was taken as indicator for the activity of the catalase-peroxide system. The results, compared against similarly treated rat liver homogenate are tabulated in terms of carbamate esterase (1:15), monoamine oxidase (1:18), and the catalase- H_2O_2 -system (1:27).

- 824 Ivie, G.W., Dorough, H.W. FURADAN- C^{14} (NIA-10242) METABOLISM IN A LACTATING COW. *Bull. ent. Soc. Am.* 13, 3 (1967) 189. Abstr. 31, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Furadan (NIA-10242) given to a cow as a single oral dose of 0.5 mg/kg resulted in detectable milk residues for 132 h after treatment, with 1.95% of the dose being excreted by this route. The nature of the metabolites in the milk, urine and faeces was investigated. (Abstr.)

- 825 Kearney, P.C. PURIFICATION AND PROPERTIES OF AN ENZYME RESPONSIBLE FOR HYDROLYZING PHENYLCARBAMATES. *J. agric. Fd Chem.* 13, 6 (1965) 561-584.

The purification and properties of an enzyme, isolated from a soil microorganism, which catalyses the hydrolysis of isopropyl *N*-(3-chlorophenyl)carbamate to 3-chloroaniline are described. Purification was achieved by a combination of salt fractionation and chromatography on DEAE cellulose. The purified enzyme was characterized as to pH optimum, metal ion requirement, inhibitors, and substrate specificity. Degradation of CIPC was determined by assaying for chloride ion liberation or $^{14}\text{CO}_2$ production from the labelled compound. 1 μCi of ^{14}C -CIPC (randomly labelled in the ring, specific activity 5.99 $\mu\text{Ci}/\text{mg}$) was incubated with the purified enzyme. The reaction was terminated after 10 min at 30°C . Subsequent steps are described in detail. Enzymic rates of hydrolysis of several phenylcarbamates are correlated to a physical-chemical property of the substrate. Differences in rates can be explained by considering certain steric and electronic characteristics of the phenylcarbamate.

- 826 Knaak, J.B., Tallant, M.J., Sullivan, L.J. THE METABOLISM OF 2-METHYL-2-(METHYLTHIO)-PROPIONALDEHYDE O-(METHYLCARBAMOYL)OXIME IN THE RAT. *J. agric. Fd Chem.* 14, 6 (1966) 573-578.

The metabolic fate of *S*-methyl- ^{14}C , tert-butyl- ^{14}C , and *N*-methyl- ^{14}C Temik [2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl)oxime] was investigated in the rat. The over-all recovery of the *S*-methyl, tert-butyl, and *N*-methyl label was, respectively, 95, 96 and 72% of the doses. Tissue residues (8-10% of the dose) were found only in the case of *N*-methyl labelled Temik. 70% of an oral dose of Temik was excreted as 2-methyl-2-(methylsulfinyl)propionaldehyde oxime and 2-methyl-2-(methylsulfinyl)propionaldehyde O-(methylcarbamoyl)oxime. The remaining metabolites appeared to be acids formed by further oxidation of the oxime. In conjunction with the metabolic studies, in vivo cholinesterase depression and recovery curves were obtained with plasma, red blood cells, and brain. At an oral dose of 0.33 mg/kg, the cholinesterase activity of Temik-treated rats recovered from inhibition 2 h prior to the rats treated with 2-methyl-2-(methylsulfinyl)propionaldehyde O-(methylcarbamoyl)oxime. (Auth.)

- 827 Krishna, J.G. METABOLISM AND PERSISTENCE OF METHYLCARBAMATE- C^{14} INSECTICIDES IN MAMMALS. *Diss. Abstr.* 26 (1966) 3998-3999.

Carbaryl (1-naphthyl methylcarbamate) is rapidly metabolised so that little or no residue of this compound appears in milk or persists in tissues of treated animals. Baygon (2-isopropoxyphenyl

methylcarbamate) and Zectran (4-dimethylamino-3,5-xylyl methylcarbamate) are also rapidly metabolised in mammals to yield hydrolysis products and their conjugates in urine. Liver enzymes serve to hydroxylate and oxidize many methyl- and dimethylcarbamates. Detoxication mechanisms may therefore include oxidation, hydroxylation and conjugation with or without ester hydrolysis. It therefore appeared desirable to compare the detoxication and elimination mechanisms for several methyl- and dimethylcarbamate insecticides under a standard set of conditions with mammals. The following methylcarbamates- ^{14}C and ^{14}C -labelled hydrolysis products were investigated: methylcarbamates-carbonyl- ^{14}C of 1) 1-naphthol, 2) 2-isopropoxyphenol, 3) 3-isopropylphenol, 4) 3,5-diisopropylphenol, 5) 2-chloro-4,5-xyleneol, 6) 4-methylthio-3,5-xyleneol, 7) 4-dimethylamino-3,5-xyleneol, 8) 4-dimethylamino-3-cresol; methyl- ^{14}C -carbamates of 9) 1-naphthol, 10) 2-isopropoxyphenol, 11) 2-chloro-4,5-xyleneol; methylcarbamates of 12) 1-naphthol-1- ^{14}C , 13) 2-isopropyl-(1,3- ^{14}C)-oxyphenol; dimethylcarbamates-carbonyl- ^{14}C of 14) 1-isopropyl-3-methyl-5-pyrazolone, 15) 2-dimethylcarbamoyl-3-methyl-5-pyrazolone; hydrolysis products including 16) sodium carbonate- ^{14}C , 17) methyl- ^{14}C -amine hydrochloride, 18) 1-naphthol-1- ^{14}C , 19) 2-isopropyl-(1,3- ^{14}C)-oxyphenol. Compounds 1-10 and 12 were synthesised; others were obtained by hydrolysis of the respective radiolabelled carbamates or from commercial sources. All compounds were adjusted to 1.0 mCi/mM and administered at 7.5 $\mu\text{M/kg}$. Male white rats (160-170 g) were injected intraperitoneally. Expired $^{14}\text{CO}_2$ was continuously collected over a 48-h period. Urine and faeces were collected at regular intervals. 11 representative tissues were sampled after termination of each experiment. All radioactive measurements were made by scintillation counting. Expired $^{14}\text{CO}_2$ was trapped in a mixture of 2-methoxyethanol and monoethanolamine for counting. Urine was counted directly. Faeces and tissue samples were combusted to yield $^{14}\text{CO}_2$, which was absorbed in the above mixture and counted. Each experiment was repeated so that all results represent averages of duplicate analyses of each sample from duplicate experiments. Radioactivity recoveries are reported without regard to the chemical nature of the metabolites present. Expired $^{14}\text{CO}_2$ from the carbamates-carbonyl- ^{14}C ranged from $\frac{1}{4}$ for carbaryl (compound 1) to $\frac{3}{4}$ of the administered radioactivity for Zectran and isolan (compounds 7 and 14, respectively) while sodium carbonate- ^{14}C yielded 98% as $^{14}\text{CO}_2$. Methylcarbamates-carbonyl- ^{14}C without a para-substituent in the phenyl ring (group I) and those with a para-substituent in the phenyl ring (group II) behaved differently. Radioactivity from group I was largely excreted in the urine while much of the radioactivity was recovered as $^{14}\text{CO}_2$ from compounds of group II. Zectran, in general, yielded the highest and Baygon the lowest persisting tissue residues, and the liver, spleen and kidney usually retained the highest levels. The difference in distribution of the radioactivity between the methyl- and dimethylcarbamates-carbonyl- ^{14}C was not as great as it was within the methylcarbamates. Methyl- ^{14}C -carbamates usually yielded higher radioactivity levels in tissues and much lower in expired $^{14}\text{CO}_2$ as compared to carbonyl- ^{14}C compounds. Each methyl- and dimethylcarbamate, each hydrolysis product, and each of the sites of the radiocarbon in the molecule yielded a different balance of the radioactivity which was expired as $^{14}\text{CO}_2$, excreted in urine or faeces or persisted in the tissues after 48 h. The biodegradability of methyl- and dimethylcarbamates continues to be one of the advantages of this type of insecticide. (From DA)

- 828 Krishna, J. G., Casida, J. E. FATE IN RATS OF THE RADIOCARBON FROM TEN VARIOUSLY LABELED METHYL- AND DIMETHYLCARBAMATE- C^{14} INSECTICIDE CHEMICALS AND THEIR HYDROLYSIS PRODUCTS. *J. agric. Fd Chem.* 14, 2 (1968) 98-104.

The radiocarbon content of expired CO_2 , excrements, and certain tissues was determined, for the most part, 2 d after intraperitoneal administration to male white rats of 19 ^{14}C -labelled materials, as follows: eight methylcarbamates-carbonyl- ^{14}C ; two dimethylcarbamates-carbonyl- ^{14}C ; three methyl- ^{14}C -carbamates; two methylcarbamates labelled in a ring or a ring substituent; four hydrolysis products. The following labelled compounds were used: -

Chemical Name	Common or Trade Name
1-naphthyl methylcarbamate-carbonyl- ^{14}C	carbaryl
2-isopropoxyphenyl methylcarbamate-carbonyl- ^{14}C	Baygon
3-isopropylphenyl methylcarbamate-carbonyl- ^{14}C	UC-10854
3,5-diisopropylphenyl methylcarbamate-carbonyl- ^{14}C	HRS-1422
2-chloro-4,5-xylyl methylcarbamate-carbonyl- ^{14}C	Banol
4-methylthio-3,5-xylyl methylcarbamate-carbonyl- ^{14}C	Mesuroi
4-dimethylamino-3,5-xylyl methylcarbamate-carbonyl- ^{14}C	Zectran

4-dimethylamino-3-cresyl methylcarbamate-carbonyl- ¹⁴ C	Matacil
1-naphthyl methyl- ¹⁴ C-carbamate	carbaryl
2-isopropoxyphenyl methyl- ¹⁴ C-carbamate	Baygon
2-chloro-4,5-xylyl methyl- ¹⁴ C-carbamate	Banol
1-naphthyl-1- ¹⁴ C methylcarbamate	carbaryl
2-isoprop-(1,3- ¹⁴ C)-oxyphenyl methylcarbamate	Baygon
1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate-carbonyl- ¹⁴ C	Isolan
2-dimethylcarbamoyl-3-methyl-5-pyrazolyl dimethylcarbamate-carbonyl- ¹⁴ C	Dimetilan
sodium carbonate- ¹⁴ C	...
methyl- ¹⁴ C-amine hydrochloride	...
1-naphthol-1- ¹⁴ C	...
2-isoprop-(1,3- ¹⁴ C)-oxyphenol	...

Expired ¹⁴CO₂ accounted for 25-77% of the radioactivity administered as carbonyl-¹⁴C-labelled carbamates. Such methylcarbamates without a para-substituent in the phenyl ring gave rise to more radioactivity in the urine and less in the tissues than those with a substituent in this position. The radioactivity-distribution pattern was specific and distinctive for each methyl- and dimethyl-carbamate, for each hydrolysis product, and for each of the sites of radiocarbon in the molecule.

829 Kuhr, R.J. METABOLISM OF METHYLCARBAMATE INSECTICIDE CHEMICALS IN PLANTS. *Diss. Abstr.* 27, 12 Pt.1 (1987) 4437-B.

Ten carbonyl-¹⁴C-labelled compounds were investigated as follows: 2-chloro-4,5-xylyl methylcarbamate (Banol); 2-isopropoxyphenyl methylcarbamate (Baygon); 1-naphthyl methylcarbamate (carbaryl); 1-dimethylcarbamoyl-5-methyl-3-pyrazolyl dimethylcarbamate (dimetilan); 3,5-diisopropylphenyl methylcarbamate (HRS-1422); 1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate (Isolan); 4-dimethylamino-3-cresyl methylcarbamate (Matacil); 4-methylthio-3,5-xylyl methylcarbamate (Mesurol); 3-isopropylphenyl methylcarbamate (UC 10854); 4-dimethylamino-3,5-xylyl methylcarbamate (Zectran). Additional labelled compounds were used, including: Banol N-methyl-¹⁴C; Baygon isoprop-1,3-¹⁴C-oxy; Baygon N-methyl-¹⁴C; carbaryl N-methyl-¹⁴C; carbaryl naphthyl-1-¹⁴C; methyl-¹⁴C-amine; 1-naphthol-1-¹⁴C; sodium carbonate-¹⁴C. Each of the labelled samples was individually injected into the stems of growing bean plants. At selected time intervals after treatment, the plants were extracted with acetone and chloroform to yield an organic phase, a water phase and an unextractable portion. ¹⁴C-loss from the growing plant or on extraction was also recorded. The organosoluble fraction was subjected to thin-layer chromatography (TLC) and, where possible, metabolites were tentatively identified by cochromatography with known, unlabelled compounds. On metabolism in beans, Mesurol forms the sulfide and sulfone derivatives. Zectran yields the 4-formamido-, 4-methylformamido-, 4-methylamino- and 4-amino-3,5-xylyl methylcarbamates, while Matacil forms only the 4-formamido and 4-methylamino derivatives. Little, if any, formation of organoextractable degradation products, containing an intact carbamate moiety, occurs with the other carbamate esters. The fate of the radiocarbon, 8 d after injection into bean plants, varies considerably with different compounds: with Baygon and UC 10854 the main fraction of the radiocarbon is in the water phase; with Matacil and Zectran it appears in the unextractable portion; with Mesurol it shows up as loss, possible as the result of expired ¹⁴CO₂. Degradation within the plant is not directly related to the rate of non-enzymic hydrolysis. Horseradish peroxidase degrades Matacil and Zectran to products similar to those found in the organic phase of bean plants treated with these compounds. This enzyme does not degrade the other carbamates, and mushroom tyrosinase is without activity in carbamate degradation. Little difference is found in the ¹⁴C distribution resulting from use of the three carbaryl samples, individually labelled in different positions. Most of the ¹⁴C from each of the hydrolysis products appears in the unextractable portion after 6 d. Radioactive components in the water phases from plants treated with different labelled samples of Banol, Baygon, or carbaryl were partially resolved by TLC, subsequently hydrolysed with β -glucosidase, and the chemical nature of the released aglycones-¹⁴C determined. Aglycones tentatively identified include: N-hydroxymethyl Banol from Banol; O-depropyl Baygon, 4-hydroxy Baygon and N-hydroxy-methyl Baygon from Baygon; 5,6-dihydro-5,6-dihydroxy carbaryl, 4-hydroxy carbaryl, 5-hydroxy carbaryl, N-hydroxy-methyl carbaryl and 1-naphthol from carbaryl. Cleavage of the glycosides, derived from each of the 10 carbonyl-labelled methyl- and dimethylcarbamates, with β -glucosidase yields several aglycones-¹⁴C, most of which are

anticholinesterase agents. The relative stability of the carbamate grouping of some carbamate insecticides to metabolism in plants allows the formation of degradation products involving only alterations of the *N*-methyl group, the ring, or a ring substituent. Many of the initial products are similar, if not identical, to those formed in insects and mammals treated with the same carbamates; however, differences occur in the nature of the conjugates formed. In plants, the products are conjugated as persisting glycosides, and the glycosides are susceptible to cleavage by β -glucosidase to free aglycones which are anticholinesterase agents. In future studies on crop residues associated with the use of carbamate insecticide chemicals, these metabolites should be considered. (From DA)

- 830 Kühr, R.J., Casida, J.E. PERSISTENT GLYCOSIDES OF METABOLITES OF METHYLCARBAMATE INSECTICIDE CHEMICALS FORMED BY HYDROXYLATION IN BEAN PLANTS. *J. agric. Fd Chem.* **15**, 5 (1967) 814-824.

Studies with eight substituted phenyl methylcarbamate and two substituted pyrazolyl dimethylcarbamate insecticide chemicals indicate that the water-soluble metabolites formed from them, following injection into bean plants, result in part from hydroxylation of the carbamate on the *N*-methyl group, on the ring, or on a ring substituent, followed by conjugation of the hydroxylated carbamates mainly as glycosides. These glycosides are quite persistent and, in many cases, yield anticholinesterase agents on hydrolysis by β -glucosidase. The aglycones derived from carbaryl, which include the *N*-hydroxymethyl, 4-hydroxy, 5-hydroxy, and 5,6-dihydro-5,6-dihydroxy derivatives, are the same carbamate intermediates involved in carbaryl metabolism by mammals and insects. *N*-hydroxy-methyl formation also occurs with Banol, Baygon, and UC 10854. Hydroxylation of the tertiary carbon of the isopropyl group yields hydroxypropyl UC 10854 from UC 10854, and 2-hydroxyphenyl methylcarbamate on *O*-depropylation of Baygon. Horseradish peroxidase degrades Matacil and Zectran while tyrosinase systems do not metabolise the four carbamates studied. The following radioactively labelled compounds were used:

Banol carbonyl- ¹⁴ C	carbaryl naphthyl-1- ¹⁴ C
Banol <i>N</i> -methyl- ¹⁴ C	Dimetilan carbonyl- ¹⁴ C
Baygon carbonyl- ¹⁴ C	HRS-1422 carbonyl- ¹⁴ C
Baygon isoprop-1, 3- ¹⁴ C-oxy	Isolan carbonyl- ¹⁴ C
Baygon <i>N</i> -methyl- ¹⁴ C	Matacil carbonyl- ¹⁴ C
carbaryl carbonyl- ¹⁴ C	Mesuroil carbonyl- ¹⁴ C
dihydrodihydroxy carbaryl carbonyl- ¹⁴ C	UC 10854 carbonyl- ¹⁴ C, and
carbaryl <i>N</i> -methyl- ¹⁴ C	Zectran carbonyl- ¹⁴ C

- 831 Lamoureux, G.L., Shimabukuro, R.H. THE METABOLISM OF 4-BENZOTHIENYL-*N*-METHYLCARBAMATE IN BARLEY AND ALFALFA. *Bull. ent. Soc. Am.* **13**, 3 (1967) 189. Abstr. 29, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

The insecticide 4-benzothienyl-4, 7-¹⁴C-(*N*-methylcarbamate) is readily translocated upward in the xylem of root-treated barley and alfalfa plants. One of several conjugates of the eight *n*-butanol-soluble metabolites is 4-benzothienyl- β -D-glucoside. In alfalfa roots the radioactivity occurs in the lignin fraction. Lack of ¹⁴CO₂ evolution from either species suggests limited degradation. (Abstr.)

- 832 Leeling, N.C. METABOLITES OF CARBARYL (1-NAPHTHYL *N*-METHYLCARBAMATE) AND ENZYMATIC MECHANISMS FOR THEIR FORMATION. *Diss. Abstr.* **26** (1966) 5011-5012.

Radiotracer studies established that hydroxylation rather than hydrolysis might be the major detoxication mechanism for carbaryl. Enzymatic mechanisms for formation of the metabolites and the chemical nature and biological activity of these metabolites were therefore investigated. Carbaryl-naphthyl-1-¹⁴C was metabolised to yield the same 8 ether-extractable metabolites by the liver microsome fraction from mice, rats, and rabbits. The rat liver microsome fraction was selected for a detailed study of the *in vitro* metabolism. Reduced nicotinamide adenine dinucleotide, or, particularly, reduced nicotinamide adenine dinucleotide phosphate was required for significant metabolism. These cofactors could be replaced by their oxidized forms if the soluble fraction from

liver was added to the microsomes. The amount of metabolism was directly proportional to the level of cofactor present, the optimum pH was 7.3, certain divalent cations increased metabolism, and several known inhibitors of microsomal oxidations decreased the metabolism. Evidence from *in vitro* experiments also suggested formation of ethereal sulfate, glutathione, or glucuronide conjugates for all but one of the ether-extractable metabolites. Rabbits treated with carbaryl excreted in the urine small amounts of the same metabolites produced by the microsome preparations. Three additional ether-extractable and four or five *n*-butanol-extractable metabolites appeared in urine of carbaryl-treated rabbits, but were absent in urine from 1-naphthol-treated rabbits. Six ether-extractable metabolites of carbaryl from urine and enzymatic preparations were tentatively identified as follows: 1-naphthyl *N*-hydroxymethylcarbamate; 4-hydroxy-1-naphthyl *N*-methylcarbamate; 5-hydroxy-1-naphthyl *N*-methylcarbamate; 5,6-dihydro-5,6-dihydroxy-1-naphthyl *N*-methylcarbamate; 1-hydroxy-5,6-dihydro-5,6-dihydroxy-naphthalene; and 1-naphthol. Methods used in identification of one or more of these metabolites were: infrared spectra, melting point, co-chromatography with known compounds on two-dimensional thin layer chromatography before and after alkaline or acid degradation, and fluorescence before and after treatment with alkali. The biological activity of the ether-extractable carbaryl metabolites was compared to that of carbaryl by cholinesterase inhibition determinations and housefly (*Musca domestica* L.) toxicity studies. Detectable inhibition of human plasma cholinesterase by metabolites occurred at levels five or more times greater than that of carbaryl (0.02 μ g). Houseflies were each treated with 10 μ g of piperonyl butoxide, α -[2-(2-butoxy-ethoxy)ethoxy]-4,5-methylenedioxy-2-propyltoluene, and varying levels of carbaryl or individual metabolites. Carbaryl gave a 24-h LD₅₀ of 0.05 μ g/fly, but none of the metabolites produced mortality in 24 h at 10 μ g/fly. (From DA)

- 833 Leeling, N.C., Casida, J.E. METABOLITES OF CARBARYL (1-NAPHTHYL METHYL CARBAMATE) IN MAMMALS AND ENZYMATIC SYSTEMS FOR THEIR FORMATION. *J. agric. Fd Chem.* 14, 3 (1966) 281-290.

Carbaryl-naphthyl-1-¹⁴C was synthesised by reacting 1-naphthol-1-¹⁴C with methyl isocyanate. The specific activity of carbaryl-naphthyl-1-¹⁴C was adjusted to 1.0 mCi/mM (~2500 cpm/ μ g). Ether-extractable carbaryl (1-naphthyl methylcarbamate) metabolites found in the urine of treated rabbits and formed by enzyme preparations from rat, mouse, and rabbit liver are tentatively identified as follows: 1-naphthyl *N*-hydroxymethylcarbamate; 4-hydroxy-1-naphthyl methylcarbamate; 5-hydroxy-1-naphthyl methylcarbamate; 5,6-dihydro-5,6-dihydroxy-1-naphthyl methylcarbamate; 1-hydroxy-5,6-dihydro-5,6-dihydroxy-naphthalene; and 1-naphthol. Additional unidentified metabolites are also present in ether and butanol extracts of the urine. Each of the ether-extractable metabolites formed by liver enzymes is of reduced biological activity compared with carbaryl. Optimum conditions are given for metabolism of carbaryl by rat liver microsomes plus soluble fractions; inhibition of the metabolism system by five insecticide synergists is demonstrated. Hydroxylated carbaryl metabolites are probably conjugated, in part, as glucuronides and ethereal sulfates, based on *in vitro* studies with conjugation systems.

- 834 Lindquist, D.A., Coppedge, J.R., Bull, D.L., Dorrough, H.W. THE FATE OF RADIOLABELED TEMIK® IN COTTON PLANTS AND SOIL. *Bull. ent. Soc. Am.* 12 (1966) 264. Abstr. 56, at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec, 1966".

The metabolism of radiolabelled Temik® and toxic Temik metabolites in cotton plants was studied. Studies of the fate of Temik in three types of soil was also investigated. (Abstr.)

- 835 Matsumura, F., Ward, C.T. DEGRADATION OF INSECTICIDES BY THE HUMAN AND THE RAT LIVER. *Archs env. Hlth* 13 (1966) 267-281.

Ring ³H-labelled carbaryl, naphthyl-1-¹⁴C carbaryl, and ¹⁴C-malathion were used. The results of a survey on the human and rat liver capacity to degrade these three insecticides indicated that (1) the general degradation patterns of the livers from these two different species are very similar, (2) aging at room temperature and freeze-storing had some denaturation (or deactivation) effects upon malathion phosphatases and, to a less extent, upon carbaryl oxidative degradation enzymes, (3) malathion carboxyesterases and parathion phosphatases seem to be very stable enzymes against the above treatments, and (4) no detectable evidence to suggest a relationship between the enzyme activities toward these substrate insecticides and the age, sex, the cause of death, postmortem period

(aging), and freeze-storing period of each liver sample: except for one case with carbaryl, where the liver samples from male patients showed a higher rate of water-soluble metabolite production as compared with those from female patients.

- 836 Metcalf, R. L., Fukuto, T. R., Collins, C., Borck, K., Burk, J., Reynolds, H. T., Osman, M. F. METABOLISM OF 2-METHYL-2-(METHYLTHIO)PROPIONALDEHYDE O-(METHYLCARBAMOYL)-OXIME IN PLANT AND INSECT. *J. agric. Fd Chem.* **14**, 6 (1966) 579-584.

Temik, (registered trademark for Union Carbide 21149) has a structure resembling acetyl choline. The metabolism of the systemic insecticide Temik has been investigated in the cotton plant and in the housefly using ^{14}C -labelled radiotracers and column and thin layer chromatography. Temik is readily and completely oxidized to its sulfoxide within 4-9 d in cotton leaves at moderate temperatures. The sulfoxide which is more active as a cholinesterase inhibitor is the active metabolite and its long term persistence and relatively slow oxidation to Temik sulfone is responsible for the persistent systemic activity of the compound. Temik sulfoxide is hydrolysed to the oxime which is the principal degradation product in the cotton plant. Metabolism in the housefly followed a completely similar pattern.

- 837 Metcalf, R. L., Osman, M. F., Fukuto, T. R. METABOLISM OF C^{14} -LABELED CARBAMATE INSECTICIDES TO C^{14}O_2 IN THE HOUSE FLY. *J. econ. Ent.* **60**, 2 (1967) 445-450.

The absorption, metabolism to $^{14}\text{CO}_2$, and excretion by several strains of houseflies, *Musca domestica* L., were evaluated for nine insecticidal carbamates labelled with ^{14}C in various parts of the molecule. Ring, N^{14}CH_3 -, and $^{14}\text{C}=\text{O}$ -labelled Banol[®] (6-chloro-3,4-xylyl methylcarbamate), $^{14}\text{C}=\text{O}$ - and N^{14}CH_3 -labelled Mesurol[®] (4-(methylthio)-3,5-xylyl methylcarbamate), and Matacil[®] (4-dimethylamino)-m-tolyl methylcarbamate), tert- ^{14}C -, N^{14}CH_3 -, and $^{14}\text{CH}_3\text{S}$ -labelled Temik[®] (2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl) oxime), o-isoprop-1,3- ^{14}C -oxy-labelled Baygon[®] (o-isopropoxyphenyl methylcarbamate) were used. The absorption and metabolism to $^{14}\text{CO}_2$ was not appreciably different in a susceptible and in two carbamate-resistant strains of flies. However, the rate of conversion of the various labelled carbamates to $^{14}\text{CO}_2$ was highly specific for the individual carbamates and for the position of labelling. Detoxication of the carbamates was demonstrated to occur through N-dealkylation, S-dealkylation, O-dealkylation, and hydrolysis. The synergists piperonyl butoxide, 2-(3,5-dichlorobiphenyloxy)-triethylamine, and isobornylthiocyanate materially decreased the rate of formation of $^{14}\text{CO}_2$ from the isopropoxy side chain of 2-isopropoxyphenyl N-methylcarbamate.

- 838 Mostafa, I. Y., Hassan, A., Zayed, S. M. A. D. METABOLISM OF CARBAMATE DRUGS. III. TRANSLOCATION AND DEGRADATION OF ^{14}C -LABELLED SEVIN IN COTTON PLANTS. *Z. Naturf.* **21 b** (1966) 1060-1062. (In English)

The distribution and metabolic fate of Sevin (1-naphthyl-N-methyl carbamate) in cotton plants (*Gossypium barbadense*) was investigated using ^{14}C -insecticide labelled at two different sites. Sevin I (specific activity 1.7×10^5 cpm/mg) was prepared by dilution of 0.5 mCi 1-naphthyl-N-methyl (carbamate- ^{14}C) with non-radioactive pure Sevin, m.p. 142°C , and Sevin II from 1-naphthyl chloroformate and ^{14}C -methylamine hydrochloride, with an activity of 1.0×10^5 cpm-mg. Sevin was readily absorbed by the root system. Hydrolytic and non-hydrolytic mechanisms contribute almost equally to the metabolism of the insecticide. A specific esterase hydrolyses the ester bond to produce 1-naphthol, methylamine and CO_2 (24% of the absorbed dose). The liberated methylamine undergoes partly a process of oxidative degradation to CO_2 . A major metabolite possessing the skeleton $\text{CO}-\text{C}(\text{O})-\text{N}-\text{C}$ is probably produced by hydroxylation of the naphthalene ring.

- 839 Oonnithan, E. S., Casida, J. E. METABOLITES OF METHYL- AND DIMETHYLCARBAMATE INSECTICIDE CHEMICALS AS FORMED BY RAT LIVER MICROSOMES. *Bull. exp. Contam. Toxic.* **1**, 2 (1966) 56-59.

A series of experiments were made with each of ten carbamate-carbonyl- ^{14}C -labelled methyl- and dimethylcarbamates to determine their metabolic fate in a system containing rat liver microsomes and reduced nicotinamide adenine dinucleotide phosphate (NADPH₂). With emphasis on those with a carbamate structure, the ether-extractable metabolites were separated by thin-layer chromatography (TLC) and the radioactive spots were located by radioautography. The anti-

cholinesterase activity of the metabolites derived from five methylcarbamates was determined, in situ, on the TLC plates. (Auth.)

- 840 Sacher, R.M., Metcalf, R.L., Fukuto, T.R. SELECTIVITY OF CARBARYL-2,3-METHYLENE-DIOXYNAPHTHALENE COMBINATIONS. Bull. ent. Soc. Am. **13**, 3 (1967) 189. Abstr. 32, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

2,3-methylenedioxy-naphthalene is an extremely effective synergist for carbaryl in house flies, yet the insecticide-synergist combination is inactive against mammals. The metabolic pathway of ^{14}C and ^3H -labelled synergists was studied in both insects and mammals with relation to the selectivity and the mechanism of synergistic action. (Abstr.)
- 841 Schonbrod, R.D., Wellman, D., Terriere, L.C. THE METABOLISM OF MCA-600 (4-BENZO-THIENYL-N-METHYL CARBAMATE) BY HOUSE FLIES AND HOUSE FLY MICROSOMES. Bull. ent. Soc. Am. **12** (1966) 262. Abstr. 53, at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

In vivo and in vitro experiments were used to study the metabolism of ^{14}C -labelled MCA-600 and the phenolic constituent, 4-HBT. At least four metabolites are produced by either route, but microsomes give relatively larger quantities of one metabolite. Hydrolysis is not a major pathway, but the phenol readily forms the glucoside. (Abstr.)
- 842 Sullivan, L.J., Eldridge, J.M., Knaak, J.B. DETERMINATION OF CARBARYL AND SOME OTHER CARBAMATES BY GAS CHROMATOGRAPHY. J. agric. Fd Chem. **15**, 5 (1967) 927-930.

A method for preparing derivatives of some aryl carbamates to provide stable compounds for gas chromatography entails initial reaction at 4°C between the carbamate and acetic anhydride. The reaction is completed at 97°C over a 30-min-period. Both temperature-programmed and isothermal results using a hydrogen flame detector are given. ^{14}C detection was used for verification of results. Reaction conditions were studied using 1-naphthyl ^{14}C -carbaryl.
- 843 Tsukamoto, M., Casida, J.E. ALBUMIN ENHANCEMENT OF OXIDATIVE METABOLISM OF METHYL-CARBAMATE INSECTICIDE CHEMICALS BY THE HOUSE FLY MICRO-SOME-NADPH₂ SYSTEM. J. econ. Ent. **60**, 2 (1967) 617-619.

Activity enhancement and enzyme stabilization by bovine serum albumen (BSA) appear to result from minimizing the influence of inhibitory materials, possibly binding them. Five carbonyl- ^{14}C -labelled substrates were used; Baygon® (o-isopropoxyphenyl methylcarbamate), carbaryl, Matacil® (4-(dimethylamino)-m-tolyl methylcarbamate), Mesurol® (4-(methylthio)-2,5-xylyl methylcarbamate), and UC-10854 (m-isopropylphenyl methylcarbamate). 2-Isoprop- ^{14}C -oxyphenyl methylcarbamate was used to examine the possibility of Baygon hydrolysis. In this investigation, unless stated otherwise, the substrate was Baygon-carbonyl- ^{14}C and the flies were of the Hokota resistant strain, this strain providing the most active enzyme source. Baygon metabolism by the fly abdomen-enzyme system is characterized by the formation of three major metabolites which are listed in the order of their decreasing amounts: 2-isopropoxy-5-hydroxyphenyl methylcarbamate, 2-hydroxyphenyl methylcarbamate, and 2-isopropoxyphenyl N-hydroxymethylcarbamate. Metabolism of carbaryl, Matacil, and Mesurol is also increased by BSA; so, reactions of carbamate insecticide chemicals enhanced by BSA include, in addition to the O-dealkylation observed with Baygon, those involving conversions of aromatic groups to hydroxyaryl and dihydrodihydroxy compounds (carbaryl), of N-methyl substituents to N-hydroxymethyl (carbaryl and Matacil), N-formamido, and N-demethylated groups (Matacil), and of sulfides to sulfoxides (Mesurol) (see ref. 844). BSA also enhances alkyl side chain hydroxylation of UC 10854 to give 3-(2-hydroxy-2-propyl) phenyl methylcarbamate. Albumin is known to catalyze carbaryl hydrolysis; although BSA does not act in this manner with Baygon, it may catalyze hydrolysis of carbaryl, Matacil, and Mesurol, and/or their oxidation products.
- 844 Tsukamoto, M., Casida, J.E. METABOLISM OF METHYL-CARBAMATE INSECTICIDES BY THE NADPH₂-REQUIRING ENZYME SYSTEM FROM HOUSE FLIES. Nature, Lond. **213** (1967) 49-51.

Certain resistant strains of houseflies are distinguished from susceptible strains by greater enzyme activity for the oxidation of several insecticide chemicals. This may contribute to the mechanism of resistance. Abdomens are a convenient source of this enzyme. The following carbamates labelled with ^{14}C were used as substrates for the enzyme system: 'Baygon' (2-isopropoxyphenyl methylcarbamate); carbaryl (1-naphthylmethylcarbamate), UC 10854 (3-isopropylphenyl methylcarbamate); HRS-1422 (3,5-diisopropylphenyl methylcarbamate); 'Banol' (2-chloro-4,5-xylyl methylcarbamate); 'Mesurol' (4-methylthio-3,5-xylyl methylcarbamate); 'Matacil' (4-dimethylamino-3-cresyl methylcarbamate); 'Zectran' (4-dimethylamino-3,5-xylyl methylcarbamate); 'Isolan' (1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate); dimetilan (1-dimethylcarbamoyl-2-methyl-4-pyrazolyl dimethylcarbamate). In most of the experiments, 'Baygon' and 'Matacil' labelled with ^{14}C were used. Homogenates of the whole body of any six housefly strains in the presence or absence of NADPH_2 did not extensively metabolise ^{14}C -labelled Baygon, but the abdomen homogenates of these insects were much more active than homogenates of the head, thorax, or whole body in the presence of NADPH_2 . This abdomen activity, almost specific for NADPH_2 , resided predominantly in the microsomal fraction. The addition of homogenates of the head or thorax, individually or in combination, to the abdomen homogenates markedly reduced the activity of the abdomen NADPH_2 -requiring enzyme system. The activity of the abdomen homogenate was greater for any of three carbamate-resistant strains than for any three laboratory strains of the housefly. The enzyme activity was higher for adult flies fed milk than it was for those fed sugar and water. Similar results were obtained from nine other methylcarbamate insecticides. As determined by tentative characterization of the methylcarbamate metabolites by autoradiography and thin-layer chromatography, aromatic hydroxylation occurred at either the 4- or 5-position of carbaryl, and O -dealkylation occurred with Baygon to yield 2-hydroxyphenol methylcarbamate.

- 845 Winteringham, F.P.W. DILUTION EFFECTS ON THE MEASUREMENT OF BLOOD CHOLINESTERASE INHIBITION BY CARBAMATE. *Nature*, Lond. **212** (1966) 1368-1369.

Results indicate that the error due to enzyme reactivation after dilution when estimating the inhibition of blood cholinesterase by carbamates by a radiometric method (see III/110 and ref. 846) may be significantly smaller than expected as a result of the nominal 11-times dilution. They also confirm that significant differences exist between nominal and effective inhibitor concentrations when studying enzyme inhibition at high tissue concentrations. Further implications are pointed out.

- 846 Winteringham, F.P.W., Fowler, K.S. SUBSTRATE AND DILUTION EFFECTS ON THE INHIBITION OF ACETYLCHOLINESTERASE BY CARBAMATES. *Biochem. J.* **101**, 1 (1966) 127-34.

The kinetics of acetylcholinesterase (EC 3.1.1.7) activity and its inhibition by eserine or by Sevin (1-naphthyl N-methylcarbamate) have been studied over the substrate concentration range 5×10^{-8} to $2.5 \times 10^{-2} \text{ M}$. [Carboxy- ^{14}C] acetylcholine was used. The anhydrous chloride (0.71 mg of specific activity $6.4 \mu\text{Ci}/\mu\text{M}$) was dissolved in 7.81 ml of water to give 0.50 mM stock solution at pH 4.5 subsequently stored at -15°C . Equations are given for inhibition as a function of time, substrate and inhibitor concentrations, and the relevant parameters determined at 25° and 37°C . The observed and calculated effects of time, dilution, substrate addition and enzyme concentration were in good agreement and consistent with a steady-state carbamylation by eserine or by Sevin in the presence of excess of inhibitor. The quantitative destruction of either inhibitor at high enzyme concentrations implied by the carbamylation hypothesis has been confirmed experimentally. The importance and possibility of allowing quantitatively for dilution and substrate effects when estimating carbamate inhibition are demonstrated.

- 847 Zayed, S.M.A.D., Hassan, A., Hussein, T.M. METABOLISM OF CARBAMATE DRUGS. II. DEGRADATION OF 1-NAPHTHYL-N-METHYL CARBAMATE (SEVIN) IN ADULT LARVA OF THE COTTON LEAF WORM (*Prodenia litura* F.). *Biochem. Pharmac.* **15**, 12 (1966) 2057-2064.

The metabolic fate of Sevin has been investigated in the adult larva of *P. litura* F., using ^{14}C -Sevin, labelled at two different sites. From the topically applied dose, 32-37% was recovered as ^{14}C -metabolites in the excreta and the expired air after 20 h. The insecticide is mainly detoxified by a non-hydrolytic mechanism, probably involving hydroxylation of the aromatic ring. The minor hydrolytic pathway (~14%) involves hydrolysis of the ester bond to give 1-naphthol and N-methyl carbamic acid. The latter decarboxylates to give methylamine which undergoes a process of oxidative demethylation to produce ^{14}C -formate and $^{14}\text{CO}_2$. A scheme has been suggested for the oxidative pathway of the methyl group of Sevin. (Auth.)

Dimetilan (2-dimethylcarbamoyl-3-methyl-5-pyrazolyl dimethylcarbamate) and Isolan (1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate) have been used in Europe as an aphicide and for control of resistant and non-resistant houseflies, respectively. Dimetilan is of intermediate oral and low dermal toxicity to mammals while Isolan is highly toxic by both routes of administration. Dimetilan was selected for a more intensive study of carbamate insecticide metabolism by insects because it is selectively toxic, and contains within the molecule a variety of sites that might be susceptible to metabolic attack. A study of the chemical nature and biological activity of dimetilan metabolites was therefore undertaken, with dimetilan labelled with ^{14}C on the carbamate ester carbonyl group. Dimetilan was rapidly metabolised following injection into German cockroaches (*Blattella germanica* L.), American cockroaches (*Periplaneta americana* L.) and houseflies (*Musca domestica* L.). Dimetilan was converted in *P. americana* to metabolites which yielded formaldehyde on acid degradation, and these metabolites increased in amount with increasing time up to 24 h after treatment. This indicated that N-methyl hydroxylation might be a major detoxication mechanism for dimetilan in insects. Nine metabolites of dimetilan- ^{14}C were detected in *B. germanica*, and of these six were also demonstrated in *P. americana* and four in *M. domestica*. Most of these metabolites were formed in appreciable amounts within one-half hour after treatment, by which time more than half of the injected dimetilan was metabolised. $^{14}\text{CO}_2$ was liberated from *B. germanica* treated with labelled dimetilan, so hydrolysis was in part involved in the detoxication. Rats treated orally with dimetilan- ^{14}C also excreted two of these same metabolites in the urine. Five of these metabolites were recovered in milligram amounts within 2-24 h after injection of dimetilan into large numbers of *P. americana* adults at 1.0 mg/insect. Metabolites were resolved and purified by preparative scale thin layer chromatography. Three of these metabolites yielded formaldehyde and dimethylamine on acid degradation, one yielded formaldehyde but no dimethylamine, and one yielded dimethylamine but no formaldehyde. All metabolites could be degraded to 3-methyl-5-pyrazolone. The major metabolite from *P. americana* yielded formaldehyde, dimethylamine, methylamine and 3-methyl-5-pyrazolone on degradation. Based on these analyses and its infrared spectrum, this metabolite might be 2-dimethylcarbamoyl-3-methyl-5-pyrazolyl N-hydroxymethyl, N-methylcarbamate. Another metabolite appeared to be 2-methylcarbamoyl-3-methyl-5-pyrazolyl pyrazolyl dimethylcarbamate based on chromatographic and bioassay comparison with the known compound. None of the metabolites were 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 sesamex [acetaldehyde 2-(2-ethoxyethoxy)ethyl-3,4-methylene-dioxyphenyl acetal] as was also the case with dimetilan and several of its analogues. N-Methyl hydroxylation appears to be a major factor in the detoxication of dimetilan in insects. (From DA)

See also:

- 610 The relation between physical properties and uptake of insecticides by eggs of the large milkweed bug. (Bracha, P. et al., 1966)
- 684 The elimination of pesticide residues on apricots by washing before canning. (Viel, G. et al., 1966)
- 896 Synthesis of methylene- ^{14}C -dioxyphenyl compounds: radioactive saffrole, dihydrosaffrole, myristicin, piperonyl butoxide, and diastereoisomers of sulfoxide. (Kuwatsuka, S. et al., 1965)
- 897 Mode of action of insecticide synergists. (Metcalf, R. L., 1967)

1.5.6. Pyrethroids

Metabolism of labelled pyrethrins (dl-cis-trans-allethrins-2- ^{14}C) was studied by treating houseflies topically and resolving the metabolic products chromatographically at the end of a 24-h incubation period. It was found that the radioactive preparations were metabolised to non-insecticidal substances within 24 h.

- 850 Crombie, L., Elliott, M. CHEMISTRY OF THE NATURAL PYRETHRINS. *Fortschr.Chem.org. NatStoffe* 19 (1961) 120-164.

In this comprehensive review of the chemistry of natural pyrethrins valued for their insecticidal properties, some of these are studied by means of radio-tracing technique, and others are produced as labelled compounds. An example of the latter is allethrin labelled with ^{14}C in ketol or acid portion used for biological studies; whereas pyrethrins and cinerins are studied by means of ^{14}C labelling of $(\pm)2\text{-}^{14}\text{C}$ -mevalonic acid which is incorporated into the two chrysanthemic acids when fed to the achenes of pyrethrum flowers, and thus supports the isoprenoid derivation. (Battelle Institute Card File)

- 851 Fine, B.C., Godin, P.J., Thain, E.M., Marks, T.B. RESISTANCE TO PYRETHRINS AND DDT IN A STRAIN OF HOUSEFLIES *Musca domestica* L. 1. THE SORPTION OF A SYNTHETIC [^{14}C] PYRETHRIN I. *J. Sci. Fd Agric.* 18, 5 (1967) 220-224.

A [^{14}C]pyrethrin I mixture, consisting of a mixture of the naturally occurring ester and one of its diastereoisomers, was synthesised, via 2-[^{14}C] ethyl aminoacetate hydrochloride, 2-[^{14}C] ethyl diazoacetate, $(\pm)2\text{-}^{14}\text{C}$ trans-chrysanthemum-mono-carboxylic acid, $(\pm)2\text{-}^{14}\text{C}$ trans-chrysanthemoyl chloride. Penetration of the labelled material in a strain of houseflies that had shown resistance to pyrethroids in the field was studied. It could be shown that the resistance of the flies, which also show a high degree of tolerance to DDT, is due in part to reduced penetrations of the pyrethrin I.

- 852 Yamamoto, I., Casida, J.E. O-DEMETHYL PYRETHRIN II ANALOGS FROM OXIDATION OF PYRETHRIN I, ALLETHRIN, DIMETHRIN, AND PHTHALTHRIN BY A HOUSE FLY ENZYME SYSTEM. *J.econ.Ent.* 59, 6 (1966) 1542-1543.

In order to investigate pyrethroid metabolism it was necessary to prepare ^{14}C -labelled pyrethroids which were stereochemically pure and of high specific activity, and to develop adequate chromatographic procedures to resolve closely related metabolites or degradation products, and an in vitro enzyme system active in pyrethroid metabolism. d-trans-Chrysanthemic acid-1- ^{14}C was esterified with d-pyrethrolone to yield pyrethrin I- ^{14}C , with d-allethrolone to yield allethrin- ^{14}C , with 2,4-dimethylbenzyl alcohol to yield dimethrin- ^{14}C , and with N-hydroxymethyl-3,4,5,6-tetrahydrophthalimide to yield phthalthrins- ^{14}C . Allethrin-alcohol- ^{14}C , from labelled dl-allethrolone, and phthalthrins-N-methylene- ^{14}C were also prepared. Thin-layer chromatography on silica gel G was used in one or two dimensions.

Labelled compounds were detected by autoradiography, and phosphomolybdic acid was used as the chromogenic reagent for detecting known, unlabelled compounds in cochromatography studies. For in vitro enzyme studies, the *Musca domestica* abdomen system fortified with nicotinamide adenine dinucleotide phosphate, reduced form (NADPH_2), and the Hokota-resistant and SCR-susceptible fly strains were used. With this system and allethrin- ^{14}C as the substrate, metabolism by an unfractionated homogenate of whole abdomens or by the microsome fraction from such a homogenate was NADPH_2 -dependent and more extensive with the Hokota- than the SCR-strain; accordingly, homogenates of whole abdomens from the Hokota-strain and fortification with NADPH_2 were used for routine studies.

Allethrin- ^{14}C was converted to 13 metabolites, each with its ester group intact. The major metabolite proved to be O-demethyl allethrin II. Results indicate that pyrethrin I, dimethrin, and phthalthrins are metabolised by the in vitro enzyme systems by oxidation of the analogous methyl group and that other modifications of the molecule are not involved in forming the major metabolites. Pyrethrin I- ^{14}C was converted in vitro to at least ten metabolites and the major metabolites differed only slightly in chromatographic positions from those derived from allethrin- ^{14}C . Preliminary studies indicate that allethrin is also converted in part to O-demethyl allethrin II in vivo. This reaction involves a detoxification because allethrin is 30fold more toxic than O-demethyl allethrin when these compounds are injected into house flies.

1.5.7. Nicotine Alkaloids (including Anabasine and Related Compounds)

- 853 Decker, K., Sammeck, R. ENZYMCHEMISCHE UNTERSUCHUNGEN ZUM NIKOTINABBAU IN DER KANINCHENLEBER. (Chemical study, by means of enzymes, of nicotine degradation in rabbit liver.) Biochem. Z. **340** (1964) 326-336. (In German, with English summary)
- The degradation pathway for methyl-labelled nicotine and ring-labelled nicotine has been studied. By comparison it has been found that cotinine and norcotinine are formed in vivo as well as by the cell-free fractions of the rabbit liver. In the latter system 10-20% of the total nicotine degradation goes via norcotinine, which then is partly dehydrogenated yielding norcotinine. No demethylation of cotinine has been observed. The formation of norcotinine is accompanied by a liberation of free formaldehyde, which then subsequently is oxidized by the liver fraction yielding CO_2 . A chemical synthesis of DL-[2'- ^{14}C] nicotine is described. (Auth.)
- 854 Decker, K. THE RADIOCHEMICAL SYNTHESIS OF SPECIFICALLY LABELED NICOTINE MOLECULES. p.39-44 of "Proceedings of the Symposium on the Preparation and Bio-Medical Application of Labeled Molecules. Venice, Italy, 23-29 Aug.1964". Sirchis, J., Ed. Brussels, EURATOM. Dec.1964, 500p. EUR 2200.e, European Atomic Energy Community, Brussels (Belgium).
- The structural features of the molecule allow several catabolic pathways which lead to different intermediates and endproducts. The elucidation of these reaction sequences was greatly facilitated by the use of nicotine preparations labelled in different positions. Radioactive nicotine was synthesised ^{14}C -labelled either in C-2' of the pyrrolidine ring or in the N'-methyl group. The preparation of the ring-labelled compound 2'- ^{14}C -DL-nicotine required additional synthetic steps; [7- ^{14}C] -nicotinic acid was prepared from $^{14}\text{CO}_2$ and pyridine lithium. The analytical data are tabulated, and the chemical and radiochemical homogeneity and purity of the substances is shown.
- 855 Decker, K., Sammeck, R. METABOLIC STUDIES WITH SPECIFICALLY LABELED NICOTINE MOLECULES. p.165-172 of "Proceedings of the Symposium on the Preparation and Bio-Medical Application of Labeled Molecules. Venice, Italy, 23-29 Aug.1964". Sirchis, J., Ed. Brussels, EURATOM. Dec.64, 500p. EUR 2200.e, European Atomic Energy Community, Brussels (Belgium).
- $^{14}\text{CH}_3$ -L-nicotine and 2'- ^{14}C -DL-nicotine were used, in order to obtain qualitative as well as quantitative data on the catabolic routes of the base and intermediates of these pathways. Nicotine degradation by cell-free extracts of nicotine-adapted *Arthobacter oxidans* was studied, in order to elucidate intermediates. The degradation product was identified as γ -methylamino butyric acid. Norcotinine was found to be a metabolite of nicotine in rabbit liver. This pathway, which included further oxidation of part of the norcotinine to norcotinine amounts to some 20% of the total nicotine catabolism. Cotinine was not demethylated. The fate of N'-methyl group was elucidated using $^{14}\text{CH}_3$ -nicotine. Transmethylation and an intermediate formation of hydroxymethyl tetrahydrofolate appeared to be ruled out. Liver enzymes proved equally active with both L- and D-nicotine.
- 856 Flecker, J.R. THE ROLE OF GLYCEROL IN THE BIOSYNTHESIS OF THE PYRIDINE RING OF NICOTINE. Diss. Abstr. **26**, 8 (1966) 4207.
- The purpose of this study was to determine where the carbon atoms of glycerol were incorporated into the pyridine moiety of nicotine. Glycerol-1,3- ^{14}C and glycerol-2- ^{14}C were employed as precursors and were fed hydroponically to newly grown roots of intact *Nicotiana rustica*. The nicotine produced was isolated as the dipicrate. Nicotine was oxidized to nicotinic acid which was then converted to 2-hydroxynicotinic acid via several intermediates. The 2-hydroxynicotinic acid was decarboxylated and the resulting 2-hydroxypyridine reduced to valerolactam. The lactam was hydrolysed, then methylated to the betaine which was heated in KOH at 350°C for 10 min. The acetic and propionic acids which resulted from this cleavage were degraded carbon by carbon and the carbon dioxide collected and counted. When nicotinic acid-4,6- ^{14}C was degraded in this manner, all the radioactivity was found in the propionic acid, thus the cleavage of the betaine is between the 3 and 4 carbons of the pyridine ring. Glycerol-1,3- ^{14}C labelled the pyridine ring at the 4 and 6 positions, with a significant amount of activity in the 2 and 3 carbon atoms. Glycerol-2- ^{14}C labelled the ring almost exclusively in carbon atom 5. The results of this study are discussed and compared to the results of other studies on compounds containing the pyridine moiety. (DA)

- 857 Il'in, G.S. THE BIOCHEMISTRY OF TOBACCO ALKALOIDS. Izv. Akad. Nauk SSSR, Ser. Biol. No. 6 (1967) 835-842. (In Russian, with English and French summaries)

The biosynthesis of nicotine, (its mechanism, sites, and the influence of the stage of development on its formation) and nicotine metabolism were studied by means of nicotine labelled via $\text{NaH}^{14}\text{CO}_3$.

- 858 Jackanicz, T.M. THE INCORPORATION OF ASPARTATE AND MALATE INTO THE PYRIDINE RING OF NICOTINE. Diss. Abstr. 26, 8 (1966) 4211.

In an attempt to study the incorporation of dicarboxylic acids which might be used for pyridine ring biosynthesis, aspartic and malic acids were employed as possible precursors. Although procedures have been developed previously for the degradation of the pyridine ring, in the present study a method for the isolation of each carbon of the ring was devised which required fewer steps and resulted in a greater over-all yield than was the previous case. Therefore much less nicotine was required in each degradative study. Aspartate-3- ^{14}C and malate-3- ^{14}C were hydroponically fed to Nicotiana rustica plants. The nicotine was isolated as the dipicrate, converted to the hydrochloride, and oxidized to nicotinic acid. The nicotinic acid was methylated to trigonelline acid sulfate which was oxidized to N-methyl-2-pyridone-5-carboxylic acid. Decarboxylation of the pyridone-carboxylic acid and catalytic reduction of the ensuing product produced N-methyl-2-piperidone. Hydrolysis of the piperidone, subsequent methylation to the betaine, followed by potassium hydroxide fusion, yielded acetic acid from carbons 5 and 6 of the original pyridine ring, and propionic acid from carbons 2, 3, and 4. The over-all yield of the fatty acids from nicotine was about 15%. Therefore, about 2 g of nicotine was ample starting material for each degradation. When aspartic acid-3- ^{14}C was studied, 57% of the label resided in carbon 3 of the pyridine ring, whereas 38% was in carbon 2. When malic acid-3- ^{14}C was employed, 61% of the tracer appeared in carbon 3, whereas 38% was in carbon 2. The remaining small percentage of radioactive carbon was scattered among the other carbon atoms. (From DA)

- 859 Jackanicz, T.M., Byerrum, R.U. INCORPORATION OF ASPARTATE AND MALATE INTO THE PYRIDINE RING OF NICOTINE. J. biol. Chem. 241, 6 (1966) 1296-1299.

A unique nicotinic acid degradation was devised which permitted the isolation of each individual C atom of the pyridine ring. Aspartate-3- ^{14}C and malate-3- ^{14}C were administered to Nicotiana rustica tobacco plants for 4 h and were incorporated almost exclusively into carbons 2 and 3 of the pyridine ring of nicotine. When aspartate-3- ^{14}C was used, 57% of the tracer resided at C-3 and 38% at C-2. Malate-3- ^{14}C labelled C-3 with 61% of the isotope and C-2 with 38%. The dilution of incorporation of aspartate-3- ^{14}C was 600 and of malate-3- ^{14}C , 1200. The incorporation of aspartate and malate with low dilution and the lack of randomization of ^{14}C between C-2 and -3 of the pyridine ring indicate either that aspartate or malate is the immediate precursor of the pyridine ring of nicotine, or that they are converted to the immediate precursor without passing through a symmetrical intermediate. (CA 64:1966, 13106 ef)

- 860 Kisaki, T., Tamaki, E. PHYTOCHEMICAL STUDIES ON TOBACCO ALKALOIDS. PART IV. STEREOSPECIFIC DEMETHYLATION OF NICOTINE IN TOBACCO LEAVES. Agric. biol. Chem., Tokyo 28, 7 (1964) 492.

The preparation of radioactive nicotine is described. From the findings of the feeding experiments of d- and l-nicotine- $^{14}\text{CH}_3$ and d-nicotine to the excised tobacco leaves, it was demonstrated that demethylation of nicotine was stereospecific for the d-form in tobacco leaves. Such preferential demethylation to the enantiomer was also observed with N-methylanabasine and 1-(3'-pyridyl)-1-methylaminoethane which are analogous compounds to nicotine.

- 861 Liebman, A.A., Mundy, B.P., Rapoport, H. THE BIOSYNTHESIS OF NICOTINE IN Nicotiana glutinosa FROM CARBON-14 DIOXIDE. LABELING PATTERN IN THE PYRROLIDINE RINGS. J. Am. chem. Soc. 89, 3 (1967) 664-672.

A systematic degradation has been developed which permits isolation of each carbon atom of the pyrrolidine ring of nicotine. The independent synthesis of specifically labelled intermediates obtained during this sequence and their degradation have confirmed the integrity of the entire process. This degradation has been applied to numerous samples of nicotine obtained from short-term $^{14}\text{CO}_2$ biosynthesis with N. glutinosa, and in each experiment the pyrrolidine ring showed an

unsymmetrical labelling pattern, a condition contrary to the accepted symmetrical intermediate hypothesis of pyrrolidine ring formation. Ornithine feeding experiments, from which the symmetrical theory had evolved, were applied to *N. glutinosa* and results were identical with those in other species. These experiments establish a greatly different labelling pattern in the pyrrolidine ring from CO_2 than from preformed precursors such as ornithine. (Auth.)

- 862 Lovkova, M. Y. BIOSYNTHESIS OF NICOTINE. *Izv. Akad. Nauk. SSSR, Ser. Biol.* No. 3 (1967) 413-421. (In Russian, with English summary)

The literature on nicotine biosynthesis is reviewed, as are studies of the biosynthesis of the pyridine and pyrrolidine cycles of the nicotine molecule and the formation of the methyl group of nicotine. Radioactive labelled compounds used in these studies include ^{14}C -labelled succinate, glycerine, ornithine-2- ^{14}C , ^3H -labelled nicotinic acid, and others. Some of her own work is mentioned. 55 papers are reviewed.

- 863 Makky, A. M. M. RADIOACTIVE NICOTINE: BIOSYNTHESIS, TOXICITY AND METABOLISM. *Diss. Abstr.* 27, 3 (1966) 724-B.

Carbamate groups attached to the 2- or 6-position of nicotine (Carbamic acid, dimethyl-, 3-(1-methyl-2-pyrrolidinyl)-2-pyridyl ester and Carbamic acid, dimethyl-, 5-(1-methyl-2-pyrrolidinyl)-2-pyridyl ester) were synthesised. These groups did not increase nicotine toxicity when the compounds were applied to mosquito larvae. However, the compound of nicotine with the carbamate in the 2-position (Carbamic acid, dimethyl-, 3-(1-methyl-2-pyrrolidinyl)-2-pyridyl ester) was very toxic to mice, and its toxicity was at least ten times that of nicotine. Radioactive nicotinic acid (nicotinic acid 2- ^3H) was synthesised and fed to *Nicotiana tabacum* plants to obtain radioactive nicotine (nicotine 2- ^3H) biosynthetically. The toxic effects of both radioactive and natural nicotine were evaluated on mosquito larvae *Aedes aegypti*. Also, the effects of larval population density on radioactive and natural nicotine were studied. It was concluded that there was a significant difference caused by differences in population density, excessive population density (400 larvae/100 ml water) decreased natural nicotine toxicity. In case of radioactive nicotine, however, the population density showed no effect on toxicity. On the other hand, radioactive nicotine was found to be significantly more toxic to the larvae than natural nicotine. These results showed a great deal of evidence that C-2 of nicotine which was labelled with ^3H is involved in nicotine metabolism. This involvement of the pyridine ring in nicotine metabolism by higher animals is a novel hypothesis. It had never been known before that the pyridine ring of nicotine interferes in nicotine metabolism by higher animals (Vertebrates or Invertebrates). (DA)

- 864 McKennis, J., Jr., Turnbull, S.B., Schwartz, J.L., Tamaki, E., Bowman, E.R. DEMETHYLATION IN THE METABOLISM OF (—)-NICOTINE. *J. biol. Chem.* 237, 2 (1962) 541-546.

The metabolism of (—)-nicotine-methyl- ^{14}C has been studied in both the rat and the dog. After administration to the former species, 6-10% of the radioactivity of the dose appeared as respiratory carbon dioxide. An examination of the metabolism of (—)-nicotine and the intermediate (—)-cotinine in both species leads to the conclusion that the conversion of cotinine to demethylcotinine is involved in the formation of carbon dioxide- ^{14}C . After administration of nicotine-methyl- ^{14}C , cotinine and γ -(3-pyridyl)- β -oxo-N-methylbutyramide were isolated from the urine of dogs. All of the radioactivity of the latter compound was found in the N-methyl group. As a consequence of this and other considerations, methylamine arising from the hydrolysis of the keto amide in vivo may be an intermediate in the formation of the carbon dioxide- ^{14}C observed in the studies. (Auth. summary)

- 865 Scott, T. A., Glynn, J. P. THE INCORPORATION OF [2,3,7- ^{14}C] NICOTINIC-ACID INTO NICOTINE BY *Nicotiana tabacum*. *Phytochemistry* 6, 4 (1967) 505-510.

[2,3,7- ^{14}C] Nicotinic acid, prepared from [U- ^{14}C] aniline hydrogen sulphate, was administered to tobacco plants via the roots in hydroponic culture. Radioactive nicotine was isolated from the plant and purified as the dipicrate. The dipicrate was converted into nicotine, which was oxidized to nicotinic acid. The nicotinic acid was degraded stepwise to give the radioactivity of each carbon atom. A feature of this degradation is the rapid hydrogenation of nicotinic acid with rhodium on charcoal as the catalyst; there is a 50% simultaneous decarboxylation to give hexahydronicotinic acid, piperidine and CO_2 . Radioactivity was detected and measured in positions 2 and 3 of the nicotinic acid, with negligible activity in positions 4, 5 and 6. This shows that the pyridine ring of nicotinic acid does not

become symmetrical during its conversion into nicotine; the attachment of the pyrrolidine moiety occurs only at the site from which the carboxylic acid group is lost, i.e. at position 3. (Auth.)

- 866 Weiss, G.B. THE EFFECT OF pH ON NICOTINE-INDUCED CONTRACTURE AND ^{45}Ca MOVEMENTS IN FROG SARTORIUS MUSCLE. J. Pharmacol. exp. Ther. **154** (1966) 605-612.
- The contracture and three-fold increase in ^{45}Ca uptake induced by 2.5 mM nicotine in frog sartorius muscle could be inhibited by lowering the pH of the Ringer's bathing solution from 8.4-7.4. The nicotine-induced contracture and ^{45}Ca efflux obtained at pH 8.4 after prolonged washout in Ca-free Ringer's solution containing 4 mM EDTA were also inhibited by decreasing the pH to 7.4. If the amount of nicotine in pH 7.4 Ringer's solution was raised to 10 mM, the concentration of non-ionized nicotine was equal to that present in pH 8.4 Ringer's solution containing 2.5 mM nicotine. The contracture and increased ^{45}Ca uptake induced by 10 mM nicotine in the pH 7.4 Ringer's solution did not differ significantly from that obtained using pH 8.4 Ringer's solution containing 2.5 mM nicotine. The uptake of ^{14}C -labelled nicotine into frog sartorius muscles was more than doubled by increasing the pH of the Ringer's solution from 7.4-8.4. These observations indicated that the magnitude of the nicotine-induced contracture and ^{45}Ca movements is dependent upon the concentration of non-ionized nicotine in the bathing solution. Thus, the non-ionized form of nicotine appeared to be the molecule of importance not only for penetration of the cell membrane, but for alterations in ^{45}Ca movements and contracture tension in frog sartorius muscle. (NSA 22:1968, 6738)
- 867 Yasumatsu, N., Sakurai, A., Tamura, S. STUDIES ON THE CHEMICAL REGULATION OF ALKALOID BIOSYNTHESIS IN TOBACCO PLANTS. I. INHIBITION OF NICOTINE BIOSYNTHESIS BY HELMINTHOSPOROL AND HELMINTHOSPORIC ACID. Agric. biol. Chem., Tokyo **31**, 9 (1967) 1961-1965. (In Japanese, with English summary)
- A tobacco plant, Nicotiana tabacum, cut off at the 16th leaf, with roots removed, was treated with ^{14}C -ornithine, ^{14}C -glutamic acid, ^3H -nicotinic acid, helminthosporol, and helminthosporic acid. The biosynthesis of nicotine was studied, also the inhibiting effect of helminthosporol and helminthosporic acid.
- 868 Yoshida, D. RELATIONSHIPS BETWEEN THE TRANSLOCATION OF PHOTOSYNTHETIC PRODUCTS AND THE NICOTINE SYNTHESIS IN TOBACCO PLANTS. Soil Pl. Fd., Tokyo **13**, 3 (1967) 63-70. (In Japanese, with English summary)
- Nicotine synthesis and the translocation of photosynthetic products were studied in Nicotiana tabacum, the output of radioactive CO_2 ($^{14}\text{CO}_2$) being measured.
- 869 Yoshida, D. EFFECTS OF NUTRIENT DEFICIENCIES ON THE BIOSYNTHESIS OF NICOTINE IN TOBACCO PLANTS. Soil Pl. Fd., Tokyo **13**, 4 (1967) 107-112. (In Japanese, with English summary)
- ^{14}C -labelled glutamic acid, ornithine, arginine and putrescine, and ^3H -labelled agmatine and nicotinic acid were used in studying the effect of nutrient deficiencies on the biosynthesis of nicotine in tobacco plants (Nicotiana tabacum). The nutrient solution used was either normal or deficient in Mg, N, P, K, Ca, S or B.

1. 5. 8. Rotenoids

- 870 Fukami, J., Yamamoto, I., Casida, J.E. METABOLISM OF ROTENONE IN VITRO BY TISSUE HOMOGENATES FROM MAMMALS AND INSECTS. Science, N.Y. **155** (1967) 713-716.
- Hydroxylation of rotenone in vitro in the enzyme system composed of microsomes and reduced nicotinamide-adenine dinucleotide phosphate, and in living mice and houseflies, yields products tentatively identified as rotenolone I; rotenolone II; 8-hydroxyrotenone, 6', 7'-dihydro-6', 7'-dihydroxyrotenone; two rotenolones of each of the last-mentioned two compounds; and uncharacterized polar material. The toxicity of certain of these rotenoids to mice is of the same order as that of rotenone. Rotenone-6a- ^{14}C (97% radiochemical purity) was used, and the metabolites resolved by thin-layer chromatography.

- 871 Horgan, D.J., Singer, T.P. CHARACTERISTICS OF THE BINDING OF ROTENONE IN THE RESPIRATORY CHAIN AND THE INHIBITION SITES OF AMYTAL AND PIERICIDIN A. Biochem.J. 104, 3 (1967) 50C-52C.

The specificity, stoichiometry and reversibility of rotenone binding were investigated using [^{14}C] - rotenone (2.36 mCi/mM). Although on titration with electron-transport particles with rotenone the inhibition rises in a hyperbolic curve, rotenone binding is quite linear, even though five times as much rotenone is added as that required for max. inhibition. When the titration was performed in the presence of 2% (w/v) bovine serum albumin, however, a biphasic binding curve was obtained, showing a rapid initial rise, corresponding to the specific binding site in the NADH dehydrogenase segment of the chain, and a slower secondary rise, representing binding at other points. Amytal and piericidin A compete with rotenone for the binding site responsible for inhibition by rotenone. The effects of piericidin A and Amytal on the binding of rotenone at the specific site clearly suggest that all three substances react at the same point in the respiratory chain, although not necessarily with the same groups. For the stoichiometry of binding at the specific site it was calculated that $\sim 40 \text{ } \mu\text{M}$ of rotenone are bound per gram of protein in electron-transport particles at that point. The amount of rotenone bound at the specific site is of the same order as the NADH dehydrogenase content.

- 872 Horgan, D.J., Singer, T.P. REACTION SITES OF ROTENONE IN THE RESPIRATORY CHAIN AND IN SOLUBLE DPNH-COENZYME Q REDUCTASE. Biochem.biophys.Res.Comm. 27 (1967) 356.

The experiments reported offer independent evidence that the reaction site of coenzyme Q homologues and of rotenone are not the same in intact particles and in the soluble reductase. Rotenone-6a- ^{14}C (2.36 mCi/mM) was used. A diagrammatic flow sheet of the preparation of soluble DPNH-CoQ reductase from ^{14}C -rotenone labelled ETP is given, also a table showing the distribution of enzyme activity and of radioactive rotenone during purification of DPNH dehydrogenase. On solubilization of DPNH dehydrogenase from ^{14}C -rotenone labelled ETP, $\sim 9\%$ of the rotenone accompanies 90% of the activity in the extract. On further purification all but a trace of the radioactive rotenone is separated from the dehydrogenase. The absence of CoQ reductase activity in the dehydrogenase obtained by phospholipase A extraction does not appear to be due to the presence of an inhibitor but to the absence of exposure to modifying agents.

1.5.9. Chemosterilants

- 873 Bořkovec, A.B. INSECT CHEMOSTERILANTS. Adv.Pest Control Res. 7 (1966) 1-114.

This is a compilation of the pertinent information currently available on chemosterilants, with an outline of their development and considered generalizations as to their potential application. The author is concerned primarily with the diverse features of chemosterilant compounds and with their varying effects on different species of insects. However, in out-lining the advantages inherent in the use of chemosterilants, including the economically important aspects, he presents chapters on the theoretical basis of the insect-sterility control method and on the testing and practical application of insect chemosterilants. The very comprehensive bibliography is complete up to July 1966. The book includes chapters on the chemistry of insect sterilitants (alkylating agents, antimetabolites, miscellaneous agents), the physiological effects (in female and male insects, and other organisms) and their testing and practical application. A number of studies on chemosterilants are mentioned in which radioisotopes were used (e.g. ^{32}P -metapa, ^{14}C -tepa) or the effectiveness of sterilization by chemosterilants and ionizing radiations is compared.

- 874 Chang, S.C. METABOLIC STUDY OF C- 14 -HEMPA IN MALE HOUSE FLIES. Bull.ent.Soc.Am. 12 (1966) 286. Abstr.101, at "Portland Meeting. Portland, Oreg., USA. 28 Nov.-1 Dec.1966".

Uniformly labelled ^{14}C -hempa with a specific activity of 98 mCi/mM was used in the study of the rate of sterilisation action in vivo, the rate of disappearance from flies, and the rate of recovery from fly excreta. The isolation and identification of a metabolite was discussed. (From abstr.)

- 875 Chang, S.C., Bořkovec, A.B., Woods, C.W. FATE OF TEPA UNIFORMLY LABELED WITH C- 14 IN MALE HOUSE FLIES. J.econ.Ent. 59, 4 (1966) 937-944.

Tepa uniformly labelled with ^{14}C with a specific activity of 12 mCi/mM was used to study the metabolism and mechanism of sterilization in male house flies, Musca domestica L. A wet-combustion

method was developed for ^{14}C -labelled compounds which gave quantitative recovery and reproducible results. The injection of ^{14}C -labelled tepa was adjusted to about 1 $\mu\text{g}/\text{male fly}$. Total recovery of radioactivity from treated flies and their excreta was almost quantitative; radioactivity in respiratory CO_2 was only 0.75% of the injected dose during the first 12 h. When male flies were allowed normal activities after an injection of about 1 μg of ^{14}C -labelled tepa, 50% of the dose was retained in the fly 5 h after treatment. Radioactivity was present in treated flies as tepa or aziridinyl metabolites; radioactive metabolites in the excreta did not contain aziridinyl groups. Radiometric and colorimetric determinations indicated that treated flies retained about 9 and 5%, respectively, of the injected dose over prolonged periods. Radioactivity was transferred to female flies by copulation with treated males. Because this radioactivity was found within the female body and not on its surface, we concluded that transfer was by copulation rather than by body contact. However, no detectable radioactivity was found in the sperm or the seminal fluid present in the spermathecae of inseminated females. An electron microscopic scrutiny of house fly sperm failed to reveal any structural changes brought about by the chemosterilant. (Auth.)

- 876 Chang, S.C. METABOLISM OF C^{14} -HEXAMETHYLMELAMINE (HEMEL) IN MALE HOUSE FLIES. Bull. ent. Soc. Am. 13, 3 (1967) 192. Abstr. 101, at "New York Meeting of the Entomological Society of America. New York, N.Y., 27-30 Nov. 1967".

Hemel-(methyl- ^{14}C) has a specific activity of 6.5 mCi/mM . The sterilizing potency of hemel.HCl by injection to male house flies was determined to be 6.2 μg at 50% effective level. From fly and faeces extract, 6 and 7 radioactive metabolites were resolved respectively. The identification of metabolites will be discussed. (Abstr.)

- 877 Chang, S.C., Terry, P.H., Woods, C.W., Bořkovec, A.B. METABOLISM OF HEMPA UNIFORMLY LABELED WITH C^{14} IN MALE HOUSE FLIES. J. econ. Ent. 60, 6 (1967) 1623-1631.

When hempa was uniformly labelled with ^{14}C and its metabolism in male house flies, Musca domestica L., was studied, total recovery of radioactivity from treated flies and their excreta was about 90%. The recovery of radioactivity from respiratory CO_2 was only 1.25% of the injected 5.71 μg of ^{14}C -hempa/fly during the first 24 h. Radiometric and colorimetric determinations indicated that 2.5-3 h after treatment, treated flies retained 50% of the dose and that at the end of 24 h they retained about 2-3% of the dose. The treated flies were 50% sterile 4 h 45 min after treatment and completely sterile about 7 h after treatment. The only major metabolite of hempa found in treated flies and in their excreta was pentamethylphosphoric triamide. Unchanged hempa and its metabolite were separated from the extracts of treated flies and their excreta by thin-layer chromatography, gas-liquid chromatography, and radiochromatography. For identification, the two compounds were isolated by thin-layer chromatography, and their structure was confirmed by infrared spectroscopy. (Auth.)

- 878 Collier, C.W., Tardif, R. ANALYSIS OF MALE GYPSY MOTHS FOR MICROGRAM QUANTITIES OF TEPA. J. econ. Ent. 60, 1 (1967) 28-20.

Two methods were used. In initial tests adult males of Porthetria dispar (L.) < 24-h-old were treated with residual films of ^{14}C -labelled tepa for 8 h, at the 8 mg/bottle level. ^{14}C -tepa, with a specific activity of 6.8 mCi/mM , was diluted with unlabelled tepa. A 16-h holding time reduced the ^{14}C -containing alcohol solubles in the moth by roughly a factor of 2, which suggests incorporation of tepa or its metabolites into tissue proteins. A colorimetric method was developed whereby tepa residues could be determined easily to 0.5 $\mu\text{g}/\text{moth}$. The method involves clean-up of moth extracts by means of column chromatography followed by colorimetric analysis. Preliminary cleanup attempts with thin-layer chromatography were unsuccessful. Data obtained indicate that the amount of tepa residues in moths depends on the holding time after treatment. The residues diminish with increasing holding times between treatment and analysis. Washing treated moths with water also has been found helpful in lowering the tepa residue. In general, it can be stated that the lowest practical level obtainable is in the order of 1-5 μg . These levels were obtained by washing immediately after treatment followed by a holding period of 0-16 h. All residue data were determined on moths which had been exposed for a period of 8 h to residual films of 1 mg/dm^2 of tepa. This treatment is currently considered the most practical for producing sterile moths for field release.

- 879 Cox, H.C., Young, J.R., Bowman, M.C. PERSISTENCE OF TEPA IN FALL ARMYWORM MOTHS. J.econ.Ent. 60, 4 (1967) 1111-1115.

The persistence of tepa in male and female fall armyworm moths, *Spodoptera frugiperda* (J.E. Smith), was determined by radiometric and gas chromatographic (GLC) procedures. The radiometric analyses showed considerably more tepa on and in the insects than did the specific GLC analyses, an indication that ^{14}C -labelled fragments of the tepa molecule were being analysed as tepa. Within 24 h > 90% of the tepa disappeared from moths that ingested as much as 100 μg /moth. More than 95% disappeared within 48 h. (Auth.)

- 880 Fletcher, T.E., Dennis, D.L., Ross, H.B. DISTRIBUTION AND POSSIBLE MECHANISM OF ACTION OF THIO-TEPA IN EXPERIMENTAL BREAST CANCER. Trans.R.Soc.trop.Med.Hyg. 46, 6 (1952) 1437-1440.

The uptake and distribution of ^{32}P -labelled thiotepa was studied in induced hormone-sensitive breast cancer in the Sprague-Dawley rat. The concentration of labelled thiotepa in the ovary and adrenal was over twice that in the tumour and the concentration in the pituitary was 15 times that in the tumour. Pituitary, ovary and adrenal weights of treated animals kept for 5 weeks were less than those of untreated control animals. The possibility that the antitumour effect of thiotepa may be mediated through the neuro-endocrine system rather than by a direct effect on the tumour is discussed. (Auth. summary)

- 881 Hedin, P.A., Wiygul, G., Mitlin, N. ABSORPTION AND METABOLISM OF C^{14} -LABELED TEPA BY THE BOLL WEEVIL. J.econ.Ent. 60, 1 (1967) 215-218.

Some aspects of the absorption and metabolism of ^{14}C -labelled tepa by the male boll weevil, *Anthonomus grandis* Boheman, were studied. Topically applied tepa* is absorbed almost immediately into the haemolymph, where it reaches a peak in 1-3 h and then slowly declines. This trend parallels a decline of tepa on the cuticle to 10% within 6 h. Values of the differential distribution ratio for body parts and organs were determined for injection and for topical treatment on the abdomen. Selective concentration occurred in the foregut, testes, and wings with injection and in the wings only with topical treatment. Radioactivity detected in the spermathecae of females mated to treated males gave presumptive evidence that the sperm was labelled. About 85% of the initial radioactivity was detected in faeces, expired CO_2 , other expired volatiles, and body of injected insects after 2 d. Of the residual radioactivity in the body at 2 d, more than 85% was bound by constituents with low mol. wt. (Auth.)

* (0.63 μg /weevil)

- 882 Hedin, P.A., Wiygul, G., Vickers, D.A., Bartlett, A.C., Mitlin, N. STERILITY INDUCED BY TEPA IN THE BOLL WEEVIL: EFFECTIVE DOSE AND PERMANENCY, GONADAL CHANGES, AND BIOLOGICAL TURNOVER OF LABELLED COMPOUND. J.econ.Ent. 60, 1 (1967) 209-214.

The male boll weevil, *Anthonomus grandis* Boheman, was sterilised with tepa, either by feeding 1500 ppm in the diet for 2 d or by an injection of 3.5 μg . Lower levels produced transitory sterilisation. At the effective levels, mortality was significant. A recovery of fertility occurred about 5 d after treatment at the 1.5 μg level. This recovery was less marked with an artificial diet than with cotton buds. In a study of single pairs 12 of 27 males, surviving treatment at the 1.0- μg level, regained fertility within 36 d. Decreases in the size of the testes and changes in morphology and cytology occurred. ^{14}C -Tepa (0.63-1.86 μg) in 0.1 M phosphate buffer (pH 7.5) was either applied topically to the prothorax or injected into the abdomen. The tissue was subsequently digested with nitric acid immediately after treatment, and the radioactivity counted individually with a gas-flow counter. Treated groups containing at least five insects were analysed individually at intervals during a 10-d period. The radiosensitivity of such treated insects decreased by half in 6-48 h, depending on the diet but 10-20% was retained for at least 10 d. No differences related to post-treatment diet were observed. Nitric acid was employed for digestion of insect tissue prior to ^{14}C gas-flow counting. Conditions are described for reproducible and near-quantitative counting of the isotope.

- 883 Hoopingarner, R., Wilson, G.B. CHROMOSOME EFFECTS OF AZIRIDINYL CHEMOSTERILANTS. Bull.ent.Soc.Am. 13, 3 (1967) 192. Abstr.102, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov.1967".
- Chromosomes were examined at sequential times after 30 min treatment. Mitotic effects were characterized. Most effects were delayed at least one cell generation and persisted several cell generations. The delayed effect was examined by fractionating the chromosomal components after treatment with ^{14}C and ^{32}P aziridinyl compounds. (Abstr.)
- 884 Kilgore, W.W., Painter, R.R. PERSISTENCE OF TEPA INGESTED BY FALL ARMYWORM MOTHS. Bull.ent.Soc.Am. 12 (1966) 288. Abstr.103, at "Portland-Meeting, Portland, Oreg., USA. 28 Nov.-1 Dec.1966".
- A small quantity of ^{14}C has been found in the eggs of house flies chemosterilized with ^{14}C -tepa. Most of the radioactivity is in the acid-soluble fraction of the nucleic acids. It has also been demonstrated that these eggs are low in DNA as has been found for apholate eggs. (Abstr.)
- 885 Kilgore, W.W., Painter, R.R. INSECT CHEMOSTERILANTS: INCORPORATION OF 5-FLUOROURACIL INTO HOUSE FLY EGGS. J.econ.Ent. 59 (1966) 746-747.
- A mixed population of 400 newly emerged adult houseflies was fed a diet containing 0.05% 5-fluorouracil-2- ^{14}C (specific activity 5.0 mCi/mM) for 48 h. The total amount actually incorporated into the fly egg RNA, and existing as 5-fluorouridylic acid, was very small. Evaluation of the nucleotide content of the purified material showed that the sample contained $\sim 0.79 \mu\text{M}$ uridylic acid and $0.0004 \mu\text{M}$ 5-fluorouridylic acid-2- ^{14}C /mg RNA. In treating either sex and then allowing it to mate with the untreated sex 5-fluorouracil-2- ^{14}C was found to be incorporated into sperm while a measurable amount was incorporated into the eggs. The study indicates that the chemosterilant may sterilize M. domestica eggs by replacing the normal metabolite uracil in RNA. This abnormal RNA undoubtedly causes changes in the metabolism of the eggs which is sufficient to render them non-viable. The antimetabolite, or a metabolic product, is transferred to the fertilized eggs through the females, and not the males.
- 886 Kilgore, W.W. CHEMOSTERILANTS. p.197-239 of "Pest Control. Biological, Physical, and Selected Chemical Methods". Kilgore, W., Doutt, R.L., Eds. New York, Academic Press. 1967, 477p.
- Comprehensive review article. In a section dealing with chemicals affecting reproduction, a partial list of which is given in a table, the chemical types of compounds are broken down into three major categories: alkylating agents, antimetabolites, and miscellaneous chemicals. In reviewing work on the metabolism and mechanism of action of antimetabolites and alkylating agents, the use of radioisotopes is indicated for numerous of the studies cited (p.219-225).
- 887 Painter, R.R., Kilgore, W.W. THE EFFECT OF APHOLATE AND THIOTEPA ON NUCLEIC ACID SYNTHESIS AND NUCLEOTIDE RATIOS IN HOUSEFLY EGGS. J.Insect Physiol. 13, 7 (1967) 1105-1118.
- The nucleic acid synthesis in normal viable housefly eggs and non-viable housefly eggs deposited by flies chemosterilized by apholate and thiotepa has been studied. During normal embryonic development, there is a rapid many-fold increase in DNA after an initial lag period. In the chemosterilized eggs there is almost no increase in DNA, but some accumulation of the deoxyribosidic components of the acid-soluble extract. The effect on the levels of RNA and ribosidic components of the acid-soluble extract is less apparent. In an effort to study the metabolism of aziridinyl compounds in houseflies, normal and chemosterilized flies were fed glycine- ^{14}C in an attempt to label the adenine and guanine moieties of egg RNA. The nucleotide ratios of normal housefly eggs has been determined to be similar to that reported for other insect eggs. Apholate-sterilized eggs were significantly lower in adenylic acid than normal-fly egg-RNA. The RNA of the thiotepa sterilized eggs was a little lower in guanylic acid and contained an unidentified compound not present in normal egg RNA. When thiotepa ^{32}P was the chemosterilant, all components of the isolated sodium RNA were labelled. This suggests that thiotepa may have been degraded and the resulting inorganic phosphate reincorporated into the RNA. There was no evidence of alkylated guanine in the RNA.

- 888 Rukavishnikov, B. STERILISATION CHIMIQUE DES INSECTES NUISIBLES. Zashch. Rast. No.3 (1967) 46-51. (In Russian, with French summary)
- 889 Terranova, A.C., Schmidt, C.H. METABOLISM OF HEMPA IN THE CABBAGE LOOPER. Bull. ent. Soc. Am. 12 (1966) 288. Abstr.102, at "Portland Meeting. Portland, Oreg., USA. 28 Nov.-1 Dec.1966".

Several chromatographic analytical techniques were developed. 5th-instar larvae were injected with ^{14}C -hempa; the material was rapidly excreted, over 80% of activity was present in the faeces in 6 h. Analytical and biological results were discussed. (From abstr.)

- 890 Terranova, A.C., Schmidt, C.H. PURIFICATION AND ANALYSIS OF HEMPA BY CHROMATOGRAPHIC TECHNIQUES. J.econ.Ent. 60, 6 (1967) 1659-1663.

Paper chromatography was of little value in determining the purity of hempa because of co-chromatography. Thin-layer chromatography in 8:2 benzene:ethanol on silica gel G successfully separated hempa from seven contaminating materials. Also, gas chromatography on an 8-ft column of 6% (w/w) DEGS separated the eight components present in a sample of ^{14}C -labelled hempa. The quantitation of the mass and radioactive responses was linear from 0.2 ng to at least 20 ng. (Auth.)

- 891 Wickramasinghe, D.N.T. OBSERVATIONS ON THE MODE OF ACTION OF 2-IMIDAZOLIDINONE, A FEMALE STERILANT OF THE ADULT HOUSEFLY Musca domestica L. (DIPTERA: MUSCIDAE). Diss. Abstr. 26, 2 (1965) 680.

Oral administration of 2-Imidazolidinone for prolonged periods caused sterility in female house flies. Depending on the dose, the flies laid a high percentage of non-viable eggs or failed to oviposit. The dose at which almost complete inhibition of oviposition occurred was 0.8% in the diet for at least 4 d prior to the 1st protein meal. The treated flies deposited yolk at a slower rate; had ovaries containing less DNA, RNA, protein, and lipid; and incorporated less injected radioactive acetate into various biochemical fractions than control flies. In addition, the treatment resulted in a decrease in the level of a specific blood protein and accumulation of secretory granules in the neuro-secretory cells of the brain. The increase in neurosecretory material appeared to be correlated with the inability of the treated fly to lay eggs. Whether the antihormonal effect is due to a direct action on the endocrine organs or whether it is a result of a lack of feed-back from the ovaries was not clarified. The data indicate that the drug did not act as an antimutagenic agent nor as an alkylating agent. Rather the evidence suggests an anti-metabolic effect of 2-imidazolidinone. (DA)

1.5.10. Synergists

- 892 Casida, J.E., Engel, J.L., Essac, E.G., Kamienski, F.X., Kuwatsuka, S. METHYLENE- ^{14}C -DIOXYPHENYL COMPOUNDS: METABOLISM IN RELATION TO THEIR SYNERGISTIC ACTION. Science, N.Y. 153 (1966) 1130-1133.

The methylene- ^{14}C group is hydroxylated yielding formate- ^{14}C in the microsome-reduced nicotinamide-adenine dinucleotide phosphate system in vitro and yielding expired $^{14}\text{CO}_2$ in living mice and houseflies. Methylene-dioxyphenyl compounds apparently serve as alternate substrates for this enzymatic hydroxylation system of microsomes, and thus reduce the rate of metabolism and prolong the action of certain drugs and insecticide chemicals. (Auth.)

- 893 Essac, E.G., Casida, J.E. METABOLISM AND ACTION OF METHYLENEDIOXYPHENYL SYNERGISTS IN THE HOUSE FLY. Bull. ent. Soc. Am. 12 (1966) 266. Abstr.62, at "Portland Meeting. Portland, Oreg., USA. 28 Nov.-1 Dec.1966".

Houseflies metabolised each of 7 methylene- ^{14}C -dioxyphenyl compounds to yield $^{14}\text{CO}_2$. The microsome-NADPH₂ system is involved in this metabolism which is apparently initiated by hydroxylation of the methylene group. Studies on synergist metabolism under in vivo and in vitro conditions will be discussed in relation to the mechanism of synergist action. (Abstr.)

- 894 Fishbein, L., Fawkes, J., Falk, H.L., Thompson, S. THIN-LAYER CHROMATOGRAPHY OF RAT BILE AND URINE FOLLOWING INTRAVENOUS ADMINISTRATION OF TROPICAL-METHYLENE- ^{14}C . J.Chromat. 31, 1 (1967) 102-108.

The nature of the metabolites of Tropital-methylene- ^{14}C (I) in rat bile and urine, after intravenous injections of I, was studied by thin-layer chromatography. The bile and urine samples (20 μl) were applied to Silica Gel GF-5 plates. Bile samples were developed with 10:10:1 PhMe-HOAc- H_2O and urine samples with 70:10:20 EtOAc-HOAc-MeOH. The developed plates were photographed in colour under u.v. (2537 Å) illumination, then 4-d autoradiograms were made of the plates. Finally, each plate was sprayed with the chromotropic acid reagent of Beroza (CA 58:4986e) heated 5-10 min at 120°C, and photographed by the procedure of Fishbein et al. (CA 66:114861z). The R_f values and the duration and appearance times are tabulated for the 14 metabolites observed in the bile samples and the 4 metabolites in urine samples (CA 68:1966, 2234g).

- 895 Garren, R., Jr. UPTAKE AND DISTRIBUTION OF LABELED DIMETHYLSULFOXIDE AND ITS INFLUENCE ON NUTRITIVE ELEMENT TRANSPORT IN PLANTS. *Ann. N.Y. Acad. Sci.* **141**, 1 (1967) 127-130.

The penetration and distribution of dimethyl sulphoxide (DMSO) in a 2-yr-old pear tree, *Pyrus calleryana*, was followed by means of ^{35}S -labelled DMSO [using $(\text{CH}_3)_2^{35}\text{S}$], to provide information on systemic distribution, time involved, and possible phytotoxic symptoms. The ability of DMSO to penetrate through bark tissue and to become systemic in young pear trees was demonstrated. - In another study, the enhancement of ^{32}P -uptake by roots of 1-yr-old strawberry plants, *Fragaria ananassa*, in both soil and nutrient solutions treated with DMSO was demonstrated.

- 896 Kuwatsuka, S., Casida, J.E. SYNTHESIS OF METHYLENE- ^{14}C -DIOXYPHENYL COMPOUNDS: RADIOACTIVE SAFROLE, DIHYDROSAFROLE, MYRISTICIN, PIPERONYL BUTOXIDE, AND DIASTEREOMERS OF SULFOXIDE. *J. agric. Fd Chem.* **13** (1965) 528-533.

Five radiolabelled methylenedioxyphenyl compounds, all active as insecticide synergists, were prepared. 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, sulfoxide synergist {1,2-methylenedioxy-4-[2-(octylsulfinyl)propyl]benzene}, and piperonyl butoxide { α -[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, octylsulfinyl, and octylsulfonyl analogues of sulfoxide synergist, substituted on the 1-, 2-, or 3-position of the propyl group, were prepared in non-radioactive form for comparative purposes. Sulfoxide synergist and the 1-octylsulfinyl analogue were resolved by chromatography into the enantiomorphs of the diastereoisomers about the sulfoxide 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*) was compared for all the non-radioactive methylenedioxyphenyl compounds prepared. Carbaryl was highly synergized in its toxicity to houseflies by safrole, dihydrosafrole, and piperonyl butoxide, but less effectively by analogues of sulfoxide synergist. The three (octylthio)propyl analogues were more effective than their sulfoxides and sulfones for carbaryl synergism and, in each series, the potency decreased in the order of 1 > 2 > 3 for the position of sulphur attachment to the propyl group. (NSA 20:1966, 41014)

- 897 Metcalf, R.L. MODE OF ACTION OF INSECTICIDE SYNERGISTS. *A. Rev. Ent.* **12** (1967) 229-250.

Review article. Individual sections deal with pyrethroids (site of detoxication relation of structure to synergism), carbamates (N-dealkylation of carbamyl group, hydrolysis, relation of structure to synergism, carbamate detoxifying enzymes and synergism, synergism by organocyanates), organophosphates (activation, N-demethylation and hydrolysis of OP compounds, OP hydrolysing enzymes, synergists), and DDT (DDT-detoxifying enzymes, structure and activity of DDT synergists, synergism with other DDT analogues, resistance to DDT-synergist combinations). - Radioisotopes had been used in numerous studies. (The author's bibliography is complete up to April 1966.) Some otherwise unpublished work by M.F. Osman, the author and T.R. Fukuto is cited on "Metabolism of C^{14} -labelled carbamate insecticides to C^{14}O_2 in the house fly". With 2-isopropoxyphenyl-N- ^{14}C -methylcarbamate (Baygon®), from 1-2% of the absorbed dosage was converted to CO_2 in 24 h but with 2-isoprop-1,3- ^{14}C -oxyphenyl N-methylcarbamate, an average of ~30% was converted to $^{14}\text{CO}_2$. Pretreatment of the flies with 50 μg of piperonyl butoxide decreased the $^{14}\text{CO}_2$ output from the 2-isoprop-1,3- ^{14}C -labelled compound to 6-8% of the amount absorbed. These data strongly suggest the major pathway of Baygon® detoxication in *Musca domestica* to be O-dealkylation of the

isopropoxy side chain to form ultimately 2-hydroxyphenyl N-methylcarbamate, which is doubtless hydrolysed and conjugated. N-dealkylation of the N-methyl group to form 2-isopropoxyphenyl N-hydroxymethylcarbamate, followed by conversion to the unsubstituted carbamate and to formaldehyde, and then to CO₂ would appear to be a less important pathway.

- 898 Moos, W.S., Kim, S.E. RADIOPROTECTIVE EFFECT OF TOPICALLY APPLIED DIMETHYL SULFOXIDE ON MICE. *Experientia* 22, 12 (1966) 814-815. (In English)

Dimethyl sulfoxide (DMSO) applied topically to the major part of mice tails prior to lethal amounts of x-rays offered considerable protection, with 4 of 10 DMSO-treated and 2 of 10 water-treated mice surviving 30 d after a 760-R exposure. Application of DMSO after irradiation did not alter survival significantly. A single treatment with DMSO for 1 or 5 min before irradiation was as effective in providing protection against x-rays as daily immersions. (CA 66:1967, 26452m)

- 899 **ERRATUM:** This reference should have followed ref.581. O'Brien, R.D. TARGET ENZYMES AND INSECTICIDAL ACTION. p.35-39 of "Research in Pesticides". Proceedings of the "Conference on Research Needs and Approaches to the Use of Agricultural Chemicals from a Public Health Viewpoint. Davis, Calif., USA, 1-3 Oct.1964". Chichester, C.O., Ed. New York, Academic Press. 1965, 380p.

Two different approaches to the study of target enzymes appear valuable in the design of insecticides. One approach is the examination of the properties and the precise mechanism of inhibition of known target enzymes. The other is to hunt for new targets to attack. The most fully understood target enzyme is cholinesterase, the target for organophosphate and carbamate insecticides. In the light of a great deal of varied experimental evidence which included data from using radioisotopes it would appear that some real differences exist among cholinesterases, and that these differences can cause selective toxicity, which offers hope for the invention of new selective compounds. In the search for new targets one may (i) explore the mechanism of action on known toxicants, (ii) attempt to inhibit known enzymes or systems whose blockade might be suspected to be lethal, and (iii) look for targets whose identity is unknown (e.g. the neuromuscular junction of insects differs radically from vertebrates in being non-cholinergic).

- 900 Tzanakakh, M.E. SYNERGISM AND INSECTICIDE ACTIVATION. *Hém.Hron.* 28 (1963) 86-97. (In Greek)

General article.*

* Original not available.

See also:

- 625 Effect of various synergists on toxicity and in vivo metabolism of DDT in *Triatoma infestans* nymphs. (Fine, B.C. et al., 1966)
- 797 Relation between synergism and metabolism of dimethoate in mammals and insects. (Uchida, T. et al., 1966)

1.5.11. Repellents

- 901 Lal, H. DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT. AD-633782, Armour Research Foundation, Chicago, Ill. Jul.1962, 4p.

The objective of the research programme is to develop orally administered insect repellents affording better and longer-lasting protection than conventional surface repellents. Current efforts are concerned with securing selected surface repellents, establishing certain physico-chemical properties of these chemicals and the development of a mosquito colony. (Auth.)

- 902 Lal, H. DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT. Progress Report for 1 Nov.1962 - 31 Jan.1963. AD-617896, IIT Research Inst., Chicago, Ill. Jan.1963, 15p.

The objective of this programme is to develop a mosquito repellent which is effective when given internally, preferably orally, in order to afford better protection than the conventional surface repellents presently available. Development of a bioassay technique for testing candidate agents using mice as bait and radioactive albumin as an indicator and the repellent properties of several chemical compounds were previously reported. The present report describes further progress on this programme. (Auth.)

1.5.12. Miscellaneous (including Host Plant Resistance)

- 903 Klun, J.A., Brindley, T.A. ROLE OF 6-METHOXYBENZOXAZOLINONE IN INBRED RESISTANCE OF HOST PLANT (MAIZE) TO FIRST-BROOD LARVAE OF EUROPEAN CORN BORER. J.econ.Ent. 59 (1966) 711-718.

11 maize inbreds were used in a quantitative analysis for 6-methoxybenzoxazolinone (6MBOA) by the technique of isotopic dilution. 2-¹⁴C-6-Methoxy-2(3)-benzoxazolinone was synthesised, and isolation and purification of 6 MBOA from plant tissues were accomplished by thin layer chromatography. A correlation exists between the amount of 6MBOA produced by 11 inbred strains of maize at the whorl stage of plant development and the field rating of resistance of the inbred strains to 1st-brood larvae of the European corn borer, Ostrinia nubilalis (Hübner). The correlation can be expressed by the general equation:

$\text{Log}_{10} (\text{concentration of 6MBOA}) = K(\text{resistance rating}) + B$, where K and B are constants.

Highly resistant inbred lines yielded about ten times more 6 MBOA than the highly susceptible inbred strains. The yield of 6MBOA or the content of the glucoside precursor of inbred strains of maize may serve as an indicator of the degree of resistance a given inbred strain may express in the field. Bioassay tests of 6MBOA showed the compound to be an inhibitor of the rate of borer pupation when it was incorporated into an artificial diet at a concentration of 0.5 mg/g diet. No significant difference of mortality or average pupal weight was detected. Addition of vitamin supplement to the diet of the borer grossly attenuated the effect of 6MBOA. If 1 g of diet is assumed to be equivalent to 1 g of tissue from fresh corn plants, the concentration of 0.5 mg per g diet is twice the concentration found in any inbred strain analysed for content of 6MBOA. Evidence indicates that 6MBOA is of little consequence in the phenomenon of resistance. However, precursors of 6MBOA may play an active role. (Auth.)

2. IONIZING RADIATIONS

2.1. CELLULAR AND GENETIC EFFECTS

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

- 904 ERRATUM: This reference should have followed ref. 694.

Albanus, L., Heilbronn, E., Sundwall, A. ANTIDOTE EFFECT OF SODIUM FLUORIDE IN ORGANOPHOSPHORUS ANTICHOLINESTERASE POISONING. Biochem. Pharmac. **14**, 9 (1965) 1375-1381.

The effect of NaF in sarin, Tabun, and $^{35}\text{S-N}^+$ (the thiocholine analogue of sarin) poisoning was studied. In mice NaF alone could not protect against sarin, but had a substantial antidote effect against $^{35}\text{S-N}^+$. When given prophylactically together with atropine, NaF (20 mg/kg) increased the LD 50 of sarin 4.5-fold, that of $^{35}\text{S-N}^+$ 7.5-fold, and that of Tabun 2.5-fold. Therapeutic effect in sarin and Tabun poisoning was noticed. Brain and particularly muscle cholinesterase from sarin-poisoned mice was higher after previous administration of NaF, and the cholinesterase activity of the erythrocytes from sarin-poisoned dogs increased upon administration of NaF. In anaesthetized sarin-poisoned cats NaF restored the blocked neuromuscular function. The effect on the bradycardia and on the blood pressure was small. (CA)

- 905 Baccetti, B. ATOMIC ENERGY IN THE CONTROL OF INSECTS. Georgofili **9** (1962) 319-334. (In Italian)

The effect of ionizing radiation on the life span, fertility, and histologic structure of various species of insects is surveyed, and relative radiosensitivities of the species are compared. Success of the sterile male technique with different insect pests is outlined. Problems encountered in raising large numbers of insects for field studies are pointed out and discussed. Requirements that must be met for use of the sterile male technique on a large scale are listed and discussed. The author discusses, in particular, his own studies on Dacus oleae and Thaumetopoea pityocampa (pine tree pest). (NSA 21: 1967, 18178)

- 906 Chiang, J. J. H. STUDIES ON THE INHERITABLE VARIABILITY OF RADIATION OF INSECTS AND THE BIOLOGICAL CONTROL OF (?) STERILIZED INSECTS. J. Agric. For., Nanking **14** (1965) 255-269. (In Chinese)

- 907 Dubinin, N. P. "EVOLUTION OF POPULATION AND RADIATION". Atomizdat, Moscow, USSR, 1966, 743p. (In Russian)

The book discusses theoretical and experimental fundamentals of modern general and radiation genetics of population, and includes mutagenic effects on plants, insects and domestic animals.

- 908 European Atomic Energy Community. Leiden Rijksuniversiteit (Netherlands). MOLECULAR AND RADIATION GENETICS (ANNUAL REPORT 1965). Euratom Inf. **4**, 11/12 (1966) 1284.

The report covers investigations of the structural and functional effects of ionizing radiation upon various types of DNA under a variety of conditions, as well as investigations of further promising and far-reaching systems. In parallel, extensive investigations are made of the mechanism of

induction of mutations in Drosophila by ionizing radiation with an emphasis on the elucidation of processes involved in postradiation repair. (From Nucl. Med.)

- 909 Gorodetskiĭ, A. A., Ed. THE BIOLOGICAL ACTION OF NEUTRON RADIATION. "Biologicheskoe Deistvie Neitronnogo Izlucheniya". Kiev, Ukrainian SSR, Naukova Dumka Publishing House. 1965, 133p. TT-65-32317. Springfield, Va. 1965, 135p. Translation.
- Some mention of work with Drosophila, though most of the work deals with other systems. The relative biological effectiveness of fast neutrons is compared with x- and γ -radiation in a number of biological systems.
- 910 Grosch, D. S. "Biological Effects of Radiations. A Blaisdell Book in the Pure and Applied Sciences". New York, Blaisdell Publishing Co. 1965, 306p.
- The major principles and problems of radiation biology are presented in an orderly framework from which students can expand subjects of particular interest. After introductory considerations of the radiations and their direct and indirect modes of action, the discussion continues through the cellular to the tissue, organ, and organism level of effect. Industrial applications of radiation for pest control and food processing are discussed briefly. Each of the 16 chapters is followed by a list of references. (From NSA 19: 1965, 42346)
- 911 Klimpinya, A. DER EINFLUSS DER GAMMA-STRAHLUNG AUF Pegomya hyoscyami. (The effect of γ -radiation on Pegomya hyoscyami.) (Entomophaga 12: 1967, 1294) Zashch. Rast. Vredit. Bolez. (1965) 41-43. (In Russian)
- 912 Lambrev, Z., Dushev, T. EFFECT OF IONIZING RADIATION ON SILKWORM (Bombyx mori). (Bag: 1966, 96711) Nauchny Trud. vissh. selskop. Inst. Vasil Kolarov 14, 2 (1965) 179-182.
- 913 Montalenti, G. "The Scientific Research Promoted by the Commission for Study of Genetics (now National Center of Genetics) of the National Research Council from its Institution (20 Jul. 1961 - 31 Dec. 1968). Rome, Consiglio Nazionale delle Ricerche". 1964, 224 p.
- The genetic studies on plants, insects, microorganisms, monkeys, other mammals, and man carried out at the Universities of Milan, Padua, Bari, Pisa, Firenze, Pavia, Parma, Turin, Cagliari, Naples, Rome, and Modino and by the Istituto Superiore de Sanita and the Centre for the Study of Genetics at Pavia are briefly summarized. The publications made on completed studies are tabulated. (NSA 19: 1965, 21809)
- 914 Rai, K. S. TECHNIQUES FOR THE STUDY OF GENETICS AND CYTOGENETICS OF VECTORS. In "Genetics of Disease Vectors". Wright, J., Pal, R., Eds. Amsterdam, The Netherlands, Elsevier Publishing Company. In press 1967.
- 915 Stern, C. RADIATION, MUTATION RATES AND DEVELOPMENTAL GENETICS OF Drosophila. p. 85 of "Research and Development in Progress - Biology and Medicine. Issue No. 4". TID-4204, Division of Biology and Medicine (AEC), Washington, D. C. Apr. 1966, 229p. Abstr. B1A 2467.
- x-rays to be used.
- 916 Zimmer, K. G. SOME UNUSUAL TOPICS IN RADIATION BIOLOGY. Radiat. Res. 28 (1966) 830-843.

Among the topics discussed in the lecture, presented at the 14th Annual Meeting of the Radiation Research Society, Coronado, Calif. were Single Hit Effects in Radiobiology. Experiments with Drosophila on sex-linked lethal mutations indicate a single-hit effect. The influence of the stage of germ cells on x-ray-induced mutations is shown by dose effect curves for various stages of germ cells. Radiation studies on water snails demonstrate that single-hit curves can arise through superposition of multi-hit curves. γ -radiation experiments with RNase in air and in N_2 result in single-hit inactivation curves.

See also:

- 1287 Effect of ionizing radiation x-rays on the silkworm (Bombyx mori). (Lambrev, Z. et al., 1965)
1260 Biological organization in relation to differential gene response to mutagens. (Fahmy, O. G. et al., 1965)
1290 Effects of γ -radiation on the cotton stainer. (Simon, F. et al., 1963)

2.1.2. Nuclear and Cytoplasmic Biochemistry, Physiology and Ultrastructure

- 917 Bonnier, G. NOTE ON THE RELATIVE SENSITIVITY TO IRRADIATION DAMAGE IN HOMOZYGOUS AND HETEROZYGOUS Drosophila melanogaster WITH REGARD TO THEIR CAPACITY OF PRODUCING OFFSPRING. Hereditas 40, 2/3 (1959) 676-677.

Doses of 6-10 kR of x-rays were administered to D. melanogaster, Canton-S. Differential radio-sensitivity was observed in different stocks. The degree of x-ray sensitivity was largely dependent on the degree of homozygosity. The dose effect is described.

- 918 Borstel, R.C., von INDUCTION OF NUCLEAR DAMAGE BY IONIZING AND ULTRAVIOLET RADIATION. p. 243-250 of "Progress in Photobiology". Christensen, B. C., Buchmann, B., Eds. Amsterdam, Elsevier. 1961.

To assess radiation effects on the nucleus, the haploid-diploid genetic system of the wasp Habrobracon were studied and the results correlated with data for the fruit fly Drosophila. The value of the haploid cell is in its lack of two genetic complements that would buffer, cover, or alter the radiation effects. Nuclear radiation damage was divided into five classes according to the various syndromes associated with death of the cell or embryo. These are summarized as follows: Type I, death after one or a few nuclear divisions; Type II, death after many nuclear divisions (in Habrobracon characterized by death after blastoderm formation and before hatching in unfertilized eggs, death occurs predominantly after hatching in fertilized eggs); Type III, death after many nuclear divisions (in Habrobracon death occurs after blastoderm formation and before hatching in unfertilized and fertilized eggs); Type IV, death and pycnosis soon after irradiation (characteristic of lymphocytes, young primary gametocytes, late gonial cells, and neuroblasts); and Type V, dominant lethality expressed in eggs after irradiation in the gonial stage (in Habrobracon, embryo dies late in development). In Habrobracon, the Type-I lethal syndrome can be induced by agents that inhibit meiosis or mitosis. Therefore, the depression of the rate of the mitoses following meiosis is a sufficient action of the radiation to bring about the Type-I lethality syndrome. Type II lethality can be attributed to chromosome imbalance of limited extent. Following treatment of oocytes with ionizing radiation, a small consistent fraction of Type-I lethality is repaired when the egg is fertilized with a normal sperm. It seems likely that the Type-I lethality from irradiation of the nucleus can be induced through at least two distinct mechanisms, one capable of being reactivated. (NSA 21: 1967, 16491)

- 919 Borstel, R.C. von EFFECTS OF RADIATION ON CELLS. p. 60-125 of "The Biological Basis of Radiation Therapy". Schwartz, E., Ed. London, Pitman Medical Publishing Co., Ltd. 1966, 624p.

After dealing with kinetic considerations the author describes manifestations of radiation-induced cellular injury and modifications of response. A series of tables have been compiled. The tables giving a survey of relative sensitivity of the nucleus and cytoplasm to irradiation includes some studies on insects (p. 80-81), also in the table on the types of cell killing and sperm inactivation events induced by radiation or chemical mutagens in mature gametes and during gametogenesis (p. 82-83, consisting essentially of expanded data of III/998), and some references to insects in the survey of studies concerned with chromosome number and x-ray sensitivity (p. 105-106). A total of 242 references are given.

- 920 Kernaghan, R.P. GENETIC CONTROL OF XANTHINE DEHYDROGENASE IN Drosophila melanogaster. Thesis, Connecticut Univ., Storrs. 1963, 86p.

Xanthine dehydrogenase activity in *D. melanogaster* is controlled by at least three functional units; rosy (*ry*), maroon-like (*ma-l*), and bronzy (*bz*). Mutation in any one of the units results in a pleiotropic phenotype including the absence of xanthine dehydrogenase activity. 24 x-ray induced rosy mutants selected with a chromosome totally deficient for the rosy genetic unit, fail to complement *ry*². These data support the notion that the rosy⁺ unit conditions a single function in the control of xanthine dehydrogenase activity. Several rosy mutants which occupy separable mutational sites in the rosy unit, as well as *ma-l*¹, *ma-l*², and *bz* were analysed with respect to the presence of an altered enzyme molecule capable of cross reacting with antibody to xanthine dehydrogenase (CRM). Extracts of wild type and mutant genotypes were partially purified with Sephadex. Xanthine dehydrogenase activity was estimated by the increase in optical density at 395 mμ due to the production of reduced thionicotinamide adenine dinucleotide as a measure of the enzymatic conversion of 2-amino-4-hydroxy-pteridine to isoxanthopterin. Mutant extracts were tested for their ability to remove specific anti-enzyme activity from antibody preparations. The anti-enzyme activity remaining following pre-treatment was estimated by the addition of active enzyme and subsequent assay of residual enzyme activity. *Ma-l*¹ and *bz* were positive while *ma-l*² was negative with respect to CRM activity. Several rosy mutants (*ry*¹, *ry*², *ry*³, *ry*⁴, and *ry*²³) were substantially negative. An anti-*ma-l*¹ antibody preparation inactivated the wild type enzyme whereas an anti-*ry*² antibody preparation was ineffective. These data are interpreted on a combining subunit hypothesis with contributions from rosy, maroon-like, and bronzy genetic units producing the xanthine dehydrogenase molecule. (DA)

- 921 Khashim-Akhmed, M.S. CYTOGENETIC ANALYSIS OF LETHAL MUTATION INDUCED DURING DIFFERENT STAGES OF SPERMATOGENESIS IN *Drosophila*. *Vest. leningr. gos. Univ.*, Ser. Biol. 20, 4 (1965) 85-93. (In Russian, with English summary)

Premeiotic stages of spermatogenesis of *D. melanogaster* (D-18), after irradiation by x-ray 2000 R show a higher percentage of mutation when treated males were transferred to high temperature (38.5°C) for 8 h as compared to 25°C. This phenomenon does not occur at a higher dose of 4000 R. The effect of higher temperature on the x-ray induced rate of point mutation in these stages may involve an enhancement of the restitution mechanism which gives rise to interstitial micro-aberrations and lethals. High temperature led to an insignificantly higher rate of induced sex-linked lethals in 9 out of 10 repetitions in postmeiotic stages (sperms and spermatids). The difference in per cent of recessive lethals in sperm and spermatid stages is due mainly to higher induced chromosomal aberrations in the latter. Between post- and premeiotic stages there is a period of complete sterility, the duration of which was more than 2 d for 2000 R and more than 5 d for 4000 R, and complete sterility was absent during spermatogenic stages of males irradiated with 550 R and 700 R. (From auth. summ.)

- 922 Kroege, H. ZELLPHYSIOLOGISCHE MECHANISMEN BEI DER REGULATION VON GENAKTIVITÄTEN IN DEN RIESENCHROMOSOMEN VON *Chironomus thummi*. (Cell physiological mechanisms in the regulation of gene activities in giant chromosomes of *Chironomus thummi*.) *Chromosoma* 16, 1 (1964) 36-70. (In German, with English summary)

The sequence of appearance and disappearance during normal development of 7 puffs in the giant chromosomes of the salivary gland of *C. thummi* is described. Among these the loci sensitive to a sudden increase in the titer of ecdysone are determined by transplantation of whole glands into prepupae. The cytological effect of ecdysone is copied by $ZnCl_2$ at $2.3 \times 10^{-2} M$ concentration both in the intact larva and in the explant. Identical effects are produced by chloroform, butanol and high doses of urethane. Salivary gland cells explanted into haemolymph without addition of Zn^{++} or narcotics change their puffing pattern spontaneously; they revert their direction of development and return to a more juvenile stage. This process is investigated in detail and is found to copy the action of juvenile hormone; it is termed rejuvenation. Rejuvenation and ecdysone effect are antagonistic reactions and exclude one another. Aside from explantation rejuvenation is brought about by x-irradiation, oxygen poisoning and mechanical injury. Rejuvenation proceeds in the partial or total absence of cytoplasm in isolated nuclei. A technique is described that allows for a removal of various fractions of the karyotype from salivary gland nuclei. Using this method it is determined that during rejuvenation the genetic loci form puffs independently of one another and regardless of the presence or absence of the larger part of the karyotype. It is argued that a similar independence of other loci must exist in response to ecdysone. In the explant $ZnCl_2$ starts to lose its power to counteract rejuvenation and to copy the effect of ecdysone at concentrations below

$2.8 \times 10^{-5} M$. The threshold at which the ecdysone effect is replaced by rejuvenation varies independently from one cell to the next. It can be altered by special handling during the process of explantation. Rejuvenation and the ecdysone effect, as produced by Zn^{++} , are all-or-none reactions; once initiated they both proceed fully to their end points. Zn^{++} has the same effect in haemolymph with a low ecdysone titer as in haemolymph with a high ecdysone titer. Rejuvenation produced by oxygen poisoning in intact larvae persists for more than 20 h after transfer to normal conditions. Once established rejuvenation cannot be reversed by ecdysone imitators. It is concluded that a system controlling the activity of genetic loci resides in the nuclear sap. It is argued that ecdysone and juvenile hormone act via this control system. It is argued that patterns of genetic activities are not maintained and correlated by feedback of the single loci with the cytoplasm or by interaction of parts of the genome. Instead the loci seem to respond individually to a situation prevailing in the nuclear sap. The combination of genes active at any given time (and, therefore, the combination of enzymes available to a cell at any given time) is predetermined by the individual sensitivities of the loci towards the control system in the nuclear sap. The genetic loci acquire their individual sensitivities during the process of determination. (Auth.)

- 923 Lasora, Z. NUCLEIC ACIDS IN NORMAL AND γ -RAYS IRRADIATED EGGS OF *Bombyx mori*. *Acta biochim. pol.* 14, 1 (1967) 7-20.

Normal eggs of *B. mori* contained at diapause about 0.2 mg of DNA and 3 mg of RNA per 1 g. The DNA content increased about 6-fold on embryogenesis and RNA increased by about 70% but before hatching decreased back to diapausal level. The effects of γ -rays given at diapause, were visible at postdiapausal period only; 5 kR resulted in delayed DNA synthesis and reduced by 15% the hatching; 20 kR delayed the synthesis of DNA, damaged the synthesis of RNA and inhibited hatching completely; 200 kR stopped the synthesis of DNA and induced the break-down of RNA. The eggs were less susceptible to 20 kR when irradiated after the peak of RNA synthesis had been attained. The damage of gastrular RNA synthesis is suggested as a probable cause of injured embryogenesis in 20 kR treated eggs. (Auth.)

- 924 Nakanishi, Y.H., Iwasaki, T., Kato, H. CYTOLOGICAL STUDIES ON THE RADIOSENSITIVITY OF SPERMATOGONIA OF THE SILKWORM. p. 28-29 of "Annual Report 1964". NIRS-4, National Inst. of Radiological Sciences, Chiba (Japan). Dec. 1965, 94p.

Six successive generations or stages of spermatogonia were accurately identified microscopically. Their relative radiosensitivity was determined by scoring the number of gonocytes containing pycnotic spermatogonia I-VI following irradiation with 1000 R of x-rays, at 300 R/min. An autoradiographic study with 3H -thymidine revealed a significant difference in the percentage of labelled gonocytes among different stages of pycnotic spermatogonia. A definite correlation between radiosensitivity and degree of DNA synthesis at the time of irradiation is indicated. Results showed spermatogonia VI to be most susceptible to x-rays in terms of production of pycnotic degeneration and chromosome clumping. Radiosensitivity was found to decrease in spermatogonial stages VI to I, in that order.

- 925 North, D.T., Holt, G.G. THE CYTOGENETIC BASIS OF RADIORESISTANCE IN LEPIDOPTERA SPECIES, *Trichoplusia ni*. *Genetics* 56, 3 Pt. 2 (1967) 580. Paper presented at the "1967 Meetings of the Genetics Society of America. Stanford, Calif., USA. 31 Aug. - 2 Sep. 1967".

The cabbage looper *T. ni*, as most species of Lepidoptera, is highly resistant to radiation. The chromosomes of Lepidopteran species possess diffuse centromeres and this appears to be the contributing factor to the high degree of radioresistance exhibited by the cabbage looper. The role of the diffuse centromeres in relation to radiation-induced dominant lethal mutations, cell death, and sperm formation will be discussed as well as physiological effects of radiation on mature spermatozoa as they relate to the radioresistance. (Abstr.)

- 926 Rai, K.S. A CYTOGENETIC STUDY OF THE EFFECTS OF X-IRRADIATION IN *Aedes aegypti*. *Caryologia* 17 (1963) 595-607.

- 927 Riemann, J.G. A CYTOLOGICAL STUDY OF RADIATION EFFECTS IN TESTES OF THE SCREW-WORM FLY, *Cochliomyia hominivorax* (DIPTERA: CALLIPHORIDAE). *Ann. ent. Soc. Am.* 60, 2 (1967) 308-320.

When pupae were irradiated with γ -rays from ^{60}Co , wide differences were found in the radiosensitivity of different cell types in screw-worm testes. Almost all very young primary spermatocytes were

apparently killed after having received only 100 R. Most secondary spermatogonia were killed with 500 R, and total destruction of the primary spermatogonia in different testes occurred over a range of dose levels from 1500-3000 R. In testes irradiated with 6000 R, necrosis of most young spermatocytes and of all but a few early secondary spermatogonia was evident at 6-7 h. Until the 8th hour most primary spermatogonia did not show evidence of necrosis and some non-degenerate cells of this class were still seen at 12 h but not at 25 h. Death of all cells apparently occurred during interphase or perhaps very early prophase. Even at the highest dose level (6200 R), secondary spermatocytes and those primary spermatocytes that had reached a certain stage of development were not killed. However, they did suffer gross chromosomal damage, and most spermatids formed from them failed to develop into normal-appearing sperm. No morphological changes could be seen in those cells irradiated as spermatids or as immature sperm, and they developed into normal-appearing mature sperm. The stages in the recovery of spermiogenic activity were traced out in flies that had received 1500 R as 2-d-old pupae. (Auth.)

- 928 Sado, T. CYTOLOGICAL EVALUATION OF DOSE-RATE EFFECTS OF RADIATION ON MUTATION FREQUENCY OF SILKWORM GONIA. I. KINETICS OF PROLIFERATION AND KILLING OF SPERMATOGONIA DURING CHRONIC IRRADIATION. *Mutation Res.* 3, 6 (1966) 510-21.

The kinetics of proliferation and killing of spermatogonia of young silkworm larvae during chronic irradiation (^{60}Co or ^{137}Cs γ -rays, 0.126 or 0.130 R/min for 5 d; total dose, 900 R) was studied. The following kinetic indices were determined at various intervals after the onset of the exposure: (a) total viable cell (or gonocyst) counts, (b) incidence of pycnosis, (c) mitotic index, and (d) labelling index, or the percentage of cells that take up ^3H -thymidine in 1 h after isotope administration. The results indicate: (1) The majority of secondary spermatogonia were killed during chronic irradiation, and only a few of them (12 cysts per testis) survived the exposure when the larvae were irradiated between 5 and 10 d after hatching where the Type II dose rate effect is observed. (2) With regard to the primary spermatogonia, there was a considerable suppression of mitosis as well as a block of cells in G_1 entering the S phase during the early intervals after the onset of the chronic exposure starting on day 5 after hatching. The distribution of cells at various phases of the cell cycle during chronic irradiation was significantly different from that of unirradiated cell populations to which a single acute dose is generally given to compare the dose rate effect on mutation induction. (3) The radiosensitivity of spermatogonia (both primary and secondary) varied, depending upon the developmental stage of the larvae. The earlier the larvae were exposed to chronic irradiation, the less sensitive were the spermatogonia to radiation killing and mitotic inhibition. The significance of these findings to the mechanism of dose rate effect on mutation frequency in silkworm gonads is discussed. (From auth. summary)

- 929 Tahmianian, T.N., Devine, R.L., Wright, B.J. AN ELECTRON MICROSCOPE STUDY OF THE EFFECT OF X-IRRADIATION ON DIAPAUSE GRASSHOPPER EMBRYOS. p. 219 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, 26 Jun.-2 Jul. 1966, 263p". Abstr. 870.

In former communications, the effect of x-irradiation on diapause grasshopper embryos was discussed. Diapause is a stage of arrested development in which metabolism is basal and cell duplication does not occur. The embryos remain in "suspended animation" until diapause is interrupted by chilling at 0-5°C for 3 months. After chilling, the embryos develop and hatch in 17 d. A dose of 25 kR during diapause abolishes anabolism but catabolism continues at an accelerated rate. Morphological observations with the light microscope indicate both cell shrinkage and nuclear pyknosis. The embryo undergoes "negative" growth and becomes smaller; it does not maintain normal size. Presently, the electron microscope reveals that the ribosomes disappear and the nuclei become myelinated and pyknotic so that individual chromatin masses are not discernible. The mitochondria throughout the period of negative growth studied appear morphologically normal up to 40 d post-irradiation. The mitochondrial membranes and cristae mitochondrialis survive until the embryo becomes very small. At this time, the mitochondria degenerate and form a separate pyknotic sphere. Since yolk present about the embryo remains constant, it appears that the relationship of the process of anabolism to tissue transformation and maintenance is destroyed. Furthermore, it appears either that RNA and DNA are more susceptible to ionizing radiation than the oxidative mechanisms of the mitochondria, or that a feedback mechanism that maintains the integrity of the chromatin during the quiescent period of diapause is interrupted. Slides of electron photomicrographs were shown to illustrate the state of cells irradiated during diapause. (From abstr.)

- 930 Treherne, J. E. THE COMPARATIVE PHYSIOLOGY OF THE TRANSFER OF SUBSTANCES BETWEEN THE BLOOD AND CENTRAL NERVOUS SYSTEM. p.4 of "Studies in Comparative Biochemistry. Proceedings of a Symposium of the Biochemical Society. Munday, M. A., Ed. ". Int. Ser. Monographs pure appl. Zool. Div. 23 (1967) 208p.

- 931 Zimmering, S., Fowler, G. x-IRRADIATION OF THE Drosophila MALE AND ITS EFFECT ON THE NUMBER OF SPERM TRANSFERRED TO THE FEMALE. Z. VeterbLehre 98 (1966) 150-151.

Experiments were carried out to determine the number of sperm transferred by the male Drosophila after irradiation, with 5000, 25 000, and 50 000 R acute doses (1000 R/min) of x-radiation. Reductions were 20 - 25%, 60-65%, and 85 - 90%, respectively. Thus, at a dose (5000 R) used in many radiation experiments, a significant proportion of sperm failed to be transferred. Some aspect of sperm behaviour, possibly motility, may have been affected by x-radiation. An unexplained result from these experiments was that the proportion of sperm in the spermatheca was greater at higher doses of x-radiation. Preliminary experiments suggested that this was related to the small size of the ejaculate, and not to the effect of the x-rays. Sperm in ejaculates of relatively small size (< 50) from unirradiated males were observed to distribute themselves such that 20-50% or more were observed in the spermathecae. Should the mean percent of sperm in the spermathecae turn out to be of the order of 50% or so from ejaculates of 50 sperm or fewer, it could account for the apparent 1 : 1 sperm : progeny ratio previously reported from ejaculates of this size. In earlier experiments, only sperm in the ventral receptacle was scored. (NSA 21: 1967, 26650)

See also:

- 169 Biochemical mechanisms of hormone action. (Karison, P., 1961)
- 934 Evidence of a diffuse centromere in the European corn borer, Ostrinia nubilalis (Lepidoptera: Pyralidae). (Barry, B. D. et al., 1967)
- 944 Cytogenetic analysis of lethal mutations induced at various stages of spermatogenesis. (Hashim-Ahmed, M. S., 1965)
- 973 The effect of x-radiation on the spermatogenesis in certain grasshoppers. (Suomalainen, H. O. T. et al., 1966)
- 976 Comparative study of the radiosensitivity at different stages of oogenesis. (Trikhomirova, M. M., 1967)
- 978 Radio-induced mitotic delay in spermatogenesis of Drosophila melanogaster. (Traut, H., 1966)
- 996 Electron microscope studies of early morphological effects of x-rays on the internal structure of the chromosome. (Carlson, J. G., 1963)
- 997 Studies of early effects of radiation on chromosomes and mitosis. Progress Report, March 1, 1966-February 28, 1967. (Carlson, J. G., 1967)
- 1016 Early chromosomal response to x-rays. (Leach, W. M. et al., 1966)
- 1017 Lack of x-ray induced chromosome "stickiness" in grasshopper neuroblasts. (Leach, W. M., 1967)
- 1025 Evidence for the two-hit nature of x-ray induced crossing-over in the centromeric region of Drosophila males. (Olivieri, G. et al., 1964)
- 1042 x-ray induction of 2:2:3 translocations in mature and immature oocytes of Drosophila melanogaster. (Traut, H., 1967)
- 1046 Linkage group-karyotype correlation in the house fly determined by cytological analysis of x-ray induced translocations. (Wagoner, D. E., 1967)
- 1086 On the relationship between the frequency of two types of mutation and soft x-ray doses in Drosophila. (Matsudaira, Y. et al., 1967)
- 1142 Radiation-induced male sterility exhibited in the P₁ and F₁ generation in Lepidoptera. (North, D. T., 1967)
- 1224 The effects of nitrogen and oxygen treatments on the frequencies of x-ray-induced dominant lethals and on the physiology of the sperm in Drosophila melanogaster. (Sankaranarayanan, K., 1967)
- 1249 Retention of the blood-meal in Aedes aegypti following sterilization by chemicals and irradiation. (Akov, S., 1966)
- 1273 Cytological analysis of formaldehyde induced chromosomal changes in Drosophila melanogaster. (Slizynska, H., 1957)
- 1283 Institut national de génétique du Japon. (Tokin, B. P., 1967)

- 1325 A cytological study of the effects of radiation on the development of the reproductive organs of two species of fruit flies, Dacus oleae and Ceratitis capitata; part of a co-ordinated programme of insect control using radiation. (IAEA, Vienna, Austria, 1967)
- 1384 Cytological study of embryo development in Drosophila melanogaster, following x-irradiation at early developmental stages. (Schneider-Minder, A., 1966)
- 1419 Estimation of sensitivity of Drosophila melanogaster to radiation using a third-order rotatable design. Three Year Comprehensive Report. (Ratty, F.J., 1966)
- 1585 Studies on the eradication of Anopheles pharoensis Theobald by the sterile-male technique using cobalt-60. VI. Sperm activity in males irradiated with the sterilizing dose. (Abdel-Malek, A. A. et al., 1967)

2.1.3. Meiotic and Mitotic Sensitivity

- 932 Abrahamson, S., Meyer, H.U., Himoe, E., Daniel, G. FURTHER EVIDENCE DEMONSTRATING GERMINAL SELECTION IN EARLY PREMEIOTIC GERM CELLS OF Drosophila MALES. Genetics 54 (1966) 687-696.

Drosophila males were irradiated with ^{137}Cs γ -rays, and germ cells which were early spermatogonia at the time of irradiation were scored for X-chromosome and II-chromosome lethals. Only the primary, or pre-definitive gonial cells were tested and the experimental procedures avoided the inclusion of clusters of identical mutations in the data. The ratio of induced X to autosome lethals recovered was 1 : 5.5 providing further evidence that germinal selection has occurred in these cells. (Auth. summary)

- 933 Akhalaya, Y.G. STUDIES OF THE GENETIC NATURE OF RADIATION EFFECTS IN THE SILKWORM. Sobshch. Akad. Nauk, gruz. SSR 58 (1967) 453-454. (In Russian)

Changes observed in the mutation rates in the silkworm exposed to ionizing x-irradiation during various stages of gametogenesis were analysed. The analysis of the two generations produced by x-irradiated parents confirmed the genetic nature of radiation effects in the silkworm. (NSA 22: 1968, 17014)

- 934 Barry, B.D., Guthrie, W.D., Dollinger, E.J. EVIDENCE OF A DIFFUSE CENTROMERE IN THE EUROPEAN CORN BORER, Ostrinia nubilalis (LEPIDOPTERA: PYRALIDAE). Ann. ent. Soc. Am. 60, 2 (1967) 487-488.

Larvae were irradiated with x-rays during the late 3rd or early 4th instar. The total x-ray dosage ranged from 1000 to 4000 R. Analysis of spermatocytes at diakinesis revealed that 46% of the 241 cells examined from irradiated material contained 1 or more fragments. Occasional fragments could be observed in the metaphase I plate in cells from irradiated material. No fragments were found in the cytoplasm away from the plate in the 374 cells examined from irradiated material. All the fragments appear to have migrated to the plate, and one may assume that, since the fragments showed centromere activity, the chromosomes must have diffuse centromeres.

- 935 Borstel, R.C. von, Smith, R.H., Whiting, A.R. GENETIC EFFECTS OF CHRONIC GAMMA RADIATION ON Habrobracon SPERM. Paper presented at the "Radiation Research Society. San Juan, Puerto Rico. 7 - 11 May 1967".

- 936 Carlson, J.G. A DETAILED ANALYSIS OF MITOTIC DELAY AND REVERSION INDUCED IN THE PROPHASE OF THE GRASSHOPPER NEUROBLAST BY SMALL DOSES OF x-RAYS. Radiat. Res. 27 (1966) 495-496. Abstr. Bc-3, at "14th Annual Meeting of the Radiation Research Society, Coronado, Calif., USA, 13-16 Feb. 1966."

The mitotic progress of selected prophase cells in hanging-drop preparations of grasshopper neuroblasts was determined individually before and at short time intervals after x-raying. Observations were continued for several hours after treatment, or until the nuclear membrane disappeared. Doses of 8, 16, 32, 64, and 128 R were given. In order to make possible a detailed analysis of this delay, prophase was subdivided into seven microscopically distinguishable stages: early, initial middle, intermediate middle, terminal middle, initial late, intermediate late, and terminal late prophase.

The mitotic progress of intermediate late and terminal late prophase is not altered by any of the doses used. Other stages are delayed by each of the doses given, with or without reversion of the cells to an earlier stage. After 128, 64, and 32 R initial, intermediate, and terminal middle prophase revert to earlier stages, the amount of reversion and the total duration of the delay being positively correlated with the dose; after 16 R they show delay but only an occasional intermediate middle prophase cell reverts; after 8 R they are delayed, but with no reversion. Early prophase are delayed but not reverted by any of the doses used. The critical stage is initial late prophase, which may show no delay even after 128 R or reversion with as little as 32 R, or delay with 8 or 16 R. An interesting feature of delay and reversion is the inertia of the mitotically progressing cell, which after treatment nearly always progresses at a normal rate to the next stage before slowing down or reverting 1-4 stages, depending on the dose and stage irradiated. All cells eventually recover and complete division. (Abstr.)

- 937 Dickerman, R. L. MUTAGENIC EFFECT OF NEUTRONS AND x-RAYS ON Drosophila melanogaster OOCYTES AND OOGONIA. p. 167-169 of "Biological and Medical Research Division Annual Report, 1966". ANL-7278, Argonne National Lab., Ill. Dec. 1966, 335p.

The effects of 250 kVp x-rays and of 0.2-0.3 MeV neutrons were investigated on stage 7 (the most mature stage in newly emerged adult females) and oögonia. For irradiation, the flies are placed in small lucite cells and constrained into a layer 1 fly thick. Survival curves (egg to adult) plotted for the radiations gave an RBE of neutrons to x-rays of ~4.9. - Any irradiated oögonial cell able to complete the 4 synchronous mitotic divisions to form 16 nurse cells and 1 oöcyte has an equal probability of surviving, largely independent of dose. - Intended work is discussed.

- 938 Fox, D. P. THE EFFECTS OF x-RAYS ON THE CHROMOSOMES OF LOCUST EMBRYOS. I. THE EARLY RESPONSES. Chromosoma 19 (1966) 300-316.

5-d-old eggs of Schistocerca gregaria were incubated at 27°C and exposed to 100 R/min, the exposure rate being maintained constant and the exposure time varied. Irradiation of embryo cells of S. gregaria in the 2 h before mitotic anaphase produces a characteristic series of responses. An apparently insensitive stage is followed by the production of "stickiness" and side-arm bridges and finally by mitotic delay. Mitotic delay is complete at doses as low as 25 R. It is argued that "stickiness" is due to a generalised physiological process and that side-arm bridges are due to a localised exchange of discrete sub-units of the chromatid. These conclusions are based upon the kinetics of appearance and dose-response and a comparison of haploid and diploid cells in a haplo-diploid mosaic embryo.

- 939 Fraccaro, M., Tiepolo, L. BIOLOGICAL EFFECTS OF IONIZING RADIATION. Path. Biol., Paris Sem. Hôp. Paris 11 (1963) 1171-1178. (In Italian)

The mode of action of ionizing radiations, their effects on functions and cellular structures and effects on the synthesis of DNA, of RNA, and of proteins are discussed. It is pointed out that radio-induced mutations can be due to effects on chromosomes or genes. These two categories are examined separately. Particular attention is paid to the problem of the differences of sensitivity of the gametic cells in the various stages of their development in the light of experimental work on Drosophila and mice. The problem of chromosomal anomalies induced by radiation in cells of mammals in tissue culture is examined. The question of the genetic effects of radiation in man is discussed, with emphasis on methodological difficulties. (Auth.)

- 940 Fritz-Niggli, H. RADIOMUTABILITY AND HETEROGENEITY OF MALE GERM CELLS OF Drosophila BEFORE, DURING, AND AFTER MEIOSIS. Biophysik 3 (1968) 97-117. (In German)

A cytological study of the testes of D. melanogaster in the larval and prepupal stages was made, following electron and γ -irradiation. Irradiation of larval and prepupal stages resulted in heterogeneity of developing germ cells. Heterogeneity was evident in radiosensitivity and in mutability of germ cells. The effect of radiation on the frequency of dominant lethal factors was studied. Mortality of embryos was highest after irradiation of spermatocytes in 78- to 91-h larvae. Recessive sex-linked lethal factors were observed frequently in meiotic and post-meiotic stages of germ cells. Translocations occurred rarely in spermatocytes and spermatogonia. Chromosome losses occurred in meiotic and post-meiotic stages more often than in spermatocytes. (NSA 21: 1967, 18021)

- 941 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. Advantages of using Habrobracon in cytological studies are presented. Cells differing in radiation vulnerability are present in the ovariole of Habrobracon. Egg production data following a series of x-ray doses are shown. In the developing state the ovariole contents present differentiated, transitional, and primitive cells. Eggs deposited at any time subsequent to exposure may be traced back to the cytological condition of the oocyte or stem cell at the time of treatment. Eggs ready for deposit or large oocytes about to become eggs are unresponsive, short of massive radiation doses, if oviposition is the criterion. Hatchability is another matter entirely. Just because an egg is laid does not mean that it will hatch. It will not if genetic damage seriously interferes with embryonic development. Problems in the use of ionizing radiations to destroy insect pests are also considered. (NSA 20: 1966, 6650)

- 942 Hannah-Alava, A. THE PREMEIOTIC STAGES OF SPERMATOGENESIS. TID-21562, Turku Univ. (Finland). 1964, 91p.

A review is presented on germ-cell maturation primarily in D. melanogaster. The subjects discussed include: maintenance of the germ-line and spermatogonial multiplication; relating temporal and spatial patterns of spermatogenesis; and radiosensitivity of spermatogonia. 175 references are cited. (NSA 20: 1966, 14224)

- 943 Hannah-Alava, A. MUTATION RATES AT SPECIFIC AUTOSOMAL LOCI IN DIFFERENT SPECIES OF Drosophila. p. 59-61 of "IAEA Research Contracts. Sixth Annual Report". Technical Reports Series No. 53. Vienna, International Atomic Energy Agency. 1966, 131p.

The period of contract was from 1 Nov. 1959 - 31 Oct. 1964. The primary purpose of the work was the accumulation of data on mutation frequencies, in Drosophila melanogaster, of specific IIIrd-chromosome loci from cells that were in different stages of maturation at the time of treatment with x-rays, with particular emphasis on spermatogonial mutation rates. Data on frequencies for IIIrd-chromosome recessive lethals, and on dominant (visible) mutations and Minute mutations in all chromosomes have also been obtained. Methods and results are summarized, and a list is given of 8 papers published during tenure.

- 944 Hashim-Ahmed, M. S. CYTOGENETIC ANALYSIS OF LETHAL MUTATIONS INDUCED AT VARIOUS STAGES OF SPERMATOGENESIS. Genetika No. 3 (1965) 49-55. (In Russian)

Premeiotic stages of spermatogenesis in x-irradiated (2000 R) Drosophila melanogaster showed a higher percentage of mutation when treated males were transferred to high temperature (36, 5°C) for 8 h as compared to 25°C. This phenomenon does not hold equally for a higher dose of 4000 R. Results indicate that the effect of high temperature on x-ray induced rate of point mutation in these stages may involve an enhancement of the mechanism of restitution which gives rise to interstitial microaberrations and lethals. High temperature led to an insignificantly higher rate of sex-linked lethals in nine repetitions out of ten in postmeiotic stages (sperms and spermatids). Between post- and premeiotic stages there is a period of complete sterility, the duration of which exceeded 2 d for 2000 R, ran beyond 5 d for 4000 R and was not observed during spermatogenetic stages of males irradiated with 550 and 700 R. (Auth.)

- 945 Kale, P. G. SPERMATOGONIAL CROSSING OVER IN Drosophila melanogaster AND Drosophila ananassae. Genetics 55, 2 (1967) 255-262.

Wild females inseminated by recessive males were allowed to lay in petri dishes for an hour, which were then irradiated for 24 or 36 h with 1000 R, 1500 R or 2000 R. Heterozygous males from the resultant pupae were used in the subsequent experiments, details of which are given. The crossover induced by irradiating early developmental stages, of Drosophila is described. Great individual variation was observed in crossover values. The complementary crossovers are very unequal in some of the positive males. Continued appearance of crossovers in the progeny of the positive males throughout the tested period is attributed to the multiplication of primary spermatogonia behaving in an analogous fashion to that of the cambial cells of higher plants.

- 946 Karimov, A. D., Malinovsky, O. V. ON THE ROLE OF GAMMA TREATMENT OF OOCYTES IN THE REALIZATION OF RADIATION INJURY. Genetika No. 6 (1966) 140-143. (In Russian)

Hatching of eggs obtained from irradiated and non-irradiated females crossed with irradiated and non-irradiated males was studied. It was found that the radiation effect in the case when both oocytes and sperm cells were irradiated simultaneously equals the sum effect of separate irradiation of the female and male sex cells. It follows that oocytes' irradiation does not influence the yield of radiation injured sperm cells. (Auth.)

- 947 Karimov, A. L., Malinovsky, O. V. ON THE ROLE OF GAMMA TREATMENT OF OOCYTES IN THE REALIZATION OF RADIATION INJURY OF Drosophila SPERM CELLS. Genetika No. 6 (1966) 140-143. (In Russian)

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- 948 Klimtina, A. Y. EFFECT OF GAMMA RAYS ON DEVELOPMENT OF THE SEX CELLS IN THE BEET FLY. "Sbornik. Ioniziruyushchie izlucheniya v Biologii. Riga, Izd-v-Zinatne. 1965".

- 949 Lamb, M. J., McSheehy, T. W., Purdom, C. E. THE RELATIVE MUTAGENIC EFFECTIVENESS OF FAST NEUTRONS AND x-RAYS IN PRE- AND POST-MEIOTIC GERM CELLS OF Drosophila melanogaster. Mutation Res. 4 (1967) 461-468.

Adult male D. melanogaster were irradiated with doses of up to 1000 rad of x-rays or neutrons (+ 10% γ -rays) and germ cells irradiated at pre-meiotic and post-meiotic stages were tested for the presence of 11nd chromosome recessive lethals by the Cy/B1 method. Lethal mutations found in sperm irradiated at the premeiotic stages were tested for allelism. A satisfactory fit to a linear dose response was obtained for x-rays and neutrons in each germ cell stage. In post-meiotic germ cells, the mutation frequency was 4.35×10^{-5} /rad for x-rays and 9.77×10^{-5} /rad for neutrons with an RBE of 2.24. For pre-meiotic germ cells the mutation frequency for x-rays was 1.36×10^{-5} /rad and 2.80×10^{-5} /rad for neutrons with an RBE of 2.05. There was no evidence that the RBE differed for the two types of germ cells. (Auth.)

- 950 Leiden Rijksuniversiteit (Netherlands). MOLECULAR AND RADIATION GENETICS. Annual Report 1965. p. 17-21 in "I - Mutation Studies with Drosophila". EUR-2983. e. Sep. 1966, 24p.

Mutation studies on Drosophila, under F. H. Sobels, are described. They are divided into

- (1) the analysis of post-radiation recovery phenomena in mature sperm;
- (2) differential radiosensitivity of spermatids, mature and almost mature sperm;
- (3) post-radiation recovery by O_2 in early spermatids and spermatocytes, sampled from Drosophila pupae;
- (4) the effect of storage of sperm after irradiation in N_2 or O_2 on the realization of chromosome aberrations and lethal mutations;
- (5) modification of x-ray induced mutation frequencies in different stages of Drosophila spermatogenesis by pre-treatment with actinomycin-D;
- (6) nucleic acid synthesis during spermatogenesis in Drosophila;
- (7) the mutagenic effect of 3H -uridine.

- 951 Liining, K. G. CAN Drosophila SPERMATOZOÏA BE USED IN STUDIES OF RECOVERY PROCESSES? J. cell. comp. Physiol. 58 (1961) 197-201.

3-4 d old M5; sc Y males were irradiated in air or in N atmosphere. Within 2 min after treatment the males were mated for 24 h to y w sn females and were then transferred to a new group of virgin females for another 24 h mating. After mating the females were allowed to oviposit for two 3-d periods. In the 2nd-day sperm the change in atmosphere had a much slighter effect than in 1st-day sperm. - Heterogeneity was found in sperm available the 1st day after irradiation. - If a recovery process is involved at a dose level below 1100 R one would expect a sigmoid curve on plotting dose against frequency of XO males. Males (3-4 d old) were irradiated and mated for 4 h (0-4th) and again for 4 h (15th-18th hour after irradiation), the doses ranging from 550 to 4400 R. Already at 550 R there was a significant difference between the two mating periods. The experiment fails to show a recovery process in sperm irradiated at a stage supposed to be well supplied with O_2 .

- 952 Makino, S. EFFECTS OF RADIATION ON CELL DIVISION AND CHROMOSOMES IN ANIMALS. Quarterly Report, March 15, 1961 - June 14, 1961. AD-438540, Hokkaido Univ., Sapporo (Japan). 15p.

Progress is reported in studies on the effects of radiations on cell division and chromosomes in animals. Results are reported, amongst others, from studies on the effects of β -particles on cell division in grasshopper spermatocytes, the effects of x-radiation on human cells in culture with emphasis on chromosome breaks, the effects of x-radiation on spermatogenesis of *Drosophila virilis*. A list is included of publications resulting from these studies.

- 953* Mandl, A.M. THE RADIOSENSITIVITY OF GERM CELLS. Rev. Camb. phil. Soc. Biol. 39, 3 (1964) 288-370.

The radiosensitivity of germ cells depends on (a) the criterion by which it is assessed, and (b) the developmental stage at the time of irradiation. For any given parameter and cell-type, the final effect exerted by ionizing radiations depends on the genetic make-up and age of the organism; type of irradiation; method of irradiation (acute, fractionated, chronic at different dose rates); oxygen tension; and temperature. The claim that a reduction in dose rate lowers the yield of mutations following gonial irradiation in the male mouse has so far not been confirmed by studies on *Drosophila*. Primary meiocytes are relatively insensitive to cell-killing. Cells irradiated as spermatocytes may fail, or be slow to complete normal maturation division(s), or they may give rise to morphologically abnormal spermatids. The effect depends upon the phase of meiosis at irradiation. In both sexes, sensitivity to cell-death appears to decrease more or less progressively as meiotic prophase advances; in most female mammals, the trend is sharply reversed at early diplotene, when the oocytes become enveloped within primordial follicles. As the oocyte enters upon its rapid phase of growth which, in many species, is associated with vitellogenesis, sensitivity decreases again. Growing oocytes at the diplotene stage are relatively resistant to cell-killing in almost all species investigated. Due to the brief duration of subsequent stages of meiosis (diakinesis, metaphase I), sensitivity to cell-death is difficult to establish. As judged by the induction of dominant lethals, sensitivity of oocytes increases sharply between diplotene and metaphase I; in rodents, the rise becomes manifest a few hours before the onset of diakinesis. Increases of the same magnitude in the incidence of chromosomal aberrations at anaphase I and II have been scored for microsporocytes. Corresponding data for spermatocytes are less reliable, but there is some evidence indicating the same trend. In general, sensitivity to the induction of mutations is greater in meiocytes than in gonias. The yields of some mutations in the female have been shown to rise as meiotic prophase proceeds; but the relative increase as metaphase I approaches is not always as striking as that recorded for dominant lethals. Differential sensitivity to mutagenesis in spermatocytes at various stages of meiotic prophase has not been fully documented. There is some reason to believe that spermatocytes at early stages of meiotic prophase are less susceptible to mutation induction than those nearing the end of prophase. The sensitivity of secondary meiocytes has not been quantitatively assessed except by the incidence of chromosomal aberrations and dominant lethality. In both plants and animals, cells at metaphase II appear to be somewhat less sensitive than those at metaphase I. Spermatids, whose homologous stage is absent in the female, are apparently highly resistant to the induction of morphological abnormalities or cell-death. In contrast, they are highly sensitive to the induction of dominant lethals and a variety of mutations; those at early stages of spermatogenesis appear to be more susceptible than those approaching full differentiation. Corresponding changes are less readily induced in fully differentiated spermatozoa. Anoxia during irradiation diminishes the difference between spermatids and spermatozoa, without however abolishing it. Spermatozoa irradiated after insemination are more sensitive to mutagenesis than are those retained within the testes or the male genital ducts. Irradiation of differentiated gametes of either sex shortly before fertilization induces a delay in subsequent cleavage. While eggs undergo some spontaneous recovery if the period between irradiation and fertilization is prolonged, spermatozoa do not. There is at present no single working hypothesis to account for all the stage differences recorded. (Auth.)

* See III/539, originally cited without abstract.

- 954 Michigan State Univ., East Lansing. BASIC FERTILIZATION PHENOMENA AND GAMETIC LETHALITY IN *Drosophila*. Technical Progress Report, 1966. COO-1033-16, 1966, 11p.

In the course of studying abnormal progeny rates, the effect of supernumerary Y chromosomes has been investigated. The shift in sex ratio related to paternal age has been investigated in X2Y and X3Y males with marked Y-chromosomes. A temperature shock during meiosis can influence the frequency of recovery of X- and Y-bearing sperm; the frequency can, however, also be altered by temperature shock given to mature sperm. - The frequency with which SD-bearing gametes are recovered can be lowered by x-irradiation during meiosis (e.g. 450 R given to 3rd-instar larvae; no noticeable effect on irradiating adult males). Insemination studies (sperm competition for storage) were carried out, using a specially developed autoradiographic technique. Oregon-R females were allowed to lay eggs on a modified Offerman's (non-nutritive) medium on which yeast moistened with an aqueous solution of ^3H -thymidine was placed. Adult males grown on these cultures were mated to non-labelled virgin females, and the ventral receptacle of the female dissected after insemination. Individual sperm can thus be labelled.

- 955 Morey, M. ANALISIS DE LA SENSIBILIDAD GENETICA A LOS RAYOS X EN HEMBRAS DE Drosophila melanogaster. (An analysis of genetic sensitivity to x-rays of ovaries of Drosophila melanogaster.) Genet. Iber. 17, 1/2 (1965) 1-68. (In Spanish)

This is essentially a study of oogenesis in D. melanogaster, comparing the normal process with individuals x-rayed at the following dosages: 600 R, 1800 R and 4390 R. The claim is made that an unknown part of the spectrum was discovered and divided into four zones of sensitivity. A new theory for germinal selection in oögonia for dominant lethals is proposed. Oocytes given 4390 R may die but the germinal follicle continues development. They may be reabsorbed or develop into mature eggs but they are sterile. (BA)

- 956 Murakami, A. RELATION BETWEEN SENSITIVITY TO KILLING AND MUTATION OBSERVED DURING A MITOTIC CYCLE OF SILKWORM CLEAVAGE NUCLEI. Rep. natn. Inst. Genet., Misima No. 17 (1966) 102-103.

- 957 National Inst. of Genetics, Mishima (Japan). ANNUAL REPORT OF THE NATIONAL INSTITUTE OF GENETICS, NO. 16, 1965. NP-16482. 1966, 148p.

Progress is reported in studies on genetics, cytology, and biochemistry of Drosophila, and other animals, and of certain plants (crop). Radiation genetics studies include the following investigations of silkworm: mechanisms underlying the enhancing effect of induced-mutation frequency after fractionated γ -irradiation of silkworm gonads; time of reversal of radiation dose-rate effect on mutation induction in silkworm gonads; post-irradiation treatment of silkworm spermatogonia with various metabolic inhibitors; proliferation kinetics of silkworm spermatogonia during chronic γ -irradiations; change in distribution of primary spermatogonia of the silkworm at various phases of the cell cycle after irradiation; radiosensitivity of silkworm spermatogonia during the cell cycle; variation in radiosensitivity during the early developmental stage of the silkworm egg; enhancing effect of fractionated irradiation with 14-MeV neutrons on the induction of visible recessive mutations in silkworm gonads.

- 958 National Inst. of Radiological Sciences, Chiba (Japan). BIOLOGICAL STUDIES: CYTOLOGY AND MORPHOLOGY. p. 28-34 of "Annual Report, 1964". NIRS-4. Dec. 1965, 103p.

Amongst others, some results are also summarized of cytological studies on the radiosensitivity of silkworm spermatogonia to x-rays.

- 959 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.

The effects of injected ^{91}Y on reproduction in Drosophila and the x-ray sensitivity of Drosophila spermatogonia are described in one part of the report.

- 960 Parker, D.R. INDUCED HETEROLOGOUS EXCHANGE AT MEIOSIS IN Drosophila. I. EXCHANGES BETWEEN Y AND FOURTH CHROMOSOMES. Mutation Res. 4 (1967) 333-337.

Break points have been mapped for a group of 51 Y chromosome fragments induced in irradiated D. melanogaster females. The fragments used were derived from a doubly-marked Y-chromosome, B^3Y^+ , which was irradiated in attached-X females in which the oldest oocytes were in stage 7. Fragments arising by exchange with the right arm of chromosome 4 (4R) have the breakages clustered in the long arm of the Y (Y^+) proximal to the most distal male-fertility locus, and proximal to the

cubitus interruptus locus in 4 R. Fragments arising by other exchanges have the breakages clustered toward the ends of the Y, usually distal to the most distal male-fertility loci of either arm of the Y. It is suggested that specific, relatively short regions are regularly associated to form "sites" within which the induction of exchange is possible.

- 961 Parker, D.R. A SURVEY OF METHODS FOR THE INDUCTION OF ABERRATIONS IN MEIOTIC STAGES IN Drosophila FEMALES AND FOR OBSERVATION OF THEIR DISJUNCTIONAL PROPERTIES IN THE ENSUING MEIOTIC DIVISIONS. ORNL-P-3077, Oak Ridge National Lab., Tenn. 1967, 21p. For abstract, see 962.

- 962 Parker, D.R. A SURVEY OF METHODS FOR THE INDUCTION OF ABERRATIONS IN MEIOTIC STAGES IN Drosophila FEMALES AND FOR OBSERVATION OF THEIR DISJUNCTIONAL PROPERTIES IN THE ENSUING MEIOTIC DIVISIONS. p. 209-218 of "Effects of Radiation on Meiotic Systems. Report of a Study Group. Vienna, Austria 8-11 May 1967". Vienna, International Atomic Energy Agency. 1968, 223p.

The variety of chromosomes available in Drosophila permits the synthesis of special purpose stocks for use in studies on (x-) radiation-induced chromosome breakage and rejoining, the behaviour of newly-induced aberrations in the ensuing meiotic divisions, and factors that affect radiosensitivity. Obtaining identifiable meiotic stages is possible in the case of the female Drosophila, since the meiotic divisions do not occur until after the oocyte is laid, and meiotic prophase extends over a period of approximately a week, making it possible to obtain fairly uniform samples of a single stage by limiting the period of egg collection so that not more than one oocyte is recovered from each ovariole. In the male, meiosis occurs long before the completion of sperm development and the insemination of the female and at best one can distinguish meiotic stages from pre- or post-meiotic ones. Methods are described for the induction of aberrations in meiotic stages in Drosophila females and for observation of their disjunctional properties in the ensuing meiotic divisions. (From NSA 21: 1967, 30869)

- 963 Rai, K.S. TECHNIQUES FOR STUDYING THE EFFECTS OF RADIATION ON MEIOSIS AND RELATED PROCESSES IN MOSQUITOES WITH PARTICULAR REFERENCE TO Aedes aegypti. p. 185-200 of "Effects of Radiation on Meiotic Systems. Report of a Study Group. Vienna, Austria, 8 - 11 May 1967". Vienna, International Atomic Energy Agency. 1968, 223p.

The author has concentrated work on (1) the radiosensitivity of the meiotic and mitotic cycles and of various developmental stages; (2) the cellular and chromosomal basis of radiation- (and chemosterilant-) induced infecundity and sexual sterility in A. aegypti and the possible application of the sterile-male technique for mosquito control; the cytogenetics of radiation-induced heritable, chromosomal aberrations, e.g. reciprocal translocations, paracentric inversions and the evaluation of their potential for possible genetic control purposes; (4) the cytogenetics of sex-linked lethals induced by irradiation and chemosterilants; and (5) heterosis and radiation protection. - The paper stresses radiation-related methodology as it applies to mosquitoes in general and to A. aegypti in particular. Rearing procedures, irradiation and chemosterilant-treatment procedures, general cytological techniques, cytogenetic techniques for isolating specific chromosomal aberrations, and a technique for the detection of sex-linked, recessive lethals on chromosome I of A. aegypti are described.

- 964 Sado, T., Oishi, K. CYTOLOGICAL EVALUATION OF DOSE-RATE EFFECTS OF RADIATION ON MUTATION FREQUENCY OF SILKWORM GONIA. II. EVIDENCE OF G_2 ACCUMULATION OF PRIMARY SPERMATOGONIA AFTER ACUTE IRRADIATION. Mutation Res. 3, 6 (1966) 522-38.

The effects of acute irradiation on the kinetic indices of primary spermatogonia of the silkworm have been studied in an attempt to gain cytological insight into the mechanisms of dose-fractionation effects on the induction of mutation. (1) Kinetic studies, with the use of colchicine treatment and the 3H -thymidine-labelling technique, on primary spermatogonial populations in unirradiated larvae showed that primary spermatogonia of this insect had a mean generation time of 34 h, of which the relative time occupied by the various phases of cell cycle was roughly as follows: G_1 , ~40%; S, ~40%; G_2 , ~18%; and M, ~2%. (2) Cytokinetic studies on the effect of acute irradiation (1000 R) on the population of primary spermatogonia showed that during the first 24 h after irradiation the relative frequency of cells in different phases of the cell cycle changed noticeably. Thus,

at 24 h as many as 58% of the total population was shown to be in the G₂ population in contrast to 18% of the unirradiated primary spermatogonial population. Furthermore, only 3%, instead of 40%, in the control, was in the S phase at this time. (3) It is tentatively concluded that enhanced mutation frequency in dose-fractionation experiments was primarily due to an increase in the relative frequency of cells in the G₂ population. However, the possibility remains that accumulation of cells in late G₁ might also be responsible for the enhancement of mutation frequency by dose fractionations. (Auth. summary)

- 965 Sankaranarayanan, K. DOSE-RATE EFFECT IN THE REPAIR OF RADIATION DAMAGE IN SPERMATIDS OF *Drosophila melanogaster*. *Mutation Res.* 4 (1967) 222-224.

Mutation frequency was studied in *D. melanogaster* males exposed to low dose-rates of x-radiation under conditions of anoxia and followed by treatment with either nitrogen or oxygen. Frequencies of sex-linked lethals were not significantly different in the N₂- and the O₂-post-treated groups. Following irradiation, neither gas was effective in bringing about repair. (NSA 21; 1967, 20127)

- 966 Schwalm, F. E. ZELL- UND MITOSENmuster DER NORMALEN UND NACH RÖNTGENBESTRAHLUNG REGULIERENDEN KEIMANLAGE VON *Gryllus domesticus*. (Cell and mitotic patterns of the regenerating germ core of *Gryllus domesticus* in controls and after irradiation.) *Z. Morph. Ökol. Tiere* 55, 8 (1965) 915-1023.

The formation of the germ core (Keimanlage) was studied from the point of view of the time sequence, localization and growth. The effects of x-radiation showed that, after killing of the nuclear material in the anterior half of the egg with 2000 R, regulation of the germ core from the surviving nuclei may still occur after an irradiation of the core with up to 600 R. After whole-body irradiation up to 800 R reorganizing may cause the migration from anterior regions of nuclei which were no longer undergoing mitosis when they would be stimulated to renewed mitotic activity. Nuclei of the original germ core which were already in a less sensitive phase at the time of irradiation will resume mitotic activity. Following doses sufficient to kill all nuclei of the germ core a high degree of reorganization comes into effect. It is only possible by an interplay between nuclear material from the anterior non-irradiated egg half which has reached the germ area after irradiation, and the mitosis-stimulating and germ forming potency of the posterior irradiated half. These potent areas of yolk entoplasma systems are only negligibly disturbed by 1000 R at 48-49 h post-oviposition. The extent of irradiation damage is discussed. The migration processes involving nucleus aggregation and nucleus migration over the egg surface are not disturbed at 500 R at either 36 or 49 h. The mitosis-stimulating factors in the region of the germ core are highly resistant to radiation, and are able to stimulate mitosis and organise complete germ core after an irradiation of up to 1000 R.

- 967 Slizynski, B. M. DIFFERENTIAL x-RAY SENSITIVITY OF SPERMATOGONIA IN *Drosophila melanogaster*. *Drosoph. Inf. Serv.* 40 (1965) 48.

Slizynska found that in regard to the effects of irradiation there was a profound heterogeneity between males as well as between the germ cells of individual males in brood. Heterogeneity between the males would arise if at the time of treatment some males have more spermatogonial mitoses than the others. Heterogeneity between the germ cells of individual males can be reduced to the fact that in the testis some spermatogonial cells are in a susceptible stage (metaphase) while the majority of cells are in a resistant stage. The question was studied cytologically and the following results were obtained. Among 129 2-3 d-old males of y w stock there were 25 males in which there were no mitotic divisions in the testes, 23 males had mitoses in the apex cells and 81 males had spermatogonial mitotic divisions in the cysts. Among the males of this last category there were 51 with 4 or less dividing spermatogonial cells, 14 males with 5-7 divisions per testis, and 16 males with 8-16 divisions of spermatogonial cells per testis. Thus the highest sensitivity to treatment in brood is expected to occur in about 12% of males. This figure will be doubled if two last classes of frequency of mitoses are taken as resulting in high sensitivity. (Auth.)

- 968 Smith, R. H., Whiting, A. R. x-RADIATION SENSITIVITY OF *Habrobracon* OOCYTES AT DIAKINESIS. *Genetics* 54, 1 Pt. 1 (1966) 364. Paper presented at the "1966 Meetings of the Genetics Society of America, Chicago, Ill., USA. 1-3 Sep. 1966".

The complex nature of prophase I in meiosis requires that, for greatest significance of irradiation studies, the exact condition of the chromosomes at time of exposure be determined. Previously

reported tests of Habrobracon oocytes have demonstrated the high resistance of earlier stages in prophase I and the high sensitivity of oocytes in metaphase I, a ratio of 20 to 1. We focus our attention here on the sensitivity of diakinesis. The Habrobracon female has four ovarioles, each ending posteriorly in a uterine sac. A well-fed female restrained from ovipositing for 16 h has in each uterine sac four eggs in the first meiotic metaphase and one in diakinesis. Previous studies have demonstrated that an exposure of 2000 R or 2500 R, sufficient to induce dominant lethal changes in over 99% of eggs in metaphase I, has imperceptible effects on oocytes in prediakinesis stages. In the present experiment, hatchability and times of death of embryos were followed closely over six, short, egg-laying intervals. By cytological examination, the maximum number of metaphase I eggs per female was found to be 16, as expected. At the exposures used (2000 R and 2500 R), the number of non-hatching eggs exceeded this max. number in 59 out of 113 females. The average number of non-hatching eggs exceeding the 16 egg max. was 19 and the range was up to 23 eggs/female. Therefore, the diakinesis stage is in the same range of radiation sensitivity as the 1st meiotic metaphase. (Auth.)

- 969 Smith, R. H., Whiting, A. R. x-RADIATION SENSITIVITY OF Habrobracon OOCYTES AT DIAKINESIS. p. 62-63 of "Biology Division Semiannual Progress Report for Period Ending July 31, 1966". ORNL-3999, Oak Ridge National Lab., Tenn. 1966, 217p.

For abstract, see 968.

- 970 Sobels, F. H. OXYGEN DEPENDENT DIFFERENCES IN RADIOSENSITIVITY BETWEEN FULLY MATURE AND ALMOST MATURE SPERMATOOZOA. Drosoph. Inf. Serv. 41 (1966) 150.
x-irradiation in O_2 , (2000 R), air (3000 R) or N_2 (4000 R) were carried out to investigate whether these differences in radiosensitivity between fully mature, motile spermatozoa and the immotile, late spermatids (in Lefevre's terminology) are associated with differences in oxygenation. The most radiosensitive kind of sperm was sampled by using the first ejaculate from 7-d-old males. Sperm with lowest sensitivity was obtained from the first ejaculate of 1-h-old males. After radiation exposures in O_2 and N_2 , post-treatments with N_2 or O_2 were given, after irradiation in air with N_2 or air. The pooled results from a number of (tabulated) replica experiments show that considerably higher mutation frequencies were only obtained for sperm from 7-d-old males after irradiation in air than from 1-h-old males; X^2 of the difference is 9.41, with $P < 0.003$. After radiation in O_2 , the radiosensitivity in sperm of 7-d-old males was not significantly higher than in that from 1-h-old males, and a similar result was obtained after irradiation in N_2 . The O_2 -enhancement ratio under comparable conditions of post-treatment, and this radiosensitivity in the presence of O_2 , is only slightly higher for sperm in 7-d-old males than for that in 1-h-old males. The pronounced differences in sensitivity after radiation in air therefore clearly originate from a greater availability of O_2 for sperm in the old than for that in the young males, and a priori it is not unlikely that similar causes underly the differences in sensitivity of successive ejaculates derived from 3-d-old males. The present results confirm an earlier conclusion by Oster (see II/1996), based on observations for 1st- and 2nd- day sperm.

- 971 Sturmmaes, Ø. RADIATION GENETICS. A REVIEW. Hereditas 52 (1964) 241-242. Abstr. Paper presented at the "3rd Meeting of the Scandinavian Association of Genetics, Helsinki, Finland, 10-12 Jun. 1964".

The radiosensitivity of the different stages of spermatogenesis and oogenesis was discussed, and also the effect of irradiation in different atmospheres. Fractionation and protraction of radiation dosages were also considered. Data published on the sensitivity of spermatogonia may indicate differential sensitivity regarding mutability and viability, while other data indicate that there may exist positive as well as negative males with respect to induction of mutations in spermatogonia. This problem and the problem of recovery in mature sperm were discussed at some length. The effects of chemicals, especially of protein synthesis inhibitors were outlined. The review covered also the effect of temperature during irradiation, and pointed out misinterpretations that may be made if the killing effect of irradiation is overlooked. Finally, new lines of attack on the radiation problem were suggested. (From abstr.)

- 972 Sugai, E., Tadahiko, I. DOSE RATE EFFECT OF RADIATION ON SPERMATOGONIA OF THE SILKWORM. Nature, Lond. 213 (1967) 943-944.

Silkworm spermatogonia are readily killed by acute irradiation. The effect of dose rate and re-population of spermatogonia is cytologically analysed with particular reference to possible selective elimination of the cells after exposure to different dose rates of radiation. The extent of spermatogonial death and the number of surviving or newly formed cells was approximately similar at the two very different dose rates used, except for the initial cell degeneration after the exposures. For chronic irradiation, ^{60}Co γ -rays were administered continuously for 122 h for 5-10 d post hatching, total dose 1000 R at 0.136 R/min; acute irradiation was carried out 7 d after hatching, at 200 R/min for 5 min. (Larval testes were fixed and stained every 24 h after initiation of chronic irradiation or completion of acute irradiation. Selection was found not to be involved in the dose-rate effect on mutation frequency in the spermatogonia. Surviving spermatogonia remain in a state of arrest for several days after irradiation.)

- 973 Suomalainen, H. O. T., Petäjä, T. E. THE EFFECT OF α -RADIATION ON THE SPERMATOGENESIS IN CERTAIN GRASSHOPPERS. p. 216 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun. - 2 Jul. 1966, 263p". Abstr. 859.

x-rays generated at 50 kV with an intensity of 180 - 600 R/min were used as total body irradiation of male grasshoppers representing the following species: Chorthippus elegans, Ch. parallelus, Omocestus viridulus, Gomphoceris maculatus, and Mecostethus grossus. The dose range was from 90 R - 9 kR. The testes were fixed at intervals of 1 - 14 d after irradiation and examined as paraffin sections or Feulgen squashes. The distribution of different types of chromosomal effects was used in an attempt to determine the radiation sensitivity of the different meiotic stages. The initial process of meiosis seemed to be inhibited at pachytene, since diplotene and diakinesis stages were virtually absent after the higher doses. On the other hand, the occurrence of certain types of chromosomal rearrangements shows that the meiotic divisions were not suppressed by the lower doses. Of special interest was the occurrence of an abnormal ball type of metaphase which can be clearly distinguished from ordinary pycnosis or karyolysis. This particular effect in which the often heavily fragmented chromosomes are drawn together in the centre of the nucleus, was generally seen as a uniform response of whole cysts of spermatocytes in the 1st or 2nd meiotic division. (Abstr.)

- 974 Tazima, Y., Sado, T. POST-IRRADIATION MODIFICATION AND A POSSIBLE MECHANISM OF THE REVERSE DOSE-RATE EFFECT ON MUTATION INDUCTION OBSERVED IN SILKWORM GONIA. p. 220 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun. - 2 Jul. 1966, 263p." Abstr. 875.

An enhancing effect on radiation-induced mutation was observed in the silkworm after fractionated exposure of gonial cells. As a possible interpretation of this phenomenon a kind of modification in cellular metabolism was assumed. The modified state, which is detectable by increased mutation frequency, persists at least for 48 h and is characterized by a peak appearing 18-24 h after the initial exposure. The non-decay type curve suggests that this is not due to a biochemical disturbance but presumably to cell synchronization. The results of an experiment, where two split doses were given to two experimental series in reciprocal order (250 R + 750 R and 750 R + 250 R) 6 h apart up to 48 h, showed that the peak appears earlier for the initial 250 R than for the initial 750 R series. By labelling S phase cells with ^3H -thymidine, Sado observed that irradiated cells are blocked in their progression at G_2 and their proportion increases remarkably in the cell population. These results favour the hypothesis of the cell synchronization. If this were the case, decrease in mutation frequency could also be detected when a 2nd irradiation is given at an appropriate interval after the initial exposure. This, however, was not observed up to 72 h interval, suggesting that synchronization, if occurred, is destroyed immediately in the subsequent cell cycle. Presumably the cells are released from the blockade at a reduced rate. Based on those results we examined the validity of the same mechanism for the interpretation of the reversed type dose-rate effect. Cytological observation revealed that the mitotic process of gonial cells at a late stage is inhibited, being blocked at G_1 and G_2 , during chronic exposure. Furthermore, it was confirmed genetically that the chronic treatment becomes more effective for mutation induction than the acute one as early as 1 d after hatching, coinciding with the initiation of cellular activity. This observation explains why dose-rate effect is reversed within a very short period. (Abstr.)

- 975 Tazima, Y. CHANGES IN THE MUTATION RESPONSE OF POST-MEIOTIC SILKWORM GERM CELLS TO γ -RAYS WITH THE PROGRESSING SPERMIOGENESIS. Rep. nat. Inst. Genet., Misima No. 17 (1966) 97.

- 976 Tikhomirova, M. M. COMPARATIVE STUDY OF THE RADIOSENSITIVITY AT DIFFERENT STAGES OF OOGENESIS. Genetika No. 6 (1967) 24-32. (In Russian)

It was shown by a comparative study of the radiosensitivity at the different stages of oogenesis of Drosophila, carried out by means of the comparison of the frequency of the cases of X-chromosome loss as the result of breaks, that at least three groups of cells could be distinguished: the most radio-sensitive 14-stage oocytes; the less sensitive early oocytes at other stages; and the nonsensitive oogonia. The potential damages in the 14-stage oocytes were shown to be repaired under normal conditions. The course of the repair was not uniform; thus most damages were repaired during the first 30 min after the irradiation, but some persisted for more than an hour. During the period of 0.5 - 8.5 h after the irradiation the aftereffect was proportional to the duration of the exposure to high temperature; i. e., the realization of the potential damages under high temperature was uniform in character. In early oocytes (7 - 13 stages) the aftereffect of radiation could be detected only after a long period (8 h) of temperature treatment, which was indicative of their higher reparative ability as compared to the 14-stage oocytes, and of the similarity of breaks (with respect to the duration of the time during which they remained open) at these stages. No perceptible aftereffect of radiation was observed in oogonia which was probably associated with the elimination of the damaged oogonia during the meiosis. The study of the x-radiosensitivity by means of the comparison of the frequency of the non-disjunction of X-chromosomes revealed no differential sensitivity of gametes in oogenesis. (Auth.)

- 977 Traut, H. REPAIR OF GENETIC RADIATION DAMAGE: A POSSIBLE CAUSE OF DIFFERENTIAL RADIOSENSITIVITY IN Drosophila melanogaster. p. 67-78 of "Genetical Aspects of Radiosensitivity: Mechanisms of Repair. Proceedings. Vienna, Austria. 18-22 April 1966". STI/PUB/130, International Atomic Energy Agency, Vienna 1966, 175p.

The extent to which differential radiosensitivity in gametogenesis of D. melanogaster can be explained by metabolic repair of premutational damage (including the rejoining of radiation-induced chromosome breaks) is discussed. Three stages of gametogenesis are considered, in which repair might occur: late spermatids ("immature sperm"); the gonial stage (both of spermatogenesis and oogenesis); and prophase I-oocytes. Experimental proof is given that there is no repair by storing of mature sperm. An hypothesis is proposed to explain the striking differences observed for the dosage-effect-relations for dominant lethal induction in metaphase I ("stage 14") and prophase I ("stage 7") oocytes, respectively. This hypothesis is partly based on differential repair (restitution) of chromatid breaks in these two oocytic stages. The implications of the low radiosensitivity of gonial and early oocytes for radiation damage to human germ cells are briefly considered. (Auth.)

- 978 Traut, H. RADIO-INDUCED MITOTIC DELAY IN SPERMATOGENESIS OF Drosophila melanogaster. Nature, Lond. 209 (1966) 92-93.

Careful examination of the results obtained by Welshon and Russel (Proc. natn. Acad. Sci. U. S. A. 43: 1957, 608) in their histological observations on the testis of x-irradiated adult D. melanogaster indicates a mitotic delay in addition to cell-killing induced by x-rays. The author (H. T.) implies that radiation-induced mitotic delay, as well as cell killing and dominant lethality, contributes to the sterile interval observed in brood pattern experiments, using irradiated Drosophila males.

- 979 Truckenbrodt, W. SENSIBILITÄT UNDIFFERENZIERTER UND DIFFERENZIIERTER KERNE NACH RÖNTGENBESTRAHLUNG IN DER FRÜHEN ENTWICKLUNG DER TERMITE Kaloterms flavicollis Fabr. (The sensitivity of undifferentiated and differentiated nuclei following x-irradiation in the early stage of development of the egg of the termite Kaloterms flavicollis Fabr.) Wilhelm Roux Arch. EntMech. 156, 2 (1965) 101-126. (In German)

Eggs were irradiated between cleavage and end of the blastular stage. Cellular lesions vary with the moment in mitosis at which irradiation occurs (e.g. metaphase is very sensitive). The blastomeres are more sensitive than the micromeres. Doses leading to immediate and deferred death are discussed.

- 980 Varti, K. V. DEPENDENCE OF MUTATION FREQUENCY ON THE x-RAY DOSAGES IN THE SENSITIVITY OF PREMEIOTIC AND POSTMEIOTIC STAGES OF SPERMATOGENESIS. Genetika No. 4 (1965) 94-99. (In Russian)

The frequency of sex-linked recessive lethal mutations was studied in Drosophila sperm and spermatogonia exposed to 100-3000 R doses of x-rays. The data obtained indicate a linear relationship

between dosage and frequency of induced mutations in mature sperm. In spermatogonia the mutation rate shows a complicated characteristic ascribed to the heterogeneity of the spermatogonial stages. At low (0 - 300 R) and high (1200 - 3000 R) doses, a linear relationship was noticed that reflects the real frequency of the corresponding sensitive and insensitive fractions of spermatogonia. At mild doses (300 - 1200 R) the dependence of mutation rate on dosages of x-rays disappeared due to the death of sensitive cells within which a mutation was induced (germinal selection). At low doses spermatogonia (sensitive fraction) are more sensitive than mature sperms. At mild and high doses the frequency of mutation in mature cells is higher than in immature ones. (Auth.)

- 981 Westerman, M. THE EFFECT OF X-IRRADIATION ON MALE MEIOSIS IN Schistocerca gregaria (Forsk.). I. CHIASMA FREQUENCY RESPONSE. Chromosoma 22, 4 (1967) 401-416.

The pattern of response of chiasma frequency to x-irradiation was studied in germ line cells of male imagines of S. gregaria. ^3H -thymidine was used to mark cells undergoing DNA synthesis at the time of irradiation. It was injected abdominally ($\sim 10 \mu\text{Ci}$ in 0.02 ml of water). A correlation has been established between the observed changes in chiasma frequency of the L and M type bivalents and the time in the meiotic cycle at which the treatment is given. Two radiosensitive periods have been identified in meiosis itself. At one (meiotic DNA synthesis) x-irradiation produces a decrease in chiasma frequency while at the other (leptotene-early zygotene) the treatment leads to an increase in chiasma frequency. Small bivalents however do not respond to treatment and form a single chiasma under all conditions.

- 982 Whiting, A. R., Smith, R. H., Borstel, R. C. von METHODS FOR RADIATION STUDIES DURING OOGENESIS IN Habrobracon juglandis (Ashmead). p.201-208 of "Effects of Radiation on Meiotic Systems. Report of a Study Group. Vienna, Austria, 8-11 May 1967". Vienna, International Atomic Energy Agency. 1968, 223p.

Review. The particular suitability of Habrobracon for this work is stressed. Eggs were placed with a larva of Ephestia kuehniella as food supply. Hatchability, adult survival, classification of stages of death, and separation of meiotic stages by timed intervals of egg-laying are discussed from the experimental point of view. When females are irradiated, clusters of eggs are laid which, by accurate timing, can be placed in homogeneous categories of oocytes irradiated in the 1st meiotic metaphase (I), diakinesis, and the earlier 1st meiotic prophase (presumably diplotene) stages. Since diakinesis is in the same range of sensitivity as the 1st meiotic metaphase, it is often convenient to compare only the sensitive metaphase I and the resistant prophase I. In most experiments the females are bred unmated, so the criterion is not that of dominant lethality per se but that of total dominant and recessive lethality. Recessive lethal mutations, inherited partial sterility, sterility, visible mutations, sterility and semisterility are discussed. Estimation of genetic parameters, in particular, accurate methods for estimating the dominant lethality and recessive lethality in Habrobracon are made by using certain equations. As for stage sensitivity, for dominant and recessive lethality induced by x-rays, metaphase I was found to be 20 times more sensitive than prophase I. Translocations are formed rarely among chromosomes of irradiated oocytes. A sterile period has been found to occur between the 5th to 8th day which separates oogenesis from the oögonial period. Dominant lethals are present in eggs that had been irradiated as oögonia. The balance of meiosis resembles metaphase I in sensitivity to x-rays. When DNA synthesis begins at late telophase of the 2nd meiotic division, the nucleus becomes extremely sensitive, and the late prophase (G_2) of mitosis is extremely resistant; the metaphase of 1st meiosis has about the same sensitivity as metaphase I of meiosis.

- 983 Wu, C. K. MEIOTIC X-Y EXCHANGE AND NONDISJUNCTION INDUCED BY X-RAYS IN PRIMARY SPERMATOCYTES OF MALE Drosophila melanogaster. Diss. Abstr. 28, 1 (1967) 57-B - 58-B.

In the present experiments, males bearing the doubly marked Y-chromosome, $\text{BS Y } y^+$, and singly marked Y-chromosome, y^+Y , were x-rayed, in separate experiments, as prepupae and adults, while $Y \text{ w}^+$ -bearing males were x-rayed as prepupae only. x-rayed adult males were brooded daily with three virgin females for 10 d, and males irradiated as prepupae for 4-6 d. Untreated males brooded in the same manner served as controls. An increase in the frequency of X-Y exchange and of X-Y non-disjunction was observed in those broods corresponding to the primary spermatocyte stage at the time of irradiation. In all experiments x-irradiation of primary spermatocytes of both immature and mature testes was shown to yield a greater proportion of X-Y exchanges than X-Y non-disjunctionals. The present work confirms Zimmering's preliminary results (unpublished) that after irradiation of the

prepupal testis more cases of X-Y exchange than X-Y non-disjunction were recovered. From experiments in which the doubly marked Y-chromosome, $\overline{B}^S Y \underline{y}^+$ was employed, the spontaneous frequency of X-Y^S exchange was higher than that of X-Y non-disjunction. With the singly marked Y, $\underline{y}^+ Y$, non-disjunction exceeded exchange. The reason for this difference with the two types of Y-chromosomes is not clear, although it may be possible that (1) XXY non-disjunctionals, hyperploid for both \underline{y}^+ and \overline{B}^S , may be less viable than those hyperploid for \underline{y}^+ alone, and / or (2) since the $\overline{B}^S Y \underline{y}^+$ carried the \underline{y}^+ allele on Y^S, and its associated X-derived heterochromatin, pairing of Xh and Y^S may be facilitated resulting in fewer nondisjunctional cases of X and Y as well as favoring the rejoining of spontaneous breaks leading to exchange. It was observed that the spontaneous frequency of X-Y^S exchange is higher than that of X-Y^L exchange. On the other hand, approximately equal frequencies of induced exchanges between X and Y^S and X and Y^L were recovered in doubly marked Y experiments. It was found that in the doubly marked Y experiments, immature testes treated with x-rays yielded more X-Y exchanges than the treated mature testes. The testes at prepupal stage may possess a larger cell population of primary spermatocytes than the adult. The spontaneous and induced frequencies of XXY females, as compared with that of XO males and that of X-Y exchange females, are relatively low. The possible bearing of the Peacock and Erickson's hypothesis (1965) on the interpretation of these observations is discussed. (From DA)

- 984 Würzler, F.E. INDUCED MUTATIONS AND LETHALITY IN *Drosophila* AFTER x-IRRADIATION OF MEIOTIC AND POST-MEIOTIC STAGES OF THE EGG. p. 43-62 of "Effect of Radiation on Meiotic Systems. Report of a Study Group. Vienna, Austria. 8-11 May 1967". Vienna, International Atomic Energy Agency. 1968, 223p.

In radiobiological experiments with new-laid eggs and young embryos of *D. melanogaster* the role of nuclei and chromosomes in radiation-induced death has been analysed. The predominant role of the nuclei was demonstrated by means of partial irradiation of uncleaved eggs which showed that the region of highest radiosensitivity corresponds with the region containing the nucleus. This was further corroborated by the findings that radiosensitivity can be correlated with the nuclear division stage and the number of nuclei present at the moment of irradiation. The correlations with nuclear division stages are different for induced lethality and for specific types of mutations (sex-linked lethals and reciprocal translocations). Assuming that chromosomal damage is an important factor in radiation-induced lethality, we postulated that other types of chromosomal changes contribute also to lethality, e.g. induced breakage-fusion-bridge cycles, with still another correlation with nuclear division stages. Preliminary results on the radiosensitivity of different genotypes indicate that the above assumption can probably be tested experimentally. (Auth.)

- 985 Ytterborn, K.H. RATES OF AUTOSOMAL RECESSIVE LETHALS AFTER x-RAY TREATMENT OF SPERMATOGONIA AND SPERMATOZOA IN *Drosophila melanogaster*. *Hereditas* 58, 1-2 (1967) 165-190.

Adult males were irradiated, then mated for 4 h in order to test the incidence of IIrd-chromosome recessive lethals in spermatozoa. To test the effects of irradiation on spermatogonia, 17-h-old larvae were irradiated. After eclosion males were mated in six consecutive periods. Male progeny from two of these matings, 0-3 d and 15-18 d respectively after eclosion, were sampled for tests of lethals. The dose used was 900 R x-rays. The total mutational damage when measured as frequencies of chromosomes with lethals is similar in the two tests from irradiated spermatogonia. The incidence of independent lethal mutations, however, is higher in the period 0 - 3 d than in the period 15 - 18 d while the average cluster size is larger in the last period than in the first. The distributions of independent lethal mutations among males in the two spermatogonia series do not deviate from Poisson expectations. The spermatogonia of different males therefore seem to be equally sensitive. The frequency of chromosomes with lethals was found to be about three to four times higher after irradiation of spermatozoa than after the same treatment of spermatogonia. (From auth. summary)

- 986 Zimmerman, S., Wu, C.K. MEIOTIC X-Y EXCHANGE AND NONDISJUNCTION INDUCED BY IRRADIATION IN THE *Drosophila* MALE. *Genetics* 50 (1964) 633-638.

D. melanogaster males of the composition $\underline{y}\underline{v}/\underline{y}^+Y$ were x-rayed as prepupae and mated upon eclosion to $\underline{y}\underline{v}; \underline{b}\underline{w}$ females. The phenotypically vermilion female offspring which were non-

yellow were tested further using a genetic scheme which permitted an unequivocal distinction between those that arose following X-Y non-disjunction and those that arose following X-Y^s exchange. The results from these tests demonstrated that X-Y^s exchanges are recovered appreciably more frequently than X-Y non-disjunctionals with ratios as high as 6-7:1, and disclosed a class of exceptional females interpretable as having arisen from the recovery of Y-autosome translocations induced in primary spermatocytes. Applying a correction for the occurrence of these translocations not tested in previous prepupal experiments involving the B^sYy⁺ the ratios of induced X-Y^s exchanges to non-disjunction nonetheless turn out to be as high as those found in the present experiment. It seems likely that the explanation for the sharp disagreement between these results and those reported by Sävghagen (1961) is related to the difference in the genetic test used to distinguish between these two kinds of females, with only the present test being critical. (Auth.)

See also :

- 20 The so-called recovery phenomenon after irradiation in Drosophila melanogaster. (Trout, W. E., III., 1966)
- 248 Somatic mutations in the moth Ephesia. Report on Research, August 1, 1964-September 1, 1967. (Caspary, E. W., 1967)
- 921 Cytogenetic analysis of lethal mutation induced during different stages of spermatogenesis in Drosophila. (Khashim-Akhmed, M. S., 1965)
- 924 Cytological studies on the radiosensitivity of spermatogonia of the silkworm. (Nakanishi, Y.H. et al., 1965)
- 927 A cytological study of radiation effects in testes of the screw-worm fly, Cochliomyia hominivorax (Diptera: Calliphoridae). (Riemann, J.G., 1967)
- 928 Cytological evaluation of dose-rate effects of radiation on mutation frequency of silkworm gonads. I. Kinetics of proliferation and killing of spermatogonia during chronic irradiation. (Sado, T., 1966)
- 997 Studies of early effects of radiation on chromosomes and mitosis. Progress Report, March 1, 1966-February 28, 1967. (Carlson, J.G., 1967)
- 1001 The effects of x-rays on the chromosomes of locust embryos. II. Chromatid interchanges and the organization of the interphase nucleus. (Fox, D.P., 1966)
- 1002 The effects of x-rays on the chromosomes of locust embryos. III. The chromatid aberration types. (Fox, D.P., 1967)
- 1003 The effects of x-rays on the chromosomes of locust embryos. IV. Dose-response and variation in sensitivity of the cell cycle for the induction of chromatid aberrations. (Fox, D.P., 1967)
- 1011 Induced crossing-over in the males of Drosophila ananassae: exchanges mainly in spermatocytes of adults. (Kaie, P.G., 1967)
- 1016 Early chromosomal response to x-rays. (Leach, W.M. et al., 1966)
- 1017 Lack of x-ray induced chromosome "stickiness" in grasshopper neuroblasts. (Leach, W.M., 1967)
- 1019 Genetic crossing over in both sexes of Megaselia scalaris. (Mainx, F. et al., 1967)
- 1024 Inheritance of radioresistance in Drosophila. (Ogaki, M. et al., 1966)
- 1027 Identification of the proposal: x-ray induced changes in Drosophila germ cells. Progress Report, September 1, 1965-August 31, 1966. (Rinehart, R.R.)
- 1045 On frequency of x-ray-induced chromosome breaks at various stages of Drosophila melanogaster spermatogenesis. (Vatti, K.V., 1966)
- 1058 Radiation induced tandem duplications in Drosophila melanogaster. (Bender, H.A., 1967)
- 1062 Dependence of radiation induced mutation rate on maturity and dose for chrysalis of Drosophila melanogaster Meigen. (Ebeling, W., 1962)
- 1088 Segregation of tritium-labeled DNA at meiosis in Chorthippus. (Moen, P.B., 1966)
- 1091 Enhancing effect of fractionated irradiation with 14 MeV neutrons on the induction of visible recessive mutations in silkworm gonads. (Murakami, A. et al., 1966)
- 1139 Sterility, chromosome breakage, x-ray-induced mutation rates and detected mutation frequencies in Drosophila melanogaster. (Lefevre, G., Jr., 1967)
- 1188 Fast neutron and x-ray irradiation of Drosophila melanogaster oögonia and oocytes. (Dickerman, R.C., 1967)
- 1189 Mutational response of Drosophila melanogaster oocytes and oögonia to x-ray and fast neutron irradiation. (Dickerman, R.C., 1967)

- 1201 Investigations on the influence of 5-bromouracil desoxyriboside (BUDR) on the radioinduced mutation rate in Drosophila melanogaster. (Magdon, E. et al., 1967)
- 1212 The potentiating effect of sodium fluoride on the induction of mutations by x-rays in mature spermatozoa of Drosophila melanogaster. (Mukherjee, R.N., 1967)
- 1220 X-ray induced changes in Drosophila germ cells. Three-Year Comprehensive Report September 1, 1964- August 31, 1967. (Rinehart, R.R., 1967)
- 1229 Sensitivity differences in the successive stages of spermatogenesis in Drosophila after irradiation in nitrogen or air. (Shiomi, T., 1967)
- 1234 The contrasting effects of O₂ and N₂ in determining initial sensitivity and post-radiation recovery in Drosophila sperm and spermatids. (Sobeis, F.H., 1964)
- 1235 Processes underlying repair and radiosensitivity in spermatozoa and spermatids of Drosophila. (Sobeis, F.H., 1966)
- 1242 Post-radiation recovery in early spermatids and spermatocytes sampled from Drosophila pupae. (Watson, W.A.F., 1966)
- 1243 Post-radiation recovery in spermatids sampled from 24 hr old pupae of Drosophila melanogaster. (Watson, W.A.F. et al., 1967)
- 1244 Post-radiation recovery in early spermatids sampled from Drosophila pupae. (Watson, W.A.F., 1967)
- 1246 Genetic x-radiation damage and its modification by some gases and a time factor in Drosophila melanogaster. (Yoon, J.S., 1967)
- 1265 Mutagenesis at a complex locus in Drosophila with the monofunctional alkylating agent, ethyl methanesulfonate. (Jenkins, J.B., 1967)
- 1271 Relative biological effectiveness of 14 MeV neutrons to gamma-rays for inducing mutations in mature sperm of the silkworm. (Murakami, A., 1966)
- 1327 Midgut epithelium of adult Chelisoche morio (Dermoptera: Chelisocheidae) and Ceratitis capitata (Diptera: Tephritidae) following ionizing irradiation. (Little, H.F., 1967)
- 1328 Effet des rayons x sur l'intestin moyen de Blabera fusca Br. (Mortreuil-Langlois, M., 1960)
- 1329 Histopathological study of the midgut of Blabera fusca Br. (Orthoptera) over an extended post-irradiation period. (Mortreuil-Langlois, M., 1963)
- 1331 Irradiation effects on midguts and testes of the adult boll weevil, Anthonomus grandis, determined by histological and shielding studies. (Riemann, J.G. et al., 1967)
- 1343 Applications of genetic technology to mosquito rearing. (Craig, G.B., Jr., 1964)
- 1370 Variation in radiosensitivity during the early developmental stage of the silkworm egg. (Murakami, A., 1966)
- 1386 Biochemical and developmental response of grasshopper embryos and spermatogonia to x-irradiation. (Tahmisiian, T.M., 1965)
- 1388 Récentes expériences de radiobiologie sur Bombyx mori. (Teulade, P., 1966)
- 1425 Lifespan studies with strains of gamma-irradiated Drosophila adults. (Sonnenblick, B. P. et al., 1967)

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

- 987 Akhalaya, Y.G. ETUDE DE L'EFFET GENETIQUE DES RAYONNEMENTS IONISANTS CHEZ LE VER A SOIE. Soobshch. Akad. Nauk, gruz. SSR 48, 2 (1967) 449-454. (In Georgian, with Russian summary)
- 988 Amy, R.L., Borstel, R.C. von. TIME OF DEATH OF A TRANSLOCATION SEGREGANT IN Habrobracon. p. 83 of "Biology Division Semiannual Progress Report for Period Ending July 31, 1966". ORNL-3999, Oak Ridge National Lab., Tenn. 1966, 217p.

Translocation can be induced by x-raying Habrobracon males, and detected by inherited partial sterility methods. It would appear that the particular translocation involves a part of the genome that exerts its influence during the last one-third of the 29-h embryonic period.
- 989 Arnheim, N., Jr. THE REGIONAL EFFECTS OF TWO MUTANTS IN Drosophila ANALYZED BY MEANS OF MOSAICS. Genetics 56, 2 (1967) 263-263.

The genes Tufted and l(1) N^B have rather extensive regional effects on the differentiation of the mesonotal bristles in D. melanogaster. The former adds macrochaetae to the posterior mesonotal region while the latter removes numerous microchaetae from the mesothorax. For mosaic production, larvae of the genotypes y⁺ Tft/(1) Tft⁺ were irradiated, on Petri dishes containing standard Drosophila medium, 24-48 h after hatching. This led to an increase over that occurring spontaneously, in the frequency of somatic crossing over. A dose of 1500 R, at 75 R/min, was delivered for 20 min. All experiments were conducted at 25 ± 1°C. After emergence flies were inspected for mosaic patches. An analysis of genetic mosaics has shown that both of these mutations affect the competence of cells in specific regions of the mesonotum to initiate and/or complete bristle differentiation. The extreme phenotype manifested by individuals carrying these mutations therefore is not the result of a change in the underlying prepattern.

- 990 Asman, M. CYTOGENETIC AND DEVELOPMENTAL EFFECTS OF GAMMA-IRRADIATION ON Aedes aegypti (L.). Thesis. Notre Dame Univ., Ind. 1966, 112p.

- 991 Bateman, A.J. x-IRRADIATION OF HETEROZYGOUS ATTACHED-X. Drosoph. Inf. Serv. 40 (1965) 79.*

The attached-X used had arisen in progeny from sc ec cv/ct v g q q which had been irradiated. It was homozygous for sc ec and cv, and heterozygous for ct v and g. ♀♀ were irradiated with 4000 rad or kept as unirradiated controls. The progeny of eggs laid on days 7-11 after irradiation were scored for homozygosity for ct v and g, the results being tabulated. 4000 rad produce a 3-fold increase in c-o between g and the centromere. The increase in homozygosity for v is the same as for g, meaning that there has been no change in c-o between v and g. The absence of any change in homozygosity for ct means that c-o between ct and v must have decreased by an amount equal to the increase proximal to g. These results confirm those presented in DIS 37 : 68 in respect of segments ct-v-g and add the additional information that x-rays enhance c-o near the centromere (to the right of g). The controls show relatively low homozygosity for ct. This is in all probability due to some parental attached-X ♀♀ being homozygous ct. (From auth.)

* See also a longer paper (III/529) on "Effects of x-rays on female germ cells of Drosophila melanogaster. II. Crossing-over in the X-chromosome", which includes these data.

- 992 Bateman, A.J. NON-DISJUNCTION AND ISOCHROMOSOMES FROM IRRADIATION OF CHROMOSOME 2 in Drosophila. p.63-70 of "Effect of Radiation on Meiotic Systems. Report of a Study Group. Vienna, Austria, 8-11 May 1967". Vienna, International Atomic Energy Agency. 1968, 223p.

Using a stock of Drosophila in which chromosome II is represented as two isochromosomes, a study has been made of the induction of non-disjunction (and loss) of chromosome II in q q by x-rays. At the same time it was found that there was a high yield (one quarter of all progeny) of induced isochromosomes. There is a high yield of all classes of progeny from irradiated oocytes and a lower yield from irradiated oogonia and stem cells. The fractionation of the progeny into the various classes is independent of the stage of oocyte. Oogonia give relatively few nullisomic progeny when compared with oocytes, 90% of the disomic progeny from oocytes arise from 1st-division non-disjunction. There is evidence that at 2nd division the disjunction of the two half-bivalents is not random. Most of the disomic progeny from oogonia have arisen via asynapsis which, paradoxically, is accompanied by increased crossing-over in the normal progeny. Phenotypic analysis of the isochromosomes shows that $\frac{1}{4}$ contain sister centromeres compared with the expectation, with random association, of $\frac{1}{2}$. The mode of origin of isochromosomes, and its relevance to sister strand exchange in meiosis, are discussed. The ease of reconstruction of normal chromosomes from isochromosomes also has bearing on the mode of origin. (Auth.)

- 993 Bauer, H. DIE KINETISCHE ORGANISATION DER LEPIDOPTEREN-CHROMOSOMEN. (The kinetic organization of lepidopteran chromosomes.) Chromosoma 22, 2 (1967) 101-125. (In German, with English summary). Also published as ORNL-tr-1817, Oak Ridge National Lab., Tenn. nd, 33p.

In monokinetic chromosomes half of the recombinations from reciprocal translocation are expected to be lethal owing to the formation of bikinetic and akinetic chromosomes. In holokinetic chromosomes all reciprocal recombinations should be viable, because all again are holokinetic. This difference can be used as a tool other than the study of fragment behaviour to decide which type of chromosome

is present in an animal species. — Pieris brassicae males x-rayed with 6000 R units and mated to normal females gave in F₁ only 19.9% lethal zygotes (14.7% of which dying late) as compared to a control mortality of about 7.7%. Among the hatched male caterpillars cytologically tested in the last larval instar 64.9% contained in their spermatocytes 1 - 4 heterozygous translocation rings or chains consisting of from 5 - 14 chromosomes. Translocations of similar frequency and even greater complexity have been observed in preliminary experiments on Philosamia cynthia. — The discrepancy between these results and those on species with monokinetic chromosomes (Drosophila, Phryne etc.) where very high zygotic lethality is observed at comparable R. doses is proof of the holokinetic nature of Pieris and Philosamia chromosomes. Together with earlier results on Bombyx mori by Astaurov and Frolova and the cytogenetic studies especially by Seiler, sufficient proof exists to conclude that all Lepidoptera have holokinetic chromosomes. — A survey of the known groups of organisms with chromosomes of this type leads to the assumption that holokinetic chromosomes must be derived from monokinetic ones. The problems connected with this change in kinetic organization of chromosomes are discussed. (Auth.)

- 994 Beermann, W. OPERATIVE GLIEDERUNG DER CHROMOSOMEN. (Functional organization of chromosomes.) Naturwissenschaften 52, 13 (1965) 365-375. (In German)

Review article, citing numerous autoradiographic studies.

- 995 Brito da Cunha, A., Magalhães, L.E. de, Toledo, J.S. de, Toledo, F., S.A., Souza, H.L. de, Pavan, C. CONTRIBUTION TO THE UNDERSTANDING OF THE DYNAMICS OF LETHAL CHROMOSOMES IN POPULATIONS OF Drosophila willistoni p.198 of "Dynamics of Populations, Quantitative Genetics, and Breeding. International Symposium of Genetics. São Paulo, Brazil. Aug. 1966".

- 996 Carlson, J.G. ELECTRON MICROSCOPE STUDIES OF EARLY MORPHOLOGICAL EFFECTS OF X-RAYS ON THE INTERNAL STRUCTURE OF THE CHROMOSOME. p.82 of "Research and Development in Progress - Biology and Medicine, Issue No. 4". TID-4204, Division of Biology and Medicine (AEC), Washington, D.C. Apr. 1966, 229p. Abstr. BIA 1683.

Grasshopper neuroblasts to be used, also doses of the order of several thousand R of x-rays.

- 997 Carlson, J.G. STUDIES OF EARLY EFFECTS OF RADIATION ON CHROMOSOMES AND MITOSIS. Progress Report, March 1, 1966-February 28, 1967. ORO-2575-32, Tennessee Univ., Knoxville. Inst. of Radiation Biology. 1967, 4p.

The effects of various wavelengths of monochromatic u.v. radiation on mitosis and the incorporation of ³H-thymidine in the nucleus of grasshopper embryos in hanging drop cultures were evaluated in autoradiograms. Preliminary results suggest that at least a portion of the induced incorporation of ³H-thymidine is not simply repair of directly damaged DNA. Electron microscope studies of early morphological effects of x-radiation on the internal structure of chromosomes of grasshopper neuroblasts were continued and methods of sample preparation are discussed. A preliminary study indicated that the addition of actinomycin D to the culture media blocked the uptake of ³H-uridine (RNA synthesis) in neuroblasts. (NSA 21:1967, 20322)

- 998 Day, J.W., Grell, R.F. THE EFFECTS OF EXCHANGE AND STRUCTURAL HETEROZYGOSITY ON RADIATION-INDUCED NONDISJUNCTION AND LOSS. p.64 of "Biology Division Semiannual Progress Report for Period Ending January 31, 1966". ORNL-2922, Oak Ridge National Lab., Tenn. May 1966, 207p.

The effect of 4000 R of x-rays on the frequencies of X-chromosome nondisjunction and loss in the oocytes of Drosophila melanogaster females homozygous and heterozygous for Ins(1)d(-49), B^{h1} is shown in tabulated form. The results indicate that neither structural heterozygosity nor the presence of a crossover between homologues modifies the frequencies of radiation-induced nondisjunction or loss.

- 999 Day, J.W., Grell, R.F. RADIATION-INDUCED DISJUNCTION AND LOSS OF CHROMOSOMES IN Drosophila melanogaster FEMALES. II. EFFECTS OF EXCHANGE AND STRUCTURAL HETEROZYGOSITY. Mutation Res. 3, 6 (1966) 503-9.

The role of exchange and structural heterozygosity in radiation induced non-disjunction and loss in the oocyte of D. melanogaster has been investigated by irradiating two types of females, one

heterozygous and the other homozygous for a multiply inverted X-chromosome. The frequencies of exchange tetrads in the oocytes of the two genotypes were estimated as ~24% for the heterozygote and ~90% for the homozygote. An examination of the first 7 d broods from both kinds of females irradiated with 4000 R of x-rays revealed no significant difference in X-chromosome loss or non-disjunction between the two genotypes. The average non-disjunction frequencies for the entire period were $1.57 \pm 0.19\%$ for the homozygotes and $1.74 \pm 0.24\%$ for the heterozygotes. The corresponding frequencies of loss were $5.21 \pm 0.37\%$ and $7.19 \pm 0.67\%$. The values obtained for stage 8-14 oocytes from homozygous and heterozygous females irradiated with 500 R were $0.22 \pm 0.21\%$ and $0.33 \pm 0.18\%$, respectively, for non-disjunction, and $2.46 \pm 0.33\%$ and $2.57 \pm 0.33\%$, respectively, for loss. The results indicate that neither structural heterozygosity of homologue nor exchange between homologues modifies the frequencies with which they non-disjoin or are lost following irradiation of the oocytes. (Auth. summary)

- 1000 Dhillon, T.S., Rai, K.S. DETECTION OF RADIATION-INDUCED PARACENTRIC INVERSIONS IN Aedes aegypti. p. 8-9 of "Information Circular Radiation Techniques and their Application to Insect Pests". WP/31/7, International Atomic Energy Agency, Vienna (Austria). 1966, 49p.
- 1001 Fox, D.P. THE EFFECTS OF X-RAYS ON THE CHROMOSOMES OF LOCUST EMBRYOS. II. CHROMATID INTERCHANGES AND THE ORGANIZATION OF THE INTERPHASE NUCLEUS. Chromosoma 20 (1966) 173-194.

The structure and frequency of chromatid interchange types induced by x-irradiation of Schistocerca gregaria embryo cells in the late S or early G₂ stage are described. These interchange types occur with different frequencies. On the basis of the observed polarization of the chromosomes in interphase and of the observed occurrence of loops in these polarized chromosomes in embryo cells, a model is described which can account for these differences. The model has six main features. The chromosomes in the interphase nucleus are polarized and lie parallel, possibly close to the nuclear membrane. U-type exchanges are fundamentally different from X-type exchanges and U-type exchanges are more frequent than X-type. Twisting at the point of exchange, between formation in interphase and observation at C-metaphase, is rare. The chromosomes have looped regions which may take part in interchanges. Chromosome ends may be involved in interchanges due to terminal overlapping in the nucleus as the chromosome elongates during interphase. The latter two factors result in aberrations between polarized chromosomes in interphase appearing in a non-polarized position at C-metaphase. Evidence supporting this model was derived from a study of the exchange point relative to the two centromeres and two telomeres, since the mean centromere distance C, mean telomere distance T, and mean differential distance D are expected to be different for the various hypothetical modes of aberration formation. The model implies that if the mechanism of chromosomal aberration formation is by breakage and reunion, rejoining within a site cannot be at random. Thus the results are more compatible with an exchange type of mechanism for aberration formation (NSA 21: 1967, 18023)

- 1002 Fox, D.P. THE EFFECTS OF x-RAYS ON THE CHROMOSOMES OF LOCUST EMBRYOS. III. THE CHROMATID ABERRATION TYPES. Chromosoma 20 (1967) 386-412.

Eggs of Schistocerca gregaria were cultured and irradiated. Irradiation of embryo cells during the S and G₂ stages of interphase produces the same general classes of chromatid aberration as have been seen in organisms, such as Vicia faba. The types of aberration are described qualitatively only, in this paper. In addition, however, a series of intrachange aberrations has been found which is novel. In order to account for these Revell's exchange hypothesis has been extended to include the involvement of isolocus primary lesions. The exchange-type hypothesis is preferred because it can more readily accommodate the whole spectrum of aberrations found.

- 1003 Fox, D.P. THE EFFECTS OF x-RAYS ON THE CHROMOSOMES OF LOCUST EMBRYOS. IV. DOSE-RESPONSE AND VARIATION IN SENSITIVITY OF THE CELL CYCLE FOR THE INDUCTION OF CHROMATID ABERRATIONS. Chromosoma 20 (1967) 413-441.

The variation in yield and the dose-response for chromatid aberration types following x-irradiation of Schistocerca gregaria embryo cells is described. Marked variations in yield are found for all aberration types during the G₂ and latter part of S stages of interphase. Only gaps appear to follow similar curves, other aberration types having unique patterns of response. The dose exponents for the various chromatid aberration types are similar to, but lower than, those reported for other organisms. Chromatid "breaks"

appear to have a dose exponent greater than 1.0 — a fact which is in conformation with the exchange hypothesis. The chromosome radiosensitivity of this organism is similar to that reported for other organisms. (Auth.)

- 1004 Giotov, N. V., Sushkin, A. G. THE INFLUENCE OF THE GENOTYPE ON THE FREQUENCY OF RADIATION-INDUCED ANEUPLOIDY IN THE OOGENESIS OF Drosophila melanogaster. I. RING X-CHROMOSOME. Genetika No. 8 (1967) 60-64. (In Russian)

In the opening communication of this series of studies concerning the influence of the genotype on the frequency of radiation-induced aneuploidy in the oogenesis of D. melanogaster the dose-response curves are compared for normal and X-ring strains. In the progeny of the normal (i. e. with telomeric X) yellow-strain females the spontaneous frequencies of XXY-females and XO males were 0.22% and 0.36%, respectively, while in the progeny of females of the X-ring strain (X^c, yv) the corresponding frequencies were 0.03% and 0.12% respectively. 2-d-old females were irradiated by ^{60}Co γ -rays (doses of 1, 2, 3, 4, and 5 kR) and mated immediately to Berlin wild males. The progeny of the first 3 d of egg deposition was scored. Dose-response curves for both strains studied coincided well (the control being subtracted) and were in good agreement with the results obtained by Traut [Mut. Res. 1:1964, 157]. The lower frequency of XO-males in the progeny of irradiated X^c, yv females might be due to the lower frequency of chromosome aberrations in females [Glass, Genetics 40:1955, 252 and 281], as well as to the relatively lower sensitivity of the method used, as compared to the calculation of females: males ratio. (Auth.)

- 1005 Gregg, T. G., Day, J. W. NONDISJUNCTION OF THE X CHROMOSOMES IN FEMALES OF Drosophila hydei. Genetica 36 (1965/66) 172-182.

An investigation of non-disjunction in D. hydei has disclosed that spontaneous primary non-disjunction of the X-chromosomes occurs with a frequency of 1/13 000, and secondary non-disjunction with a frequency of 1/3500. These rates are much lower than the ones previously reported for D. melanogaster which are about 1/1000 for primary non-disjunction and 1/50 for secondary non-disjunction. Data are included on a population derived from matings with females exposed to 2000 R or 4000 R x-radiation. The low rate of secondary non-disjunction in hydei is attributed to the much greater genetic length of the X-chromosome and the corresponding reduction in noncrossover X's available for distributive pairing with the Y-chromosome. The low rate of primary non-disjunction is attributed to both a reduction in noncrossover X-chromosomes, and to the large heterochromatic arm of the X-chromosome which, it is suggested, makes the X-centromere a strong centromere. Thus, it is further suggested, the reduction in non-crossover chromosomes reduces the opportunity for non-homologous distributive pairing and non-disjunction of the type involving non-crossover chromosomes. Non-disjunction of the type involving crossover chromosomes then is prevented by the success of the strong centromeres in overcoming entanglements that would lead to non-disjunction in the case of ordinary or weak centromeres. (NSA 20:1966, 22653)

- 1006 Grell, R. F. CHROMOSOME PAIRING, CROSSING OVER AND DISJUNCTION IN Drosophila melanogaster. ORNL-P-654, Oak Ridge National Lab., Tenn. 1964, 38p.

Results are summarized from studies of the meiotic mechanism in Drosophila. (NSA 19:1965, 3809).

- 1007 Grell, R. F., Muñoz, E. R., Kirschbaum, W. F. RADIATION-INDUCED NON-DISJUNCTION AND LOSS OF CHROMOSOMES IN Drosophila melanogaster FEMALES. I. THE EFFECT OF CHROMOSOME SIZE. Mutation Res. 3, 6 (1966) 494-502.

Newly eclosed females carrying two extra small chromosomes of equivalent length were irradiated, one a free IV and the other a free X duplication. In the unirradiated controls the extra chromosomes segregate from one another ~99.9% of the time and show no loss. After irradiating the mothers with 4000 R of x-ray, the average non-disjunction frequency of the two small chromosomes, as measured in the first 12 daily broods, was $1.24 \pm 0.07\%$. This value is not significantly different from the $1.19 \pm 0.15\%$ obtained for the large X-chromosomes for the same period despite a 10-fold difference in chromosome length. The result indicates that radiation-induced non-disjunction is unrelated to chromosome length. A comparison of the frequency of loss for the large and small chromosomes discloses that in the oocyte the X-chromosomes are lost about three times as often as the duplication and the IV ($5.82 \pm 0.20\%$ and $1.95 \pm 0.10\%$, respectively). There is a marked stage sensitivity in the oocyte, with the max. loss for both the large and small chromosomes occurring in the 1st or 2nd

brood and lower frequencies occurring in later broods. The results are compatible with the hypotheses that events at the centromere or adjacent regions, incident to radiation, are responsible for non-disjunction and that radiation-induced sister-chromatid dicentric formation contributes to chromosome loss. (From auth. summary)

- 1008 Heddle, J. A., Wolff, S. ESTIMATION OF THE REJOINING DISTANCE FOR CHROMOSOME EXCHANGES INDUCED IN *Drosophila* SPERM BY COMBINED DOSES OF X-RAYS AND NEUTRONS. Int. J. Radiat. Biol. **10**, 3 (1966) 207-310. Also published as ORNL-P-1580, Oak Ridge National Lab., Tenn.

The yield of x-ray-induced exchanges, Y_X , is given by

$$Y_X = \frac{2\pi h^3 n_X (n_X - 1)}{3V}$$

when h is the rejoining distance, n_X the number of primary breaks induced by x-rays and V the volume of the sperm nucleus. The yield of neutron-induced exchanges, Y_N , is given by

$$Y_N = \frac{h n_N (n_N - 1)}{d}$$

when n_N is the number of primary breaks induced by the neutrons and d = dose \times energy deposited in the nucleus per unit dose \div track average LET. The combined number of breaks, n_C , is $n_X + n_N - 2Y_N$. The procedure outlined in the paper was repeated for three different values of V since there is some variation in the reported estimates of the dimensions of the *Drosophila* sperm nucleus, assumed to be cylindrical. The value of 0.1μ obtained for h is remarkably close to the values obtained previously for *Vicia faba* and *Hordeum vulgare*. In these calculations, a dose square relation was assumed for x-ray-induced and a linear relation for neutron-induced exchanges. The combined yield would therefore really equal the observed yield at somewhat lower values of h , with a slightly overestimated value reported here.

- 1009 Hinton, C. W., Whittinghill, M. THE DISTRIBUTION OF X-RAY INDUCED CROSSOVERS FROM CURLY INVERSION HETEROZYGOTES OF *Drosophila melanogaster* FEMALES. Proc. natn. Acad. Sci. U.S.A. **36** (1950) 552-558.

The induced cross-over offspring from testcrossed $S \text{ Pfd/Cy } 1t^3 \text{ L}^4$ females x-rayed with 2250 R as adults were so distributed that their meiotic origin is unlikely. The effects of the x-rays were evident for as long as 31 d, with a peak in recombination between 4 and 8 d after treatment. Wide variations from female to female were observed in total % recombination, in the relative numbers of recombinants from adjacent regions, and in the distribution of complementary cross-over classes within each region. Some tendency toward clustering of the recombinants among the testcross offspring was revealed. These results are indicative of some oögonial influence upon recombinants. This influence may be merely a weakening of oögonial chromosomes followed much later by meiotic crossing over at the weak point, or it may be completion of crossing over in the oögonia. The data on the variable balance of complementary classes favours the latter hypothesis. (Auth. summary)

- 1010 Ives, P. T. GENETIC AND DIRECT EFFECTS OF GAMMA RADIATION ON *Drosophila*. NYO-2467-17, Amherst Coll., Mass. Dept. of Biology. 20 Sep. 1966, 5p.

Additional data were procured to help elucidate the pattern of mutagenesis displayed in successive stages of spermatogenesis following acute doses of radiation. Under controlled conditions the peak rate of induced translocations in males raised at 18°C, which doubles the length of time needed to complete development compared to 25°C, hits a peak in the 10-20 d sample of sperm instead of in days 5 and 6 characterizing 25°C-males. Thus the production of chromosomal aberrations shows the same change in pattern as does the production of point mutations when developmental temperature is lowered to 18°C. The rate of mutational effect thus appears to depend on the stage of spermatogenesis at which radiation enters the gonads. Additional data were obtained from pattern analysis of the comparative mutagenic rates in mature sperm, those deposited in the 1st mating after irradiation and in those sperm deposited in subsequent matings during the first day after irradiation ("premature sperm"). At doses of 1 kR γ -rays or hard x-rays point mutations are induced at equal

frequencies in the two types of sperm, whereas chromosome rearrangements (autosomal and Y-chromosome translocations) are produced at nearly twice the frequency in mature sperm.

- 1011 Kale, P.G. INDUCED CROSSING-OVER IN THE MALES OF Drosophila ananassae: EXCHANGES MAINLY IN SPERMATOCYTES OF ADULTS. Mutation Res. 4, 5 (1967) 631-639.

Crossing-over in males of D. ananassae was studied by treating young and 48-h-old adults with 1000 R and 2000 R of x-rays. Among the 76 irradiated males only three showed exchanges in their gonial cells, while the others produced crossovers in the period of partial sterility. The individual variation in crossover production of these males can be fitted to a Poisson distribution and the complementary recombinants from the individual males show no significant departures for equality. These crossovers therefore appear to have originated in treated spermatocytes. Continued appearance of only one complementary recombinant class in two males gives evidence in favour of cambial-like divisions of the primary spermatogonia. A proportional increase of recombination frequency with radiation dose, after exposure of adults, suggests a one-hit nature of induced crossing-over. (Auth.)

- 1012 Kale, P.G., CROSSING-OVER IN THE MALES OF Drosophila ananassae: EXCHANGES IN IRRADIATED PUPAE. Int. J. Radiat. Biol. 13, 1 (1967) 1-12.

Crossing-over in the males of D. ananassae has been studied by treating early and mid-pupal stages with 1000 R and 2000 R of x-rays. Spermatocytes produce single cross-overs distributed evenly between males. Spermatogonia produce clusters of cross-overs, the progeny of particular males. A 2-fold increase in the frequency of cross-overs from independent events by doubling the dose indicated the breakage of two chromatids by a single ionizing particle. The frequency of these exchanges in early pupae is much greater than of those in later stages of the life-cycle. This has been attributed to the predominant proportion of the spermatocytes in the young pupae. Alternatively these early spermatocytes may be intrinsically more sensitive. (Auth.)

- 1013 Kang, Y.S., Lee, C.C. THE GENETIC STUDIES OF Drosophila POPULATION. 2. ON THE FREQUENCIES OF RECIPROCAL TRANSLOCATION IN D. melanogaster IRRADIATED WITH x-RAYS. Korean J. Zool. 8, 2 (1965) 9-14. (In Korean, with English summary)

The frequency of reciprocal translocation damage in males of D. melanogaster irradiated with x-rays was observed in this study. The frequencies were checked at four periods with 2-d intervals and during spermatogenesis after irradiation. (1) Modifications in the percentage of the reciprocal translocation damage were not obtained at intervals after irradiated with 500 R and 1500 R of x-rays respectively. (2) In two experimental groups irradiated with 500 R and 1500 R of x-rays, the frequencies showing in the spermatogenesis were 0.50% (500 R), 3.85% (1500 R) in mature sperm, and 1.59%, 8.10% in the spermatocyte. (3) The frequency of reciprocal translocation between the Y- and 3rd chromosomes was the highest, but in accordance with dosage increase that of the 2nd and 3rd chromosomes relatively increased from 9.34% - 30.49% while decreased from 68.75% - 46.80% in the group of the Y- and 3rd chromosomes. (4) It was supposed that these modifications of the frequency were due to heavy damage of the 2nd chromosomes than other chromosomes in accordance with dosage increase. (5) Spontaneous reciprocal translocations involving the Y-, 2nd and 3rd chromosomes was 0.23%. (Auth.)

- 1014 Kang, Y.S., Lee, C.C. THE FREQUENCY OF RECIPROCAL TRANSLOCATION IN D. melanogaster IRRADIATED WITH 500 OF x-RAYS. Drosoph. Inf. Serv. 41 (1966) 114-115.

D. melanogaster (Seoul strain) males and vg:se mutant females were used. Data on the frequency of reciprocal translocations in the control group, at intervals and during spermatogenesis after irradiation, and data from a comparison of the translocation frequency among Y-, 2nd and 3rd chromosomes in control and irradiated group are tabulated. The mean frequency of reciprocal translocations appearing in the control group was 0.256% in the Seoul strain. At the three intervals tested, no significant difference in frequency was observed. The frequency of reciprocal translocations during spermatogenesis was 0.503% on days 1-2, 1.594% on days 5-6, involving a factor of 3. The comparison of the translocation frequency among Y-, 2nd and 3rd chromosomes indicated that the Y- and 3rd chromosomes were involved most frequently.

- 1015 Karlson, P. ZUR CHEMIE UND WIRKUNGSWEISE DER INSEKTENHORMONE. (The chemistry and mode of action of insect hormones.) p.37-47 of "Proceedings of the 4th International Congress of Biochemistry. Vienna, 1-6 Sep. 1958". Vol.12. Levenbook, L., Ed. London, Pergamon Press. 1959, 252p. (In German)

Review article. The insect hormones known to date are discussed: (1) the brain (prothoracotropic) hormone; (2) the prothoracic gland hormone (ecdysone); (3) juvenile hormone. Another hormone, the diapause factor, is produced by the subesophageal ganglion, and controls diapause in *Bombyx* embryos and perhaps also other types of diapause in other species. - Ecdysone had proved active in all insects tested so far, and also seems to be active in Crustacea, and Crustacean extracts appear active in insects. The interchangeability also holds for some other hormones. The mode of action of ecdysone and the biochemical basis of *Calliphora* assays were studied by the author. In experiments with radioactive tyrosine and dopa these compounds were shown to be precursors of the presumed quinones, which are largely incorporated into the cuticle. The process occurred 20-24 h after injection of the hormone; without ecdysone, no radioactivity was incorporated into the cuticle. During the last days of larval life, tyrosinase activity changes considerably. Tyrosinase is present in the larva in an inactive form; homogenates develop activity within 15-20 min. The author believes that the hormone acts on the activating system and induces production of active tyrosinase, which in turn produces the quinones to be subsequently incorporated into the cuticle.

- 1016 Leach, W.M., Carlson, J.G. EARLY CHROMOSOMAL RESPONSE TO x-RAYS. (Read by title only) *J. Cell Biol.* 31, 2 (1966) 148A. Abstr. 299, at "6th Annual Meeting of the American Society for Cell Biology, Houston, Texas, USA. 17-19 Nov. 1966".

Grasshopper neuroblasts which are in late prophase, very late prophase, or prometaphase during exposure to x-rays may contain "sticky" chromosomes during the subsequent mid-mitotic period (metaphase and anaphase). Three types of "stickiness" may be distinguished: (1) clumping, separate chromosomes appearing fused, usually near their distal ends; (2) adhesion, sister chromatids appearing fused to each other; and (3) beading, the chromosome outline appearing moniliform. Embryos of *Chortophaga viridifasciata* (De Geer) were exposed to 1024 R of x-rays at a rate of about 220 R/min. The target-to-specimen distance was either 30 or 60 cm. Amperage was adjusted so that the exposure rate was essentially constant for both distances. Embryos were fixed 15 min after x-ray exposure, and acetocarmine squashes were prepared. At the 30-cm distance 291 mid-mitotic neuroblasts were observed, 52% with chromosome clumping, 59% with chromatid adhesions, and 12% with chromosome beading. At the 60-cm distance 130 mid-mitotic neuroblasts were observed, 24% with clumping, 32% with adhesions, and 10% with beading. Placement of 12 mm of Lucite above the embryos during exposure substantially reduced the yield of clumping, but not of adhesions or beading, at the 30-cm distance: of 143 mid-mitotic neuroblasts observed, 32% showed clumping, 53% showed adhesions, and 10% showed beading. The ratios between the mid-mitotic stages observed were about the same from embryo to embryo. The differences in frequencies of types of "stickiness", then, were not a result of differences in composition of cell populations, but rather the result of different conditions of x-ray exposure. (Abstr.)

- 1017 Leach, W.M. LACK OF x-RAY INDUCED CHROMOSOME "STICKINESS" IN GRASSHOPPER NEUROBLASTS. *Radiat. Res.* 31, 3 (1967) 575-576. Abstr. Cc-12 at "15th Annual Meeting of the Radiation Research Society, San Juan, Puerto Rico, 7-11 May 1967".

Embryos of the grasshoppers *Chortophaga viridifasciata* (De Geer) and *Encoptopholus sordidus* (Burnmeister) were exposed to 1000 R of x-rays (250 kV, 15 MA, from a Westinghouse "Coronado" machine with inherent filtration equivalent to a half-value layer of 0.4 mm Cu, no added filtration, target-to-specimen distance 50 cm, exposure rate about 168 R/min). At 15 or 30 min after the beginning of exposure, embryos were fixed with 1:3 acetic ethanol, then stained with aceto-orcein and squashed. About 60% of *Chortophaga* neuroblasts in midmitosis (prometaphase, metaphase, and anaphase) contained "sticky" chromosomes. However, only an occasional midmitotic *Encoptopholus* neuroblast had "sticky" chromosomes. Similar results were obtained for the *Encoptopholus* neuroblasts, whether the embryos were exposed intact in eggs or dissected in a glutamic acid-glycine culture medium. The virtual lack of "sticky" chromosomes in the *Encoptopholus* neuroblasts suggests that x-ray-induced "stickiness" may result from an early action of chromosomal material other than deoxyribonucleic acid. (Abstr.)

- 1018 Lucchesi, J.C. THE EFFECT OF HETEROZYGOUS AUTOSOMAL INVERSIONS ON INDUCED EXCHANGES BETWEEN THE ATTACHED-X AND Y CHROMOSOMES IN Drosophila melanogaster FEMALES. Genetics 54, 4 (1966) 1013-1018.

The presence of an inverted major autosome increases the frequency with which x-ray⁶ induced exchanges between the attached X- and Y-chromosomes are recovered. This increase, magnified when both autosomes are structurally heterozygous, is manifested in three 3-d progeny broods but is increasingly marked in successive broods. These experimental results are considered in terms of possible physiological and mechanical explanations. (Auth. summary)

* 3000 R.

- 1019 Malin, F., Doschek, E. GENETIC CROSSING OVER IN BOTH SEXES OF Megaselia scalaris. Mol. Gen. Genet. 99 (1967) 203-218. (In German)

Recombination in Megaselia males as compared to females is variably reduced. The magnitude of the reduction of crossing-over values within the different chromosomes and within the different zones of chromosomes depends on the site of the sex-realizer. Crossing-over in females is of the common meiotic type. Crossing-over in males is probably premeiotic, spermatogonial. Double crossing-over between the sex-realizer and the next marker and between this and the 2nd marker shows always a high negative interference. Low temperature and x-irradiation enhance the crossing-over values in females and in males. Low temperature enlarges the interference, x-irradiation reduces the interference of double crossing-over in the female. (Auth.)

- 1020 Maldno, S., Nakanishi, Y.H. BEHAVIOR OF THE CHROMOSOMES IN GRASSHOPPER, Podisma sapporensis GERM-CELLS IN RESPONSE TO LOCALIZED BETA-IRRADIATION. (Bag 30: 1966, 21897) Nippon Saibo Kagakkai Shinpojuma 14, Suppl. (1964) 355-359.

- 1021 Mallich, C.W., Binnard, R.M. CHROMOSOME BREAKAGE AND LOSS FOLLOWING ALPHA PARTICLE TREATMENT OF Drosophila. Radiat. Res. 27 (1966) 493. Abstr. Bb-2, at "14th Annual Meeting of the Radiation Research Society, Coronado, Calif., USA. 13-16 Feb. 1966".

Alpha particles with LET 200 MeV/gm/cm² produce unhealed breaks in the chromosomes of mature sperm of D. melanogaster about as frequently as equal doses of 300 kVp x-rays, even though the induction of autosomal translocations is one-hit for alphas and two-hit for x-rays. The use of a marked Y-chromosome, $y^{+} \cdot Y \cdot B^S$, discloses partial losses of 0.2% per krad and losses of the whole Y (or X) of 0.3% per krad, while sex-linked recessive lethals occur at a rate of 3% per krad. Further studies show that both alphas and x-rays produce the same proportion of mosaics: 14% of the partial losses and 2% of the whole losses. In addition, crisscross mosaics occur as frequently as regular mosaics involving both traits. Although all classes of mosaics can be explained by mitotic loss of the whole Y with appropriate (sometimes irregular) cell lineages during embryonic development, limited progeny tests indicate that most of the mosaics represent fractionals. Breeding the treated males to females having both arms of a Y attached to their X-chromosomes increases the fertility of whole losses from 3% - 94% and will permit cytogenetical investigations as well as more comprehensive progeny tests. Apparent loss of the whole Y (or X) has nearly doubled with this stock (for both alphas and x-rays), suggesting the possibility of some selective loss with standard stock. From these diverse observations of breakage events in different regions of the sperm head, we conclude that the radial spread rather than the density of ionization along an α -particle track is responsible for the one-hit kinetics of the translocations, and that this spread of ionization is effective over several tenths of a micron but probably not as far as a few microns. (Abstr.)

- 1022 Novitski, E., Myszewski, M.E., Goldin, H. DICENTRIC CHROMOSOMES IN Drosophila. Drosoph. Inf. Serv. 42 (1967) 105.

Females heterozygous for a long inversion provide the system where dicentric chromosomes are formed with regular frequency: Irradiation of these females would introduce random damage to the centromere regions of these crossover-produced dicentrics. In the instance where one of the centromeres is altered in the manner described previously, the 2nd centromere could act to carry the new chromosome to the pole. This would provide a class of progeny generally lost and would also provide chromosomes with particularly interesting properties. Should dicentric chromosomes such as these be recovered, their analysis may provide useful information concerning centromere strength,

activity of heterochromatin and chromosome structure. A simple experiment was designed to generate dicentric chromosomes. 4-d-old females were x-rayed with 2700 R and mated immediately to X/Y males carrying a yellow mutant. Among 37370 progeny from irradiated females, 324 flies carrying y^{+BS} and intermediate markers indicative of single crossing over were observed. No flies of the y^{+BS} phenotype appeared among 18628 progeny from nonirradiated females. Of the original 324 exceptional y^{+BS} flies, 186 (62 males, 124 females) proved to be fertile. These fertile exceptions are currently being tested to ascertain whether the y^{+BS} markers are actually carried by a dicentric chromosome or if they merely represent a tantalizing rearrangement of the markers. (From DIS)

- 1023 Oak Ridge National Lab., Tenn. Drosophila CYTOLOGY AND GENETICS. p.59-64 of "Biology Division Semiannual Progress Report for Period Ending January 31, 1966". ORNL-3922. May 1966, 207p.

Research progress in Drosophila cytology and genetics is reported on: a tandem duplication that lowers recombination throughout a chromosome arm; translocations as crossover suppressors; the frequency of x-radioinduced crossover-suppressing aberrations recovered from oocytes; scintillation counting of 3H -thymidine transferred to females by labeled males; a mutation induced by ethyl methanesulfonate that alters electrophoretic mobility of alcohol dehydrogenase isoenzymes; the meiotic origin of temperature-induced crossing-over; and the effects of exchange and structural zygosity on radioinduced non-disjunction and loss. (NSA 20; 1966, 40625)

- 1024 Ogaki, M., Nakashima-Tanaka, E. INHERITANCE OF RADIORESISTANCE IN Drosophila. Mutation Res. 3 (1966) 438-443.

Two wild-type strains of Drosophila melanogaster, Hikone-H and Mino-H, are radioresistant to γ -rays, but a Yamaguchi wild-type strain is radiosensitive, as are also two mutant strains, bw;st ss and vg-ms;se. In general, the females from these strains are more resistant than the males. Reciprocal crosses showed that resistance to radiation is dominant to sensitivity, and that maternal or cytoplasmic effects are negligible. The III-chromosome is mainly responsible for radioresistance in these strains, and the locus of the principal gene(s) for radioresistance may be near the right end. (Auth.)

- 1025 Olivieri, G., Olivieri, A. EVIDENCE FOR THE TWO-HIT NATURE OF x-RAY INDUCED CROSSING-OVER IN THE CENTROMERIC REGION OF Drosophila MALES. Mutation Res. 1 (1964) 279-295.

In order to study the relationship between dosage and frequency of x-ray-induced crossing-over in males of D. melanogaster, four samples of about 130 males each were irradiated with doses of 500, 1000, 2500, and 4000 R respectively. On the 10th to 11th day after irradiation, the two classes of complementary crossovers were found to occur independently of each other in the progeny of the individual males, and the distribution of crossovers per irradiated male followed a Poisson distribution. In consequence, the clusters in this brood were considered as pseudo-clusters, originating from different crossover events in the latest gonial cells. It is this stage that is characterized by the highest sensitivity to the induction of crossing-over. The number of crossovers found on these days has therefore been used as a direct estimate of the number of crossing-overs produced, taking into account the probable induction of crossing-over at the fourstrand stage. After logarithmic transformation, a linear relationship was observed between the dose and the percentage of crossovers produced in the late gonial cells in the centromeric region of the IIrd chromosome (regression coefficient = 1.788 ± 0.030). Crossing-over induced in this chromosome region therefore is most probably a two-hit phenomenon, to be explained in terms of two distinct and independent breaks. This conclusion is further supported by the observation that fractionation of the dose significantly reduced the frequency of induced crossing-over. When N_2 was given between the fractions the crossing-over frequency was restored to that of unfractionated radiation. It is thought that N_2 acts by preventing restitution of the breaks required for the pseudo-crossing-over. Post-treatment with N_2 after unfractionated radiation resulted in a significant enhancement of the crossing-over frequency. Irradiation in N_2 reduced the frequency of induced crossing-over to about $1/5$ of that observed in air, whereas radiation exposure in oxygen approximately doubled the crossing-over frequency as compared to that induced in air. The radiosensitivity in O_2 and N_2 differed by a factor of about ten. This is considered to offer further support for the two-hit origin of induced centromeric crossing-over in this stage. (Auth.)

- 1026 Reddi, O.S. INTERACTION OF x-RAY AND FAST NEUTRON-INDUCED CHROMOSOME BREAKS IN Drosophila. p.185 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun. -2 Jul. 1966, 263p". Abstr. 733.

Lack of interaction of x-ray- and neutron-induced chromosome breaks was noticed in Vicia and Tradescantia as expected on the basis of linear neutron kinetics for two break aberrations. However, interaction was observed between x-ray and chemically induced breaks in Drosophila. Experiments were undertaken 1) to evaluate the interaction of x-ray-and neutron-induced breaks;2) to check the dose linearity with fast neutrons;and 3) to detect any dose-fractionation effect. Adult males of D. melanogaster were exposed to x-rays (3000 R; 150 kV at a rate of 200 R/min) or varying doses of fast neutrons (400, 800 and 1600 rad) of 12-14 MeV energy spectrum from a Cascade generator or both. After irradiation each male was mated with three virgin females of a dual purpose stock, y sc^{S1} In-49 sc^{S1}; bw; st. After 3 d all the males were discarded and the fertilized females were transferred to bottles heavily seeded with yeast. The F₁ males were used to screen the translocations and the F₁ females were utilised to detect the incidence of sex-linked recessive lethals. The results are presented below:

Interaction data

Type	Dose	SRL	Trans
x-rays	3000 R	(480) 5.00	(510) 4.11
Fast neutrons	800 rad	(720) 3.75	(700) 5.00
x-rays followed by neutrons	(600) 9.66	(520) 11.92
Neutrons followed by x-rays	(591) 9.98	(559) 10.93

The results indicate that the yield of combined treatment is more than additive. Dose linearity with neutrons was also checked and the results are shown below:

Dose in rad	SRL	Trans
400	(800) 2.5	(840) 2.14
800	(720) 3.75	(700) 5.00
1600	(500) 7.6	(552) 10.68

The results were discussed. (From abstr.)

- 1027 Rinehart, R.R. IDENTIFICATION OF THE PROPOSAL: x-RAY INDUCED CHANGES IN Drosophila GERM CELLS. Progress Report, September 1, 1965-August 31, 1966. SAN-590-1, San Diego State Coll., Calif. 18p.

A further series of tests concerning the mutability of irradiated food and food components has been completed. Irradiated DNA added to Drosophila media has no modifying effect on sex-linked recessive lethality. Tests with irradiated sucrose as a food supplement are nearing completion. Dr. Frank Ratty is concerned with this aspect of the work. Measurements of frequencies of detachment of attached-X chromosomes as well as detachment partner from females given extended helium treatments have supported previous similar tests in which dominant lethality was the parameter of x-ray damage. In addition, these tests have indicated a random association of chromosomes in stage 7 oocytes while some polarization of pairing exists in stage 14 oocytes. When irradiated single females were extensively brooded so that a large sample of eggs were available from one female, it was observed that there were multiple detachments in many females, more than could be expected from randomness alone. If a detachment occurred in an egg from one female, many more detachments would be found in subsequent eggs, and they were of a similar kind. A decrease in sex-linked recessive lethality and a concomitant increase in dominant lethality in stage 7 oocytes from females given extended helium treatments has been observed. Experiments to test the modifying effects of extended helium

treatments on the recovery of different male spermatogenic stages as well as sex-linked recessive lethal, dominant lethal, II-III translocation and non-disjunction frequencies were performed. Work in progress is discussed, including clarification of possible repair of premutational events.

- 1028 Roberts, P. SPONTANEOUS AND x-RAY INDUCED EXCHANGE IN Drosophila melanogaster. Genetics 50, 2 (1964) 280. Abstr., at "15th Annual Meeting of the American Institute of Biological Sciences. Boulder, Colo., USA, 23-28 Aug. 1964".

See III/576: original published without abstract.

Females homozygous for In(1)sc⁸ or the normal X-chromosome but heterozygous for recessive markers were exposed to 4000 R and recombination was measured in 12-d brood fractions. Induced exchange in the heterochromatin that is moved distally by In(1)sc⁸ was greater than that observed in the heterochromatin in its normal proximal position. If successful recombination is dependent on proximity of broken ends at the time of irradiation, the heterochromatic regions of homologues are probably more closely associated in early oocytes at the time of crossing-over and in oögonia than in late oocytes. The increase in both spontaneous and x-ray induced exchange in proximal regions which have been moved distally suggests that effective pairing of homologues is normally lowered in centromeric regions, perhaps as a compensation for heterochromatic associations there. A comparison of x-ray induced exchange in the normal and inverted chromosomes with and without the crossover suppressor c3G indicates that most of the heterochromatic increase after Day 8 can be attributed to exchanges induced in oögonial chromosomes at the time of irradiation. The proximaleuchromatic increase and the euchromatic decrease apparently result from radiation effects which persist through at least one cell division and alter the behaviour of chromosomes during meiosis. - Unequal crossing-over in the Bar tandem duplication (B-57.0) was measured with and without a closely linked tandem duplication which also undergoes unequal crossing-over, Bx^{49k} (Bx-59.4). A slight increase in B reversions in the presence of Bx^{49k} is proportionate to an increase in regular crossovers in this region caused by addition of the duplication. Failure of the Bx duplication to increase asymmetrical pairing of B suggests that pairing in Drosophila oocytes is discontinuous and that the effective pairing segment is less than 2.4 map units in length. (Abstr.)

- 1029 Scriba, M. E. L. BEEINFLUSSUNG DER FRÜHEN EMBRYONALENTWICKLUNG VON Drosophila melanogaster DURCH CHROMOSOMENABERRATIONEN. (Influence of chromosomal aberrations on early embryo development in Drosophila melanogaster.) Zool. Jb., Anat. Ontol. Tiere 81, 3 (1964) 435-490. (In German)

The cleavage period of the egg was studied by paying special attention to chromosome aberrations which lead to dominant lethals. The normal development of the embryo, up to 6 h, is described. Unfertilized eggs give an indication of the contribution made by the egg cytoplasm. Such an egg is able to maintain its normal structure and function for 3-4 h. Irradiation of sperm with 15 000 R of x-rays induces chromosome aberrations. Cleavage nuclei of eggs fertilized by irradiated sperm reach the 32-nuclei stage, at best. Arrested cleavage is due to disturbances in the spindle, and not to the effect of dominant lethals. The egg structure remains normal beyond the moment of cleavage inhibition. The loss of the X-chromosome in the zygote nucleus from an attached -X-crossing does not affect cleavage. The nullo-X-eggs show lethal characteristics only at the stage of blastoderm formation. They have two Y-chromosomes in their nuclei, in addition to the diploid autosome set. The nullo-X-gamete is capable of developing the posterior midgut. The proctodeum remains uninverted. Following the loss of the X- and Y-chromosomes a zygote nucleus is formed, which possesses only a diploid autosome set. The sites of nucleolus formation are lost together with the sex chromosomes. Nullo-XY-eggs pass through the cleavage stage in the normal way. The pattern of damage largely follows that of the nullo-X-eggs. Merely the formation of the generative cells, the pole cells, appears to be more markedly disturbed in the nullo-XY-gametes. Presumably there is some relation between the incompletely organized pole cells and the absence of the basal structure for the posterior midgut. There is no indication of growth around the posterior pole towards the dorsal side of the egg. The proctodeum does not get formed. The developmental processes in the early embryo involving lethal factors show a certain independence of the loss of genetic material during the cleavage period. Cleavage of the Drosophila egg appears to be more subject to cytoplasmic influence.

- 1030 Sinkha, S. P. COMPARATIVE STUDY OF CROSSING-OVER IN TWO LINES OF Drosophila melanogaster. p.201-208 of "Vliyaniye Ionizirovannykh Izlucheniĭ na Nasledstvennost". Dubinin, N. P., Ed. Moscow, Izdatel'stvo Nauka, 1966. (In Russian)

Heterozygotic females of two lines of D. melanogaster, Magarach and D-18, 0-24 h old were kept at 37°C for 8 h. A high rate of crossing-over was found in the offspring on the 6th to 7th day. After irradiation with 2000 R of x-rays, flies exhibited the same increase on the 6th to 7th days and it was also found to the 11th day in Magarach and the 14th day in D-18. Comparative study of the induced crossing-over showed the former is radioresistant and the latter radiosensitive. After irradiation with 2000 R it was found that higher temperatures increased the frequency of induced crossing-over in Magarach but not in D-18, and that the increase occurred in D-18 with a dose of 1000 R. (NSA 22: 1968, 21484)

- 1031 Sperlich, D. EQUILIBRIA FOR INVERSIONS INDUCED BY x-RAYS IN ISOGENIC STRAINS OF Drosophila pseudoobscura. Genetics 53 (1966) 835-842.

Strains made isogenic for their IIrd and IIIrd chromosomes were irradiated. Males were exposed either to three x-ray doses of 3000 R with intervals of 3 d between the exposures, or to two doses of 4500 R with the same interval, at 2183 R/min. Nine inversions (one of them double) were induced in chromosome III and four in chromosome II. Experimental populations were made carrying the induced inversions, with initial gametic frequencies of 25%. In six of the populations the induced inversions were eliminated, or were close to elimination, within a year; three populations were lost by contamination (including one with inversions both in the IIrd and in the IIIrd chromosomes); and in two remaining populations the inversions established balanced equilibria. These two heterotic inversions are the more remarkable since they are lethal, or at least semilethal, in homokaryotypes. Induced heterotic mutants, as well as heterotic position effect, could explain these heterotic inversions.

- 1032 Srivastava, M. D. L., Bachher, K. S. EFFECT OF x-RAYS ON THE CHROMOSOMES OF Chrotogonus incertus Bolivar (ACRIDIDAE). Caryologia 19 (1966) 513-521.

Specimens of C. incertus were exposed to 400, 500, and 800 R and spermatocytes were examined 24 h subsequent to exposure. Exposure to 800 R caused aggregation of chromosomes into large vacuolated masses, which were unequally divided between the secondary spermatocytes. Another effect was extreme fragmentation of chromosomes. Exposure to 400 and 500 R caused comparatively moderate aberrations—lagging and incomplete breaks. (Auth.)

- 1033 Strangio, V. A. BROOD SENSITIVITY PATTERNS AFTER THE IRRADIATION OF MALES BEARING A ROD, RING OR INVERTED-X AND A DOUBLY MARKED Y-CHROMOSOME. Drosoph. Inf. Serv. 41 (1966) 176.

Males bearing either a rod (R), ring (X^{C2}) or inverted (M5) X-chromosome and a doubly marked Y-chromosome ($B^s Y y^+$) were irradiated with 800 R x-rays. Partial or complete sex chromosome loss, induced X-Y exchange and/or non-disjunction were recorded. A table is given showing the daily brood sensitivity patterns for some of these aberrations. In general, the sex chromosome loss patterns are comparable except for the markedly increased amplitude found in the ring-X series as expected and as previously noted by Sobels (1963). An unexpectedly high recovery of yellow-Bar females, i. e. recombinant X's from induced exchange between the inverted-X (a Barless Muller-5 chromosome) and $B^s Y y^+$ during a study of spermatogenic sensitivity to the induction of sub-terminal deletions (Lüning 1954) led to a re-appraisal of supposed non-disjunctional exceptionals from rod-X experiments (Strangio 1961), confirming studies independently undertaken by Zimmering and Wu (1964). Induced X-Y exchange is predominant over non-disjunction in both rod and inverted-X experiments. This is not immediately apparent in the results given for the inverted-X which have not been adjusted here for a relatively inflated spontaneous rate of primary non-disjunction. However, the position is definitely reversed for the ring X. The dicentric configuration produced after exchange between the ring X and Y probably accounts for this situation. However, a rare rupture of this dicentric in a heterochromatic region may sometimes be followed by healing and the recovery of a monocentric recombinant X. (From auth.)

- 1034 Thomas, R. E., Roberts, P. A. COMPARATIVE FREQUENCY OF x-RAY INDUCED CROSSOVER-SUPPRESSING ABERRATIONS RECOVERED FROM OOCYTES AND SPERM OF Drosophila melanogaster. Genetics 53 (1966) 855-862.

One thousand chromosome arms from x-irradiated oocytes of *D. melanogaster* (stage 7 and earlier) were screened for crossover-suppressing aberrations; two such aberrations were recovered, but neither was an inversion. The yield of intrachromosomal rearrangements recovered from oocytes was an order of magnitude below that recovered from sperm given the same radiation exposure. Possible explanations for the differences in aberration yield from the two germ-cell stages and their relation to the problem of dominant lethality in oocytes are considered. (Auth.)

- 1035 Thomas, R.E., Roberts, P.A. COMPARATIVE FREQUENCY OF x-RAY-INDUCED CROSSOVER-SUPPRESSING ABERRATIONS RECOVERED FROM OOCYTES AND SPERM OF *Drosophila melanogaster*. p. 60 of "Biology Division Semiannual Progress Report for Period Ending January 31, 1966". ORNL-3922, Oak Ridge National Lab., Tenn. May 1966, 207p.

For abstract, see 1034.

- 1036 Thompson, P.E., Yamazaki, T. TRANSLATION AND NONHOMOLOGOUS ACTIVITY OF SEGREGATION-DISTORTER (SD) IN MALES OF *Drosophila*. *Genetics* 56, 3 Pt.2 (1967) 592-593. Paper presented at the "1967 Meetings of the Genetics Society of America. Stanford, Calif., USA 31 Aug. - 2 Sep. 1967".

Modifiers of the activity of Segregation-distorter (SD) have been induced by irradiation of males with high activity. Several modified lines can be shown to have rearrangements in chromosome II, carrying SD itself. To some extent, the reduction in SD activity seems related to the positions of breaks in chromosome II, although many of the induced modifiers are in non-homologous chromosomes. Distant breaks in 2 R have much less effect on segregation-distortion in males than on female crossing over in the same region: - In the case of two among nine reciprocal translocations of Y and 2, where SD is included in the translocation, heterozygous males produced a remarkably high frequency of exceptional X0 sons having the SD+ homologue and no translocation elements. The reciprocal class of exception XX, T(Y;2) females is negligible in number. Because the exceptional X0 class is virtually absent when the SD-bearing translocations are paired with an insensitive homologue, its occurrence clearly depends on segregation-distortion and not on the rearrangement or on the mechanics of pairing alone. - Although the two translocations distort strongly against their SD+ *cn bw* homologue, and this activity has been shown to depend on the genic composition of chromosome II, their net effect against recovery of the X-chromosome is even greater. Curiously, this larger non-homologous effect depends on the exceptional male class in which SD itself is lost. In these cases, the elimination of the X-chromosome cannot involve pairing of the kind which determines segregation. (Abstr.)

- 1037 Tikhomirova, M.M. MECHANISM OF x-RAY INDUCTION OF ANEUPLOID GAMETES. *Genetika* No.4 (1965) 63-68. (In Russian)

Studies with *Drosophila* showed that intensity modified the effects of x-irradiation within the same dose range. Data are given also that attribute radioinduced non-disjunction in *Drosophila* chromosomes to chromosome breakage and reunion. (NSA 20: 1966, 24892)

- 1038 Tikhomirova, M.M., Dzhimelin, A.A., Belyatskaya, O.Ya. GENETICAL AFTER-EFFECTS OF x-RAYS DEPENDING ON THE TEMPERATURE REGIME. *Genetika* No.5 (1967) 95-104. (In Russian)

It was shown by the study of the dependence of the aftereffect of x-rays on the regime of the subsequent high temperature treatment on chromosomes of *Drosophila melanogaster* that the aftereffect is proportional to the duration of exposure to high temperature within the interval between 30 min and 8 h and 30 min after irradiation; each hour of exposure to high-temperature resulted in the actual occurrence of 0.24% of potential breaks. Without temperature treatment, however, the kinetics of repair of hard x-ray-induced potential damages had an uneven character: most of them were repaired during the first 30 minutes after irradiation, but subsequently the rate of reparation slowed down. In case of soft x-rays the aftereffect (120%) could be detected only when the temperature treatment was immediate, which suggests that all the potential breaks are repaired during an hour after irradiation without any subsequent temperature treatment. By the comparison of the effects of hard and soft x-rays it was shown that they are equally effective so far as the total frequency of breaks is concerned. Both kinds of x-rays differed only in the relative proportion of the types of breaks: hard x-rays induced somewhat more potential breaks and less actual breaks as compared to soft x-rays. (Auth.)

- 1039 Tokunaga, C., Arnheim, N., Jr. AGE DEPENDENCE OF LOCATIONS OF x-RAY-INDUCED SOMATIC CROSSING-OVER IN Drosophila. Genetics 54 (1966) 267-276.

Radioinduced somatic crossing-over was studied in the left arm of the IIId-chromosome in D. melanogaster. In experiments with the genes Tufted (Tft, 48.5 - 54.5) or Bristle (Bl, 54.8), x-irradiation given early in development resulted in more somatic exchanges to the left of these loci than to the right of them. Later in development the opposite was true, with more crossing-over occurring to the right than to the left. It would appear that both the Bl and Tft loci lie between two chromosome regions which differ in the time during ontogeny at which they are maximally sensitive to x-ray induced somatic crossing-over. (Auth.)

- 1040 Traut, H. x-RAY INDUCTION OF AUTOSOMAL TRANSLOCATION IN MATURE OOCYTES OF Drosophila melanogaster. Nature, Lond. 214 (1967) 718-719.

The rather low dose of 500 R of x-rays was shown to induce a relatively high frequency of autosomal translocations in mature oocytes. The difference between the irradiated (12/2653) and the control series (0/3283) is highly significant ($P = 0.001$, calculated by the χ^2 -method with Yates' correction for continuity). The same dose (500 R), applied under similar physical conditions, induces a II-III-translocation frequency of 0.55% in mature sperm (see 11/979). This sperm value can be directly compared with the oocyte value of 0.45%, because the corrections for the diploid nature of oocytes as compared with the haploidy of sperm and the loss of symmetrical translocations by meiotic segregation at least roughly compensate each other. A comparison with the stage 7 experiments shows that in stage 14 oocytes about 100 times as many autosomal translocations are induced by 500 R as in stage 7 oocytes.

- 1041 Traut, H. X-CHROMOSOME LOSS INDUCED BY LOW x-RAY DOSES IN MATURE AND IMMATURE OOCYTES OF Drosophila melanogaster. Mutation Res. 4, 4 (1967) 510-513.

X-chromosome loss is a useful criterion for the radiation sensitivity of oocytes. D. melanogaster females, 7 ± 1 d old, of the genotype y sc⁵¹ ln49 sc⁸; bw; st were used and immediately mated with normal Berlin wild males. Actually y is the only marker necessary to distinguish F₁ XO males (phenotype y⁺) and XXY females (phenotype y) from the regular offspring (y⁺ females and y males). The experimental procedures are described. Only sterile y⁺ males were counted as males resulting from X loss. Subsequent calculations show that in the low dose range from 0-400 R the frequency of x-ray-induced X-chromosome loss is ~ 30 times higher for stage 14 oocytes than for stage 7, i.e., by an order of magnitude greater than has been reported by other workers. The data might be utilised as an argument for the high efficiency of stage 7 oocytes in repairing radiation-induced chromosome breaks.

- 1042 Traut, H. x-RAY INDUCTION OF 2; 2; 3 TRANSLOCATIONS IN MATURE AND IMMATURE OOCYTES OF Drosophila melanogaster. Genetics 56, 2 (1967) 265-272.

Resistance to induction of autosomal translocations proved characteristic only of stage 7 oocytes (and the earlier stages), while in stage 14 translocations were readily induced. Doses of 500, 1000 and 4000 R were used. With 500 R, the translocation frequency was about 100 times greater for stage 14 than for stage 7. Differential restitution of radiation-induced chromatid breaks together with differences in the spatial arrangement of the chromosomes in the two oocytes stages is proposed to explain this great difference in sensitivity. For stage 14 the frequency of translocation obtained by irradiation with 1000 R is significantly lower than that obtained with 500 R. The departure even from a linear, and much more so from a quadratic dose-effect relationship is highly significant. It is suggested that this decrease in translocation frequency with increasing dose is caused by a close connection between the induction of autosomal translocations and dominant lethals.

- 1043 Traut, H. DOSE-EFFECT RELATIONSHIP OF AUTOSOMAL TRANSLOCATIONS INDUCED BY x-RAYS IN MATURE OOCYTES OF Drosophila melanogaster. Int. J. Radiat. Biol. 12, 6 (1967) 583-586.

A flattened shape is obtained for the dose-dependence curve of the frequency of 2:3 translocations induced by x-rays in mature oocytes of D. melanogaster. It was plotted for doses of 250, 500, 700, and 1000 R. A significant ($P \approx 0.05$) departure from the $\frac{1}{2}$ power rule in the dose-effect relationship was observed. (This difference is not significant as calculated by the χ^2 method using Yates' correction

for continuity.) For x-ray doses < 500 R administered to mature sperm the translocation frequency is directly proportional to the dose (not to its square). For pure samples of mature oocytes at low doses a linear dose-effect relationship may also be expected.

- 1044 U. R., Mittler, S. EFFECT OF IONIZING RADIATION AND INCIDENCE OF TRIPLO-X FEMALES IN OFFSPRING OF ATTACHED-X *Drosophila melanogaster*. Radiat. Res. 31, 3 (1967) 613. Abstr. Eb-4, at "15th Annual Meeting of the Radiation Research Society, San Juan, Puerto Rico, 7-11 May 1967".

Oregon-R males, 1-12 h old, were irradiated with 1500 R of x-rays and mated every 3 d to a new harem of attached-X y w f at a ratio of one male to three females. The appearance of exceptional females (usually y⁺ w⁺ f⁺ and rough eyes, dumpy wings, twisted abdomen) in F₁ are result of an egg containing the attached X's, fertilized by a normal X-bearing sperm which results in a triplo-X chromosome zygote with diploid number of autosomes. These zygotes supposedly rarely develop into the adult fly. However, 4.3% of the spontaneously arising triplo-X females in the offspring of the control group survived as compared to 2.7% for the group in which males were treated with 1500 R of x-rays. A statistical analysis by 2 x 2 contingency table showed a Chi-square of 25 which is a significant difference between the two groups. Since spontaneously arising triplo-X females do survive more frequently than in the irradiated group, the decrease in the number which survive is a measure of radiation induced damage either to the autosome chromosomes or to gamete as a whole. The time for maturation of triplo-X females into adult flies was usually 4-6 d behind that of her normal siblings. The various physical expressions of triplo-X females are discussed. (Abstr.)

- 1045 Vatti, K. V. ON FREQUENCY OF x-RAY-INDUCED CHROMOSOME BREAKS AT VARIOUS STAGES OF *Drosophila melanogaster* SPERMATOGENESIS. Genetika No. 3 (1966) 98-100. (In Russian)

Breaks of the ring X-chromosome of *Drosophila* induced by various x-ray doses (100-3000 R) at different stages of spermatogenesis were studied. It was found by means of the brood pattern method that frequency of breaks is characterized by a linear dependence on the irradiation dose at meiotic and postmeiotic stages of spermatogenesis. In contrast to this the spermatogonia do not follow such a dependence pattern within the same dosage range and are characterized by a number of breaks, approaching that of the control. A connection between breaks frequency and male fertility was observed due to irradiation of different stages at spermatogenesis. Thus increase of breaks number due to irradiation of spermatids with massive doses resulted in stressed fertility decrease; decrease of breaks number in irradiated spermatogonia caused stressed fertility increase, which is tentatively explained by an irreparable elimination of the damaged spermatids and a simultaneous substitution of damaged spermatogonia for intact cells. A dependence of breaks frequency induced in the spermatogonia on the stage of ontogenesis being irradiated was also found. (Auth.)

- 1046 Wagoner, D. E. LINKAGE GROUP-KARYOTYPE CORRELATION IN THE HOUSE FLY DETERMINED BY CYTOLOGICAL ANALYSIS OF x-RAY INDUCED TRANSLOCATIONS. Genetics 57, 3 (1967) 729-739.

Males, 4-6 d old, were irradiated in gelatine capsules, 2000 to 2750 R x-rays being administered at an approx. dose rate of 280 R/min. Cytological studies of induced translocations in the housefly, *Musca domestica* L., showed that the five linkage groups previously reported by other workers belong to the five pairs of autosomes also previously reported. No sex-linked mutants have been found thus far. The correlation of the linkage groups to particular chromosomes as seen cytologically had not been previously attempted and was the objective in this work. The new assignment of linkage groups to particular chromosomes (made by using Perje's numbering of the housefly karyotype with X and Y representing the sex chromosomes and Roman numerals I to V representing the autosomal pairs starting with I as the longest pair and ending with V as the shortest pair) shows the R1 marker and its associated linkage group located on chromosome I, the car marker and its linkage group on chromosome II, the bwb marker and its linkage group on chromosome III, the rb marker and its linkage group on chromosome IV, and the ocra marker and its linkage group on chromosome V.

- 1047 Wallace, B. NATURAL AND RADIATION-INDUCED CHROMOSOMAL POLYMORPHISM IN *Drosophila*. Mutation Res. 3 (1966) 194-200.

The retention of x-radiation-induced inversions in small populations of *D. pseudoobscura* whose parental flies were from different geographic origins is discussed. 50 populations were studied; five were found to be polymorphic for newly induced autosomal inversions 6 months to 1 yr later;

three of these polymorphisms persisted for another 2 yr when the experiment was terminated; three of the five original polymorphisms involved chromosome-II, a chromosome that is generally monomorphic in natural populations. The restriction of naturally occurring polymorphisms in this species to chromosome-III cannot be explained, then, by the absence of fitness heterosis in individuals heterozygous for genes on other chromosomes. Nor can such a lack of fitness heterosis explain the tendency for closely related species (such as *D. pseudoobscura* and *D. persimilis*) to utilize homologous chromosomes for adaptive polymorphisms. Alternative possibilities are discussed. (Auth.)

- 1049 Warters, M. X-AUTOSOMAL TRANSLOCATIONS OF *Drosophila melanogaster*. Final Report. TID-23233, Centenary Coll., Shreveport, La. Dept. of Biology. 1966, 12p.

Studies on *D. melanogaster* were aimed at developing a technique that would make possible the recovery of all X;autosomal translocations and the maintenance of them as a balanced stock. Further, a cytological analysis of a representative sample of X;autosomal translocations was made in an effort to determine the difference between those that were male fertile and those that were male sterile. Using the procedure of Lindsley, 274 translocations were found from 2188 tested genomes distributed in classes T(X;2), T(X;3), T(X;2;3), and T(2;3). Sex-linked recessive lethals suppressed by the Y-chromosome were analysed and are presented in tabular form. Differences between male fertile and male sterile translocations were established cytologically. With the exception of a few very complex rearrangements, the exact breakpoints as lettered subdivisions and the new chromosome sequence of each was determined, and analysed in terms of heterochromatin and euchromatin. (NSA 20: 1966, 42709)

- 1049 Zimmering, S., Johnsen, R. C., Fowler, G. POISSON ANALYSIS ON THE DISTRIBUTION OF x-RAY-INDUCED CROSSOVERS IN SPERMATOCYTES OF *Drosophila*. *Can. J. Genet. Cytol.* 8 (1966) 216-219.

Drosophila males of the autosomal composition *dp cn bw*/+++ were x-irradiated 1-2 h after the onset of the prepupal stage with 1000 R and upon eclosion brooded each day for 5 d with 3 *dp cn bw* females. For each brood, crossover data for the *dp-cn* region were analysed to determine their fit to the Poisson distribution. There was no good evidence of a significant deviation from this distribution in broods 1-4 representing the recovery of late and early spermatocytes, and possibly late spermatogonia (in broods 3 and 4). Brood 5 was characterized by a steep rise in population size and a marked deviation from Poisson distribution indicating the recovery of earlier spermatogonia. Failure to find a significant deviation in spermatocytes suggested that 1 crossover of the complementary pair was not recovered, that is, each recovered crossover arose from an independent event. The data appear to satisfy the prediction from the Peacock-Erickson model postulating the existence of a functional and a non-functional pole at meiosis I, but alternative possibilities are discussed. (NSA 21: 1967, 22385)

- 1050 Zimmering, S., Johnsen, R. C. SIMULTANEOUS MEASURE OF x-RAY INDUCED X-Y AND AUTOSOMAL CROSSINGOVER IN SPERMATOCYTES OF *Drosophila*. *Z. Vererblehre* 98 (1966) 137-140.

x-rays induce crossingover between X- and Y-chromosomes in primary spermatocytes of *Drosophila*. A study of the relation between the pattern of induced X-Y and autosomal crossingover suggested that the two patterns are different. Radiation-induced X-Y and autosomal crossingover was followed in primary spermatocytes of *Drosophila* males. Males of the composition *y/B⁸y⁺* were irradiated 1-2 h after the prepupal stage and mated daily with 3y; *dp cn bw* females. The results indicated that the frequency of recovered X-Y crossovers is highest in the late spermatocyte stage about to undergo the 1st meiotic division, whereas the peak frequency of autosomal crossovers occurs in earlier spermatocytes. The results are explainable if (1) a more appropriate pairing configuration exists between X and Y than between autosomes at later stages of the primary spermatocyte, a situation which is reversed in earlier stages; (2) breakability of Y (and/or X) heterochromatin and centromeric heterochromatin of autosomes are different from each other at different stages of the primary spermatocyte; or (3) a combination of both. (NSA 21: 1967, 18026)

See also:

- 919 Effects of radiation on cells. (Borstel, R. C. von, 1966)
945 Spermatogonial crossing over in *Drosophila melanogaster* and *Drosophila ananassae*. (Kale, P. G., 1967)

- 951 Can Drosophila spermatozoa be used in studies of recovery processes? (Lüning, K.G., 1961)
- 961 A survey of methods for the induction of aberrations in meiotic stages in Drosophila females and for observation of their disjunctional properties in the ensuing meiotic divisions. (Parker, D.R., 1967)
- 962 ibid.
- 983 Meiotic X-Y exchange and nondisjunction induced by x-rays in primary spermatocytes of male Drosophila melanogaster. (Wu, C.K., 1967)
- 984 Induced mutations and lethality in Drosophila after x-irradiation of meiotic and post-meiotic stages of the egg. (Wünger, F.E., 1968)
- 986 Meiotic X-Y exchange and nondisjunction induced by irradiation in the Drosophila male. (Zimmering, S. et al., 1964)
- 1062 Dependence of radiation induced mutation rate on maturity and dose for chrysalis of Drosophila melanogaster Meigen. (Ebeling, W., 1962)
- 1121 The theory of radiation-induced dominant lethality in sperm. (Borstel, R.C. von, 1966)
- 1139 Sterility, chromosome breakage, x-ray-induced mutation rates and detected mutation frequencies in Drosophila melanogaster. (Lefevre, G., Jr., 1967)
- 1150 x-Radiation induction of mutations in Habrobracon. (Smith, R.H. et al., 1966)
- 1152 Mutation pattern in two wild-type stocks of Drosophila melanogaster. (Strömnaes, Ø., 1959)
- 1175 Influence of arginine on radiation damage of spermatids and spermatocytes in Drosophila. (Abeleva, E.A., 1965)
- 1179 Investigation of the complex effect of ionizing radiation and other factors of space flight on the organism. (Antipov, V.V. et al., 1966)
- 1180 Results of biological investigations conducted during flights of "Vostok" type vehicles with the participation of cosmonauts A.G. Nikolayev, P.R. Popovich and V.F. Bykovskiy. (Antipov, V.V. et al., 1966)
- 1190 "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". (Elequin, F.T. et al., 1966)
- 1191 Modification of induced genetic damage in Drosophila melanogaster by oxygen and argon treatments between two doses of x-rays. (Elequin, F.T., 1966)
- 1203 AET and radiation induced crossing-over in male D. melanogaster. (Mittler, S., 1965)
- 1204 ibid (1966)
- 1205 Modification of radiation induced chromosome loss by ATP in Drosophila. (Mittler, S. et al., 1966)
- 1206 Effect of urethane and colchicine on radiation-induced chromosome loss in male Drosophila. (Mittler, S. et al., 1966)
- 1207 Adenosine triphosphate: protection against radiation-induced chromosome loss in Drosophila.
- 1208 Effect of ATP upon radiation induced chromosomal aberrations in Drosophila. (Mittler, S. et al., 1967)
- 1221 Influence of helium posttreatments and exposure fractionation on x-ray induced dominant or sex-linked recessive lethality and X-chromosome loss in stage 7 oocytes of Drosophila melanogaster. (Rinehart, R.R., 1967)
- 1230 Effect of ethylene-diaminetetraacetic acid sodium salt on the process of crossingover in different lines of Drosophila melanogaster. (Sikha, S.P., 1965)
- 1234 The contrasting effects of O₂ and N₂ in determining initial sensitivity and post-radiation recovery in Drosophila sperm and spermatids. (Sobels, F.H., 1964)
- 1235 Processes underlying repair and radiosensitivity in spermatozoa and spermatids of Drosophila. (Sobels, F.H., 1966)
- 1236 Repair of radiosensitivity phenomena in Drosophila males. (Sobels, F.H. et al., 1967)
- 1237 RBE values for genetic effects of 15 MeV neutrons in relation to stage sensitivity in Drosophila. (Sobels, F.H., 1967)
- 1246 Genetic x-radiation damage and its modification by some gases and a time factor in Drosophila melanogaster. (Yoon, J.S., 1966)
- 1251 Genetic damage induced in the sex chromosome and autosomes, with x-ray and ethylenimine treatments. (Alexander, M.L., 1967)
- 1259 A comparison between the effects of x-rays and heat treatment on recombination in the X-chromosome of Drosophila melanogaster. (Chandley, A.C., 1966)
- 1260 Biological organization in relation to differential gene response to mutagens. (Fahmy, O.G. et al., 1965)

- 1263 The action of radiation and other mutagenic agents 1. in inducing mutation in Drosophila females, and 2. in controlling the action of specific genes responsible for suppressing uncontrolled growth. (Glass, H. B., 1966)
- 1273 Cytological analysis of formaldehyde induced chromosomal changes in Drosophila melanogaster (Slizyńska, H., 1957)
- 1285 Brood data on crossover recovery from pretested heated adult females. (Whittinghill, M., 1964)
- 1395 Studies on the radiosensitivity of early embryonic stages of Drosophila melanogaster. (Würgler, F. E., 1964)
- 1419 Estimation of sensitivity of Drosophila melanogaster to radiation using a third-order rotatable design. Three Year Comprehensive Report. (Ratty, F. J., 1966)
- 1492 Chromosomal polymorphism in irradiated natural populations of Chironomus. (Blaylock, B. G., 1966)
- 1493 Cytogenetic study of a natural population of Chironomidae inhabiting an area contaminated by radioactive waste. (Blaylock, B. G., 1966)
- 1494 Population genetics and radiation effect studies. (Blaylock, B. G., 1966)
- 1506 On the interaction between the chromosomes carrying the detrimental genes or gene blocks in viability. (Matsudaira, Y., 1965)
- 1518 The fate of x-ray induced chromosomal rearrangements introduced into laboratory populations of Drosophila melanogaster. (Vann, E., 1966)
- 1519 A genetic analysis of induced chromosomal rearrangements in laboratory populations of Drosophila melanogaster. (Vann, E. G., 1966)

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

- 1051 Altenburg, E., Browning, L. S. COMPARATIVE VISIBLE MUTATION RATES IN THE X-CHROMOSOME OF Drosophila AT VARIOUS STAGES IN OOGENESIS. Drosoph. Inf. Serv. 41 (1966) 95-96.

Among approx. 40 530 female progeny of Muller's Vix stock (heterozygous at 13 visible loci in the X-chromosome), a total of 77 mutations (45 whole body and 32 mosaic) were recovered at the visible loci under study, or about 1 in 530, after treatment of the female parents with CB 1506 (2-chloroethyl-methanesulfonate) vapour, and about a 20% sex-linked lethal rate from a smaller sample. Most of these mutations were recovered in the first five 3-d brooding periods, but none among the relatively few progeny in the first brood, in which most of the oocytes treated in stage 14 would be represented. On the basis of work reported by R. Valencia, we calculate that the mutation rates at the same loci as the above (but in Muller's "jyrd" stock) were about ten times as high after x-ray treatment of stage 14 oocytes (the stage studied by Valencia) than the rate we recovered after treatment of the earlier stages of oogenesis with an equivalent mutagenic dose of CB 1506. The "equivalence" is based on the lethal rates induced by the agents under study, and on the assumption that the lethal rates induced by radiation of earlier stages in oogenesis (not obtained in our experiments) would be about the same as the rates usually recovered after radiation of the mature sperm cells, though actually they are somewhat lower in the former than the latter case. The visible rates, relative to the lethal, were not widely different after x-ray treatment of stage 14 oocytes, as reported by Valencia, and CB 1506 treatment of the earlier stages, herein considered. The extreme radiosensitivity of stage 14 oocytes has been pointed out by Valencia. (Auth.)

- 1052 Anonymous. PRESERVING FOOD BY RADIATION: SAFE OR UNSAFE. Sci. Cult. Calcutta 33 (1967) 364-365.

Objections to the use of radiation for preservation of food are discussed. In some cases an unpleasant flavour is produced by radiation. Another objection is the high cost of equipment. The association of radiation with harm to human beings causes prejudice against radiopreservation of food, even though many experiments failed to produce evidence that irradiated food is harmful. Harmful mutations developed in fruit flies fed on heavily irradiated food. It is pointed out that rats, pigs,

mice, and monkeys fed on irradiated food over a period of 10 yr failed to show any evidence of harmful effects. (From NSA 22: 1968, 21642)

- 1053 Baldwin, W.F., Cross, W.G. EFFECTS OF FAST NEUTRONS ON EYE COLOR MUTATIONS IN Dahlbominus. Nature, Lond. 210 (1966) 1396-1397.

The mutagenic effects of 14-MeV neutrons as compared to ^{60}Co γ -rays in adult females of D. fuscipennis were studied. The numbers of four classes of eye colour mutants (carmine, claret, chestnut, and russet) were scored following exposure of Dahlbominus adults. The total dose, whether of neutron or of γ -rays, was about 750 rad. The neutron exposures produced about 30% more mutations. However, as the age of the insects at the time of exposure was increased from 12-108 h, the frequency of mutations rose about twofold for both neutrons and γ -rays. Overlapping of the standard limits for each age group demonstrated that no significant differences were detected between the results with γ -rays and with neutrons. (NSA 20: 1966, 33023)

- 1054 Baldwin, W.F. AN INCREASED YIELD OF GAMMA INDUCED EYE COLOUR MUTATIONS FROM CHRONIC VERSUS ACUTE EXPOSURES IN Dahlbominus. To be published in the Proceedings of the "IAEA Symposium on the Use of Isotopes and Radiation in Entomology. Vienna, Austria, 4-8 Dec. 1967".

- 1055 Baldwin, W.F. AN INCREASED YIELD OF GAMMA INDUCED EYE COLOUR MUTATIONS FROM CHRONIC VERSUS ACUTE EXPOSURES IN Dahlbominus. AECL-2791, Atomic Energy of Canada Ltd., Chalk River (Ontario). Nov. 1967, 7 p. Paper SM-102/29 also presented at "IAEA Symposium on the Use of Isotopes and Radiation in Entomology. 4-8 Dec. 1967, Vienna, Austria". (See 1054, above)

Susceptibility to induced mutation reaches a plateau in aging females at ~9 d after they become adult, and over the following 4 d the mutation rate maintains a comparatively constant frequency. Accurate records of the number of cocoons parasitized by Dahlbominus, and the number of progeny per female, have made it possible to test for differential killing by seeing if decreased fecundity is associated with a depression of mutagenic rates. Studies of the effects of 500 rad of γ -radiation delivered chronically over the period of comparable sensitivity, i.e. over 100 h from 9-13 d after the pupal stage, and of the same dose as acute exposures at different times in this period are now complete, and are complemented by similar studies using 250 rad. The results with 500 rad indicate an approx. 20% greater mutagenic effect of the chronic as compared with the acute exposures. The results of 250 rad show that the difference in mutation frequency as compared with chronic doses is less at this lower exposure, implying that the difference in effect is probably the result of a disproportionately greater killing by the acute irradiation of cells which would have produced mutations. Records of parasitization and the number of progeny per female following acute and chronic exposures at 500 and 250 rad give conflicting results, indicating that differential killing may not be a factor determining mutagenesis. The results are based on 823 eye colour mutations in a total of 346171 flies scored. (From auth.)

- 1056 Bartlett, A.C., Bell, A.E. "IVORY", AN EYE-COLOR MUTATION IN Tribolium castaneum. Ann. ent. Soc. Am. 59, 4 (1966) 865-866.

The ivory mutant was isolated from an x-rayed population under selection for large body size (strain LCS in ref. 1487). Preliminary data suggest that ivory and pearl are closely linked and at approximately equal distances from pegleg. The occurrence of ivory further emphasizes the need for study of possible homologies between mutants in other species, as well as the biochemical relationships between similar mutants of the same species. Biochemical study of the two eye mutants, pearl and ivory, might yield significant information concerning the biosynthesis of eye pigments in both Tribolium and other insects.

- 1057 Ben-Zeev, N., Falk, R. ABSENCE OF Y-SUPPRESSED LETHALS IN AN AUTOSOME OF Drosophila. Mutation Res. 3 (1966) 174-176.

Male D. melanogaster were exposed to 3-4 kR x-radiation and mated three times, on days 1-3, 3-5, and 5-9 after irradiation. The frequency of chromosome lethals in offspring was determined for each group. Data are included on the constitution and phenotypes of the sex chromosomes of each

test generation. Not a single Y-suppressed lethal was found in the second chromosome although 15-18 were expected by the standard of the X-chromosome. Possible explanations are suggested. (NSA 20: 1968, 28683)

- 1058 Bender, H. A. RADIATION INDUCED TANDEM DUPLICATIONS IN Drosophila melanogaster. Genetics 55, 2 (1967) 249-254.

Tandem direct duplications of the lozenge (*lz*) region have been induced by x-irradiation of the diploid meiotic stages of the female. Detection was based upon partial complementation between two of the *lz* pseudoallelic mutants, and the duplications were confirmed by cytological and genetic analysis. (Auth. summary)

- 1059 Bowman, J. T., Jr., Green, M. M. x-RAY INDUCED REVERSION OF THE WHITE-IVORY MUTANT OF Drosophila melanogaster. Genetica 37 (1966) 7-16.

Following x-irradiation, *wⁱ* reverts in oogonia and in spermatogonia. Following treatment of adult females, *wⁱ* reverts equally frequently in homozygotes and deficiency heterozygotes. Induced reversion is commonly recovered as clusters, indicating that they are of gonial origin. In contrast to *wⁱ*, two partial reversions recombine normally with *w^{ch}*. One of these has been tested for x-ray-induced reversion and found to be stable. (Auth.)

- 1060 Conner, G. W. PREFERENTIAL SEGREGATION IN Mormoniella. Genetics 54 (1966) 1041-1048.

In the parasitoid wasp *M. vitripennis* (Walker) many eye-colour mutations had been obtained with x-rays, fast neutrons, and slow neutrons. Three different types of crosses are possible involving triple complementary allelic genes affecting eye colour in *Mormoniella*. Females homozygous for each gene are mated to males compound for the other two. Because diploid males produce diploid sperm, triploid females result having one maternal gene and two paternal. Such females unmated produce six types of sons, three haploid and three diploid, which are to be expected in equal numbers. Previously reported data are inadequate to test whether the maternal type appears in excess because of being maternally contributed or because of some innate quality of the gene itself. The new data of the present paper are derived from the three possible three-gene tests with oyster, scarlet, and dahlia females and wild-type males compound for each two of the recessives. Haploid F₂ males of the maternal type were in highly significant excess over the expected $\frac{1}{8}$ in each case, totalling 3937 maternal and 5856 "recombinant" (with paternal genes). - Diploid males are in all cases low in number, fluctuating about 40% of the haploid. Excess of the maternal type among the haploids and deficiency of diploids are explained by excess of hexad divisions separating the maternal from the two paternal chromosomes and by excess of diploids among the polar nuclei. This preferential segregation in *Mormoniella* eggs is compared with loss of paternal chromosomes in spermatogenesis of *Sciara* and of lecanoid coccids, which appear to be the only hitherto reported cases of non-random segregation dependent upon parental origin rather than upon the nature of the chromosomes themselves.

- 1061 Dinu, M., Popa, A., Adler, A., Dumitrascu, N., Tanasescu, R. EFFECT OF IONISING RADIATION ON THE ONTOGENETICAL DEVELOPMENT AND SEX OF Bombyx mori. Lucr. stint., Ser. C 9 (1966) 199-213. (In Rumanian)

- 1062 Ebeling, W. DEPENDENCE OF RADIATION INDUCED MUTATION RATE ON MATURITY AND DOSE FOR CHRYSALIS OF Drosophila melanogaster Meigen. Thesis, Technische Hochschule, Darmstadt (West Germany). 1962, 100p.

The dependence of the rate of radiation-induced recessive sex-linked lethal factors and II-III translocations on dose and maturity of germ cells of 174-h-old chrysalis are studied. For the translocation curves, an exponent of approx. 1.5 was observed. Dose curves for lethal factor have an exponent smaller than unity. This can be explained by assuming that for increasing dose a larger fraction of lethal factors for which at least two events are necessary is produced. (Gmelin Inst.) (NSA 17: 1963, 30397)

- 1063 Falk, R., Ben-Zeev, N. VIABILITY OF HETEROZYGOTES FOR INDUCED MUTATIONS IN Drosophila melanogaster. II. MEAN EFFECTS IN IRRADIATED AUTOSOMES. Genetics 53 (1966) 65-77.

The viability of flies heterozygous for unselected samples of irradiated II-chromosomes was studied in repeated tests in different genotypic combinations. A dose of 2000R* caused no significantly detectable reduction in the viability of heterozygotes for irradiated chromosomes. The slight effect suggested by the results could be due to induced lethals. Severe detrimental mutations were rare, and only 10-20% of the deleterious effect in homozygotes was due to non-lethals. It could not be decided whether their effect in heterozygous condition was too small or whether they had no effect at all. (Auth.)

* x-rays

- 1064 Falk, R. VIABILITY OF HETEROZYGOTES FOR INDUCED MUTATIONS IN Drosophila melanogaster. III. MUTATIONS IN SPERMATOGONIA. Mutation Res. 4, 1 (1987) 59-72.

A random array of mutations was obtained by irradiating D. melanogaster with x-rays. Irradiation was given in 1, 2 and 4 instalments of 4000 Reach. Only chromosomes irradiated in spermatogonial stages were sampled. There was a significant increase in the mean viability coefficient of heterozygotes for the series of chromosomes irradiated with 8000 and 12000 R. In these two series many mutations were induced which drastically reduced the viability of the homozygotes: only about 20% of the homozygotes for chromosomes irradiated with 12000 R were in the normal range. On the other hand, the number of flies heterozygous for the irradiated chromosomes in tests designed to determine viability of homozygotes indicated that the induced detrimental mutations were not completely recessive. The contrast between the findings of the two parts of the experiments are considered in relation with the current hypotheses on the effect of induced mutations on viability. Since the genetic background of the flies was highly heterozygous even before irradiation the viability of the heterozygotes for induced mutations was expected to decrease according to all current hypotheses. Probably the increased viability coefficients were biased by factors other than viability, but it would be premature to suggest at this stage a hypothesis that explains all the findings satisfactorily. (Auth. summary)

- 1065 Falk, R. VIABILITY COEFFICIENTS AND PREFERENTIAL RECOVERY. Mutation Res. 4, 6 (1967) 821-830.

The proportion of progeny heterozygous for two marked balancer chromosomes varied in reciprocal matings. Preferential segregation of the marker chromosomes, either in females or in males, was suspected. Adult males of Drosophila were irradiated with x-rays. When irradiated chromosomes were transmitted to progeny by their fathers the induced mutations appeared to give heterotic effects. The effects were, however, detrimental when the irradiated chromosomes were transmitted to the progeny by their mothers. This difference was ascribed to slight preferential segregation caused in males by many of the induced detrimental mutations.

- 1066 French, W.L., Kitzmiller, J.B. TESTS FOR MULTIPLE FERTILIZATION IN Anopheles quadrimaculatus. p. 374-380 of "19th Annual Meeting of the American Mosquito Control Association", and the "50th Annual Meeting of the New Jersey Mosquito Extermination Association, Atlantic City, N.J., USA, 12-15 Mar. 1983".

In the course of a study on x-ray induced mutations in the Bethesda strain several morphological markers were found. One of these was a variation in the colour pattern of the dorsal portion of the thorax and abdomen. In some of the larvae, a broad, brightly pigmented white mid-dorsal stripe was found, entirely lacking in others. These genetic markers proved extremely useful since they can be recognized in three stages of mosquito development; easily in the larvae, the pupae, and with some difficulty in the adult. Using the dominant stripe and recessive non-stripe markers it could be shown that multiple fertilization of young A. quadrimaculatus females does not occur when they are placed in a cage with males of the same age under the experimental conditions described. When the males and females which vary in age from 3-17 d are present in the same cage multiple fertilization may occur but with a relatively low frequency. The presence of active Aedes aegypti in a cage with A. quadrimaculatus appears to stimulate copulatory activity of the Anopheles as assayed by a higher frequency of multiple insemination.

- 1067 Garcia-Bellido, A. FENOGENETICA DEL LOCUS "FURROWED" (fw) DE Drosophila melanogaster. I. ESPECIFICIDAD DEL SINDROME PLEIOTROPICO. (Phenogenetics of the locus "furrowed" of Drosophila melanogaster. I. Specificity of the pleiotropic syndrome). Genet. Iber. 15, 1/4 (1963) 1-74. (In Spanish, with English summary)

Of the three alleles of furrowed (fw) studied, two were recovered following irradiation of spermatids with low x-ray doses (fw^{59} and fw^{60}); the 3rd was spontaneous in origin (fw^0). These alleles are all recessive to the normal Oregon-R. The phenotype of the mutants is highly variable. The penetrance of the syndrome depends upon the nutritional background of the larvae. The females show decreased fecundity but normal fertility. The syndrome appears in all three alleles, with different and decreasing expression of the abnormal trait for each allele. The sequence is $fw^{59} > fw^{60} > fw^0$, fw^+ . The expression of the individual traits varies in correlated fashion under experimental conditions. This suggests that a common epigenetic mechanism governs behaviour of these alleles. (BA)

- 1068 Glembotskiĭ, Y. L., Abeleva, E. A., Grozdova, T. Y., Myasnyankina, E. N. MOSAICISM OF INHERITANCE OF SEX-LINKED RECESSIVE LETHALS OF Drosophila melanogaster IN CONNECTION WITH CHROMOSOME STRUCTURE. p. 188-200 of "Vliyaniye Ionizirovannykh Izlucheniĭ na Nasledstvennost". Dubinin, N. P., Ed. Moscow, Izdatel'stvo Nauka, 1966. (In Russian)

The purpose of this investigation was to elucidate the mechanism for the development of gonadal mosaicism, and hence solve the problem of the chromosome structure in gametes at post-meiotic stages of their development from one or two threads, and to clarify the problem of the relative frequency of the occurrence of chromatid sex-linked recessive mutations in comparison with the frequency of such chromosome mutations. It was shown that chromatid, along with chromosomal, sex-linked recessive lethals occurred following irradiation of the male gametes of Drosophila at postmeiotic stages. During γ -irradiation in a dose of 1000 R they amounted to 21% of the number of chromosome mutations, and during irradiation by 1-MeV fast neutrons in a dose of 1000 rad + 250 R of γ -rays, they amounted to 13% of the number of chromosome mutations. The question of the time of formation of chromatid point mutations, whether directly in the irradiated gametes or in the zygote as a result of the secondary effect of irradiation, was left unsolved. (NSA 22: 1968, 21483)

- 1069 Glembotskiĭ, Ya. L., Abeleva, E. A., Grozdova, T. Y., Myasnyankina, E. N. CAUSES OF VARIATED INHERITANCE OF RECESSIVE SEX-LINKED LETHAL MUTATIONS IN Drosophila melanogaster. Genetika No. 3 (1967) 68-75. (In Russian)

The appearance of F_1 individuals, in which only a part of their body bears a mutation, following the treatment with chemical mutagens or radiation, is usually explained as the results of multi-stranded chromosome structure in mature spermatozoa. Since it was already shown earlier that the mutations can take place in the non-irradiated chromosomes of the ovids fertilized by the irradiated male germ-cells, an assumption was made that the occurrence of partial mutants can be accounted for by the action on the chromosomes of cells, during the 1st stages of the zygote cleavage, of the mutagenic agent formed as the result of the irradiation and introduced by the spermatozoon. This hypothesis also apparently explains the low frequency of the detection of such mosaic individuals and the relatively high efficiency of chemical mutagens. In these studies the frequencies of chromosome and chromatid sex-linked lethals and sublethals were determined both in the directly irradiated chromosomes of males (doses of 1000 and 1500 R of x-rays and γ -rays) and in the chromosomes of eggs that had not been irradiated but had been fertilized by irradiated male gametes (dose 1500 R of γ -rays). It was established that the frequencies of chromatid mutations in the directly irradiated chromosomes are 5-6 times as high as those in the non-irradiated chromosomes. No chromatid lethals were ever found in the non-irradiated chromosomes. Therefore the appearance of partial mutants can be associated with the delayed effect of irradiation to but an insignificant extent. (NSA 21: 1967, 20136)

- 1070 Green, M. M. THE GENETICS OF A MUTABLE GENE AT THE WHITE LOCUS OF Drosophila melanogaster. Genetics 56, 3 Pt. 2 (1967) 467-482.

The origin of the frequently mutating gene, w^C , white crimson, as a derivative of w^1 , white-ivory, is described which initially involved the treatment of attached-X females homozygous $w^1 spf$ with ~4000 R x-rays and their subsequent crossing with $y^{sc} w^1 spf$ males. w^C mutates spontaneously in both females and males to a number of different allelic states the phenotypes of which range from

w^+ to w . The mutation event appears to occur primarily, if not exclusively, before meiosis and appears not to involve any recombination or similar event. Alleles derived from w^c may be stable or mutable. In addition to apparent point mutations, w^c and its mutable derivatives produce deficiencies which include loss of the w gene and adjacent loci to the right or left of w . The causes of the high mutation rate are discussed in terms of an autonomous event and of an event controlled by a "foreign" element akin to the controlling elements demonstrated for maize.

- 1071 Gros, C.M., Weill, F. THE RADIOLOGIST AND PRACTITIONER IN RELATION TO THE SUPPOSED HAZARDS OF x-RAYS IN RADIODIAGNOSIS. Strasb. méd. 13 (1962) 259-278. (In French)

Genetic risks are also considered, especially experiments on *Drosophila* showing an increase from 0.13%-3% in the mutation rate for 1000 R, with 40-60 R doubling the natural rate. For man, results are not conclusive, but it is estimated that 10 R/gonad would double the mutation rate and that a dose of 1 R would increase it by 0.25%. Somatic effects of small doses have not been conclusively established, but a more firm basis exists for genetic effect. It is concluded that, for small doses, a genetic effect has been proved experimentally on animals, and only by extrapolation on humans, and that radiologic examination is no more dangerous than other methods of diagnosis or than natural radiation itself.

- 1072* Hochmann, B., Gloor, B., Green, M.M. ANALYSIS OF CHROMOSOME 4 IN *Drosophila melanogaster*. I. SPONTANEOUS AND x-RAY-INDUCED LETHALS. Genetica 35 (1964) 109-126.

An analysis of 17 spontaneous and 37 x-ray-induced lethal mutations on the IV-chromosome of *Drosophila melanogaster* has revealed a min. of 22 loci on this microchromosome capable of mutating to lethality. A few of these loci had been identified earlier by their visible alleles, but 16 are new discoveries. Seven of the 22 lethal loci are situated within that proximal section of the right arm of chromosome IV delimited by the Minute-4 deficiency. Genetic tests indicate that two translocations and five deletions are included among the lethals of x-ray origin. No chromosomal aberrations were found among the spontaneous mutants. Allelism was encountered both within and between lethals from the two groups. Three independent estimates of the total number of lethal loci to be expected on this small autosome are presented. These appraisals are based on: the size of the Minute-4 deficiency; the number of bands in salivary chromosome 4; and the frequency of recurrence among the lethals. Considering the uncertainties inherent in each determination, the three estimates show remarkably good agreement. (Auth.)

* Originally (III 599) cited without abstract.

- 1073 Hughes, A.M., Hildreth, P.E. THE PRODUCTION OF A NEW MUTANT IN *D. melanogaster* BY LOW DOSES OF TRITIUM IRRADIATION. * Drosoph. Inf. Serv. 42 (1967) 86-87.

On two separate occasions, during the course of an investigation in which *D. melanogaster* larvae were being raised on tritiated medium, apparently identical mutants affecting adult colouration were recovered. Since these mutants originated among only a few thousand flies and only in the treated series, it appeared that ^3H might be repeatedly causing mutations at a specific locus. Therefore, further experiments were conducted in two series (1961-62, 1965-66) in order to test whether this one type of mutant could be routinely produced. Homozygous yellow (y/y) females that had mated with $y; B^S Y y$ males oviposited on control or ^3H -supplemented medium where the eggs hatched, the larvae and pupae developed. For the treated series, the standard cornmeal-molasses-agar-yeast medium contained either 0.1 or 1.0 $\mu\text{Ci}^3\text{H/g}$. On the basis of the table of Tolbert (1960) and assumptions of rapid equilibration between the larval body water and that of the medium, the two concentrations of ^3H used would give a max. total body irradiation of 0.5 and 5.0 R/fly during the time from hatching through eclosion. The actual irradiation is probably less. The F_1 males ($y; B^S Y y$) were then individually mated to virgin yellow non-treated females and the offspring raised on control medium. The expected offspring would again be yellow females and non-yellow Bar-eyed ($y; B^S Y y$) males. Among the 2nd-generation offspring exceptional males were recovered; they had bar-shaped eyes and wildtype-coloured wings as in the expected class, but their bristles were yellow and bodies yellowish (but not as yellow as $y; Y$ males) instead of wildtype. The mutant has been transmitted with the Y-chromosome ($B^S Y y^{sid}$) through many generations. The results are

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given in two tables. In order to determine whether other types of irradiation would produce similar mutation, experiments involving the mating procedure described were used. In the first experiment, virgin males were given 2800 R, in the second a smaller dose was used (1000 R); in the third, prepupae were collected from culture bottles, irradiated with 735 R, and then allowed to pupate and eclose. The expected offspring was the same as in the ^3H -experiments. Combining control and x-ray totals, the mutation rate amounts to 0.016/1000. Since both mutants were found in the same culture, the minimum number of mutant events could be 0.008/1000. In the ^3H -treated group, the total mutation rate is 0.148/1000, and the minimum mutant event rate 0.58/1000. In addition, in the ^3H -treatment, in one culture a gonosomal mosaic for this mutant was recovered, and in another culture one mutant in the 3rd generation.

- 1074 Inagaki, E., Nakao, Y. COMPARISON OF FREQUENCY PATTERNS BETWEEN WHOLE-BODY AND FRACTIONAL MUTATIONS INDUCED BY x-RAYS IN Drosophila melanogaster. Mutation Res. 3 (1966) 268-272.

Male D. melanogaster were exposed to 1000, 2000, 3000, or 4000 R x-radiation and mated 2 d later with virgin females carrying four visible sex-linked recessive mutations. Careful examination of the F_1 generation was made to assess the frequencies of whole-body and fractional-appearing mutations. The data indicate an increase in the frequency of whole-body mutations with increase in radiation dose. There did not appear to be a statistically observable change in the relative frequency of fractional mutations with increase in radiation dose. The ratio of fractional to whole-body mutations tended to decrease with increasing dose in the ranges studied. (NSA 20: 1966, 38850)

- 1075 Kang, Y.S., Kim, Y.J., Lee, C.C., Choi, C.C. THE GENETIC STUDIES OF Drosophila POPULATION. I. ON THE FREQUENCIES OF SEX-LINKED RECESSIVE LETHAL MUTATION IN D. melanogaster IRRADIATED WITH x-RAYS. Zoologica No. 87 (1964) 1-6.

- 1076 King, J.L. THE DUMPY LOCUS IN INDUCED MOSAICS OF Drosophila melanogaster. Thesis, California Univ., Berkeley. 1983, 69p.

Certain alleles of the gene dumpy produce changes in the configuration of the dorsal surface of the thorax and in the distribution of thoracic bristles and cell hairs, termed vortices. x-ray induction of somatic crossing over was used to produce mosaic patches, which were homozygous for dumpy and homozygous or hemizygous for yellow on a heterozygous wild type background. 13 mosaics, including eight of 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 possibly homozygous dominant tissue, and, in three cases, in the heterozygous tissue of the opposite side of the thorax. The doubling of bristles in the vortices is shown to be an indirect effect, since it sometimes occurs in the background tissue. It is suggested that the wild type allele of dumpy, in response to specific developmental environments, regulates the production of a supracellular factor which in turn affects tissue movement; and that the recessive alleles fail to regulate this production, which leads to abnormal tissue movement. The relationship between tissue movement and cellular determination in morphogenesis is discussed. It is concluded that dumpy is not a prepattern gene with respect to the distribution of thoracic bristles, since it does not have any effect on the determination of bristle organs. The differentiation of doubled bristles, however, is due to a change in the cellular environment which is indirectly brought about by dumpy; in this minor respect dumpy can be considered a prepattern gene. (DA)

- 1077 Kitagawa, O. HETEROZYGOUS EFFECT OF INDUCED RECESSIVE LETHALS ACCUMULATED ON SECOND CHROMOSOMES OF D. melanogaster. Drosoph. Inf. Serv. 40 (1965) 55.

More than 60 lethal free II-chromosomes were extracted from the heterozygous population of D. melanogaster which was maintained for 6 months. Male flies with normal viability when homozygous were irradiated by 500 R of x-rays. 34 II-chromosomes carrying induced recessive lethals were obtained. Double and triple lethals were accumulated in cis-phase on II-chromosomes through recombination of females with two or more lethals in trans-phase. In this experiment, 40 normal, 34 one, 15 double and 9 triple lethal strains were used. Hand in hand with the increase of the number of lethals per zygote, the viability decreased rapidly. This synergistic interaction between

lethals is very relevant to the problem of the maintenance of genetic loads in natural populations.
(From DIS)

See also ref. 1503

- 1078 Kvelland, I., Strømnaes, Ø. x-RAY INDUCED MINUTES IN *Drosophila melanogaster* SPERM EJACULATED IN CONSECUTIVE MATINGS. Hereditas 54 (1965) 170-176.

x-ray 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 three 12-h mating periods, the 2nd of which was without females. For all groups of males the frequency of minutes was higher in the 1st than in the 2nd mating period. The difference in frequency of minutes between age groups of males was significant when measured in the 1st mating period but insignificant in the 2nd mating period. Data supported previous reports that a change in mutation frequency does occur at an earlier time after irradiation for sperm released by young males. (NSA 20; 1966, 1836)

- 1079 LaChance, L.E., Dawkins, C., Hopkins, D.E. MUTANTS AND LINKAGE GROUPS OF THE SCREW-WORM FLY. J. econ. Ent. 59 (1966) 1493-1499.

Some radioinduced visible mutations in the screw-worm fly, *Cochliomyia hominivorax*, are described. In a programme to derive mutant strains, three techniques were used to find flies with aberrant phenotypes which could be investigated further: (1) microscopic examination of vast numbers of untreated flies (general scanning); (2) treatment of adult flies with γ -radiation or tetramine over a wide range of substerilizing doses and close examination of their F_1 progeny for inherited variations; and (3) an inbreeding programme in which a single pair of flies was used to produce a group of progeny. The F_1 (brothers and sisters) were, in turn, inbred to produce the F_2 generation. 15 genetically marked strains were derived; 13 were recessive mutations and were established as pure breeding stocks. Both dominant mutations are lethal in the homozygous condition and could not be established as a pure breeding strain. The mutation, Brc (black R-cell), was associated with a chromosome translocation (position effect). The Brc; # Blackened R-cell mutant was found in progeny from irradiated parents of a wild-type strain. It is a wing mutant in which the R-cell is blackened by dense pigmentation, and is a dominant mutation associated with a reciprocal translocation; the homozygous condition is lethal. The sh; shortened r-m mutant was among the progeny from irradiated parents of a wild-type lab strain. It is a wing mutation in which the r-m vein is shortened and without its characteristic bend. In all males the allele is penetrant and uniformly expressed; in some homozygous females, the character is indistinct. This report summarizes the data on the pure breeding strains with regard to heritability of the character, viability of the mutant genotypes in the preimaginal stages, and the linkage relations. (NSA 21; 1967, 14625)

- 1080 Lamb, M.J., McSheehy, T.W., Purdom, C.E. MUTAGENIC EFFECT OF 600-MeV PROTON IRRADIATION. Drosoph. Inf. Serv. 41 (1966) 156.

Experiments, comparing proton irradiations with x-irradiation (250 kVp, 15mA, HVL 1.2 mm Cu), were performed as part of a programme to investigate the relative effectiveness of different parts of the proton beam which have different LET values. Male *Drosophila*, 32 h old, were exposed to 600 rad of protons or x-rays at dose rates of 150 rad/min and 540 rad/min respectively. Males were mated individually to two females every 3 d, and the frequency of 11nd chromosome recessive lethal mutations was scored among offspring from six successive broods. A pronounced difference between the percentage of mutations induced by protons and x-rays was found in brood IV, but otherwise no significant differences were observed. This may be explained either on the assumption that the irradiated germ cell stages contributing to sperm used in brood IV were much more sensitive to proton than to x-irradiation, or that mutagenic efficiency of protons was slightly greater than that of x-rays and a slight shift, or sampling error, during the brood sequence concentrated the effect into a single brood. The 2nd explanation is more plausible, but the results of later experiments suggested that there is no difference between these radiations. When 250-kVp x-rays (800 rad) were compared with 600-MeV protons (800 rad) and with attenuated protons in the Bragg peak (400 rad), in only one brood was there any significant deviation from an RBE value of 1 relative to x-rays. This was brood II of the 600-MeV proton series, which was significantly low.

Overall analysis, however, showed no deviation from 1 and there was no indication, therefore, that the increase in frequency of nuclear interaction in the Bragg peak region was accompanied by any increase in genetic effectiveness. (NSA 21: 1967, 22739)

- 1081 Lamb, M.J., McSheehy, T.W., Purdom, C.E., Baarli, J., Sullivan, A.H. THE MUTAGENIC EFFECT OF 600 MeV PROTONS IN *Drosophila melanogaster*. *Int. J. Radiat. Biol.* 12, 1 (1967) 27-34.

Comparisons have been made between the mutagenic efficiency in *Drosophila* of 600 MeV protons and 250 kVp x-rays. II-chromosome recessive lethal mutation frequencies were measured in six successive 3-d broods of offspring. There was no evidence of any difference between the effectiveness of x-rays and protons from the initial beam or from the Bragg peak region of the beam in inducing mutations in any of the germ cell stages sampled. (Auth.)

- 1082 Lee, W.R., Strangio, V.A. BROOD SENSITIVITY TO THE INDUCTION OF POLYGENE MUTATIONS. *Drosoph. Inf. Serv.* 41 (1966) 124.

Males from a highly-inbred wild type *D. melanogaster* stock were irradiated with 500 R x-rays and then mated individually to three virgin females from the same stock. Four broods were established from successive matings, each 3 d in duration. Sternopleural bristles were counted in F_1 females only. Although pooled data from all 4 broods indicate a significantly increased variance of the bristle number distributions in females from the irradiated series, the preliminary results have so far failed to reveal a detectable sensitivity pattern. (Auth.)

- 1083 Lee, W.R., Kirby, C.J., Debney, C.W. THE RELATION OF GERMLINE MOSAICISM TO SOMATIC MOSAICISM IN *Drosophila*. *Genetics* 55 (1967) 619-634.

A total of 72 fertile, yellow mosaic, attached-X females were produced by (x)-irradiating their paternal Y-chromosome ($sc^y YB^S$). Among the yellow mosaics the phenotype of the head and thorax was independent of the genotype of the germ line, and among 18 yellow mosaic females with mosaic germ lines there was no correlation between the proportion of mutant tissue in the germ line and somatic tissue. From the frequency of yellow imaginal discs that had lost the y^- marker and the frequencies of complete mutant, mosaic, and non-mutant germ lines, we estimated that an equivalent of 1.5 randomly mixed cleavage nuclei developed into the germ line, an estimate that was significantly less than the three to seven nuclei that usually penetrate the pole region of the embryo to become the primordial germ line. This discrepancy was explained on the basis of poor mixing in a viscous medium. The proportion of complete mutant to mosaic germ lines among mosaic embryos was calculated for mosaics that became fixed during 1st, 2nd or 3rd cleavage division. (Auth. summary)

- 1084 LeFever, H.M. STRUCTURE AND FUNCTION OF THE 3C1,2,3, REGION OF THE X-CHROMOSOME OF *Drosophila melanogaster*. Thesis. Texas Univ., Austin. 1966, 61p.

Historically, the region of the X-chromosome of *D. melanogaster* designated as 3C1,2,3 has been associated with the recessive eye mutant white (w). One of the primary objectives of this study was to determine if a fine structure analysis of the locus would uncover mutants concerned with only one basic metabolic process or if the structure analysis would uncover mutants concerned with diverse metabolic processes. Another objective was to establish the specific cytological limits of the white locus and to determine what other genetic traits, if any, can be localized to the 3C1,2,3 region. The region in question was screened, by the use of X-chromosome deficiencies, for all mutations induced by x-ray. The mutants recovered were balanced and then subjected to further genetic analysis. Four x-ray lethals were obtained which die when screened against a 3C1 deficiency. The results of a complementation analysis show that two of the lethals are non-complementary, while all others complement in combination with each other. Recombination analysis of the lethals established their spatial relationship to one another and indicated that the relationship of the 3C1 lethals to the white locus was one of close proximity, but without overlap regarding location. Three white mutants were recovered and were analysed with respect to their location in the locus and their relationship to the recessive eye mutant zeste. The mutant w^{C1} was found to possibly be isocatal to the white locus mutant w^{8Wx} and a non-suppressor of zeste. The mutant w^{63A25} was a non-suppressor of zeste and located between the mutants w^3 and w^{C1} . The 3rd mutant $sp-w^4$ was found to be a true allele of the mutant $sp-w^1$. A mutant designated as 11G3 was reported in the literature to be located in 3C1 and act as a dominant suppressor of zeste. Analysis of this

mutant in this study indicated that the mutant 11G3 is located in or near the zeste locus (3A3). Two white lethals were analysed in this study. Analysis indicated that the lethal associated with one of the mutants occurs not in the white region but elsewhere in the X-chromosome. The 2nd white lethal was lethal because of a loss of 3C1 and was shown to act as a zeste suppressor. The results of this study indicate that the white locus is located definitely in 3C2 and possibly in 3C3, but not in 3C1. The white locus is a region concerned only with the process of eye pigment production and does not exhibit pleiotrophy. (Auth.)

- 1085 Lefevre, G., Jr. MUTATION FREQUENCIES DETECTED FOLLOWING IRRADIATION OF VIRGIN AND INSEMINATED Drosophila melanogaster FEMALES. Genetics 53 (1966) 137-143.

Sex-linked recessive lethal mutation frequencies were detected at successive intervals after irradiation with 4000 R of 3-d-old females, which were then mated with nonirradiated males. The mutation frequencies detected were compared with those obtained in parallel experiments in which irradiated females were mated with males that were separately exposed to the same dose of radiation, and with those detected following the irradiation of inseminated females. The irradiation of both paternal and maternal genomes, rather than only the maternal genome, results in a highly significant reduction in the frequency of mutations detected among eggs laid during the first 4 d after irradiation. Among eggs laid later, a small, but insignificant, reduction in frequency of mutations is detected when both genomes are irradiated. The suggestion is made that interaction between the two genomes, when both have been irradiated, leads to the elimination of a proportion of mutants induced in relatively mature germ cells. Since a similar loss of mutants does not occur following the irradiation of immature female germ cells, it is further suggested that mutants associated with chromosomal aberrations are preferentially eliminated by interaction of the two irradiated genomes. (Auth.)

- 1086 Matsudaira, Y., Ito, T., Yamasaki, T., Ishizaka, S., Domon, M. ON THE RELATIONSHIP BETWEEN THE FREQUENCY OF TWO TYPES OF MUTATION AND SOFT x-RAY DOSES IN Drosophila. Mutation Res. 4 (1967) 469-472.

The dose frequency relationship for two types of mutation, fractional- and whole-body, was obtained using soft x-rays on D. melanogaster. At low doses (e.g., 400 R-1440 R) more fractionals were induced than whole-body changes, whereas at high doses (e.g., 3000 R) the reverse relationship was observed. These results are in agreement with those of other investigations involving Drosophila and yeast. The origin of these mutations is discussed in relation to the strandedness of the DNA molecule of the gene. (Auth.)

- 1087 Meyer-Döring, H. NEUE FORSCHUNG ÜBER DIE MUTATIONS-AUSLÖSUNG DURCH STRAHLEN. (Recent research on mutations induced by radiation.) Naturw. Rdsch., Stuttgart. 13 (1960) 23-24. (In German)

Radiation experiments are reported on man, Drosophila, and mouse. Acute and chronic γ - and x-irradiation was used and analysed for mutagenic effects. In contrast to majority opinion it was found that a single (acute) dose produced a higher mutagenic effect than a fractionated dose (same total amount). The experimental results cannot just be simply extrapolated to apply to man.

- 1088 Moens, P.B. SEGREGATION OF TRITIUM-LABELED DNA AT MEIOSIS IN Chorthippus. Chromosoma 19 (1966) 277-285.

A technique is described which gives well-defined label on meiotic chromosomes which incorporated ^3H -thymidine two or more mitotic cycles prior to meiosis. Males of Chorthippus longicornis were injected with three doses of 0.0025 ml of ^3H -thymidine (1 mCi/ml, specific activity 6000 mCi/mM), given at 3-h intervals. The distribution of label on meiotic chromosomes can be used to determine in which mitotic cycles label was incorporated. It is concluded that sister chromatid exchanges are common prior to meiosis, and that chiasmata do not show crossing-over of labelled material to be expected if the chiasmata are the result of breakage and rejoining or if chiasmata and crossovers are not related.

- 1089 Mole, R.H. DOSE RATE AND TIME FACTOR. p. 18-33 of "Radiation Effects in Physics, Chemistry and Biology". Amsterdam, North-Holland Publishing Co. 1963.

Nine papers presented at the Second International Congress of Radiation Research are summarized. The work covered deals with x- and y-radiation and with several different biological systems, including *Drosophila* eggs and silkworm larvae. In general it is concluded that changes in instantaneous dose rate from 1 rad/sec up to 10^5 rad/sec produce surprisingly little change in effect. On the other hand, the demonstration of even a relatively small change in mutation rate with variation in exposure time confirms current ideas that genetic mutation is not the instantaneous, permanent, and invariant response postulated by classical theory. Experiments on recovery from radiation and possible mechanisms of recovery are discussed briefly. (From NSA 17: 1963, 25019)

- 1090 Moriawaki, D., Tobari, I., Ohba, S., Kitagawa, O., Tobari, Y.N., Ikeda, H. A SHIFT OF SEX-RATIO IN THE PROGENY FROM IRRADIATED MALES IN *Drosophila melanogaster*. *Idengaku Zasshi* (Jap. J. Genet.) 42 (1967) 23-38.

Sex ratio changes in the progeny from males x-irradiated with doses up to 3 kR at different germ cell stages in *D. melanogaster* were investigated. The sex ratio (female/male) fell to the lowest level when the progeny developed from males mated 6-8 d after irradiation, and returned to the control level in the progeny from males mated at 14-16 d. The sex ratio decreased with increasing dose. Nonirradiated younger males produced more male than female offspring, a tendency that decreased with age. The sex ratio shift changed according to the frequency changes of both induced dominant lethals and elimination of sex chromosomes, showing a negative correlation, and all the frequencies coincidentally reached a peak on the 7th-8th day after irradiation. The stage-frequency relation for the sex chromosome elimination was fundamentally the same as that for the dominant lethals, suggesting that the two phenomena probably occur through the same mechanism. The highest sterility was found from the 6th to the 8th day post-irradiation. The results suggested that sperm utilised during these days represented cells irradiated during the meiotic stages. The proportion of X-chromosome elimination (S_e) and X-chromosome dominant lethals (S_x) to the total shift of the sex ratio (S) was estimated in each of the three different germ cell stages, i.e., postmeiosis, meiosis, and premeiosis. For the present data, the contribution of S_e and S_x to S was nearly the same at the meiotic stages, while at the other stages S_x played a greater role than S_e . (NSA 22: 1968, 15102)

- 1091 Murakami, A., Kondo, S., Tazima, Y. ENHANCING EFFECT OF FRACTIONATED IRRADIATION WITH 14 MeV NEUTRONS ON THE INDUCTION OF VISIBLE RECESSIVE MUTATIONS IN SILKWORM GONIA. *Rep. natn. Inst. Genet.*, Misima 16 (1966) 109.

Earlier results obtained with low LET radiations (Tazima) had shown that the induced mutation rates were ~2-2.5 times higher in the dose fractionation group than in the single exposure group, for both spermatogonia and oögonia, when irradiation occurred around the stage of hatching. The present authors confirm that a similar enhancing effect of fractionation was also observable with 14 MeV neutron irradiation. Larvae of the wild type C108 were exposed to 14 MeV neutrons 1-3 d after hatching. A total of 1000 rad (500+500) were administered 10-12 h apart, at 0.8 rad/min. The enhancing effect of dose fractionation was more marked for spermatogonia than oögonia, the mutation frequencies were ~2 times higher than for single exposure. The highest enhancing effect was observed in spermatogonia when the 2nd dose was given 36 h after initial exposure, in contrast to the 18 h for x- and y-rays. This delay of 18 h in the manifestation of the peak effect may be due to the fact that neutrons have a higher efficiency in affecting cell division than x- or y-rays.

- 1092 Nakao, Y., Yamaguchi, E., Machida, I. MUTAGENIC EFFECTS OF MASSIVE ACUTE x-IRRADIATION IN *Drosophila melanogaster*. p. 61-62 of "Annual Report 1964". NIRS-4, National Inst. of Radiological Sciences, Chiba (Japan). Dec. 1965, 94p.

The existence of a linear relationship between mutagenic effects and dosage was tested for very high doses of x-rays and confirmed even at 10 kR. Doses of 5, 7.5, and 10 kR were used in the experiments. No parallelism between mutation frequency and sterility was observed for the acute high doses tested. Linearity for mutation frequency and x-ray dose, however, was observed even at 10 kR.

- 1093 Nakao, Y., Yamaguchi, E., Machida, I. COMPARISONS OF MUTAGENIC AND CELL-KILLING EFFECTS OF RADIATION IN THE SILKWORM. p. 62-63 of "Annual Report 1964". NIRS-4, National Inst. of Radiological Sciences, Chiba (Japan). Dec. 1965, 94p.

The specific locus method involving eye colour mutants in *Bombyx mori* was used. Pink eye (pe) and red eye (re) which are located on chromosome V at 0.0 and 31.7, respectively, were the markers.

Data are tabulated on visible mutation frequency and the number of eggs laid, their hatchability, and the percentage of dead eggs in early development. Data are based on female moths exposed to 2 kR in 0 at 400 R x-rays/min, and mated to double recessive pere/pere males. Only by a comparison with the percentage of dead eggs (at the unpigmented egg stage, which includes unfertilized eggs and fertilized eggs which die very early on) could a small significant difference be detected between groups set up according to number of eggs (<400>).

- 1094 National Inst. of Genetics, Mishima (Japan). ANNUAL REPORT NO.15 [ON GENETICS], 1964. NP-15975. 1965, 166p.

Data are summarized from genetic studies on animals, bacteria, higher plants, and human populations. Emphasis was also placed, amongst many others, on studies on Drosophila and silkworms. Data are included from studies on the mechanisms of chromosomal abnormalities induced by chemical mutagens and γ , x, or neutron radiations and related biochemical and cytological studies. A list is included of 86 publications for 1964.

- 1095 National Inst. of Radiological Sciences, Chiba (Japan). BIOLOGICAL STUDIES: GENETICS. p. 58-69 of "Annual Report 1964". NIRS-4. Dec. 1965, 94p.

The mutagenic effects of massive acute x-radiation doses in Drosophila melanogaster; a comparison of the mutagenic and lethal effects of x-radiation in silkworms; the effects of penicillin on x-radiation-induced mutations in D. melanogaster; the effects of temperature on the frequencies of deleterious genes in a population of D. melanogaster; and the genetic effects of x-radiation in a population of D. melanogaster are among the studies described.

- 1096 Olvera, O. ESTUDIO DE LA FRECUENCIA DE MUTACIONES LETALES LIGADAS AL SEXO ESPONTÁNEAS INDUCIDAS POR RAYOS X DURANTE LA ESPERMATOGÉNESIS. (Study of spontaneous and x-ray induced sex-linked lethals in spermatogenesis.) Thesis 1963. (In Spanish). Mexico?

- 1097 Plaine, H.L., Aubele, S.M. OCCURENCE OF THE ERUPT EFFECT IN THE Su-er tu bw; er⁺ Su-tu⁺ STRAIN OF D. melanogaster. Drosoph. Inf. Serv. 40 (1965) 56.

Three series of eggs and larvae of the Su-er tu bw; er⁺ Su-tu⁺ strain were collected over a 24-h period on the surface of cornmeal-dextrose media and exposed to x-irradiation at ± 12 h of age. The disks of media containing irradiated eggs and larvae were placed on the surface of the same type of media and incubated at $25 \pm 1^\circ\text{C}$. Eyes of adult flies were scored upon emergence as extreme erupt, weak erupt, or normal. Evidence of the phenotype characteristic of extreme erupt was found consistently in all of the irradiated series, while all series subjected to x-irradiation differed significantly from the non-irradiated controls of the same strain. (From DIS)

- 1098 Puro, J. REPORT ON NEW MUTANTS. Drosoph. Inf. Serv. 39 (1964) 64-65.

Four Drosophila mutants are described that were produced by x-irradiation of wild type male flies. Several other spontaneous mutants are also described. (NSA 21: 1967, 22708)

- 1099 Rinehart, R.R. x-RAY INDUCED CHANGES IN Drosophila GERM CELLS. Three-Year Comprehensive Report, September 1, 1964-August 31, 1967. SAN-590-2, San Diego State Coll., Calif. 1967, 62p.

The effects of exposure, fractionation, and He post-treatment on x-ray induced mutations in D. melanogaster stage 7 oocytes were investigated. The effects of exposure to O_2 and He on x-ray induced dominant lethality and detachment frequencies in oogenic stages of females, and on x-ray induced dominant and sex-linked recessive lethality, translocation and non-disjunction frequencies in spermatogenic stages of males were also studied. Several general observations are discussed concerning causes of differential radiosensitivities in oogenic stages. The possibility for mutagenicity of irradiated Drosophila food and food supplements has been investigated intensively. It is concluded that (1) irradiated Drosophila medium is mutagenic; (2) medium supplemented with DNA or autoclaved sucrose is mutagenic, whether irradiated or not; (3) irradiated or non-irradiated non-autoclaved sucrose is not mutagenic; and (4) aging the food or food supplements does not significantly alter the mutation frequencies. No conclusions have been reached on the effects of culturing flies on irradiated and non-irradiated yeast.

- 1100 Ross, M.H., Cochran, D.G. GENETIC VARIABILITY IN THE GERMAN COCKROACH. I. ADDITIONAL GENETIC DATA AND THE ESTABLISHMENT OF TENTATIVE LINKAGE GROUPS. *J. Hered.* 57, 6 (1967) 221-226.

Five additional mutants of *Blattella germanica* (L.) are reported, four of the new mutants having been isolated from strains exposed to ionizing radiation and subsequently inbred. Detailed morphological descriptions as well as genetic data are presented for each trait. In addition, the results of certain linkage tests are included for these new traits as well as for those previously described. The first instances of linkage between visible markers are reported, and tentative linkage groups are proposed.

- 1101 Saksonov, P.P., Antipov, V.V., Shashkov, V.S., Razgovorov, B.L., Murin, G.F., Morozov, V.S. ON THE BIOLOGICAL EFFECT OF HIGH-ENERGY PROTONS. "14th Congr. international. Astronaut, Paris, France. 1968". Polish Scientific Publishers, Warsaw, Poland. 1968.

Protons make up 85% of the primary cosmic rays. The harmful effects of 860 and 120 MeV protons was studied, and the radioprotection afforded by cystamine, serotonin, etc. in mouse and rat. The effects of protons on flies were also investigated.

- 1102 Shilenko, B.V. HETEROZYGOUS EFFECT OF MUTATIONS INDUCED IN THE SECOND CHROMOSOME OF *Drosophila melanogaster*. *Genetika* No.4 (1965) 109-114.

The effects of irradiation on the II-chromosome of an isogenous line of *Drosophila* were determined in accordance with the relative viability of individuals of the wild genotype in the F_2 cultures. There is evidence of the independence of viability from the competition. Irradiation of the chromosome did not affect the rate of heterozygotes development. (NSA 20: 1966, 22689)

- 1103 Smith, T.L. MUTANT TRAITS OF THE LARVAL AND PUPAL STADIA OF THE WAX MOTH. *J. Hered.* 58, 4 (1967) 179-184.

Larval and pupal variants were detected in stocks of *Galleria mellonella* that were being treated with ionizing radiations. The variants were isolated and upon eclosion as adults bred to their sibs. To date, 8 of 53 larval variants and 6 of 64 pupal variants have proved true mutations. The mutant effects have involved variations in the presence or absence of normal setae and the shapes and appearances of normal sclerites. The mutant traits are described and illustrated. A ^{60}Co -source was used. The dose administered was ~2000 R and was applied to virgin males ~1 d after eclosion. The treated males were in all cases mated to virgin females. The variant larvae and pupae showed up on the 2nd, 3rd, and subsequent generations of brother-sister matings of the treated male progenitors. The hereditary variants are interpreted as unit factor or point mutations.

- 1104 Speicher, B.R., Speicher, K.G., Roberts, F.L. GENETIC SEGREGATION IN THE UNISEXUAL WASP *Devorgilla*. *Genetics* 52 (1965) 1035-1041. And also ORNL-P-1330, Oak Ridge National Lab., Tenn.

The ichneumonid wasp *Devorgilla* reproduces by female parthenogenesis. Egg diploidy is retained by an abortive 1st maturation, where the separating anaphase dyads return to a common 2nd metaphase. One polar nucleus is then eliminated, so that two chromatids of each original tetrad are retained in the egg and two are discarded. The segregation of x-ray-induced recessive lethals was studied by counting the inviable eggs from heterozygous females. One lethal behaved as a point mutation and produced 12.77% homozygous recessive (lethal) eggs. Homozygous normal females also appeared in an approximately equal proportion. The frequency of homozygosis of each gene, being less than 16.67%, indicates that the centromeres involved separate reductionally at the first meiotic division and equationally at the second. The amount of detectable crossing over between the locus and the centromere is 25.53%. The actual map distance should be between 25.5 and a calculated 48.5 units. A 2nd lethal mutation produced 35.77% inviable eggs and only 2.78% homozygous normal females. The disparity between these two classes, and the high total inviability, suggest the presence of a chromosome aberration. (Auth.)

- 1105 Stromnaes, Ø., Kvelland, I. MUTATION FREQUENCIES IN SUCCESSIVE SPERM EJACULATES OF x-RAYED *Drosophila melanogaster* MALES. *Genetics* 50, 3 (1964) 337-349.

Four groups of unmated wild-type Oslo males were irradiated with 3000 R of x-rays when the males were 0-2 h, 12, 24 or 72 h of age. After irradiation the males were permitted to mate ad libitum

for 12 h, which was followed by a 12-h period without females, and again a 12-h mating period. All matings were observed and recorded, and the offspring from each individual mating were examined for the induction of Minutes, recessive sex-linked lethals, and translocations. An age effect is reflected in the mutation frequency of the sperm ejaculated during the 1st mating period, but not during the 2nd mating period. The induced-mutation frequencies observed in the 1st mating period were always higher than the frequencies induced in the sperm available in the 2nd mating period. The difference in induced mutation frequency between the two mating periods is ascribed partly to recovery and partly to differential sensitivity. (Auth.)

- 1106 Stromnaes, O., Kvelland, L. RADIOSENSITIVITY OF SPERM EJACULATED WITHIN 12 HOURS AFTER IRRADIATION. Drosoph. Inf. Serv. 40 (1965) 77.

Unmated D. melanogaster males from an Oslo wild-type stock were irradiated with 3000 R of x-rays when the males were either 12, 24 or 72 h old, and then mated individually to virgin M5 (Muller-5) females. All matings were observed and recorded. Copulating females were immediately isolated and after impregnation transferred to egg laying tubes. Thus, the frequency can be calculated of sex-linked recessive lethals in individual sperm ejaculates. Analysis of the tabulated data indicate that the frequency of sex-linked lethals increase with age of males at time of irradiation, in agreement with previous findings. All age groups of males can be seen to have a lower frequency of lethals in their 2nd ejaculate than in the 1st ejaculate. The data are not consistent in the 3rd mating for the three age groups of males. The 24-h-old males (Series 24 A) exhibit a further lowering in the frequency of lethals from the two previous matings: while the younger as well as the older males (Series 12 A and 72 A) have a higher frequency of lethals in their 3rd ejaculate than in their 2nd ejaculate. The data for 12- and 24-h-old males (Series 12 A and 24 A) are in agreement with previous findings, while we have no data directly compatible with those obtained in Series 72 A. A preliminary examination of the data suggests that for the youngest age group of males (Series 12 A) the frequency of lethals in the 1st ejaculate depends on the time after irradiation. Thus, 1st ejaculates available for fertilization the first 8 h after irradiation exhibit a higher frequency of lethals than do 1st ejaculates available for fertilization 8-12 h after irradiation. (From auth.)

- 1107 Tanaka, Y., Goto, F. EXPERIMENTAL STUDIES ON THE CHARACTERISTICS OF VARIOUS GENES IN THE SILKWORM, (No.1) Sanshi Kagaku Kenkyusho Iho No.14 (1966) 20-25. (In Japanese) (Reports of the Silk Science Research Institute)

In the strain in which the hereditary effect has been diminished after a series of close relative crossings and selections, it is very important to know whether it is possible to increase the selectivity by increasing the hereditary variations due to a certain mutation-inducing agent. However, most of the useful characters are affected adversely by application of radiations, and in addition, the non-hereditary variations that occur tend to confuse the interpretation of the results. In the present study, therefore, by way of the basic research for the future breeding of silkworms two kinds of readily discernible maculae not connected with the mutagenic effect of radiation were used. Silkworm eggs were x-irradiated at doses of 500-1000 R 1 h after laying, and the maculae distributions that subsequently occurred in the third and fourth generations were compared with those of the control group. No effect was observed in the range of experiments performed; results agreed with those obtained for chickens. (NSA of Japan)

- 1108 Tazima, Y., Sado, T. POST-IRRADIATION MODIFICATION AND MECHANISM OF REVERSE DOSE-RATE EFFECT ON MUTATION INDUCTION IN SILKWORM GONIA. Rep. natn. Inst. Genet., Misima No.17 (1966) 90.

For abstract, see 974.

- 1109 Tikhomirova, M.M. COMPARATIVE STUDY OF RADIOSENSITIVITY OF DIFFERENT Drosophila STRAINS. Genetika No.3 (1966) 93-97. (In Russian)

The frequency of breakage of X-chromosomes, estimated by appearance of exceptional males (of the X0 type), was used as an indicator of radiosensitivity of a Drosophila line. Irradiation was effected by means of x-rays of the same regime at a dose of 3000 R. Comparative analysis of three lines showed that one of them is relatively radiosensitive while the other two lines are radioresistant. Consecutive action of x-rays and high temperature caused increase of frequency of appearance of exceptional males whereas radiosensitivity of the lines became levelled. Levelling of radiosensitivity

was due to a varying manifestation of the after-effect in different lines. Discussion is presented on whether the mechanism of determining radiosensitivity of *Drosophila* lines depends on correlation of real and potential changes taking place at the moment of irradiation and realization grade of the latter. (Auth.)

- 1110 Tuptitsyna, E.M. STUDIES ON THE NATURE OF x-RAY-INDUCED SOMATIC MOSAICISM IN HETEROZYGOTE YELLOW AND SINGED FEMALES OF *Drosophila melanogaster*. *Genetika* No. 1 (1965) 123-124. (In Russian)
- The frequency of body spots (single and double) in heterozygote *y* and *sn* *D. melanogaster* females was investigated. In the control all spots, both single and double, are probably the result of crossing-over in the region between gene *sn* and the centromere. Single spots are primarily the result of the incomplete development of the complementary spot. The relationship between the manifestation of the character as a double spot and the time of its appearance is the same as the relationship between the size of a cell population and the number of cell divisions (for a given period). It is concluded that both in the experiment and the control most of the spots, including single ones, arise as a result of crossing-over. (Auth.)

- 1111 VandeHey, R.C., Craig, G.B., Jr. GENETIC VARIABILITY IN *Aedes aegypti* (DIPTERA: CULICIDAE). II. MUTATIONS CAUSING STRUCTURAL MODIFICATIONS. *Ann. ent. Soc. Am.* 55 (1962) 58-89.
- Mutations were isolated in the course of an analysis of variability in lab mosquito populations. Some mutations were obtained from stocks that were irradiated. Males about 48 h postemergence were given doses of 2000-4000 R with either x-rays or γ -rays from a ^{60}Co source. These males were crossed to unirradiated females and their progeny were again crossed to unirradiated individuals. The F_2 progeny from the latter cross was examined for modifications. Detailed descriptions are given of the mutants. Most of the mutants showed reduced penetrance and variable expressivity, which made determination of the mode of inheritance of these factors difficult. In many cases, selection over several generations improved the penetrance of the structural factors. However, lines with 100% penetrance were developed in only a few cases. (NSA 21: 1967, 10834)

- 1112 Voelker, R.A. FURTHER STUDIES ON THE GENETICS OF *Drosophila affinis*. *Genetics* 56, 3 Pt. 2 (1967) 593. * Presented at "1967 Meetings of the Genetics Society of America, Stanford, Calif., USA. 31 Aug.-2 Sep. 1967".

Miller and Stone (1962) reported a Nebraska strain of *D. affinis* to lack a Y-chromosome. It was wondered whether X0 males induced by X-chromosome non-disjunction would also be fertile in this species. - To obtain sex-linked mutants for detecting patroclinous males, wild-type males (Arkansas strains) were irradiated with 2500 R of x-rays and pair mated to wild-type females, and male progeny of F_1 pair matings were checked for mutants. The following mutants were recovered: X-linked-blistered, bristle, Notch (associated with a C-D translocation), Polychaetoid, and roughoid; autosomal-crumpled and Cut. - To recover patroclinous males, recently emerged (0-6 d) virgin females were irradiated (2000-3000 R) and mated to males differing as to sex-linked traits: wild-type females to Polychaetoid or bristle males, bristle females to wild-type males. Male offspring were patroclinous with a frequency of 4/7995. Such males were mated to their sisters. They were determined to be X0 due to non-disjunction by establishing that (1) their male offspring lacked a Y-chromosome and (2) their brothers possessed a Y-chromosome. Thus, induced X0 males, as well as X0 male offspring of wild-caught females, are fertile in this species. (Abstr.)

* Read by title only.

- 1113 Wagoner, D.E. TRANSLOCATION INDUCTION AND ANALYSIS IN THE HOUSE FLY, *Musca domestica* L. *Genetics* 56, 3 Pt. 2 (1967) 594. Presented at "1967 Meetings of the Genetics Society of America, Stanford, Calif., USA. 31 Aug.-2 Sep. 1967".

Over 150 translocations have been induced with x-rays in the housefly and have been analysed for the following information from crosses of heterozygous translocation-bearing males (no crossing over) to appropriately marked females: (1) Sex ratio of progeny; (2) ratio of translocation to non-translocation bearing progeny; and (3) egg hatchability. The most promising stocks are being selected for laboratory studies on the population-depressing effects of translocations. The tests include observations of heterozygous and homozygous double, triple, and quadruple reciprocal

translocations alone and in various combinations with one another, and one after the other in population cages. - Cytological study has been completed of enough of the induced translocations to assign the five linkage groups previously reported for the housefly (Hiroyoshi, J. econ. Entomol. 53: 1960, 985; Milani, Atti Assoc. Genet. Ital. 6: 1961, 427; Tsukamoto, Baba, and Hiraga, Japan. J. Genet. 36: 1961, 168) to their corresponding autosomes (no sex-linked markers have been found, $2n=12$, male is heterogametic). The analysis shows the R1 marker and its associated linkage group located on chromosome I (longest pair), the car marker and its linkage group on chromosome II, and hwb marker and its linkage group on chromosome III, the ye marker and its linkage group on chromosome IV, and the ocra marker and its linkage group on chromosome V (shortest pair). X and Y represent the sex chromosomes. They appear to be entirely heterochromatic, and no representative mutants have been found thus far. (Abstr.)

- 1114 Whiting, A.R. THE BIOLOGY OF THE PARASITIC WASP Mormoniella vitripennis (=Nasonia brevicornis) (Walker). Q. Rev. Biol. 42, 3 (1967) 334-406. *

The biology, economic importance, physiology, ecology, cytology, and genetics of the wasp are reviewed, and its use and value in research are also considered. Normally Mormoniella is an ectoparasite, and uses the pupae of larger Diptera as hosts; at 28°C a generation is completed in 10 d. The species is world-wide in its distribution, and may be found wherever hosts are available. Females are inefficient flyers, and males cannot fly. In genetical research, largely using Sarcophaga pupae as hosts, both spontaneous and radiation-induced mutants have been studied. The R locus, described in "orthodox" genetic terms as a chromonemal region is marked by eye colour mutants as well as many other genes, all of which show complete linkage and govern various deleterious traits, including male and female sterility and reduced viability at various stages of the life cycle. Incompatibility in reciprocal crosses is reported to be governed by cytoplasmic factors. The haploid males have five chromosomes but little is known about linkage relations or the method of sex determination at present. Dose-action curves by exposing eggs to x-rays and to neutrons, and of treating sperm with x-rays, is reported. (From auth.)

* Radiation work is discussed on p. 372 and 391-393.

- 1115 Whiting, P.W. "BLACK" EYE COLORS OF Mormoniella. Genetics 54 (1966) 639-655. And also as ORNL-P-82, Oak Ridge National Lab., Tenn.

Eye-colour mutations in Mormoniella may be grouped as "bright" and "black", the former occurring much more frequently. Of 13 separate black mutations, eight were "eb (ebony) black" and five were "bk (black) black". The first "black" mutant occurred in 1952 as a lavender-eyed male among sons of an x-rayed red-eyed (R-locus O-factor dahlia-GF) female. Three blacks, "bk-352, -386 and -394", were obtained later (Caspari) after x-raying da-GF females. Combinations were made with R-locus dahlia, da, scarlet, st, and orange, or, da eb is black phenotypically, da bk lavender; st eb is scarlet, st bk white; or eb and or bk are both white. Because some of the ebones and blacks are difficult or impossible to distinguish from wild type by inspection, the white combinations were used in determining homology, white offspring from crosses indicating homology, colored indicating nonhomology. The eight ebones proved homologous. The five bk blacks included two pairs of alleles and a third gene linked with R giving 20.1% crossovers. F₂ males from crosses of blacks and R-locus genes and between nonhomologous blacks gave data indicating linked viability depressors, linkage between a black and R, and linkage of black loci (repulsion phase) resulting in excess of whites. Several of these linkages are probably spurious owing to chromosomal irregularities. Deficiency of whites from some crosses may be due to reduced viability of the double recessives. One of the ebony genes depresses viability to 50% of normal, and a bk-black gene depresses viability to less than 90%. Differences in intensity of black between different stocks may be caused by the state of the black genes themselves, some being weak enough to give a wild phenotype, or there may be suppressors at other loci. Gene formulae for the black genes may be expressed in terms of factor states as in the R alleles. (Auth.)

- 1116 Zambruni, L. THE RESPONSE OF THE BROWN SPOTS CHARACTER FOR Drosophila melanogaster TO TREATMENT WITH x-RAYS. Rc. Ist. lomb. Sci. Lett. 97 (1963) 3-18. (In Italian)

Larvae, pupae, and adults of the two stocks carrying the brown spots character (bsp) of D. melanogaster (wild Aspra 52 and a stock derived from this, isogenic for the 11-chromosome) were irradiated.

The data reported demonstrate clearly that the character under examination is sensitive to ionizing radiation during the whole period of development of the individual, from the young larva to the newly emerged adult. In the isogenic stock, x-rays caused a decrease in the frequency of the character manifestation in the individual treated as larvae. In the pupae, on the other hand, no particular effect was noted. In adults, 24 h after emergence from the pupal case, irradiation caused an increase in the frequency of the spots. In the wild stock a response was obtained that was similar to that observed in the isogenic one, but was more marked. The decrease obtained both in the larvae and in the pupae was much more marked, as was the increase in the adults. A complex mechanism, therefore, appears to govern the manifestation of the bsp character. As to its nature, it was possible to formulate several hypotheses, among which the present data do not allow any preference. The action of x-rays, however, both in larval and pupal stage, seems to tend to inhibit the spots, presumably as a consequence of the damage caused to the whole organism and in particular to undifferentiated cells. In the adult stage, however, the action of radiation seems to facilitate the production of the spots, probably on the basis of an increase in enzymatic activities. (NSA 20; 1966, 42945)

See also:

- 33 Distribution of lethals induced by tritiated DNA precursors in Drosophila melanogaster. (Kaplan, W.D. et al., 1966)
- 34 Stability of Drosophila chromosomes to radioactive decay of incorporated phosphorus-32. (Lee, W.R. et al., 1966)
- 35 The production of mosaics by incorporation of P^{32} into DNA of Drosophila melanogaster spermatozoa. (Lee, W.R. et al., 1967)
- 36 Mutations produced by transmutation of phosphorus-32 to sulfur-32 within Drosophila DNA. (Lee, W.R., 1967)
- 916 Some unusual topics in radiation biology. (Zimmer, K.G., 1966)
- 921 Cytogenetic analysis of lethal mutation induced during different stages of spermatogenesis in Drosophila. (Khashim-Akhmed, M.S., 1965)
- 928 Cytological evaluation of dose-rate effects of radiation on mutation frequency of silkworm gonads. I. Kinetics of proliferation and killing of spermatogonia during chronic irradiation. (Sado, T., 1966)
- 932 Further evidence demonstrating germinal selection in early premeiotic germ cells of Drosophila males. (Abrahamson, S. et al., 1966)
- 940 Radiomutability and heterogeneity of male germ cells of Drosophila before, during, and after meiosis. (Frity-Niggli, H., 1966)
- 943 Mutation rates at specific autosomal loci in different species of Drosophila. (Hannah-Alava, A., 1966)
- 944 Cytogenetic analysis of lethal mutations induced at various stages of spermatogenesis. (Hashim-Ahmed, M.S., 1965)
- 949 The relative mutagenic effectiveness of fast neutrons and x-rays in pre- and post-meiotic germ cells of Drosophila melanogaster. (Lamb, M.J. et al., 1967)
- 950 Molecular and radiation genetics. Annual Report 1965. (Leiden Rijksuniversiteit Netherlands, 1966)
- 957 Annual Report of the National Institute of Genetics, No.16, 1965. (National Inst. of Genetics, Mishima, Japan, 1966)
- 963 Techniques for studying the effects of radiation on meiosis and related processes in mosquitoes with particular reference to Aedes aegypti. (Rai, K.S., 1968)
- 964 Cytological evaluation of dose-rate effects of radiation on mutation frequency of silkworm gonads. II. Evidence of G_2 accumulation of primary spermatogonia after acute irradiation. (Sado, T. et al., 1966)
- 965 Dose-rate effect in the repair of radiation damage in spermatids of Drosophila melanogaster. (Sankaranarayanan, K., 1967)
- 974 Post-irradiation modification and a possible mechanism of the reverse dose-rate effect on mutation induction observed in silkworm gonads. (Tazima, Y. et al., 1966)
- 975 Changes in the mutation response of post-meiotic silkworm germ cells to γ -rays with the progressing spermiogenesis. (Tazima, Y., 1966)
- 980 Dependence of mutation frequency on the x-ray dosages in the sensitivity of pre-meiotic and post-meiotic stages of spermatogenesis. (Vatti, K.V., 1965)

- 982 Methods for radiation studies during oogenesis in Habrobracon juglandis (Ashmead). (Whiting, A.R. et al., 1968)
- 984 Induced mutations and lethality in Drosophila after x-irradiation of meiotic and post-meiotic stages of the egg. (Würgler, F.E., 1968)
- 985 Rates of autosomal recessive lethals after x-ray treatment of spermatogonia and spermatozoa in Drosophila melanogaster. (Ytterbom, K.H., 1967)
- 1021 Chromosome breakage and loss following alpha particle treatment of Drosophila. (Malich, C.W. et al., 1966)
- 1122 Genetic effects of chronic γ -radiation on Habrobracon sperm. (Borstel, R.C. von, et al., 1967)
- 1139 Sterility, chromosome breakage, x-ray-induced mutation rates and detected mutation frequencies in Drosophila melanogaster. (Lefevre, G., Jr., 1967)
- 1143 Mutation yield in a theoretical cell population of heterogeneous sensitivity to mutation induction and to killing. (Ofstedal, P., 1966)
- 1150 x-Radiation induction of mutations in Habrobracon. (Smith, R.H. et al., 1966)
- 1176 Influence of 2,4-dinitrophenol (DNP) on mutation frequency in sperm cells and spermatids of Drosophila irradiated with gamma rays. (Abeleva, E.A., 1966)
- 1177 Normalizing effect of arginine on the relation between the ionizing radiation dose and the frequency of mutation generation in Drosophila spermatids. (Abeleva, E.A., 1966)
- 1178 Dimethyl sulfoxide treatment of Drosophila. (Alexander, M.L., 1966)
- 1180 Results of biological investigations conducted during flights of "Vostok" type vehicles with the participation of cosmonauts A.G. Nikolayev, P.R. Popovich, and V.F. Bykovskiy. (Antipov, V.V., 1966)
- 1181 Gamma radiation and heterosis in Aedes aegypti. (Asman, S.M. et al., 1967)
- 1182 Mutagenic effectiveness of known doses of gamma radiation in combination with weightlessness of Habrobracon. Summary Progress Report, February 17, 1964-June 30, 1966. (Borstel, R.C. von, 1967)
- 1183 Mutagenic effectiveness of known doses of gamma radiation in combination with weightlessness on Habrobracon. Quarterly Progress to the National Aeronautics and Space Administration, July 1-September 30, 1966. (Borstel, R.C. von, 1967)
- 1184 Effects of ecdysones on frequency and distribution of x-ray induced lethals in Drosophila melanogaster. (Burditt, W.J. et al., 1967)
- 1188 Fast neutron and x-ray irradiation of Drosophila melanogaster oögonia and oocytes. (Dickerman, R.C., 1967)
- 1189 Mutational response of Drosophila melanogaster oocytes and oögonia to x-ray and fast neutron irradiation. (Dickerman, R.C., 1967)
- 1190 "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". (Elequin, F.T. et al., 1965)
- 1191 Modification of induced genetic damage in Drosophila melanogaster by oxygen and argon treatments between two doses of x-rays. (Elequin, F.T., 1966)
- 1195 Studies on the experimental population of Drosophila melanogaster raised on irradiated banana diet. (Hossain, M.M. et al., 1966)
- 1196 ibid (1967)
- 1197 An attempt to sensitize Drosophila chromosomes to x-irradiation after 5-bromodeoxyuridine incorporation into DNA. (Khan, A.H. et al., 1966)
- 1198 Occurrence of lethal mutations in the heterochromatic region of Drosophila melanogaster X chromosome depending on preradiation development temperature. (Kogan, Z.M., 1966)
- 1199 RBE of fast neutrons to γ -rays for mutations in relation to repair mechanisms. (Kondo, S., 1965)
- 1201 Investigations on the influence of 5-bromouracil desoxyriboside (BUDR) on the radioinduced mutation rate in Drosophila melanogaster. (Magdon, E. et al., 1967)
- 1209 Effect of conjugate aromatic systems on heredity. I. Mutagenic and antimutagenic effect of certain indene compounds. (Mosse, I.B. et al., 1964)
- 1210 Effect of various compounds on spontaneous and γ -radiation-induced mutability of Drosophila melanogaster. (Mosse, I.B. et al., 1965)
- 1211 Modification of radiation-induced mutation frequencies by antibiotics in Drosophila melanogaster. (Mukherjee, R.M., 1966)
- 1212 The potentiating effect of sodium fluoride on the induction of mutations by x-rays in mature spermatozoa of Drosophila melanogaster. (Mukherjee, R.N., 1967)

- 1213 The effect of 5-bromodeoxyuridine (BUdR) on the frequency of 14 MeV fast neutron induced mutations in the gonadal cells of the silkworm. (Murakami, A., 1966)
- 1214 The effect of pretreatment with maleic hydrazide of the mutation rate induced by gamma radiation in Drosophila melanogaster. (Nasrat, G.E., 1967)
- 1218 Thymidine teratogenesis and mutagenesis in Drosophila melanogaster. (Parkash, O., 1967)
- 1220 X-ray induced changes in Drosophila germ cells. Three-Year Comprehensive Report September 1, 1964-August 31, 1967. (Rinehart, R.R., 1967)
- 1221 Influence of helium posttreatments and exposure fractionation on x-ray induced dominant or sex-linked recessive lethality and X-chromosome loss in stage 7 oocytes of Drosophila melanogaster. (Rinehart, R.R., 1967)
- 1223 Mutation in Drosophila melanogaster cultured on irradiated whole food or food components. (Rinehart, R.R. et al., 1967)
- 1223 On the biological effects of high energy protons. (Saksonov, P.P. et al., 1965)
- 1225 The failure of irradiated DNA to produce mutation in Drosophila melanogaster. (Seecof, R. et al., 1966)
- 1226 Radiosensitization of Drosophila melanogaster by N-ethylmaleimide. (Sharma, R.P., 1966)
- 1227 Differential effect of penicillin on x-ray induced mutations in Drosophila melanogaster. (Shiomi, T., 1965)
- 1228 Effects of penicillin feeding on the frequency of x-ray induced mutation in Drosophila. (Shiomi, T., 1966)
- 1234 The contrasting effects of O₂ and N₂ in determining initial sensitivity and post-radiation recovery in Drosophila sperm and spermatids. (Sobels, F.H., 1964)
- 1235 Processes underlying repair and radiosensitivity in spermatozoa and spermatids of Drosophila. (Sobels, F.H., 1966)
- 1236 Repair of radiosensitivity phenomena in Drosophila males. (Sobels, F.H. et al., 1967)
- 1237 RBE values for genetic effects of 15 MeV neutrons in relation to stage sensitivity in Drosophila. (Sobels, F.H., 1967)
- 1238 Modification of γ -ray-induced mutation frequencies in the silkworm by post-treatment of spermatids and spermatozoa with nitrogen. (Tazima, Y. et al., 1966)
- 1241 Metabolic conditions before and after irradiation. (Thornley, M.J., 1963)
- 1242 Post-irradiation recovery in early spermatids and spermatocytes sampled from Drosophila pupae. (Watson, W.A.F., 1966)
- 1243 Post-radiation recovery in spermatids sampled from 24 hr. old pupae of Drosophila melanogaster. (Watson, W.A.F. et al., 1967)
- 1244 Post-radiation recovery in early spermatids sampled from Drosophila pupae. (Watson, W.A.F., 1967)
- 1245 Mechanisms of dose-rate effects: insights obtained from intensity and fractionation. (Wolff, S., 1965)
- 1250 Disproportionate amounts of genetic damage induced by ethylenimine and x-radiation treatments. (Alexander, M.L., 1966)
- 1253 A comparison by means of x-irradiation in air and in oxygen of the suppressor-erupt systems in several strains of Drosophila melanogaster. (Aubele, A.M., 1967)
- 1255 Experience with high energy electron beam therapy. (Botstein, C. et al., 1965)
- 1260 Biological organization in relation to differential gene response to mutagens. (Fahmy, O.G. et al., 1965)
- 1261 The nature and distribution of the mutations induced by unirradiated and irradiated heterologous deoxyribonucleic acid in Drosophila melanogaster. (Fahmy, O.G. et al., 1966)
- 1262 Chemically induced viability mutants in D. melanogaster. (Friedman, L.D. et al., 1966)
- 1263 The action of radiation and other mutagenic agents 1. in inducing mutation in Drosophila females, and 2. in controlling the action of specific genes responsible for suppressing uncontrolled growth. (Glass, H.B., 1966)
- 1264 EMS and ICR-100 induced chromosome 4 lethals in D. melanogaster. (Hochmann, B., 1967)
- 1269 Mechanism of mutation and inducing factors. (Landa, Z., 1966)
- 1270 Comparative mutagenic activity of some aromatic compounds with or without γ -irradiation. (Mosse, I.B. et al., 1965)
- 1271 Relative biological effectiveness of 14 MeV neutrons to gamma-rays for inducing mutations in mature sperm of the silkworm. (Murakami, A., 1966)
- 1273 Cytological analysis of formaldehyde induced chromosomal changes in Drosophila melanogaster. (Slizynska, H., 1957)

- 1274 Dominant and recessive lethal mutations induced by mitomycin C in Habrobracon oocytes and sperm. (Smith, R.H., 1967)
- 1276 Studies on the mutagenic action of formaldehyde in Drosophila. II. The production of mutations in females and the induction of crossing-over. (Sobels, F.H., 1956)
- 1278 Stock differences in x-ray mutational sensitivity pattern of Drosophila melanogaster. (Strømnaes, Ø., 1959)
- 1280 Temperature-sensitive mutations in Drosophila melanogaster. I. Relative frequencies among γ -ray and chemically induced sex-linked recessive lethals and semilethals. (Suzuki, D.T. et al., 1967)
- 1284 Investigations on the mutagenic effect of nitroso compounds. (Trams, A. et al., 1966)
- 1312 X-ray-induced mutability of polygenes controlling hatching time in Drosophila melanogaster. (Pulitzer, J.F., 1966)
- 1360 Effect of x and γ radiation on the development of unmatched gypsy moths (Oenertia dispar L., Lymantriidae, Lepidoptera). (Kakhmanyuk, F.S. et al., 1967)
- 1367 Dependence of the somatic mutation spectrum of Ephestia kuehniella on the development stage of the irradiated animal. (Mueller, I. et al., 1966)
- 1390 Effect of gamma radiation on Trogoderma glabrum and Attagenus piceus. (Tilton, E.W. et al., 1966)
- 1395 Studies on the radiosensitivity of early embryonic stages of Drosophila melanogaster. (Würgler, F.E., 1964)
- 1397 Effects of gamma radiation on development of Dermicenter occidentalis (Ixodidae). (Ziad Al-ahmadi, A., 1967)
- 1419 Estimation of sensitivity of Drosophila melanogaster to radiation using a third-order rotatable design. Three Year Comprehensive Report. (Ratty, F.J., 1966)
- 1422 Differential gerontomimetic effects of pupal x-irradiation on adult male and female house flies. (Rockstein, M. et al., 1966)
- 1452 Results of biological experiments carried out under conditions of flight in ships Vostok with participation of cosmonauts A.G. Nikolayev, P.R. Popovich, and V.F. Bykovsky. (Antipov, V.V. et al., 1964)
- 1453 Results of biological experiments carried out under conditions of "Vostok" flights and with the participation of cosmonauts A.G. Nikolayev, P.R. Popovich and V.F. Bykovsky. (Antipov, V.V., et al., 1965)
- 1489 Induced mutations in polygenic systems. (Aastveit, K., 1966)
- 1491 A study of the genetic processes in irradiated populations of Drosophila melanogaster. III. The fecundity and the concentration of lethal mutations. (Bileva, D.S., 1967)
- 1504 Effect of selection on whaxy: an autosomal dominant mutation in the screw-worm fly with recessive lethal effects. (LaChance, L.E., et al., 1965)
- 1507 The genetic structure of natural populations of Drosophila melanogaster. IV. Heterozygous effects of radiation-induced mutations of viability in various genetic backgrounds. (Mukai, T. et al., 1966)
- 1508 Genetics. (National Inst. of Radiological Sciences, Chiba, Japan., 1966)
- 1509 Recessive lethals in second chromosomes of Drosophila melanogaster with radiation histories. (Salceda, V.M., 1967)
- 1562 A. The IAEA laboratory at Vienna and Seibersdorf. Second Report. IV. Agriculture. B. Insect eradication and pest control. 5. Co-ordinated programme on insect eradication and sterile-male technique. (IAEA, Vienna, Austria, 1965)

2.1.6. Dominant Lethality.

Sterility (See also 2.4.2.1.). Cell Killing

- 1117 Abdul Matin, A.S.M., Bhuiya, A.D., Khan, Z.A. ATTEMPT TO OBTAIN STERILITY OF MALE RICE HISPA THROUGH GAMMA RADIATION. p.155-156 of "Proceedings of the Agricultural Symposium, Dacca, Pakistan, 1966".

The adult male beetles were irradiated at various doses of γ -radiation at a fixed dose rate of 34.80 R/h and placed in cages with untreated females. Records were kept of egg production, hatch etc. When untreated virgin females were mated with irradiated males, the percentage of viable eggs decreased

with an increase in dose. The average egg hatch in the untreated controls was 71.49% whereas matings with male beetles exposed to 10000, 8000, 7000, 6000, and 5000 R showed averages of 1.4, 1.41, 9.3, 12.72, and 14.50% egg hatch respectively. (Auth.)

- 1118 Andreev, S.V., Martens, B.K., Malchanova, V.A., Saidan, L.N. RADIATION STERILIZATION IN CONTROLLING INSECT PESTS. Vest. sel'khoz. Nauki No. 1 (1967) n.p.

- 1119 Arroyo, M., Jiménez, A., Mellado, L., Caballero, F. APLICACION DE ISOTOPOS RADIATIVOS A LA INVESTIGACION DE METODOS SOBRE LUCHA CONTRA LAS PLAGAS. III. OBTENCION DE MACHOS ESTERILES DE Ceratitis capitata Wied., MEDIANTE LA IRRADIACION DE SUS PUPAS CON RAYOS GAMMA. (Application of radioactive isotopes to the investigation of methods for the biological control of pests. III. The obtaining of sterile males of C. capitata by irradiation of the pupae with γ -rays.) Boln Patol. veg. Ent. agric. 28 (1965) 257-280. (In Spanish)

An account is given of experiments carried out in 1965 to obtain sterile adults by exposing the pupae to ^{137}Cs . When pupae 5 or 6 d old received doses of 10 000 or 15 000 rad γ -radiation, 68-86 and 4-40%, respectively, gave rise to active adults, as compared with 98% of those not irradiated. The adults thus obtained were crossed. With adults derived from pupae irradiated at 10 000 rad, no eggs were laid by irradiated females confined with either irradiated or normal males. Normal females confined with irradiated males laid a reduced number of eggs, a small proportion of which hatched and developed normally. When adults derived from pupae treated at 15 000 rad were paired, irradiated females laid no eggs when confined with normal males and normal females laid non-viable eggs when confined with irradiated males. A few eggs that developed normally appeared to have been laid by irradiated females confined with irradiated males, though this may be accounted for by experimental error. In all cases, adults derived from irradiated pupae died sooner than those from normal ones. All the adults from pupae irradiated when 5 d old at 15 000 rad were dead within 15 d. In the remaining cases, 70-86% of the males and 50-77.5% of the females died within 15 d, as compared with 37.5 and 26% of normal males and females, respectively. All the irradiated individuals appeared more torpid, especially in the first few days, than normal ones, but this did not prevent them from pairing. In a further series of experiments, pupae were irradiated at 8000 or 10000 rad when 7 d old. At both rates, 89% of them gave rise to active adults. When these were crossed, no irradiated females oviposited and none of the eggs laid by normal females confined with irradiated males hatched. The mortality of adults derived from these irradiated pupae was lower during the first 15 d than that of adults in the previous series of tests, though mortality was still somewhat higher than that of normal adults. Pairing occurred normally, and in some cases the flies paired more than once. (RAE-A 55:1967, ref.254)

- 1120 Arroyo, M., Jiménez, A., Mellado, L., Caballero, F. APLICACION DE ISOTOPES RADIATIVOS A LA INVESTIGACION DE METODOS SOBRE LUCHA BIOLOGICA CONTRA LAS PLAGAS. IV. EFECTOS DE LA RADIACION GAMMA SOBRE Ceratitis capitata Wied., EN FUNCION DEL FRACCIONAMIENTO DE LA DOSIS DE IRRADIACION. (Application of radioactive isotopes to the investigation of methods for the biological control of pests. IV. The effects of γ -radiation on C. capitata when the dose of irradiation is fractionated.) Boln Patol. veg. Ent. agric. 28 (1965) 281-292. (In Spanish)

Results are given of tests carried out to investigate whether a fractionated dose of γ -radiation received by pupae of C. capitata would be less detrimental to the vitality of the resulting adults than a single dose, without impairing the degree of sterility obtained in the tests reported in the preceding paper. There, 7-d-old pupae had been irradiated at ≥ 8000 rad. It was found that no advantage was gained by irradiating the pupae when 6 d old at 5000 or 8000 rad and again when 7 d old at 5000 or 8000 rad, in any combination of these doses. (Essentially RAE-A 55: 1967, ref. 255)

- 1121 Bostel, R.C., von. THE THEORY OF RADIATION-INDUCED DOMINANT LETHALITY IN SPERM. p. 232 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966, 263p". Abstr. 921

Dominant lethality due to chromosome breakage and bridge formation results in early death of Drosophila and Habrobracon. Radiation-induced bridges can be formed in two ways: by terminal deletions and by dicentric translocations. Terminal deletions of chromosome limbs lead to attachment of the new ends together when a new chromosome is synthesised. A bridge is then formed during anaphase. Such bridges from terminal deletions arise from single events and the proportion

which escapes this fate is

$$S_1 = e^{-k_1 D} \quad (1)$$

where k_1 is the effective sensitivity and D is the dose of radiation. Dicentric translocations require that two chromosomes be broken and rejoin in such a way that two centromeres are present in one chromosome. We assume that there are a definite number of regions ("sites") in each nucleus where such translocations can occur. With this assumption it can be shown that the proportion which escapes this fate is

$$S_2 = [1 - (1 - e^{-k_1 D})^m] \quad (2)$$

where m is the number of sites. Multiplying equations (1) and (2) gives the proportion which escapes both fates:

$$S = S_1 \cdot S_2 \quad (3)$$

With the proper choice of parameters, equation (3) adequately describes the frequency of early deaths of embryos following fertilization of eggs by irradiated sperm. The frequency of dicentric translocations can be estimated from dominant lethal data by the use of equation (3). This frequency can be compared to the frequency of reciprocal translocations measured genetically. (Abstr.)

- 1122 Borstel, R.C., von, Smith, R.H., Whiting, A.R. GENETIC EFFECTS OF CHRONIC γ -RADIATION ON *Habrobracon* SPERM. *Radiat. Res.* 31, 3 (1967) 615. Abstr. Eb-8, at "15th Annual Meeting of the Radiation Research Society. San Juan, Puerto Rico, 7-11 May 1967".

Because of haploidy of the male, it is possible in *Habrobracon* to test the entire genome for dominant lethality, recessive lethality, inherited partial sterility (the majority being translocations), and visible mutations. In addition, the time of death from the lethal events can be accurately scored during the testing procedure. This genetic system was used to test the effects of chronic ^{85}Sr γ -radiation in comparison with acute x-radiation on *Habrobracon* sperm. The males were exposed to chronic γ -radiation over a 66-h period. For the acute irradiation studies, in one experiment the males were mated immediately, and in a second, after a 66-h delay. At the same dose levels the genetic effects did not differ appreciably. Further, a dose-action curve for genetic effects of the chronic γ -radiation over a range from 400 to 4000 R shows that 0.5 of the recessive lethals are embryonic and 0.5 are larval or pupal. A linear response for recessive lethals is obtained up to the highest dose given the sperm. At low doses, the inherited partial sterility increases approximately with the square of the dose; above 2000 R, the increase is less. (Abstr.)

- 1123 Buginsky, V.I. EFFECTIVENESS OF STERILIZATION OF THE MALLOW MOTH: IRRADIABILITY AT DIFFERENT STAGES OF DEVELOPMENT, AND CERTAIN FEATURES OF MATING AND EGG-LAYING. "Tezisy Dokladov. Izd-vo Akad. Nauk SSSR, 1963". Paper presented at "5th Conference of the All-Union Entomological Society".

- 1124 Burgess, E.E., Bennett, S.E. STERILIZATION OF THE MALE ALFALFA WEEVIL (*Hypera postica*; CURCULIONIDAE) BY X RADIATION. *J. econ. Ent.* 59 (1966) 268-270.

Weevils were irradiated at 3 weeks. Doses of 2000 - 10 000 R of x-rays were used to determine at what level of radiation sterility is induced in the male alfalfa weevil. Sterility was determined by observing the occurrence of viable or non-viable eggs laid after x-irradiated males had mated with normal virgin females. Mortality was very low and insignificant. There was no higher death rate at 10 000 R than there was at 2000 R or in the controls. Unirradiated females mated to x-irradiated males produced eggs, but most of the eggs from weevils mated with males given 2000 R through 10 000 R failed to hatch. Only 0.8% of the eggs deposited at the 4000-R level hatched. However, no hatching occurred at the higher exposures. The lower levels of radiation were successful in producing non-viable offspring, especially when comparing the experimental with the control group which produced almost 79% viable offspring. A decrease was noted in the rate of development of all embryos from sperm receiving a high level of radiation. This degree of damage increased in proportion to the dose of x-rays that the weevils received. It is concluded that doses ranging from 2000 - 6000 R will not induce sterilization in the males but will produce non-viable offspring. However, at the 8000 and 10 000 R levels sterility is induced. (Essentially NSA 20: 1966, 35279)

- 1125 Caprotti, M., Rubin, P.G., Springhetti, A. CASTRAZIONE DI FEMMINE ADULTE DI "Nauphoeta cinerea" [BLATTOIDEA] PER MEZZO DI RAGGI x. (Sterilization of the female adult of Nauphoeta cinerea (Blattoidea) by means of x-rays.) Genet. agr. 16 (1963) 300-306. (In Italian, with English summary) Paper presented at "Atti dell'VIII Convegno Annuale della Società Italiana di Genetica Agraria, Bergamo, Italy, 26-28 Oct. 1961".
- A dose of 10000 rad given to the last five body segments of the white imago of N. cinerea stops egg growth in the ovary and causes their atrophy. Even two months after treatment the ovary had still not resumed normal activity.
- 1126 Darfenov, G.P. OCCURRENCE OF DOMINANT LETHALS IN Drosophila UNDER THE INFLUENCE OF VIBRATION, ACCELERATION AND γ IRRADIATION. Cosmic Res. 3,4 (1965) 237-254. Also listed as N66-13790, Air Force Systems Command, Wright-Patterson AFB, Ohio, Foreign Technology Div.
- This paper presents the results of laboratory studies of the influence of vibration, acceleration, γ -irradiation and the combined effects of these factors on the occurrence of dominant lethals in the primordial cells of Drosophila males. The study was conducted to analyse the nature of the effect obtained in Drosophila in a series of space flights. It was shown that vibration and acceleration may influence the final result on indication of a biological effect of ionizing radiation by means of a given test, although in all probability they produce nonnucleic modifications. (Auth.)
- 1127 Flint, H.M. RADIATION STERILIZATION STUDIES ON THE TOBACCO BUDWORM, Heliothis virescens Fab. Bull. ent. Soc. Am. 12 (1966) 286. Abstr. 96, at "Portland Meeting, Portland, Oreg., USA, 28 Nov.-1 Dec. 1966".
- Tobacco budworms were sterilised in the late pupal stage by 55 kR of γ -radiation. Sterilised males were ineffective in reducing egg hatch in various ratios with untreated males and females. Mating studies indicate that sperm from sterilised males are non-competitive. (Abstr.)
- 1128 Gasser, R. PROBLEMS OF RESISTANCE OF SPIDER MITES AGAINST MITICIDES. p.245-253 of "Proceedings of 5th European Symposium of Acarology, Milan, Italy, 23-25 Sep. 1965". 1965, 303p. (With Italian summary)
- Recent published work on the cross-resistance of Tetranychids to acaricides and to mixtures of them [cf. 52:119, etc.], their sterilisation by chemosterilants [cf. 53:237], antibiotics [cf. 51:578, etc.] or irradiation [cf. 53:32] and the influence of plant nutrition on their fecundity [cf. 50:547; 51:583, etc.] is reviewed. The extermination (by chemical or cultural means) of small Tetranychid populations below the economic level is advocated, even at the expense of integrated control programmes, since favourable conditions can cause sudden outbreaks not easily controlled unless the most effective acaricide for the particular mite strain concerned is known. (From RAE-A 56: 1968, ref. 781)
- 1129 Gershenson, S. M. STUDY OF MUTABILITY IN THE WASP Mormoniella vitripennis Wlk. Genetika No. 2 (1965) 95-101. (In Russian)
- A study of dominant lethals induced by x-irradiation of Mormoniella vitripennis males (dosages 4500 and 3500 R) showed that dominant lethals arise with about the same frequency as in Drosophila and Habrobracon. In recombinant males obtained by intercrossing two stocks of different geographical origin the frequency of induced dominant lethals was somewhat higher than in males of the parental stocks. A study of recessive lethals induced by x-rays in males of M. vitripennis (dosage 3500 R) showed that recessive lethals arise here also with about the same frequency as in Drosophila and again their frequency was higher in recombinant males than in males of the parental stocks. The significance of the above results is discussed in relation to the mechanism of intraspecific differentiation and the influence of hybridization on mutability. (Auth.)
- 1130 Gloor, H., Kobel, H.R. ANTENNAPEDIA (SS^{Anp}), AN HOMOEOETIC MUTANT OF Drosophila hydei Sturtevant. Revue suisse Zool. 73 (1966) 229-252. (In German)
- A new mutant of the spineless-aristapedia type in D. hydei is described. It was produced by irradiation of the male flies with a 10000-R dose of 60-kV x-rays delivered at a dose rate of 380 R/min. It is designated as Anp (Antennapedia). Anp is variable in its expression, is dominant, lethal when homozygous, and inseparable from an inverted transposition in the second chromosome.

Expression and penetrance of the mutant increase with higher temperatures, while at the same time viability decreases. The phenotypic effect of *Anp* consists, apart from various deformations of head parts, of the formation of leg-like structures on, or instead of, the antenna, leading in extreme cases to the differentiation of a nearly complete leg. A trochanter was never observed, but structures resembling a coxa may originate between antenna and eye. The homoeotic leg has in all cases the appearance of a mesothoracic leg. The mechanism of homoeotic transformation is discussed in terms of divergent gradients of growth, competing tendencies of differentiation, and prepatter formation. (NSA 21: 1967, 14628)

- 1131 Katiyar, K.P. Sterilization of the coffee leaf miner. p.118-122 of "The Application of Nuclear Energy to Agriculture. Annual Report". Moh, C.C., Ed. NYO-2043-52, Inter-American Inst. of Agricultural Sciences, Turrialba (Costa Rica). 1 Jul, 1967, 165p.

Leucoptera coffeella Guer. has been exposed to various doses at the pupal and adult stage. 90 kR applied to newly emerged moths do not adversely affect longevity. Results are tabulated for the effect of irradiation (80 kR) applied to 7-d-old pupae on adult emergency (♂ 29.3%, ♀ 41.2% against 45.5 and 39.1 in controls) and mortality (♂ 88.1%, ♀ 23.6% against 0). The effect of γ -radiation on the fertility for doses from 60 to 90 kR showed a sharp drop.

- 1132 Khvatova, L. STERILIZATION OF PARASITES OF THE ASH TREE. *Zashch. Rast.* No. 12 (1965) 51-52. (In Russian)

Pupae and larvae of the wood moth, *Zeuzera aesculi*, were irradiated with x-rays (dose rate 112 R/min, doses from 2500, 4000 to 5500 R). The irradiated insects were placed in polyethylene bags attached to branches of the ash. After 3 d, 27 pupae had died and the remaining 43 pupae produced only 12 butterflies (eight females and four males). Butterflies from pupae which had received 2500 R could fly actively inside the bag, and their wings were fully grown and well shaped. Intensive oviposition was observed on ash leaves and branches inside the bag. Insects irradiated with 4000 R behaved similarly but their flight was less active. Butterflies from pupae irradiated with 5500 R showed degeneration, short wings and a thin, deformed body. They all died within 3 d, without any oviposition at all. Pupae obtained from irradiated parents were not checked for subsequent development.

- 1133 LaChance, L.E., North, D.T. GENETIC CONSIDERATION OF RADIORESISTANCE AND INHERITED STERILITY IN LEPIDOPTERAN SPECIES. *Bull. ent. Soc. Am.* 13, 3 (1967) 192. Abstr. 106, at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

The radioresistance of Lepidopteran species to the induction of sterility is related to chromosome structure. Dose-action curves for the induction of dominant lethal mutations, and the production of sterile offspring by irradiating parents with substerilizing doses is discussed in terms of its chromosomal basis and practical significance. (Abstr.)

- 1134 LaChance, L.E. THE INDUCTION OF DOMINANT LETHAL MUTATIONS IN INSECTS BY IONIZING RADIATION AND CHEMICALS - AS RELATED TO THE STERILE-MALE TECHNIQUE OF INSECT CONTROL. p. 617-650 of "Genetics of Insect Vectors of Disease". Wright, J.W., Pal, R., Eds. Amsterdam, Elsevier Publishing Company. 1967, 794p.

The author points out that amongst the causes of sterility involved in the sterile-male technique for insect control (infecundity and inability to mate in the females and aspermia and sperm inactivity in the males) must be included the production of dominant lethal mutations in the reproductive cells of both genes, and discusses the induction of these by x-rays and γ -radiation, the cytogenetic basis of dominant lethality, the detection of dominant lethal mutations induced in insects and the relation of these mutations to the sterile-male technique for insect control. (From RAE-B 56: 1968, ref. 563)

- 1135 LaChance, L.E. et al. RADIATION-INDUCED STERILIZATION. *Pest. Control Biol., Phys. Sel. Chem. Methods* (1967) 147-196.

Species table with dosage, and review of eradication and sterility components.

- 1136 Lambremont, E.N., Stein, C.I., Bennett, A.F. SYNTHESIS AND METABOLIC CONVERSION OF FATTY ACIDS BY THE LARVAL BOLL WEEVIL [*Anthonomus grandis*]. Comp. Biochem. Physiol. 16 (1965) 289-302.

Larval *A. grandis* synthesised long-chain fatty acids from labelled NaOAc in the larval diet. Larvae, pupae, and newly moulted unfed adults had an identical labelling pattern. Oleic acid possessed 60% of the incorporated radioactivity. The weevil also desaturated dietary palmitic acid and stearic acid to palmitoleic acid and oleic acid. Some dietary palmitic acid underwent chain elongation to stearic acid which was desaturated subsequently. Dietary oleic acid was not hydrogenated. The weevil was unable to form linoleic acid from acetate and could not convert closely related long-chain fatty acids into linoleic acid. The direct desaturation pathway may be in operation on all dietary long-chain fatty acids synthesised from acetate. (CA 64: 1966, 3997e)

- 1137 Lambremont, E.N., Bennett, A.F. LIPID BIOSYNTHESIS IN THE BOLL WEEVIL. FORMATION OF THE ACETATE PRECURSOR FOR LIPID SYNTHESIS FROM GLUCOSE AND RELATED CARBOHYDRATES. Can. J. Biochem. 44, 12 (1966) 1597-1606.

Glucose, sucrose, fructose, and their related glycolytic products, pyruvate and acetate, were readily converted into long-chain fatty acids by larval and adult boll weevils (*Anthonomus grandis* Boheman, Coleoptera: Curculionidae). The differentially labelled glucoses were glucose-1-¹⁴C, glucose-2-¹⁴C, glucose-3(4)-¹⁴C, and glucose-6-¹⁴C. Labelled glycolytic intermediates were acetate-1-¹⁴C, acetate-2-¹⁴C, pyruvate-1-¹⁴C, and pyruvate-3-¹⁴C. By comparison of the radiorespirometric formation of ¹⁴CO₂ of adults injected with differentially labelled glucose and pyruvate to the specific activity of lipid synthesised from these substrates, it was determined that glycolysis is the principal pathway by which acetate is produced. The patterns suggested that the boll weevil possesses the pentose phosphate pathway, which also accounts for a significant oxidation of glucose. Recombinations of labelled carbon atoms within and between intermediates of the pentose cycle allow synthesis of labelled fatty acid to take place with those carbons of glucose which could not ordinarily enter fat synthesis by glycolysis alone.

- 1138 Lambremont, E.N., Bumgarner, J.E., Bennett, A. F. LIPID BIOSYNTHESIS IN THE BOLL WEEVIL (*Anthonomus grandis*): DISTRIBUTION OF RADIOACTIVITY ON THE PRINCIPAL LIPID CLASSES SYNTHESIZED FROM ACETATE-1-¹⁴C. Comp. Biochem. Physiol. 19, 2 (1966) 417-429.

The boll weevil, *A. grandis*, synthesised fatty acids and hydrocarbons from acetate. The fatty acids were rapidly esterified with glycerol and sterol or were incorporated into the phospholipid fraction. Radioactivity was not incorporated into the sterol fraction, an indication of the absence of sterol biosynthesis from acetate. The feeding history and developmental state of the adult boll weevil determined the eventual location of the newly synthesised fatty acids. Newly emerged unfed adults incorporated the fatty acids principally into the phospholipids. In insects injected with radiolabelled acetate after several days of feeding, the new fatty acids were distributed to the glycerides. Larvae fed a diet containing acetate-1-¹⁴C had an entirely different labelling pattern with much higher amounts of ¹⁴C appearing in the free fatty acid fraction. (CA 65: 1966, 17429c)

- 1139 Lefevre, G., Jr. STERILITY, CHROMOSOME BREAKAGE, x-RAY-INDUCED MUTATION RATES AND DETECTED MUTATION FREQUENCIES IN *Drosophila melanogaster*. Genetics 55, 2 (1967) 263-276.

The frequency of sex-linked recessive lethal mutations was determined following irradiation with 4000 R of male germ cells at different stages of maturity. All F₁ females were inspected for the presence of visible changes at the *y*, *w*, *v*, and *f* loci, as well as for Notch and white-mottled mutations. Further, the occurrence of hyperploid males was noted. The fertility of both phenotypically normal and mutant F₁ females was compared, as was the frequency of mutants in the fertile and sterile classes of F₁ females. - The frequency of both visible mutants and recessive lethals is high following the irradiation of mature sperm in the male, somewhat lower when mature sperm are irradiated in the female, much lower when immature sperm are irradiated (of necessity, in the male), but high again following irradiation of early spermatids. Sterility is highest when mutation frequencies are highest, except in the case of mature sperm irradiated in the female. There, sterility is increased although mutation frequencies are lower. The frequencies of different categories of mutation do not all follow the same pattern. Chromosome mutants (hyperploid males and white-mottleds) are most sensitive, sex-linked lethals (a mixture of chromosomally normal and abnormal mutants) next, and male-viable *y*, *w*, *v*, and *f* mutants least sensitive to the effect of irradiating different germ cell stages and to

irradiating mature sperm in the male and in the female. Further, visible mutants, including Notches, are eight times more frequent among sterile than among fertile F_1 females. Results indicate that differential chromosome breakage or restitution of breaks, not differential gene mutability, is primarily responsible for the differences in lethal mutation frequency detected at successive intervals following irradiation. Further, chromosome mutants contribute to both inviability and sterility of F_1 females. Thus, variations in recessive lethal mutation frequencies do not necessarily reflect true differences in the mutability of different germ cell stages exposed to given doses of x-rays. Insofar as mutants with cytologically normal chromosomes are concerned, induced mutation rates are little, if any, different in all postmeiotic male germ cell stages. (Auth. summary)

- 1140 Lindsley, D.L., Toledo F., S.A., Musatti, C.C. THE CHROMOSOMAL BASIS OF THE STERILITY OF SONS OF IRRADIATED MALES IN *Drosophila melanogaster*. p. 141 of "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy. 26 Jun.-2 Jul. 1966, 263p". Abstr. 560.

Since the original experiments of Muller demonstrating the mutagenic effectiveness of x-rays it has been known that a fraction of the sons of irradiated males are sterile; it is further known that this sterility may be associated with either the X or the Y-chromosome, but the relative sensitivities of the various elements of the chromosomal complement have not been investigated. In the present experiments the fertility of $y w/y^+ Y$ sons of irradiated fathers of various constitution has been measured; the crosses were designed so that the $y w/y^+ Y$ sons inherited from their father either one set of autosomes only (X/Y; A*/A), an X-chromosome and one set of autosomes (X*/Y; A*/A), a Y chromosome and one set of autosomes (X/Y*; A*/A), or both an X and a Y and one set of autosomes (X*/Y*; A*/A). The parental males were treated with 0, 1, 2, 3, or 4 kR of ^{137}Cs γ - or x-rays. The X/Y; A*/A males showed no decrease in fertility with increasing paternal irradiation dose indicating that dominant autosomal sterilizing mutations do not contribute appreciably to the observed sterility of sons of irradiated males. X*/Y; A*/A males showed approximately 1.5% and X/Y*; A*/A males approximately 3.5% sterility, attributable to effects on the X* and the Y* chromosomes respectively. X*/Y*; A*/A males showed the same degree of induced sterility as X/Y*; A*/A males, indicating a lack of independence in the response of the X and the Y which is not yet understood. Testes of sterile males were sampled for phase contrast examination and found to fall into three general categories: a) pre-spermatogenic sterility in which the testes are virtually acellular and which is not dose dependent; b) spermatogenic sterility in which nonmotile sperm are produced and which is strongly dose dependent; and c) postspermatogenic sterility in which the seminal vesicles are distended with motile sperm that are not transmitted to females and which is not strongly dose dependent. (Abstr.)

- 1141 Mayer, M.S., Brazzel, J.R. LABORATORY STUDIES TO STERILIZE THE BOLL WEEVIL WITH RADIATION. *Ann. ent. Soc. Am.* 59, 2 (1966) 284-290.

γ -radiation of 7200 R or less delivered to 12- or 36-h-old eggs of the boll weevil, *Anthonomus grandis* Boheman, failed to sterilize, but did decrease the longevity of ensuing adults. Doses of 800-24250 R applied to 12- to 36-h-old pupae failed to sterilize the adults at any dose low enough to permit adult survival for at least 10 d with sufficient vitality to copulate. A dose of 8000 R delivered to 12- to 36-h-old adults reduced sperm fertility to about 18%; these adults lived for as long as 20 d and mated apparently normally for at least 10 d post-irradiation. Multiple mating experiments indicated that the last mating of the female was the effective one, but only if it was with a normal male; otherwise, there was a competitive effect between the irradiated and nonirradiated sperm. (Auth.)

- 1142 North, D.T. RADIATION-INDUCED MALE STERILITY EXHIBITED IN THE P_1 AND F_1 GENERATION IN LEPIDOPTERA. *Radiat. Res.* 31, 3 (1967) 615. Abstr. Eb-9, at "15 Annual Meeting of the Radiation Research Society. San Juan, Puerto Rico, 7-11 May 1967".

Adult cabbage looper (*Trichoplusia ni*) males demonstrate a high degree of radioresistance to the induction of sterility. The dose required to induce dominant lethal mutations in all of the sperm in the adult male is 35000 rad, a tenfold difference in contrast with Dipteran species. The radioresistance of the Lepidopteran species had been attributed by some workers to: (1) the chromosomes being either polycentric or having diffuse centromeres; and (2) a high chromosome number with extremely small chromosomes. F_1 progeny from a cross involving a normal female and a male administered a substerilizing dose of radiation are also partially sterile. This is a major deviation from known causes of radiation induced male sterility - namely, dominant lethal mutations. The cytogenetic implications of these data were discussed. (Abstr.)

- 1143 Oftedal, P. MUTATION YIELD IN A THEORETICAL CELL POPULATION OF HETEROGENEOUS SENSITIVITY TO MUTATION INDUCTION AND TO KILLING. 1) "3rd International Congress of Radiation Research. Cortina d'Ampezzo, Italy, 26 Jun.-2 Jul. 1966". 2) AED-Conf-226-77, Gmelin-Institut für Anorganische Chemie und Grenzgebiete, Frankfurt am Main (West Germany), 1966, 2p.

If there is a relationship - other than random - between radiosensitivities to killing and to mutation induction, killing of cells will influence the yield of mutations. This has been investigated in a theoretical test system, using three different sensitivity patterns for mutational response, and three patterns for the killing effect. The patterns used have in common that part of the population (or cell cycle) is sensitive, and part is resistant. The difference is about 40-fold in genetic response and about 6-fold in MLD. Within the sensitive fraction, there are differences in shape between the genetic patterns used, and in MLD and extrapolation number between the killing patterns. Mutation yields have been calculated for different sensitivity pattern combinations, for different distributions of sensitive and resistant phases, and for different degrees of coincidence in the cell cycle of the two types of sensitivity. With positive coincidence of sensitivities, a humped dose-effect curve for mutations is always found. The initial low-dose slope is equal to the built-in mean genetic sensitivity, changing with high dose to the lower slope characteristic of the resistant phase sensitivity. The hump is higher with higher extrapolation number, and is shifted to the right when the sensitive phases are more extensive. When coincidence between sensitivities is altered from complete positive to complete negative, the dose-effect curve changes from the humped type, through a more or less linear form, to a form with a "negative" hump, where the curve appears exponential in the built-in mean genetic sensitivity*.

* The above was discussed in relation to non-linear dose effect curves found in experimental work.

- 1144 Osborn, A.W., Shipp, E., Hutchinson, P.B. BIOLOGY AND RADIATION STERILIZATION OF SUGAR CANE LEAFHOPPERS. *Atom. Energy Aust.* 9, 4 (1966) 11-19.

An important disease of sugar cane in the Pacific areas is Fiji disease which is caused by a virus transmitted by leafhoppers, *Perkinsiella* spp. The possibility of eradicating leafhoppers by repeated releases of sterile insects was investigated. Several varieties of sugar cane were tested for suitability for mass-rearing experiments. Studies were conducted on the effects of nitrogenous fertilizer on fecundity of leafhoppers and on the most suitable temperature for mass-rearing of *Perkinsiella saccharicida*. Nymphal instars were irradiated with ^{60}Co to obtain sterility while maintaining mating competitiveness. Natural population fluctuations were studied in Australia and in Fiji. The most important factors influencing populations were rainfall, temperature, nitrogen content of sugar cane leaves, and egg predator, *Cyrtorhinus mundulus*. Results at present indicate that a successful sterile insect release programme can be carried out economically on sugar cane leafhoppers. (NSA 21: 1967, 20463)

- 1145 Petrushova, N. I. SEXUAL STERILIZATION IN THE FIGHT AGAINST CODLING MOTH IN APPLE. *Zashch. Rast.* No. 10 (1967) 26-27. (In Russian)

A ^{60}Co source was used to sterilise *Carpocapsa pomonella* (male nymph) using a 25-31 kR dose of γ -rays at 1080 R/min. This resulted in 96-100% sterile eggs; oviposition, longevity, and mating frequency were not affected by such irradiation doses.

- 1146 Popa, A., Mihalache, G. ON THE RADIOACTIVE ISOTOPE UTILIZATION FOR FOREST PROTECTION. *Rev. Pădur.* 80 (1965) 59-62. (In Rumanian)

Some researches have been carried out on the *Lymantria dispar* fly control by irradiating their pupae with ^{60}Co sources. The analysis of the results shows that ionized radiations emitted by ^{60}Co cause the *L. dispar* pupae sterilisation, the most convenient radiation dose being 5000 R. During the tests performed in the laboratory and followed by larger experiences in different variants, it was found that the fecundity was reduced up to 50% as against the control subjects in the variants where irradiated pupae have been introduced. The wider actions that were performed, destroyed nearly entirely some dangerous pests on rather large areas. (Auth.)